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SUPPLEMENT TO "THE ELECTRICIAN," OCTOBER 26 1906.

REMOTE STORAGE

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

VOLUME LVII.

(Second Series.)

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THE ELECTRICIAN:

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NOTES.

A FIRE which took place on St. Andrew's-hill on April 3rd was reported by the Fire Brigade to be due to a defective electric circuit, but the investigation before the City coroner, reported in this issue, shows that the ground for this belief was but slight, and a subsequent personal examination of the premises has convinced us that the fire could not have originated in the electric circuits. There can be little doubt that a light or cigarette end was thrown among some rubbish and oily waste in a corner behind the motor, at a spot now represented by a charred hole in the floor, and it was evident that the greatest heat had occurred immediately above this spot and not around the cables. A statement made at the inquest showed that in that part of the premises smoking was indulged in against rules. The only electricity supply in the building was to an 8 H.P. motor, but neither this machine nor its starting switch were damaged and the starting resistance was also evidently not the cause of the outbreak. Moreover, the fire took place shortly after the premises had been closed for the night. Service lines were led in in the ordinary way, and both company's and consumer's fuses were inserted; there was the usual double-pole main switch in addition to the starting switch, but no main switch at the point of entry. This would seem to be unnecessary, however, as the distance from the fuses to the motor switch was only some 15 ft. or 20 ft., and the cable was enclosed in iron barrel. Although this iron tubing was not carried right up to the switch, and there was a gap of an inch or two between the top of the pipe and the base of the switch, the edge of the pipe was not sharp, and moreover the copper conductors showed no signs of fusion either at this point or elsewhere, so that there could not have been a short circuit. We are glad that, although there was no loss of life, the City coroner decided to hold an inquest into the cause of the fire, and thus afforded an opportunity for an investigation which has afforded conclusive proof that the fire was not electrically caused. We should add that Messrs. Johnston Bros., on whose premises the fire took place, showed commendable readiness to allow the fullest examination into the cause of the outbreak.

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WITH characteristic enterprise the North-Eastern Railway Co., assisted by the Newcastle-upon-Tyne Electric Supply Co., have organised a new department to place before manufacturers the advantages possessed by the North-Eastern district of England for the establishment of industrial works. Although, of course, the movement is primarily intended to benefit the two companies named, it is one from which the electrical industry generally should derive considerable advantage, as is pointed out in the article which we publish elsewhere in this issue. The scheme has our cordial support, and we would impress on other railway and electric power companies the desirability of joint activity in a similar direction. In addition to the increased use of electric power for works-driving, which is furthered by such "industrial redistribution," any step that tends to diminish the cost of production should be welcomed by the whole electrical engineering community; in fact, it is a matter of national importance that our industries should profit by any means that will place the country in a better position in their competition with those of foreign nations.

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A VALUABLE addition to the recent discussion on the economic aspect of employment of storage batteries which

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centred around the Paper lately read by Mr. J. R. Salter on the subject, is to be found in our Correspondence columns. The Paper itself was given in abstract in our issue of April 6th with a short report of the discussion. Figures are brought forward by our correspondent to show that the results quoted by Mr. Salter in his Paper can hardly be said to represent up-to-date economical practice. Not only was the capital cost of the battery higher than that for which a reliable battery of the size used could be obtained at the present time, but Mr. Jacob suggests that greater economy could have been obtained if the battery had been of smaller size. While no one will doubt the accuracy of Mr. Salter's figures, every care should be taken to ascertain whether the cases which happened to come before his notice are truly typical examples before conclusions of a sweeping nature can be fairly drawn from them.

The opening of the Stoke Newington electricity supply undertaking is in itself no greater event than the starting up of one of the two 150 kw. machines which will suffice for the present to supply the needs of this district. Nevertheless, the event is one that should not be passed by without comment, for this is the first occasion in which a Metropolitan Borough Council, with its own Mayor and Aldermen, has been content to buy its electricity "in bulk," instead of erecting its own little uneconomical generating station. The sub-station has the additional interest of being the first in London to be equipped with the new La Cour motor-converters. A description appears elsewhere in this issue.

The Oerlikon Company had barely reduced the Ward-Leonard system of single-phase traction to a reliable engineering job by the lavish expenditure of time and money when the single-phase commutator motor was rescued from its scrap-heap, and pointed to a simpler way of solving the problem. Undaunted, the Oerlikon Company accepted the new order of things, abandoned the cumbersome Ward-Leonard system, and embarked on experiments on a practical scale with a new locomotive. An account of some of the principal details of the new equipment and a few results of recent trials on the Seebach-Wettingen line are given on page 8 of this issue. One of the chief features is the high line voltage employed—viz., 15,000 volts. This is 1,000 volts more than the highest voltage used in the Berlin high-speed trials a couple of years ago, and is, indeed, the highest line voltage so far employed, with the possible exception of the single-phase traction tests in Sweden, where 20,000 volts have been, or are to be, experimented with. Although the frequency had to be reduced to 15 ∾ per second, on account of neighbouring telegraph and telephone wires, the electric lighting—for which low-voltage lamps, consuming a relatively heavy current, are used—appears to be quite satisfactory. The overhead equipment and the current-collecting gear on the car are of the peculiar type first proposed by the Oerlikon Company about two years ago. Many advantages are claimed for this system; the chief one relates to the possibility of removing the trolley wire from the centre to the side of the track on the larger part of the line, but the design, it is said, also tends to greater reliability and ease of inspection. A difference from the usual single-phase motor practice is found in the motor adopted, the armature of which is of the Gramme ring type. The only advantage of this type that occurs to us is the facility of replacing a burnt-out armature coil, but the firm has no doubt a better reason for adopting this design.

A resolution was passed by the Brighton Corporation at their last meeting before Easter to the effect that "the Municipal Electrical Association should be requested to consider the advisability of requesting the President of the Board of Trade to introduce a Bill into Parliament authorising all Municipal Corporations carrying on electrical undertakings to wire consumers' premises." It is true that there is a long way between the undertaking of municipal house-wiring and requesting the Association to consider the advisability of requesting Mr. Lloyd-George to ask Parliament to authorise it; yet the Brighton Corporation were not well-advised in taking this step, and we trust that the Municipal Electrical Association will not give effect to their wishes.

The Brighton Corporation itself has, we believe, no intention of actually doing the work of house-wiring; although it has been flirting with the "free-wiring" idea for some time past, it proposes to let the work to contractors. It is surprising, therefore, that it should take the initiative in endeavouring to obtain Government sanction for municipal trading in direct competition with the enterprise of private firms. Those who have had actual experience in free wiring know that the advantages of this seductive business have been much over-estimated in the past, and a Local Authority with the full sanction to do house-wiring work would in all probability soon reorganise its free-wiring department into one doing ordinary wiring. In a few cases Local Authorities have these powers, and in still fewer cases they exercise them. Before sanction is obtained for doing this class of work, however, it should be necessary for the Local Authority to prove that local conditions warrant it. This is done now, as a special Bill has to be introduced or a clause in an omnibus Bill (although we do not approve of the latter course), and the objects of the Bill have to be properly advertised, so that the local contractors have thus an opportunity of opposing it. At Brighton, the Brighton, Hove & District Ironmongers' Association is taking active steps to induce the Corporation to withdraw the application to the Municipal Electrical Association, and we wish every success to these endeavours.

A very suggestive design for single-phase generators and motors is disclosed in the English patent specification, No. 8,569 of 1905, granted to the British Thomson-Houston Co. An abstract of this patent is published elsewhere in this issue. Briefly, the new machine—which is of the homopolar type—acts as follows: The stationary field flux is forced in an axial direction through the armature, which is built up in commutator fashion. The segments, however, are of magnetic material and not of copper, since they form part of the field circuit. E.M.F.s are generated in these segments as they rotate through the alternating field flux, and the E.M.F.s may be added by connecting the armature segments (which are insulated from one another) in series. Since the frequency of the current obtained from such a machine depends only on the frequency of the exciting field and not at all on the speed, it follows that currents of very low frequency may be obtained from high-speed sets, which is an advantage for single-phase traction work. Frequencies even as low as 15 ∾ per second have been employed on single-phase traction systems—such a low frequency is used on the Seebach-Wettingen single-phase railway, for instance—and a two-polar generating set of the usual design for this frequency would have to run at 900 revs. per min., which is rather a low speed for steam-turbine drive. As a motor, the new design promises similar advantages. It should possess a large starting torque, and theoretically it would seem that it should be possible to make a sparkless motor whose speed and output would be independent of frequency. As to the power factor and efficiency of such a motor, we should not like to venture a definite opinion, but it would seem likely that the large number of brushes required and the iron armature segments would affect the quantities adversely.

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Death of Prof. Curie.—Just as we go to press, the sad news comes in of the death of Prof. Curie in Paris. According to a Reuter telegram, he slipped in the roadway and fell beneath a heavy lorry. He was badly crushed and was conveyed to a police station, when it was found that life was extinct. An obituary notice will appear in our next issue.

Annual Meeting of the Verband Deutscher Elektrotechniker.—The 14th annual meeting of the above association is to take place at Stuttgart from May 24th to 27th. As usual, pleasure is to be combined with business, and a number of excursions are contemplated, including a visit to the exhibition at Nuremburg.

Personal.—His Majesty the King has been pleased to appoint Mr. George Raymond, the local superintendent of the Eastern Telegraph Co. at Corfu, a member of the Victorian Order (Fourth Class). The honour has been bestowed as a recognition of Mr. Raymond's services in connection with His Majesty's recent visit to Corfu.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Jamaica—Colon	Jan. 10, 1905	—
Cadiz—Teneriffe	July 20, 1905	—
Tangier—Cadiz	Feb. 17, 1906	—
Santa Lucia—St. Vincent	Feb. 19, 1906	April 13, 1906
Porto Rico—St. Croix	Feb. 26, 1906	April 13, 1906
Trinidad—Demerara	April 10, 1906	—

The Manchester Section of the Institution of Electrical Engineers.—At the annual meeting of the Manchester Section of the Institution of Electrical Engineers, the following officers and members of the committee were elected :—

Chairman, Mr. T. L. Miller. *Vice-Chairman*, Mr. M. B. Field. *Hon. Sec. and Treasurer*, Mr. H. W. Wilson. *Other Members of the Committee*, Dr. F. H. Bowman, Mr. A. A. Day, Mr. J. Frith, Dr. E. Hopkinson, Mr. A. B. Holmes, Mr. M. B. Mountain, Mr. P. A. Ramage, Dr. W. G. Rhodes, Dr. Schuster, Mr. Miles Walker, Mr. S. J. Watson, and Mr. A. P. Wood.

The American Institute of Electrical Engineers.—At a recent meeting of the Council of the American Institute of Electrical Engineers it was announced that, as the result of a preliminary ballot, Mr. E. W. Rice, jun., was nominated as president by 551 votes, Dr. Samuel Sheldon receiving 408 votes. A second ballot will be held. The following nominations were made for other members of the Council :—

Vice-presidents, Mr. A. H. Armstrong, Mr. H. H. Humphrey and Mr. F. G. Baum. *Managers*, Mr. Paul Spencer, Mr. P. M. Lincoln Mr. J. J. Carty and Mr. A. M. Schoen. *Treasurer*, Mr. George A. Hamilton. *Secretary*, Mr. R. W. Pope.

The Eruption of Vesuvius.—It is stated in the *Daily Chronicle* that Prof. Matteucci, the director of the observatory on Vesuvius, intends to offer vigorous opposition to the reconstruction of Cook's electric railway up the mountain, as its proximity has interfered with his scientific observations to such an extent that it has often been impossible to discern whether the oscillations recorded by his instruments were due to the influence of the railway or to volcanic movements. We understand that the damage done to the railway is not so great as was first reported.

Engineering Standards Committee.—The Secretary of State for India in Council has nominated Mr. A. Brereton, C.S.I., to represent the India Office on the Sectional Committee on Locomotives (chairman, Sir Douglas Fox), in the place of Sir Frederick R. Upcott, chairman of the Indian Railway Board. The Council of the Institution of Naval Architects have nominated Mr. Sidney W. Barnaby, of Messrs. John I. Thornycroft & Co. to represent that Institution on the Sectional Committee on Screw Threads and Limit Gauges (chairman, Mr. H. F. Donaldson, Chief Superintendent of the Ordnance Factories) in the place of Mr. McFarlane Gray resigned.

Electrification of the London, Brighton & South Coast Railway.—It is announced that a contract has been entered into by the London Electric Supply Corporation for the supply of power to the London, Brighton & South Coast Railway for working the trains on their South London line between London Bridge and Victoria for a period of seven years. This contract was referred to in the report of the proceedings at the annual meeting as well as the new contract entered into with the London County Council for a period of three years, for the supply of power to the Council's tramways, to commence at the expiration of the existing agreement.

Single-phase Traction in Sweden.—We learn that the Maschinenfabrik Oerlikon has been approached by the Swedish authorities in connection with the single-phase traction trials now taking place in Sweden and that the Board of Directors of the Swedish Railways propose immediately to start trials with the Oerlikon system. For this purpose a stretch of 3 km. (about 2 miles) between the Central railway station of Stockholm and Tomteboda has been fixed upon for these experiments, and is being equipped with an Oerlikon overhead contact line. At the same time one of the electric motor cars and one of the locomotives is being equipped with the Oerlikon current collectors. A description of the Oerlikon system of single-phase traction appears elsewhere in this issue.

America–China Cable.—The last link of the Commercial Pacific Cable Co.'s cable between the United States and China has been completed, and was opened on Tuesday. The section was between Manila and Shanghai, the construction of which was delayed by the Russo-Japanese war. Since the conclusion of the peace negotiations, however, the work has been rapidly pushed forward and congratulatory messages between the Empress-Dowager and the Emperor of China and the President of the United States have been exchanged. A Reuter telegram from Washington, on Wednesday, states that the United States is now in communication with its possessions in the Pacific Ocean and with China by means of the cables of an American company worked by American operators. Nearly 10,000 miles of cables have been laid at an average depth of 2,640 fathoms, the greatest depth encountered being nearly four miles.

Honorary Degrees.—The University of Edinburgh last week conferred the honorary degree of LL.D. on Dr. Alexander Graham Bell, the inventor of the speaking telephone. Dr. Bell is a native of Edinburgh, but on account of his health left the country in 1870 and took up his residence at Brantford, Ontario, where his telephone was invented. It is 26 years since Dr. Bell last visited his native land. A Reuter telegram from Philadelphia states that in celebration of the bi-centenary of the birth of Benjamin Franklin, Mr. Andrew Carnegie on Tuesday, as Lord Rector of St. Andrews University, conferred the degree of LL.D. on Miss Agnes Irwin, the Dean of Radcliffe College, and a descendant of Franklin. In a short speech Mr. Carnegie recalled the fact that in 1759 the same degree was conferred upon Benjamin Franklin, and that only four times had the LL.D. of St. Andrews been bestowed upon a woman.

"Vagaries" of Lightning.—At the monthly meeting of the Royal Meteorological Society, held on Wednesday last, Mr. Alfred Hands read a Paper on "Some so-called Vagaries of Lightning Reproduced Experimentally." He said that lightning should act in accordance with the laws that are known to govern electric discharges. There was doubtless much to learn yet as regards electricity, but even though fresh facts and laws might be discovered, they could scarcely be in direct opposition to those already known, and therefore if an occurrence did not appear to accord with our knowledge, we should try to fathom the mystery and not dismiss it as a vagary. The author, in the course of an extended investigation into the effects of lightning, had come across many cases that had been called vagaries, but which, on a close inspection, had proved to be extraordinary only in the erroneous way in which they were described. If they had been correctly reported, they would have appeared perfectly consistent with preconceived ideas; in fact, they could have been foretold in every case if the conditions that led to those effects had been known before the events occurred. The author reproduced experimentally several so-called vagaries of lightning, showing by means of rough models the conditions under which they occurred.

Cable Gear for the United States c.s. "Burnside."—In addition to the cable gear for the Japanese Government, which was described fully in *The Electrician* of March 23rd, p. 916, Messrs. Johnson & Phillips have just completed a combined paying-out and picking-up machine for the new cable-ship "Burnside," belonging to the United States Government. We had the opportunity last week of seeing the gear under steam at the firm's works at Charlton. The machine is driven by two independent high-pressure engines, which may be employed singly or in pairs to drive either or both of the drums. Slight changes in detail from the Japanese gear have been necessitated by the differences in the arrangement of the two ships, the controlling gear, for example, being mounted in the case of the American ship on a separate flying bridge instead of being on a regular spar deck. In other respects, the gear is practically a duplicate of the equipment which we have already illustrated. The drums are 5 ft. 8½ in. diameter and the maximum pull obtainable is 25 tons at 1 knot per hour. The different gears give speed ranges up to 4 knots per hour, at which speed a pull of about 6¼ tons can be exerted. The holding-back and hauling-off gears are mounted on the bridge behind the main drums, and, as in the case of the Japanese gear, are provided with automatic free-wheel arrangement so that the machine can be reversed to pay out after picking up without putting clutches in and out of gear.

Wireless Telegraph Notes—A Reuter telegram announces that a contract has been signed by Mr. Oppé, manager of the Canadian Marconi Company, with the Dominion Government, whereby the company agrees to take over and operate the wireless telegraph stations along the Labrador coast and to build and operate such others as the Government may desire. Provided the sealing steamers equip themselves with the necessary apparatus, the company will also build a station on the north-east coast of Newfoundland, receiving specific tolls on messages forwarded to or from the vessels. The company also agrees to deliver to the Government telegraph lines all commercial messages received at the Marconi station at Cape Race and other headlands from passing vessels. The Government, on its side, agrees to have all telegraphic business to and from Canada transmitted by the company's stations whenever the Government cable is interrupted. The contract remains in force for 10 years, during which period the Government agrees not to grant licences for the installation of any other system of wireless telegraphy for experimental or other purposes, and to admit Marconi equipment free of duty. According to the *Scotsman*, there are many places both in Labrador and in Newfoundland itself at present suffering from lack of adequate facilities for communication which should benefit greatly by the projected new stations. St. Antony, for example, one of the stations of the Royal National Mission to Deep Sea Fishermen, is only in communication with the outside world by a steamer which calls every fortnight from June to Christmas. Out of the five stations already established by the Government only a portion were in working order last summer, and Battle Harbour was not in touch with either the Canadian or Newfoundland telegraph systems. Sir William MacGregor, the Governor of Newfoundland, has taken great interest in the improvement of methods of communication, which, in view of the magnitude of the fishing industry in the neighbourhood, is of considerable importance.

Permission has been accorded by the Norwegian Ministry of Public Works to the Wellman North Pole expedition to establish wireless telegraphic communication from Hammerfest and Spitzbergen to the balloon of the expedition.

Electric Winding.—In view of the interest which has recently been shown in regard to electric winding, the following data of electric winders, erected, or to be erected, by the Siemens-Schuckert-Werke, deserve attention. In order to level the demand on the power house, the well-known Ilgner system has been employed in practically all cases. The winding plant at Zollern II. was put in operation in September, 1903, and serves to raise a maximum of 2,000 tons in eight hours from a depth of 306 yds. at a speed of 33 ft. per second. Later on, the depth is to extend to 545 yds. below the surface, and the speed will then be increased to 66 ft. per second. A Koepe pulley of a diameter of 19½ ft. is used and the rope is 1·77 in. in diameter. In October of the same year, the winding plant at the König Wilhelm II. pit was taken into service. It is designed to raise 600 tons in eight hours from a depth of 206 yds., the maximum speed being 23 ft. per second. The drums which are used in this case have a diameter of nearly 10 ft., and the rope is 1·2 in. thick. A year later, the firm completed a plant at Hermsdorf. Its capacity in eight hours is 100 tons, and the depth, which is at present 218 yds., is to reach ultimately to 380 yds. Drums are used in this case also (13 ft. in diameter), and the maximum speed does not exceed 16½ ft. per sec. The next plant was erected in January, 1905, and since then about one dozen installations have been put into service, while an even larger number are to be completed by the end of the present year. Not one of the newer plants approaches in capacity the Zollern II. plant, however, but the depth is in some cases larger. At the Heinrich pit at Pelkum, for instance, the depth is already 820 yds. and is to be increased later on to 1,000 yds. In eight hours some 1,400 tons can be raised, the useful load per wind being 5·2 tons. A speed of 59 ft. per second is employed. The smallest depth of all, which is found at the "Stadt Görlitz" pit, is 110 yds. and the speed is correspondingly low—viz., 19½ ft. per second. The honours are fairly evenly divided between the Koepe pulley and the drum. Messrs. Siemens Bros., of London, are now erecting at the Duffryn Rhondda Colliery an electric winding plant for a depth of 520 yds. (ultimately to be increased to 666 yds.). The useful load per wind will be 4 tons and the maximum speed 50 ft. per second. A Koepe pulley, 18 ft. diameter, will be used and a rope 1·85 in. diameter. In another plant for the Priestman Collieries (Ltd.), Newcastle-on-Tyne, the depth is about 83 yds. and the speed is not to exceed 8 ft. per second. Drums are to be employed in this case. Messrs. Siemens Bros. have also in hand smaller electric winders for the San Antonio pit at Huelva in Spain, for the United Alkali Co. (Ltd.), of Widnes. The greatest depth to be reached is in a pit in Austria, the ultimate depth of which will be 1,150 yds., but the speed of winding is not to exceed 45 ft. per second. A drum of 16½ ft. diameter was chosen, and the rope is to consist of three parts of 40 mm., 37·5 mm. and 35 mm. (1·58 in., 1·48 in. and 1·38 in.) respectively.

A New Electric Omnibus.—A large party of Press representatives and others had an opportunity on Wednesday of inspecting a new electrically-propelled omnibus which the London Electrobus Co. contemplate putting on the London streets in considerable numbers. The vehicle does not present any special new feature from an electrical point of view, and interest in the venture naturally centres round questions of cost of maintenance of the batteries under working conditions. Schemes for accumulator traction which have appeared feasible on paper have not in the past always fulfilled expectations in practice, and we shall watch with interest the progress of the undertaking. A short ride in the omnibus itself demonstrated the great advantages which a well-constructed electric vehicle undoubtedly has over the average petrol 'bus as regards comfort. The starting was silent and smooth and the running quiet and entirely without vibration. The control was easy in crowded traffic, and of course the annoyances of smoke and smell were absent. We were unable to judge of the behaviour of the vehicle on greasy roads, a point of some interest considering the great weight of the car. A single motor with two commutators is employed, situated in front of the car under the footboard, and this drives through a wide saw-tooth chain on to a "propeller shaft" which drives the live back axle by a bevel gear working on the outside of the differential in the way usual on smaller cars. The whole underframe is substantial and the springing is most satisfactory, but it is difficult as yet to express an opinion on the design of the back axle, as live back axles have frequently proved points of weakness when used with solid tyres and heavy loads. The weight of the whole vehicle fully loaded is 7½ tons, of which 2 tons 10 cwt. falls on the front axle and 5 tons on the back axle, and the weight of the car without load or battery is 3 tons 4 cwt. The control is effected by putting the two commutators in series and parallel with or without resistance in the usual way, but the controller is not provided with braking positions. The battery is contained in two cases hung under the centre of the car, so that complete fresh batteries can be quickly attached at depots by means of a suitable platform on wheels; 44 cells are used connected permanently in series and the battery has a capacity of 300 ampere-hours on a three-hour rate. The starting current is about 45 amperes on the level, and the running current varies from 40 to 120 amperes. One charge is sufficient for 30 to 40 miles, and each 'bus is to be provided with four batteries to enable it to cover 120 miles per day. In view of the recent discussions on the cost of running motor 'buses and trams the following estimated costs per day of 120 miles for a 34 seated 'bus will be of interest:—

Two drivers	£0	13	0
Two conductors	0	10	0
Tyre maintenance at 1¾d. per mile	0	17	6
Accumulator maintenance and current for charging at 3d. per mile	1	10	0
Garage expenses	0	5	0
Insurance (including third-party risks)	0	4	0
Depreciation	0	5	0
General expenses	0	4	6
Total per 120 miles	£4	9	0

This is equivalent to 8·9d. per car-mile. The figure of 3d. per car-mile for charging and upkeep of batteries is remarkably low, but as we have been given to understand that more than one firm of battery manufacturers have expressed their willingness to enter into a year's contract on the basis of 2d. per mile for upkeep and charging of batteries, we can only repeat them as given to us.

Ozonising Apparatus for the Purification of Water.—The firm of Siemens & Halske has been prominent for many years in the design of ozonising apparatus for the sterilisation and purification of water, and we have recorded the improvements introduced in this connection by the firm from time to time. In *The Electrician*, Vol. L., p. 272, for instance, there appeared a description of two installations of considerable size built for the water authorities of the towns of Schierstein and Paderborn respectively. This was 3½ years ago. We learn that the latter installation has been working day and night since its erection, and that typhoid fever, which used to break out nearly every year, has now wholly disappeared. Messrs. Siemens & Halske now inform us that for laboratory purposes a small portable plant has been designed, for which current can be taken from a wall-plug on any supply network. A glass cylinder (about 5 ft. 3 in. high) is filled with small balls of glass, clay or porcelain, over which the water to be purified trickles. In this cylinder the water comes into intimate contact with a counter current of ozonised air, the quantity of which is measured by means of a differential pressure gauge and a throttle inserted in the pipe through which the ozonised air passes. The ozone-producing apparatus itself is supplied with current from a small transformer, and a ¼ H.P. or ½ H.P. motor-generator or motor-driven commutator which also drives the fan which forces the air into the apparatus, is made use of for converting the continuous current to alternating current. On top of the box, which contains the ozonising apparatus, there is a glass receptacle in which the air is first dried by sulphuric acid or calcium chloride. Such small installations are capable of dealing with from 17½ cubic ft. to 35 cubic ft. of dry air per hour, and produce from 5 to 6 grammes (0·176 oz. to 0·212 oz.) of concentrated ozone in this time. By using pure oxygen instead of dry air, the production of ozone is stated to be from two to three times that mentioned above. Larger plants for purifying from 600 to 2,200 gallons of water per hour are arranged in principle on the same lines as the laboratory set, but contrivances are fitted which automatically interrupt the flow of water if the voltage at the transformer sinks below a predetermined limit. The ozone-producing units consist each of an internal cylinder of aluminium connected to one pole of the high-tension supply and of an outer cylinder of glass, which is water-cooled and connected to the other terminal of the supply. In this respect they differ from the laboratory plant, in which both electrodes are water-cooled glass cylinders. The most interesting of the patterns is an equipment for military service, which is mounted on two carts. One cart contains a small petrol motor directly coupled to an alternator and continuous-current exciter; a small water pump which delivers the water to the sterilisation tower on the other cart; a small fan, and, finally, a number of reserve parts. The other cart contains two spring-suspended boxes with the ozone generators (one is a reserve), a transformer, a filter in which the water is freed from coarse impurities before further treatment, and, lastly, a sterilisation tower of sheet iron 8 ft. high. A number of such portable plants were used on the Russian side in the late Russo-Japanese war. Each cart weighs about 2,000 lb. and is intended to be drawn by one horse. The plant is capable of dealing with from 450 to 650 gallons of water per hour and requires about 2 H.P. to work. The following test figures relate to a Siemens ozone apparatus operating with alternating current and fed with dry air.

Cubic metres of dry air dealt with per hour	½	1	2	5	10	20	30
Ozone (in grammes) per cubic metre of dry air	6·5	5·2	4·2	3·3	2·3	1·4	1
Quantity of ozone generated (in grammes) per horse-power-hour	5	8	15	24	34	43	46

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, April 20th.**

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read: "Recent Developments in the Construction of Suction Producer Gas Plants," by W. A. Tookey.

SATURDAY, April 21st.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7:30 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham, when a Paper on "Submarine Cables" will be read by W. Smith.

MONDAY, April 23rd.

ENGINEERING AND SCIENTIFIC ASSOCIATION OF IRELAND.

7:45 p.m. Meeting at the Royal College of Science, Dublin. Paper to be read: "Alternating Currents," by W. Brew.

TUESDAY, April 24th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Annual General Meeting to receive the report of the Council and to elect the Council and auditors for the ensuing year.

WEDNESDAY, April 25th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

7:30 p.m. Meeting in the Electrical Engineering Laboratory of the Birmingham University New Building. Papers to be read: (1) "The Testing of Transformers and Transformer Materials," by D. K. Morris and G. A. Lister. (2) "A Simple Method of Measuring High Voltages," by E. A. Watson (student). The Papers will be illustrated by demonstrations, and the laboratory will afterwards be thrown open for inspection.

THURSDAY, April 26th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. for 7:45 p.m. Annual Dinner at the Hotel Cecil, Strand, London.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Paper to be read: "Long Flame Arc Lamps," by L. Andrews.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

8 p.m. Meeting at the Society of Arts, John-street, Adelphi. Paper to be read: "All Steel Cars," by G. H. Sheffield.

THE ESTIMATION OF THE REACTANCE VOLTAGE OF CONTINUOUS-CURRENT DYNAMOS.

BY H. M. HOBART.

In the following method of estimating the reactance voltage of a continuous-current dynamo it is not necessary to know anything further about the dynamo than can be obtained as the result of five minutes' examination, when, as is usual, the machine has only one turn per segment. In such a case one merely requires to count the number of poles and the number of segments. With these quantities, and with the gross core length, the revs. per min. and the rated kilowatts and voltage, the reactance voltage may be obtained by means of the slide rule in two minutes.

The curve in Fig. 1 gives values for K for varying ratios of λg to τ.

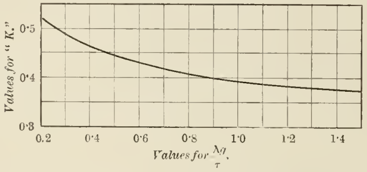
λg = gross core length in centimetres. τ = polar pitch at air-gap in centimetres.

(If D = air-gap diameter and P = number of poles, then $\tau = \frac{\pi D}{P}$.)

Having obtained K, the reactance per pole in ohms (Ω) may for machines with one turn per segment and multiple circuit single windings be obtained from the following formula :

$$\Omega = K \times \lambda g \times R \times F \times 10^{-8}$$

in which R = speed of armature in revs. per min. and F = total number of face conductors on armature.



When the dynamo is loaded with a current of I amperes, then the reactance voltage is equal to $\frac{I}{P} \times \Omega$.

When, as will generally be the case, it is not worth while bothering about greater exactness, we may substitute for K the mean value of 0·4, and our formula for the reactance per pole will then read : $\Omega = 0{\cdot}4 \times \lambda g \times R \times F \times 10^{-8}$.

Example 1.—In the case of a certain 250 kw. 550 volt dynamo, we have

$\lambda g = 31$ cm. R = 320 revs per min. F = 1,200. P = 6.

The machine has 600 commutator segments—*i.e.*, one turn per segment.

$$\Omega = \frac{0.4 \times 31 \times 320 \times 1{,}200}{100{,}000{,}000} = 0{\cdot}048.$$

At rated load of 250 kw. and 550 volts we have

$$I = \frac{250{,}000}{550} = 455 \text{ amperes.}$$

$$\text{Reactance voltage} = \frac{I}{P} \times \Omega = \frac{455}{6} \times 0{\cdot}048 = 3\ 6 \text{ volts.}$$

Example 2.—A 10 pole 550 kw. 550 volt 90 revs. per min. dynamo has a multiple circuit single winding with one turn per segment. There are 900 segments. Therefore, F = 1,800 R = 90, P = 10. At full load we have $I = \frac{550{,}000}{550} = 1{,}000$ amperes. We also have given $\lambda g = 52$ cm.

$$\Omega = 0{\cdot}4 \times 52 \times 90 \times 1{,}800 \times 10^{-8} = 0{\cdot}034 \text{ ohms.}$$

$$\text{Reactance voltage} = \frac{I}{P} \times \Omega = \frac{1{,}000}{10} \times 0{\cdot}034 = 3{\cdot}4 \text{ volts.}$$

Suppose that in this last case we wish to correct for the ratio of $\lambda g/\tau$ in accordance with the curve in Fig. 1. Then we must ascertain D, the air-gap diameter.

$$D = 244 \text{ cm.}$$

$$\tau = \frac{\pi \times D}{P} = \frac{3{\cdot}14 \times 244}{10} = 77 \text{ cm.}$$

$$\frac{\lambda g}{\tau} = \frac{52}{77} = 0\ 68,$$

and we see from the curve of Fig. 1 that the value of K ought to have been taken as 0·42 instead of 0·40. The difference is much too small to justify the trouble of correcting in any such rough approximations as those associated with the estimation of the reactance voltage. If a machine has two, three or four turns per segment instead of one, then the reactance voltage will be two, three or four times as great, as the case may be. As so great a percentage of dynamo calculations relate to designs with one turn per segment, it is not desirable to introduce this additional term in the formula. It is, moreover, easily kept in mind.

The advantage of calculating the reactance voltage, as above described, is that it brings out clearly the influence of the three main components—namely, λg—the gross length of the armature core, R—the speed of the armature in revs. per min., and F—the total number of face conductors. All other conditions remaining the same, a certain percentage change in any one of these components effects a corresponding percentage change in the reactance voltage for a given current per conductor.

There is practically nothing new in this method. Its merits relate merely to the simplicity of the formula and the saving in time which may be effected by its use. The method was, in fact, suggested to the writer as the result of reading Dr. Breslauer's recent article ("A Study in the Design of a 500 kw. Continuous-current Generator," *The Electrician*, March 9th, pp. 835-838, and March 23rd, pp. 918-920), and is only a very simple step in advance as regards simplification of the formula contained in Dr. Breslauer's article.

ELECTRIC LIGHTING AT STOKE NEWINGTON.

The Metropolitan Borough of Stoke Newington has been slow to go in for electric lighting, but at last electricity supply has been made available for the whole of the borough by the formal opening of the Council's sub-station on Wednesday night. In 1901 the Borough Council desired to have electric light in Stoke Newington High-street, which lies half in the borough of Hackney and half in Stoke Newington. Arrangements were therefore arrived at with the Hackney Borough Council, and in December, 1901, this street lighting was put into operation. As some of the shops and other houses desired to avail themselves of the supply, several private consumers were connected to the mains in High-street also, and were likewise supplied from the 2 × 240 volt network from Hackney. Inquiries and requests for supply thereupon came from other parts of the borough, but the Hackney Borough Council found that they would be unable to supply the whole of the area from their low-tension network, and that it would be necessary to erect a sub-station and to supply it with high-pressure from the Hackney works. On receipt of this information the Stoke Newington Council, advised by their consulting engineers, Messrs. Talbot & Stevenson, promoted a bill in Parliament in 1902 which enabled agreements to be entered into with any outside authority for a supply "in bulk."

It was then decided to invite tenders, and offers were received from the Hackney Borough Council, the Islington Borough Council and the North Metropolitan Electric Power Supply Co. A tender was also received from Messrs. F. Suter & Co. for a gas engine station. The tender of the North Metropolitan Electric Power Supply Co. for a supply in bulk upon the maximum demand system at 3½d. for the first hour and 1d. afterwards was provisionally accepted, but negotiations as to the definite form of the agreement took some time, and it appeared probable that the whole scheme would fall through. To prevent this, the Power Company offered to guarantee the whole of the undertaking for three years, paying interest and sinking fund charges and also a sum for depreciation to be fixed by the London County Council, which was to be refunded when the borough finally took over the works. The company undertook to bear all expenses of running and maintenance during this period and in return are to receive the revenue. This arrangement was finally concluded.

Tenders were then asked for by the Borough Council for the sub-station plant, which, as it is the Council's property, has been built throughout to the design of their consulting engineers. The lowest tender received for induction motor-generators amounted to £2,000 for two 150 kw. sets (each consisting of an induction motor driving two D.C. generators one for each side of the three-wire system) with a guaranteed overall efficiency of 78½ per cent. at full load and 76 per cent. at half load. Messrs. Bruce Peebles, however, sent in a tender for La Cour motor-converters, which exceeded the price of the cheapest motor-generator by only £100, and with guarantees of 85¾ per cent. efficiency at full load and 84½ per cent. at half load They also offered to be bound by a penalty clause, by which, if the efficiency of the machines only came out as low as that of an ordinary motor-generator, the cost of the machines would be far less, as a certain sum was to be deducted from the contract price for every 1 per cent. lower efficiency than the guarantee. The contract for the high-tension and low-tension switchboards was awarded to Messrs. Ferranti Limited, that for the cells to the Electrical Power Storage Co., and the low tension mains were supplied and laid by Messrs. W. T. Henley's Telegraph Works Co.

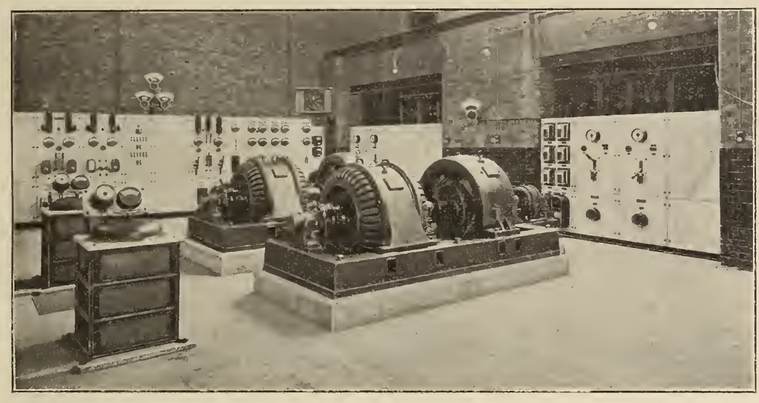


Fig. 1.—View of Sub-Station showing the Two Motor Converters and their Starting Boxes, and the H.-T. and L.-T. Switchboards.

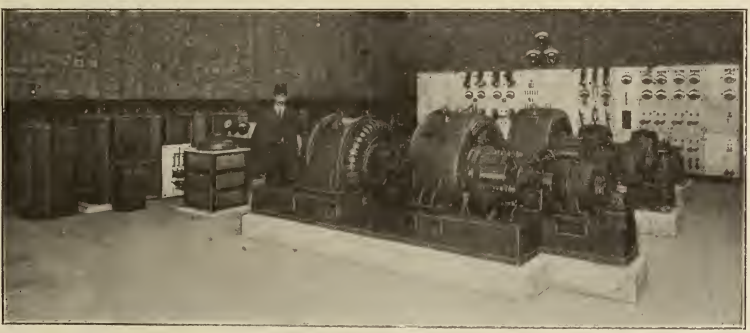


Fig. 2.—Another View of Sub-Station, showing Static Transformers, Motor Converters, Reversible Booster and L.-T. Switchboard.

The high-tension mains coming from the North Metropolitan Electric Power Co. are three core lead-covered cables made by the British Insulated & Helsby Cable Co. They enter the building in the basement, where they are supported on rounded hooks, and after being divided in tail boxes in the ordinary way, the conductors are led to the high-tension switches, which are enclosed in a space behind the switchboard together with the isolating links, instruments, transformers, &c. The two mains are in duplicate, each of 0·1 sq. in. section. In cutting the foundations for the sub-station, some trouble was experienced through water, as there are apparently some springs quite close. Everything, however, has been well concreted, and the basement and mains subways under the sub-station are continuously ventilated by means of a stove and fans.

The switches are hand-operated remote control oil switches, those on the feeders having reverse current relays, and those on the step-down transformers overload relays. The usual instruments are provided on the board, and there are three meters on each of the two phases of the feeder panel, so that the record of the energy delivered in bulk may be properly checked. From the switchboard the E.H.T. current is taken to six Ferranti transformers, three for each machine. These are of the oil-cooled type and were supplied through Messrs. Bruce Peebles & Co. as part of their contract. One spare transformer has been provided for the whole group.

The La Cour converters, being only 150 kw. machines, are naturally smaller than those described in our recent article on the Manchester extensions. It will be remembered from our previous description that the principle on which the converters act is that the motor part is an induction motor, and connection is taken from the rotor of this motor to several points on the continuous-current armature.

In these machines nine of these tappings are taken. At Manchester the size of the machines permitted direct supply to the motors at 10,000 volts, but in the case of these smaller machines it was deemed advisable to step down to

500 volts first by means of the static transformers already referred to. As is the case with a rotary converter, the La Cour motor-converter can be made to act as a balancer on the three-wire system in addition to performing its ordinary converting duties. The centre of the system is brought to the centre point of the rotor through a slip-ring. It was feared, however, that the amount of balancing that could be effected by the machine might not be sufficient, as one consumer, the local theatre, occasionally manages to require 100 amperes out of balance current, and, therefore, a small booster on the same shaft as the remainder of the machine is included in series with the middle wire, and this can deal with 125 amperes and supply 12 volts in either direction. The automatic knock-off for excess speeds provided in connection with the Manchester machines is not used on these smaller machines, and in view of the simplicity of the connections, and the proximity of the low-tension board to the machines themselves, there should be little danger of the machines racing and doing themselves damage owing to their field circuits being accidentally broken.

In addition to these two sets, a reversible booster is provided for charging and discharging the battery. This machine is hand regulated. The field is connected across the 'bus bars, and regulation is on the potentiometer principle. The booster consists of three machines, a motor in the centre running at 900 revs. per min. and a booster on each side. Each of the boosters is capable of raising or lowering the pressure 90 volts at 100 amperes, and of withstanding a maximum current of 240 amperes. The machines stand on 3 ft. foundations and the cement floor is to be covered with a thick cork carpet instead of tiles.

The battery room is on the same floor as the engine room, but there is a room of equal size immediately above it for extensions, if necessary. 244 cells have been provided with a capacity of 100 amperes for five hours.

The low tension board has five feeder panels, the necessary generator panels on the secondary side of the motor converters, and the battery and booster panel. The latter is provided with two switches which short-circuit the booster armatures to prevent the machine running away in the event of the circuit-breaker acting.

Fig. 1 is a view of the machine room, showing the two motor converters and the high-tension and low-tension switchboards on the right and left hand respectively. Fig. 2 is another view, including the static transformers. The relatively large starting boxes which are necessary for the motor converters are seen in both views of the main switch, and one of the machines is visible in Fig. 2 with its cover removed.

The network is supplied by four triple concentric feeders, each of 0·5 sq. in. section, and there is room for five feeders on the switchboard; the distributors are single cables, and all are laid on the solid system.

Our thanks are due to Mr. A. D. Stevenson, of Messrs. Talbot & Stevenson, for showing us over the sub-station and giving us the information necessary for the purposes of this article.

The system was formally inaugurated last Wednesday evening. Previous to the opening ceremony, the numerous guests assembled in the hall of the Stoke Newington Library (which is at the corner of Church-street and Edwards-lane and adjoins the electric sub-station) where Alderman W. H. Savery, the mayor, and Dr. Sidney White, the chairman of the Electricity Committee, sketched in well-chosen words the history, development and purpose of the undertaking which was about to be inaugurated. Mr. A. D. Stevenson, the consulting engineer, next outlined the technical features of the scheme and paid a warm tribute to the contractors, all of whom had carried out their allotted share exceedingly well. An interesting item which he mentioned related to the proportion of costs of the station and of the distributing system respectively. The equipment of the sub-station had cost some £4,000, while the expenditure on mains was above £10,000. The company then adjourned to the sub-station, where the Mayor first closed the H.T. switch, admitting three-phase current at 10,000 volts to the reducing transformers from the Brimsdown generating station of the supply company 7½ miles away, and then started the Bruce Peebles-La Cour motor-converters. After returning to the library hall, the Mayor switched the hundreds of electric lamps with which the hall had been artistically decorated on to the new supply. A number of congratulatory speeches followed, and two short lantern demonstrations were given, one by the Mayor himself on "The Meter," the other by Mr. Wilson on "The Electric Lamp." By the enterprise of the General Electric Co., an excellent exhibition of electric light fittings and appliances had been arranged in the library hall. This exhibition, which includes osmium, tantalum, Nernst and ordinary lamps, telephones, bells, cooking and heating apparatus, &c., will be open from 7 to 10 to-night and to-morrow night, and demonstrations will be given at intervals from 8 to 10 each evening.

SEEBACH-WETTINGEN SINGLE-PHASE RAILWAY.

As may be remembered by our readers, the Oerlikon Company have been conducting experiments on single-phase traction for some considerable time. At first the Ward-Leonard system was tried and developed, this system comprising a motor-generator set (single-phase motor, continuous-current generator) on the locomotive and continuous-current motors of the standard type for driving the axles. Since single-phase commutator motors have come into vogue, the company has turned its attention to these. Before proceeding to describe this development, we may say that the Ward-Leonard system has been developed to a thoroughly reliable system, and from January 16th to October 1st of last year a locomotive of this type has made 1,442 regular service journeys (out of a maximum of 1,532 runs, according to the time tables) between Seebach and Wettingen. The total ton-miles during the period indicated were 309,000.

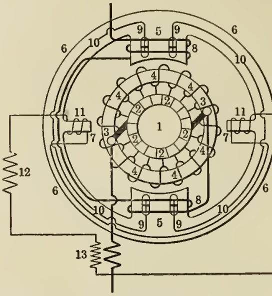


Fig. 1.—Diagrammatic Sketch of Oerlikon Single-phase Traction Motor.

According to Herr S. Herzog in *Elektrische Bahnen & Betriebe*, the new locomotive with single-phase commutator motors was put in service a few weeks ago, the old locomotive apparently being withdrawn at the same time. The overhead equipment of the Seebach-Wettingen line is essentially the same as that proposed a couple of years ago by the Oerlikon Company, and described in *The Electrician*, Vol. LIII., p 232. Single-phase current at 15,000 volts and 15 ∿ per second (a frequency of 50 ∿ per second was at first tried, but abandoned, as it led to disturbances in neighbouring telephone lines) is generated at the Oerlikon works, and fed into the trolley wire. The locomotive is fitted with two sets of collectors as shown in Fig. 3. Each set comprises two collecting rods, one for each side of the locomotive. The rods, which are suitably curved, are of steel tube having a slot on the convex side, and a curved brass rod, of 8-section, is fitted into this slot, being secured by a few small screws. This brass rod is the only part of the collecting gear which rubs against the overhead wire. On the straightaway portions of the track, the trolley wire is suspended at the side of the track by wooden poles,

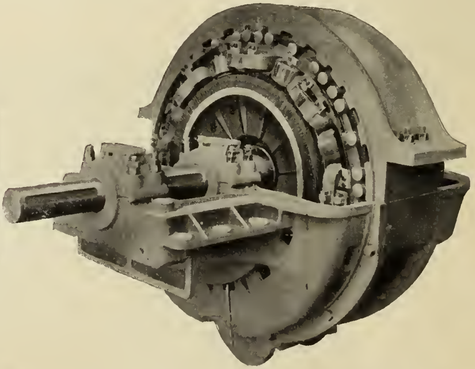


Fig. 2.—200 h.p. Single-phase Commutator Motor, Built by the Oerlikon Company for the Seebach-Wettingen Experimental Line.

and the current is collected by the rod pressing sideways against the trolley wire. In tunnels and at crossings and sidings, however, the trolley wire is suspended above the track and the collecting rod presses against the wire from below. The collecting rod is hinged to a triangular base plate which itself is supported by three substantial porcelain insulators from the parallel motion which is mounted on top of the roof. A strong spiral spring is used to press the collecting rod against the trolley wire, the rod moving in a plane at right angles to the locomotive axis. When not in use, the collecting rods are held away from the wire by a swivelling frame which can be worked either by hand or compressed air. Generally, the rods are let down on the trolley wire by hand, but are lifted off by compressed air. The locomotive is protected against lightning by a choking coil, a lightning arrester of the "horn" type and a liquid resistance. Compressed air is also used for shifting the collecting rod and base plate bodily towards the axis of the locomotive when approaching a tunnel. This is necessary to prevent the collecting gear from fouling the walls of the tunnel. All the air cylinders for operating the various devices are inside the locomotive under the roof. After passing through the collecting rods, the self-induction coil and the high-voltage switch (which is provided with a maximum cut-out) the current is fed to two air-cooled 200 kw. transformers in the centre of the locomotive. These transformers reduce the line voltage from 15,000 to 600 volts, and the secondary winding is divided into 20 sections The high-tension current returns by way of the rails. From the 20 tappings on the secondary of the transformers leads are taken to a suitable controller.

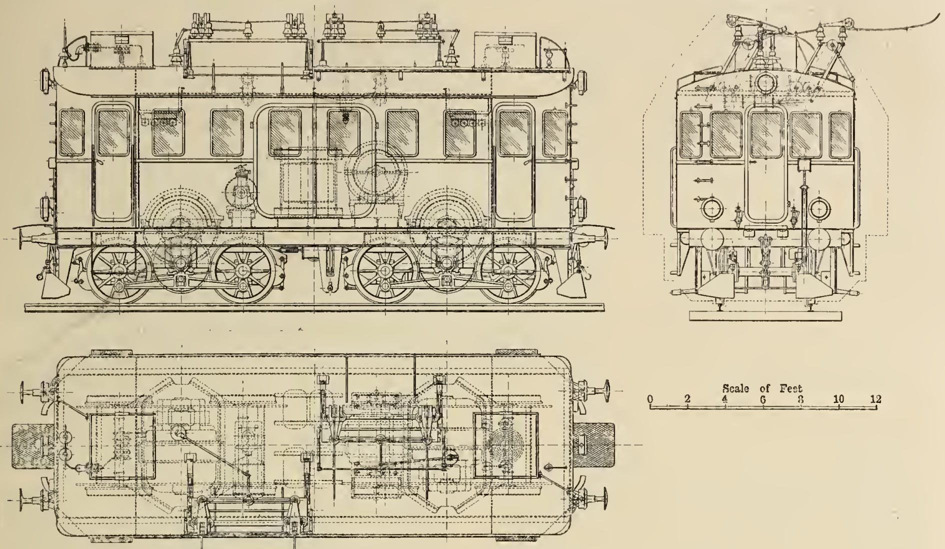


Fig. 3.—Single-phase Locomotive used on the Seebach-Wettingen Experimental Line.

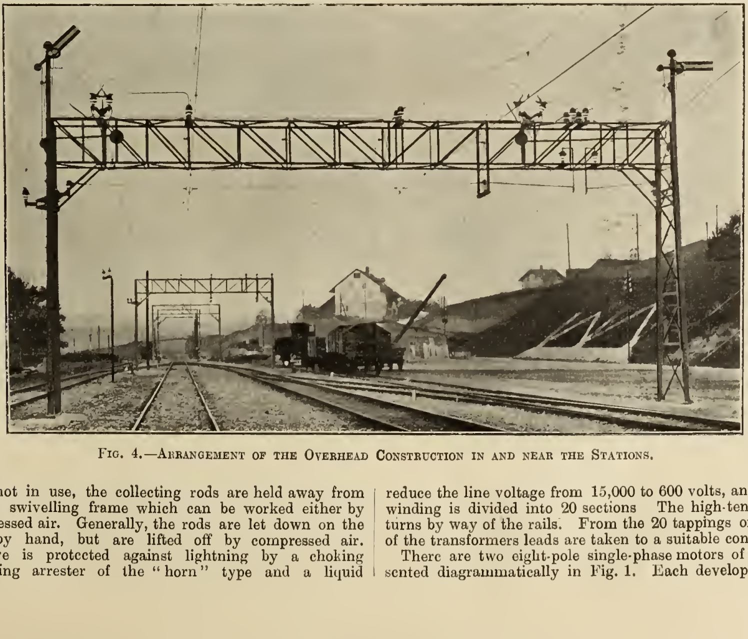


Fig. 4.—Arrangement of the Overhead Construction in and near the Stations.

There are two eight-pole single-phase motors of the type represented diagrammatically in Fig. 1. Each develops 200 H.P. when running at 650 revs. per min., and is fitted with auxiliary poles and a Gramme armature. The general construction of the motor is shown in Fig. 2, and Figs. 5 and 6 are characteristic curves. The gear ratio is 3·1:1. Compressed air for the collector gear, main switch, sanding arrangement and whistle is produced by a small compressor set, the motor being of the single-phase commutator type, capable of developing 6 H.P. when running at 500 revs. per min. Compressed air at from 95 lb. to 105 lb. per square inch is stored in tanks at either side of the locomotive, and the compressor set is automatically switched on and off according to requirements. Hand brakes are provided in addition to Westinghouse air brakes, and the lighting arrangements in the locomotive comprise six low-voltage incandescent lamps fed from suitable tappings of the main transformers.

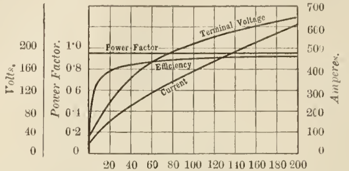


FIG. 5.—CHARACTERISTIC CURVES OF OERLIKON 200 H.P. SINGLE-PHASE TRACTION MOTOR.

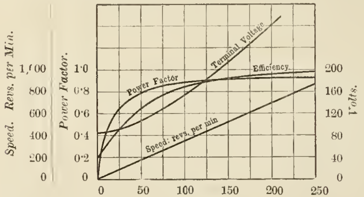


FIG. 6.—CHARACTERISTIC CURVES OF OERLIKON 200 H.P. SINGLE-PHASE MOTORS.

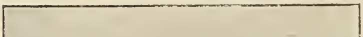


FIG. 7.—ARRANGEMENT OF "HORN" SWITCHES, WHICH ARE INTERLOCKED WITH THE SIGNALS.

The mechanical part of the locomotive was supplied by the Schweizerische Lokomotiv-und Maschinenfabrik. Since the motors, as shown, are fixed in the centre of the bogies, the latter have been connected to the frame by means of suitable links and guides. Two slanting bars serve to transmit the forces from the bogies to the frame. The motors drive a countershaft from which power is transmitted to the wheels by means of connecting rods in the manner shown in Fig. 3. Some of the principal weights are as follows: Weight of locomotive complete 43 tons, electrical equipment 19½ tons, one motor without gear 7,500 lb. When hauling a 200 ton train at about 25 miles an hour on a gradient of 0·8 per cent. in a curve, the motors are stated to have run sparklessly. At starting, the current to the two motors, which are in series, rose to about 1,000 amperes, but fell to 780 amperes (at 450 volts) when the train was running at 16·8 miles an hour in the gradient above referred to.

The overhead equipment used on the straightaway parts of the line is seen in Fig. 7 which shows the arrangement of overhead "horn" switches interlocked with the signals, and the side conductor on the top of its insulators. At portions of the line near stations, however, where there are points and crossings, a catenary suspension is used supported by light lattice girders spanning the track as shown in Fig. 4. Here also the points and signals interlock with the overhead switches.

NEW YORK, NEW HAVEN & HARTFORD SINGLE-PHASE RAILWAY.

By the courtesy of the British Westinghouse Company we are able to supplement the article on the New York, New Haven & Hartford Railway, published in our last issue, p. 1048, with the following additional information and illustrations:—

The railway company, as will be remembered, contemplates the electrical operation of their main line between New York City and Stamford, Conn., a distance of over 33 miles. That portion of the road which lies between the Grand Central Depot and Woodlawn, N.Y., utilises the tracks of the New York Central Railroad, and constitutes a portion of the electrical zone of that company within which the direct-current third rail system is being installed. Between Woodlawn and Stamford the road will be equipped with the Westinghouse single-phase system, and the trains will be operated by electric locomotives which take alternating current at 11,000 volts from the overhead trolley line. Fig. 1 is a view of the locomotive complete, and shows the current collecting gear clearly.

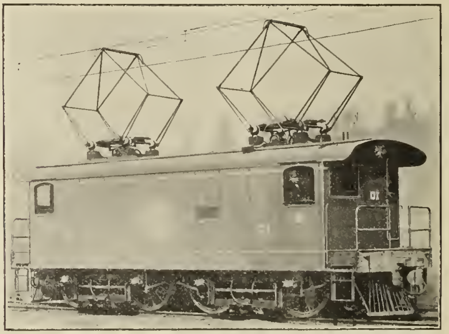


FIG. 1.—VIEW OF THE NEW YORK, NEW HAVEN AND HARTFORD RAILWAY'S ELECTRIC LOCOMOTIVE.

Thirty-five locomotives are to be furnished by the Westinghouse Company, suitable for operation on the direct-current division between the Grand Central Depot and Woodlawn, and on the alternating-current portion of the line between Woodlawn and Stamford. One locomotive has already been constructed, and the results obtained are stated to assure the complete success of the alternating-current system. The frame, trucks and cab of the locomotive were built by the Baldwin Locomotive Co., according to designs developed with the co-operation of the New Haven Railway and the Westinghouse Company. As will be gathered from the illustrations, the frame is of the rigid type, with side pieces made of steel channels, to which are bolted and riveted other steel channels placed transversely, two over each truck, forming transoms for the transmission of the weight to the centre pins. These channels are placed outside the wheels and as close together and as low down as the wheels and draw-head will permit, and are braced and squared by substantial steel flooring plates, which are riveted and bolted to the top flanges. The transoms are further braced by gusset plates, which are riveted and bolted to the bottom flanges of both sets of channels, and which transmit the tractive power from the centre pin to the side channels. Additional strength is given to the frame by diagonal plate braces.

Each of the two trucks (see Figs. 2, 3 and 4) is mounted on four 62 in. driving wheels. They have side frames of forged steel, to which are bolted and riveted pressed steel bolsters, which carry the centre plates. The weight on the journal boxes is carried by small semi-elliptic springs, with auxiliary coiled springs under the ends of the equaliser bars, to assist in restoring equilibrium. A very strong construction is secured without excessive weight by the use of bolsters 30 in. wide at the centre plate and extended to nearly double that width at the ends, which are bolted to the side frames. Centre pins 18 in. in diameter transmit the tractive effort to the frame. They are well lubricated to permit free motion on curves. The truck pedestals are provided with wedge and gib adjustments to take up wear, and the bearing brasses are easily removable by hand.

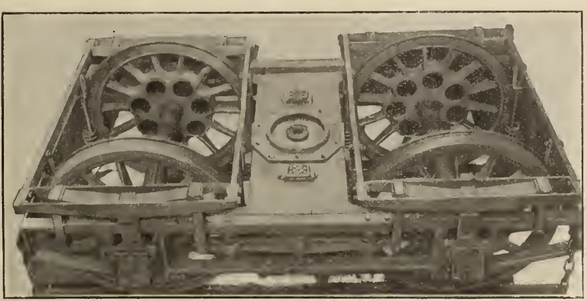


Fig. 2.—Truck of the Electric Locomotive.

Windows are provided at each end of the cab, giving an outlook on both sides and in front of the locomotive; and the driver is so close to the front that he can see the track a very few feet ahead. The master controllers, auto-transformers, instruments, grid resistances, air-operating valves, compressors and other auxiliary apparatus are mounted inside the cab upon an angle-iron framework which is built into the cab and securely anchored to floor and roof. A clear passage way is left through the centre. Trap doors in the floor furnish easy access to the motors for inspection or repair.

The equipment of the locomotive includes four gearless 200 H.P. motors (see Fig. 3), controlling apparatus and auxiliaries. The motors are of the gearless type, designed for operation on both single-phase and direct current. They are wound for approximately 235 volts on alternating current and from 275 to 300 volts on direct current. The cast-steel motor carcase is of a circular, skeleton form, and divided horizontally into two parts to give access to the inside. A laminated core with slotted projecting poles is built up within this frame and wound with field coils of flat copper strip insulated between turns with asbestos and filled with an insulating compound which is heat-conducting and waterproof, so that a sealed coil is produced which can withstand moisture and internal heat. Copper bars are placed in slots in the pole faces and connected to form a continuous neutralising winding, which forms part of the circuit including the main field coils, the armature coils and the auxiliary windings, all in series. This auxiliary winding produces a magnetic field, which opposes and neutralises the reaction of the armature. It is so formed that it need not be disturbed in order to remove the main field coils.

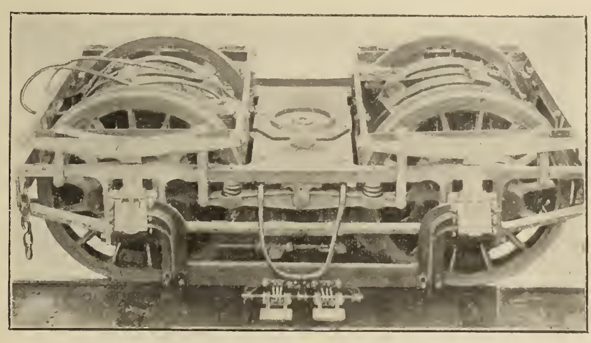


Fig. 4.—Truck of the Locomotive complete with Motors.

The armature core is built up of soft steel punchings, which are assembled on a cast-iron spider. Its surface is slotted, and the armature winding is arranged in three layers. While the two upper layers are composed of copper strip connected to form the usual direct current type of winding, the third layer is of resistance material and constitutes the preventive winding. It is connected between the commutator and the main winding. Individual coils are insulated along their entire length by overlapping layers of mica tape, and each group is further insulated from the core by a moulded mica cell. The completed winding is held firmly in position by insulating wedges, and its ends are banded down against the coil supports.

The commutator is formed of copper bars clamped between V-shaped cast-steel rings and insulated by V rings and bushings of moulded mica. It is pressed on the spider which supports the armature core. The brush-holders are of the sliding type with arms mounted on a rocker ring. Tension is provided by flat phosphor-bronze springs, which have sufficient turns and are so mounted that friction between turns is eliminated and uniform pressure secured over a considerable range without adjustment. Each spring is held in a harness which definitely fixes the radius of movement of the spring tip. A pawl on the side of the spring harness allows easy adjustment of the tension.

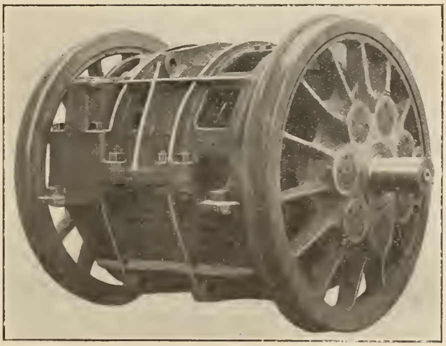
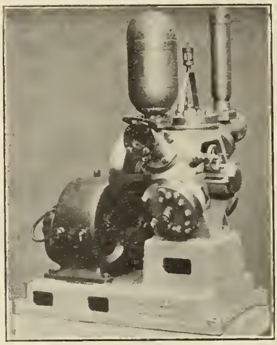


Fig. 3.—Motor mounted on Axle.

The New Haven locomotive measures 36 ft. 4 in. over the bumpers and weighs approximately 85 tons. It is capable of handling a 200 ton train in local service on a schedule speed of 26 miles per hour, with stops averaging about 2 miles apart, making in such service a maximum speed of about 45 miles per hour. It can also handle a 250 ton train on through service with a maximum speed of about 60 miles per hour. With heavier trains it is planned to couple two or more locomotives together and operate them in multiple. The first locomotive has, on actual test, repeatedly accelerated a 200 ton train at a rate of 0·5 of a mile per hour per second, which is in excess of the rate required by the service conditions of the New Haven road.

AN ELECTRIC FIRE PUMP.

An interesting application of electrical power has just been installed at the residence of Mr. Alfred de Rothschild, in Seymour-place, London. The house is fitted with a system of firemains and hydrants for protection against fire. A storage tank is fitted in the roof, the service being fed from the street main. The pressure thus obtained, however, was not high enough to discharge sufficiently powerful jets on the upper floors. It was, therefore, decided to put in an electrically-driven pump which could be put into action at any moment to supply the sets at high pressure. The set is illustrated below. The motor runs off a 100 volt continuous-current circuit, and is of the four-pole shunt-wound open type, driving the pump through a single reduction spur gear. The pump, which is of Messrs. Merryweather & Sons' "Hatfield" treble-barrel type, has its three pistons driven by a central crank, running at a speed of 360 revolutions, and delivers about 100 gallons per minute at high pressure, with an expenditure of about 5 kw. It has been arranged to take suction from the tank in the roof which is fed by the street mains and to pump directly into the fire service. An ingenious form of automatic starting gear is provided for the motor, so that when the door of the hydrant box on any floor is opened, the pump immediately commences work to maintain the pressure. An advantage presented by this form of pump for driving by electric motors is the high speed at which they can be driven, avoiding the use of several gear reductions with their consequent loss of efficiency. These pumps are also practically noiseless in working, owing chiefly to the parts being well balanced.



Electrically-driven Fire Pump.

THE FIELD OF THE ELECTRIC TRAMWAY AND MOTOR 'BUS.[*]

BY E. MANVILLE.

The phenomenal development of the motor 'bus within the metropolitan area has produced such a burst of enthusiasm in the promoters of this system of traction that I fear an inflated view is now being taken of the merits of the motor 'bus as against the older and well-tried system of the propulsion of tramcars by electricity.

In order that a fair comparison may be made, it is essential, in the first place, to realise those conditions which are of primary importance in dealing with the problem of the transportation of large numbers of the public in crowded centres.

There are two such main considerations:—

1. What system will provide the travelling public with the best and cheapest facilities for reaching their destinations with the least discomfort and inconvenience to the non-travelling public? and

2. What system, whilst embodying the first requirement, is the most profitable to the promoters of the undertaking?

In my opinion, the relative advantages and disadvantages of these two methods of traction may be summarised as follows:—

Motor Omnibuses.

Advantages.—(1) Probably greater speed from point to point, owing to their being free to move about the roads, avoiding other traffic en route; (2) ability to vary the service from one road to another, thus enabling the most profitable routes to be ascertained without loss of capital; (3) ability to draw up by the pavement, so as to facilitate passengers entering or alighting, without proceeding to the middle of the road; (4) the absence of any rails in the roadway; (5) where the roads are exceptionally narrow, non-interference with other vehicles desiring to stop by the pavement.

Disadvantages.—(1) High cost of operation; (2) great noise and corresponding inconvenience to other users of the road and residents; (3) smell, and the prevalence of the smoke of burnt lubricating oil; (4) the ever-present danger of side-slip; (5) the danger of fire; (6) vibration; (7) danger to other vehicle users on the highway; (8) unreliability.

Electric Tramways.

Advantages.—(1) Lowest known costs of operation; (2) great comfort, cleanliness and good lighting; (3) comparative absence of noise and vibration; (4) reliability; (5) absence of danger from fire and side-slip; (6) the great improvement of the surface of the roadway.

Disadvantages.—(1) Running on rails, and thus experiencing delay from other traffic; (2) need for passengers crossing to the middle of the road when entering or leaving cars; (3) the need for rails in the roadway objectionable to other traffic; (4) In narrow roads interference with other vehicles desiring to stop by the pavement.

It cannot be denied that, amongst the disadvantages of the motor 'bus, there are some which are of the very first importance. I refer particularly to such items as the danger of side slip, the prevalence of which is so well known that it requires no further comment from me; danger of fire is one that has already asserted itself on several occasions, and though so far it has not led to serious accidents, as in the case of side-slip, it obviously may do so, owing to the necessity of carrying about large quantities of highly inflammable motor spirit. The first of these serious disadvantages is entirely absent from the electric tramcar, and the second one, although not entirely absent, cannot, on the rare instances when it occurs, lead to anything in the shape of danger to the public. It cannot, on the other hand, be denied but that the tramcar, when run in very narrow roads, leads to obstruction of other vehicles wishing to stop by the roadside; also the tramcars themselves having to keep to fixed lines, are delayed by other traffic interfering with their progression. As counterbalancing the installation of rails in the roadway may be mentioned the great improvement in the paving of many roads along which tramways run. It is common knowledge to all of us that the roads leading out from the metropolis and from other cities and towns in the kingdom have been kept in a most disreputable state of repair, owing to the inability of the local authorities to spend a sufficient sum on their upkeep outside of the centres. The principle which has been instituted in enforcing good paving for a portion of the road, as a penalty to be paid for the installation of the tramway system, has very largely benefited other users of the road in this direction, and it must be recollected that the tramway itself derives no advantage from the paving which it has to instal and maintain, the benefit of which accrues entirely to the other users of the road.

Reviewing, then, impartially the statements set forth above, I think it must be conceded that the balance of advantages, both to the travelling and non-travelling public, pertain to the tramway system rather than to the motor 'buses.

If motor 'buses are started in competition with tramways already existing, or if tramways are started under suitable conditions in towns where motor 'buses already exist, it is certain that the motor 'bus, if worked will cease to exist.

Hastings was served by a system of motor 'buses, which were kept in good condition and paid, I believe, at the rate of 15 per cent. per annum. Until last year they had no opposition to face from from tramways. In the middle of last year the first section of a tramway system, to which my firm were engineers, was put into operation at normal fares, the result being that, long before the tramway system was completed, and within a very few months of its start, the motor 'bus system was entirely discontinued, and those identical motor 'buses are now, I believe, employed in the London traffic. I have seen, time after time, not only in the daily Press, but also in the automobile journals predictions that it is certain tramway systems will be superseded by motor 'buses. The incident at Hastings—which, it may be remarked, is not an exceptionally favourable town for tramways, indicates that the reverse of these forecasts is likely to be realised in practice.

At Torquay, also, a good motor 'bus service has been firmly established, and under the conditions of its working is paying well. Electric tramways are now being installed at Torquay, and we shall shortly see whether history, as represented by Hastings, will repeat itself there.

In considering how I could best put before you the financial aspect of the two systems, I came to the conclusion that my purpose would be best served by taking the actual results achieved in a town of medium size running an electric tramway system, and constructing a motor 'bus balance sheet on the same lines, as if, in fact, the town in question were completely served by motor 'buses instead of by tramways, and I have taken the town of Leicester as the example in question for two reasons: (1) That it is a manufacturing town, with a population of about 228,000, and is, therefore, neither one of the larger or one of the smaller towns of this description. (2) Because the Corporation of that town, which owns the tramways, determined that no expense should be spared in making the tramway system as perfect as possible, with the result that the capital charges to be met are heavier in proportion than would be the case if a good but not so expensive a system were installed.

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[*] Abstract of a Paper read on March 29th before the Automobile Club

The tramways at present in operation there are equipped with a total of 140 cars, each one seating 48 passengers. The total length of the route served by these tramways is practically 20 miles, of which 17 miles have double track and the remainder single track with passing places.

Last year the tramways carried about 26,000,000 passengers, and, in carrying these, ran a total of 3,342,000 car-miles. In addition to paying its maintenance and running expenses, it has to pay an interest of £21,826 per annum on the capital involved, and a sinking fund to redeem the capital, according to its Act of Parliament, of £10,664 per annum.

The following is calculated from its balance-sheet for the year ended December 31, 1905, and is reduced to average pence per car-mile —

Leicester Corporation Tramways.

Expenditure.	Av. per car-mile.
To traffic expenses—	d.
Superintendence	0·037
Wages of motormen and conductors	1·947
Wages of other traffic employés	0·185
Cleaning and oiling cars..	0·358
Cleaning, salting and sanding track	0·089
Fuel, light and water for depots	0·021
Ticket check, incl. wages, inspectors and clerks..	0·149
Uniforms and badges....	0·084
Miscellaneous	0·022
	2·892
To general expenses—	
Salaries of general officers and staff	0·068
Stores expenses	0·046
Rents	0·018
Rates and taxes	0·278
Printing and stationery..	0·019
Fuel, light and water for offices	0·003
Law charges	0 002
Compensation	0·131
Fire and other insurances	0 012
Miscellaneous	0 047
	0·624
To repairs and maintenance—	
Permanent way	0·018
Electric'l equipment of line	0·093
Buildings and fixtures ..	0·024
Workshops, tools and sundry plant	0·008
Cars	0'410
Other rolling stock......	0·003
Miscellaneous equipment.	0·005
	0·561

Expenditure.	Av. per unit.	Av. per car-mile.
To power expens's—	d.	d.
Salaries & wages.	0·1229	0·183
Fuel	0·1573	0·234
Water..........	0·0096	0·013
Oil and waste ..	0 0219	0·033
Miscellaneous supplies	0·0110	0·016
Repairs to steam plant	0·0102	0·016
Repairs to electrical plant ..	0·0034	0·005
Repairs — power station buildings	0·0039	0·006
	0·3402	0·506
Total amount of working expenses		4·583
Estimated future increase in permanent way repairs		0·142
		4·725
Interest on capital		1·568
Contributions to sinking fund		0·766
		7·059
Renewals of permanent way and paving		0·636
		7·695
Income.		
By passenger traffic—25,890,030 pass. carried..		7·763
By sundry revenue—Advertising on cars		0·079
Rents of shops and cottage property		0·024
		7·866
Expenditure...............		7·695
Profit on one year's working		0·171

Capital Account—

Net purchase price of old undertaking	£118,000
Inclusive cost of reconstruction, extensions, and electrification, including power-house..	540,985
Total capital	£658,985

From the above balance-sheet you will see that the total average receipt per car-mile run was 7·866d., whilst the total cost of operation, repairs and maintenance was 4·583d. I must draw your attention to the fact that there is one item in the balance-sheet that will increase in future years, although it is quite possible that other items may decrease. I allude to the repairs to permanent way, apart from the renewals of the same; this, in the year in question, amounted to 0·018d. per car-mile, whereas my experience and that of others in tramways which have been running over a longer period is that in the following years this amount will increase to 0·16d. per car-mile. I have, therefore, added to the total costs shown of 4·583d. the amount of 0·142d., to allow for the increase in this direction in the future, bringing the total costs, without capital charges, or the consideration of the renewal of track and paving, to 4·725d. per car-mile. The interest on the capital amounts to 1·568d. per car-mile, and the sinking fund of the capital to 0·766d. per car-mile, or a total cost, including interest, sinking fund and working expenses, of 7·059d. per car-mile.

A further item that cannot be maintained out of revenue is the special track work, consisting of points and crossings. Parts of these can be, and are, renewed out of revenue, but the remaining portions require renewing once in 10 years, and a further sum has to be set aside annually to realise the requisite amount to renew these to the end of that time. The allowances to be so made amount to a total of 0.636d. per car-mile.

This, with the previous items of expense and of interest charges, amounts to 7·695d., leaving a balance over and above all the requisite provisions of 0·171d. per car-mile. This amount will be materially added to in the present year from the increase of revenue now being experienced.

I now propose to compare with this balance-sheet of the actual tramway system in operation at Leicester a balance-sheet showing how the position would stand if the same service exactly was carried on by motor 'buses as constructed at the present time.

In framing this balance-sheet I had hoped to have been able to obtain particulars from those companies using motor omnibuses on a large scale in London of their actual costs of operations and upkeep, but I regret to say that these companies do not feel justified in putting forward any figures at present, owing to the inadequacy of their experience, which, as one of them in a letter I have received justly remarks, could only be regarded as an estimate. Under these circumstances I have taken, so far as the upkeep itself of the motor omnibuses is concerned, the estimates prepared by a prominent member of this club in giving advice on this subject. This gentleman has had, perhaps, more experience in giving professional advice as to motor 'buses than anyone else in the country, and, in the absence of definite experience on the part of the motor 'bus companies, his figures form probably the most reliable substitute.

The following, then, is from the balance-sheet in question, reduced to pence per car-mile :—

Expenditure.	Av. per car-mile.
To traffic expenses—	d.
Superintendence	0·037
Wages of motormen and conductors	1·947
Wages of other traffic employés	0·185
Oiling cars	0·280
Ticket check, incl. wages, inspectors, and clerk ..	0·149
Uniforms and badges	0 084
Clearing and fuel, light and water for depots, and miscellaneous	0·400
	3·082
To general expenses—	
Salaries of general officers and staff	0·068
Store expenses..........	0·046
Rents..................	0·018
Rates and taxes	0 278
Printing and stationery ..	0 019
Fuel, light and water for offices................	0·003
Law charges............	0·002
Compensation, fire and other insurances, and miscellaneous	0·560
	0·994

Expenditure.	Av. per car-mile.
	d.
To repairs and maintenance.	0·55
To power expenses—	
Petrol.........	1·00
Total amount of working expenses	5·626
Interest and sinking fund on capital	0 660
	6·286
Renewals—	
Tyres	2 000
Vehicles, 20 p.c. per annum	1·800
	10·086
Interest and sinking fund on purchase price of old undertaking, £118,000 ..	0·424
	10·510
Income	7·842
Loss on one year's working..	2·668
Income.	
By pass'ng'r traffic, 25,890,030 passengers carried	7 763
By sundry revenue, advertising on cars	0·079
	7·842

Capital Account—

140 cars at £900 each	£126,000
Car depôt and offices	48,000
Equipment of workshops	10,000
	£184,000

In framing this balance-sheet I have taken in those costs which would be common to a complete system, whether run by motor 'buses or by electric tramways, and have only varied those items in such cases as differ. I have, however, given the motor 'bus every possible chance. For instance, I have only debited the system with the capital cost of 140 motor 'buses, being the exact number of electric tramcars in use there, and, although these motor 'buses seat but 34 passengers in place of the 48 carried by the electric tramcars, I have assumed they would, nevertheless, be able to earn the same gross income, which, I need hardly point out, is exceedingly unlikely.

From this balance-sheet you will observe that the total cost of the motor omnibus run on such a large scale, including the renewal of both tyres and vehicles, and interest and sinking fund on the capital invested, amounts to no less a sum than 10·086d. per car-mile, and that if we add to that the interest and sinking fund on the purchase price of the old horse tramway undertaking a further amount of 0·424d. would have to be added, making, in that case, 10·51d.

Against this the income, even allowing the smaller vehicles would carry the existing number of passengers, amounts to only 7·842d., so that there would be a net loss on the working of the system of 2·668d. per car-mile, equivalent to £37,196 per annum, being nearly 25 per cent of the total working expenses, or nearly 30 per cent. of the gross receipts.

From this it is evident that such a system run by motor omnibuses under prevailing conditions could only be a financial failure, but it must be borne in mind, whatever the academical opinions of promoters of motor omnibus enterprises may be, that it is almost certain no extensive system of such vehicles would be permitted within a town without heavy contributions in some form or other towards the paving of the streets, and, in that case, still further capital and renewal charges would have to be made.

These two comparative balance-sheets take us a step further, since they enable me to construct a curve showing where, from the financial point of view, the costs of motor omnibus traction and of electric tramway traction become equal, and, following it on, where motor 'bus traction becomes more economical than electric tramway traction.

The amount invested in the permanent way and overhead equipment of an electric tramway system is practically constant per mile, whatever the service of cars might might be upon it, and, therefore, the interest on this portion of the capital must be divided amongst the car-miles run, whatever they may be, so that the smaller the service the greater the burden of these capital charges.

Fig. 1 shows the arithmetical result of this.

You will see I have taken as my by basis the number of car-miles run per route-mile per annum. The total cost of the motor 'bus, within wide limits, remains the same, as shown by the straight line on the curve. On the other hand, the total costs per car-mile run by a tramway system are as shown by the curve, for the reasons previously set forth.

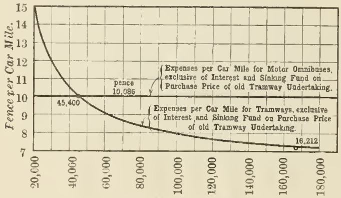

DIAGRAM OF EXPENSES.

At Leicester the average car-miles per mile of route are 167,112, and you will note the wide divergence between the total costs of electrical tramways and of motor 'buses. With this traffic it is equal to about an average service of 3½ minutes in each direction. When, however, the car-miles per mile of route drop to 45,400, then you will observe the total costs of the motor 'bus and electric tramway are equal, and this point is equal to an average service of about 13 minutes in both directions. Below this point the economy in the motor 'bus rapidly increases over that of the electric tramway

In every city or town in which electric tramways exist there are numbers of routes in which the service that could be profitably maintained is less than that shown upon the diagram, and electrical tramway undertakings are beginning to use, and doubtless will exhibit an increasing tendency to use, motor 'buses.

In all the smaller towns where the minimum profitable tramway service cannot be maintained, motor omnibuses will have the entire field to themselves. So also will be the case in those numerous instances where towns not directly lying upon the railways require communication with these.

Of the crowded centres of population London offers a unique field for the use of the motor 'bus. There the tramway system must be carried on under disadvantageous circumstances: First, because it cannot reach the centres of the City, and, therefore, provide through communication; secondly, since overhead wires are not permitted, vastly increased capital costs are experienced in the construction of the electric tramways system.

On the other hand, the vitality of the electric tramway system in London is well shown, since, although it is handicapped so materially by not being able to reach the centre of the City, it nevertheless carries enormous numbers of the public, and has proved itself a most comfortable, profitable and convenient method of travelling.

DISCUSSION.*

Mr. SHRAPNELL SMITH said that under the heading of "Disadvantages of Motor Omnibuses," Mr. Manville had spoken of "the ever-present danger of side-slip." He did not think it was quite fair to call it an "ever-present" danger, because as a matter of fact it was a danger limited to greasy roads. It was, of course, in some senses, the *bête noire* of motor vehicles of all kinds; but the twin tyre had done a lot, and the block-pad tyre could do more, and we had to remember with regard to tramways that occasionally we saw on gradients exceeding, say, 1 in 17, when the lines were very greasy, that the adhesion between the wheel and the rail was not sufficient, and that gives rise to a great deal of trouble. He could not follow Mr. Manville where he said that "the tramway company having a large capital invested in both rails, paving, &c., must run a sufficiently rapid service to enable the charges on capital account to be met and still leave a profit. Further, in order to induce the travelling public to avail themselves of the facilities offered, and thus, with a rapid service, fill the cars sufficiently, the charges must be made as low as possible." And then he proceeded to say that there was no such guarantee that motor omnibus people would run a frequent service—as much as to say that they could run a less frequent service at a profit. But in the third paragraph at the top of the next page he went to the other extreme, and pointed out that if a motor-omnibus company did not keep all its vehicles in active work throughout the whole of the day, it would be in a state of incipient bankruptcy, &c. He was afraid the two arguments really rather contradicted one another. In the case of Hastings, we had the fact of the disappearance of the service of motor omnibuses, on the other side of the question we had recently seen how Todmorden had pursued an opposite course, and we had also seen how Eastbourne, which went in very early, on a capital of £10,000, compared with at least three times that amount for any scheme of electric traction, had been able to continue its service of motor omnibuses in face of the handicap of having some relatively old vehicles in use. Mr. Manville had admitted in his Paper that from point to point the motor omnibus was quicker than the electric tramcar. The Commissioner of Police, however, had ruled that in London we must have 34-seated omnibuses; but in Leicester there were were no such provisions. The provisions of the Motor Car Act permitted you to get up to 48 seats, and if you went more quickly from point to point—the mileage was only 65 per day on the figures published by Mr. Manville with regard to Leicester—the London omnibuses could easily do 120 in the open streets of Leicester, and if the seating capacity were multiplied by the mileage the 34-seated omnibus, with its greater power of steering and overtaking, would be more than equal to a 48-seated tram, and, therefore, the suggestion that he had been generous to the motor omnibus in only reckoning 140 of them was more or less begging the question, because it did not quite agree with what would be possible in Leicester with a 34-seated omnibus. He would like to conclude by asking Mr. Manville a question. We had to remember this—that we were in the early days of motor-omnibus development. He did not know how large a reduction could be hoped for in the operating costs. We had seen great reductions in electric traction operating costs, and he would like to ask Mr. Manville, in view of the great reductions which had taken place in electric tramway operation, what figure he would have placed five years ago against that 7·482d., and whether he thought we might safely draw the inference from that reduction in electric traction costs that we should see a similar reduction in the next five years in motor omnibus costs?

Mr. EMILE GARCKE said that the Leicester tramcars were worked at undoubtedly a low figure, and it appeared to be brought about by the very frequent service that the Corporation ran. Of course, the expenses per car-mile could be made what you like, if you only ran a sufficiently frequent service, and, considering that they are running on an average every 3½ minutes over the whole of the route, the service must be regarded as an exceedingly heavy one, and more especially as was shown by the fact that the receipts per car-mile were only 7·7d. Mr. Manville had made no reference whatever to the disadvantage that electric tramways labour under in having to go to Parliament or before the Light Railway Commissioners for the necessary powers to authorise their undertakings, and to the consequent disadvantage that many electric tramways labour under in not having suitable termini. Many tramway systems were very seriously prejudiced in this country by being obliged to fix their termini at points which were not the most suitable. In a case like Leicester there was no doubt whatever that the tramway undertaking was bound to show economical advantages over a service of motor omnibuses, but if Mr. Manville had taken a smaller town and had compared it with motor omnibuses, it was very probable indeed that the comparison would have been very much more favourable to the motor omnibus. Therefore, he said, if you have tramways, have proper, well-designed tramways, and you have nothing to fear. If you have motor omnibuses put them where tramways cannot pay, where the difficulties of physical situation, narrowness of streets, and so on, and the difficulties of obtaining necessary consents, and all these other difficulties exist; let motor omnibuses be established in those places, and rightly so.

Sir JOHN MACDONALD thought Mr. Manvillo was a little too hard upon the enthusiasts of the motor omnibus. No great movement had ever succeeded in locomotion or anything else unless there was some enthusiasm to begin with that went rather beyond bounds, and he thought the enthusiasm which was shown by the early pioneers of the tramways was an enthusiasm quite, in many respects, as insane as could be attributed to the motor omnibus people of the present day. Mr. Manville had very candidly and fairly stated from his point of view the advantages and disadvantages of the two means of locomotion. One of the advantages, he said, of motor omnibuses was their greater possible speed from point to point, "owing to their being free to move about the roads, avoiding other traffic en route." But he might have added that they have also the great advantage that each vehicle was not confined to the speed or the success of the preceding vehicle. On a tramway no vehicle could move faster than another, and if you happened to have a breakdown you might have a string of vehicles reaching for 2 miles waiting for a breakdown gang to get the line clear or for the wire to be got in order so that the cars might go on again.

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* Abstracted from the *Automobile Club Journal and Motor Union Gazette* of April 5th and 12th.

Mr. FREDERICK COLEMAN made a few remarks chiefly relating to the possible improvements which might be made by the adoption of steam instead of petrol as a motive power for motor omnibuses.

Mr. J. E. WALLER agreed with previous speakers that Leicester was too big a system to be taken as a fair illustration and comparison, but drew an entirely different deduction from that to that which had been drawn. Had a smaller system been taken, with a smaller proportion of double line, where a very infrequent service was run, with a very much cheaper form of construction, you would have got results showing something very different from that 13 minutes' headway with which, according to the conclusions in the Paper, a petrol motor car could compete on even terms with the electric tramway. Coming next to the item of renewals of permanent way, Mr. Manville had provided for one-third of the rails requiring renewal in six years, one third in 12 years and one-third in 18 years. It appeared to him improbable, excepting on very sharp curves (which really ought to be renewed out of revenue) that any rails would wear out in six years. However, at Leicester, on a length of about 2 miles, there was certainly abnormally heavy tramway traffic, the cars running at intervals of less than one minute between them. The route length of the tramways was 20 miles; therefore provision should be made for renewing not one-third but one-tenth of the permanent way in six years. The service, excepting on this section, varied from intervals of 2½ minutes to intervals of 10 minutes. If it was not anticipated that the rails would wear out in less than six years on the busy streets with a minute or more frequent service, then with a 2½ minute service it would suggest an 18 years' life, and a longer life where the service was more infrequent. He would suggest that 10 per cent. of the permanent way might be taken as requiring renewal in six years and 90 per cent. in 18 years. This would mean a reduction in the cost of renewals on the basis of the present car service amounting to 0·16d. per car-mile, and with the previous suggested saving would reduce the total expenses per car-mile, comparable with the estimated 10d. of the motor omnibus, from 7·271d. to 6·571d. He was not disposed to question the balance-sheet which had been prepared of the motor omnibuses, although he thought the renewal fund at the rate of 20 per cent. per annum took, perhaps, a somewhat hopeful view of the life of the motor omnibus. Mr. Manville had prepared a very interesting curve, from which he drew the deduction that where the traffic of the district justified a service with intervals between the vehicles of 13 minutes in both directions there was nothing to choose between electric tramways and a motor omnibus; but with a more frequent service the electric tramway was more economical, and with a less frequent service the motor omnibus could be worked more advantageously. He thought there was a fallacy in this deduction. As pointed out by Mr. Manville, no expense was spared in making the Leicester tramway system as perfect as possible, with the result that the capital charges to be met are heavier in proportion than would be the case if a good but not so expensive system were installed. But the deduction Mr. Manville had made was based on this very first-class system, which was an entirely different class of construction to what anyone would have under consideration if they were advising the laying of a tramway in a district only suited to a car service at intervals of a quarter of an hour or thereabouts, and not only would the type of construction be very much cheaper, but no one would contemplate laying double lines throughout where only a service at 15 minutes' intervals was to be dealt with. Moreover, not only would the construction costs be enormously reduced, but also the whole of the power station plant, feeders and rolling stock. With such a system, and allowing for a single line and passing places, he would estimate the amount required to provide interest and sinking fund at 0·69d. per car-mile on 3,342,000 car-miles, as against the actual figure on the costly installation of Leicester of 1·91d., and permanent way renewal would work out at 0·1d. per car-mile. He would make no allowance for special work at junctions, as this country system would not have the complicated network necessary at Leicester, nor would he have to deal with granite sett paving as such a tramway would only be constructed with macadam and one serrated row of setts on each side of each rail, as is frequently laid in all but the most important thoroughfares of big cities, so that the figure of 0·1d. for renewals compares with Mr. Manville's 0·636d., and accepting the whole of the rest of Mr. Manville's figures, the total cost would amount to 5·515d. per car-mile, exclusive of the purchase of the old undertaking, as against Mr. Manville's 7·271d.

Lieut-Col. R. E. B. CROMPTON considered both Mr. Manville's and Mr. Waller's figures for maintenance of rails much too low and thought that in the near future the cost of operation of motor omnibuses would be considerably reduced.

Mr. HAMPSPHOOR referred to the rumours that motor omnibuses were about to replace tramways in Berlin, and said that there had been some motor omnibuses put in service in Berlin by private companies, and the large tramway company, the Grosser Berliner, had thought it politic to ask permission to put in service also motor omnibuses not to supersede the tramcar service, but to establish feeders for the tramway lines. It would be absolutely out of the question to put in service motor cars instead of electrical tramcars on account of the low fares that had been agreed upon by this company and the municipality of Berlin.

Mr. A. A. CAMPBELL SWINTON objected to the same figure for rates and taxes being given both for the tramway and motor omnibus undertakings, and pointed out that a tramway was rated upon the whole of its undertaking—upon the rails and the overhead equipment. upon everything except the rolling stock—whereas a motor omnibus could only be rated on its garage. There was another point which he thought Mr. Manville did not see. He had added a sum which amounted to nearly ½d. per car-mile for the interest and sinking fund on the purchase price for the old undertaking, that was, the horse tramways. That was not a figure that would apply in the case of a town where there were no horse tramways, and it would not apply in the case of motor omnibuses which started to compete with horse omnibuses. If you deducted those items from Mr. Manville's figure of 10d., that he made the cost of the motor omnibus per car-mile, you get almost down to the 9d., which was the figure he (Mr. Swinton) gave to the Royal Commission. Now, if further you deducted the depreciation and the interest and sinking fund, you got as Mr. Manville's figure for working expenses, including tyre renewals, the sum of 7·62d.; and it might be interesting to the meeting to know that at the present time at Bath, where there were six motor omnibuses running, the actual corresponding figure was 7·93d., which was only a difference of 0·31d. There was one other point with regard to Mr. Manville's figures which might be mentioned. He took 2d. a mile for tyres. Up to the present that was the correct figure, but as a matter of fact it was coming down for London already, and it was hoped soon to have this item down to 1¾d. Mr. Manville had taken an exceptionally favourable instance from the tramway point of view. He had got a list of most of the principal tramways in the country, and found that 20 of them were over 7d. for running costs. One of them was as high as 9d. But there was quite a number over 7d., so that 4½d. was really an exceptionally low figure. Then, again, Mr. Manville had added interest and sinking fund, and when that was done in the case of Leicester, the total was somewhere about 7d.; but if we took even large places, such as Liverpool, for example, it was 9·2d.; at Newcastle-on-Tyne, again, which was also a large town, for 1904 the total was 10·18d., and for 1905 it had gone up, and was 10·53d. But the best example of all was London. According to the evidence given by the Controller of the London County Council last year on the question of the Embankment Tramways, the operating costs of the London County Council trams at the present moment were 8d, and the total costs, including interest and sinking fund, came to over 1s. Mr. Swinton also dealt briefly with the questions of noise, smell and vibration and unreliability, and held out hopes of great improvements in these directions. He repudiated the suggestion that motor omnibus tyres caused undue wear of the roads.

Mr. SIDNEY STRAKER considered that the figure of £900 capital expenditure per car, on which the motor omnibus costs had been based, was an over-statement. Probably that figure included the cost of the tyres, but as the tyres were run on mileage, and were debited with an account lower down, obviously they ought not to be included in the capital account. Makers could supply good cars now, complete, without tyres, at £750 per car. Car depot and offices at £48,000 was a very exaggerated statement. £15,000 was ample to provide for a suitable garage to deal with the number of cars assumed by Mr. Manville, and that could be borne out in practice, especially on reference to the motor-car garage in Battersea, where there is sufficient space for 100 motors. That disposed of the capital account and reduced the £184,000 to £122,000, as he figured out the value of the cars at £105,000, the garage at £15,000 and the workshop at £2,000 instead of £10,000. This was all based on the experience up to the present. Now, with regard to the earnings, this was based on the six months' work of from 20 to 30 cars, taken out in their respective proportions, and the average number of passengers carried per day per car is 900 in London. The total number of working days in the year being 355, they have carried approximately 40,000,000 passengers per annum at that rate. Now, these cars were proved to be earning 1s. 1d. per car-mile, so that came out at a total car-mileage of 5,367,000 odd car-miles. That at 1s. 1d. realised a total sum of £290,000 odd, so that, instead of the balance-sheet proving a deficit of £37,000, it would prove a profit of somewhere near £60,000. Now, he was sure that any firm of motor omnibus manufacturers would be pleased to maintain their cars at 10d. per car-mile, and would make a very good profit out of it. During the last two months, of the cars supplied by his own firm there had been 94 per cent. always on the road.

Mr. LYNDEN MACASSEY said that the question must not be approached purely from the standpoint of what was the operating cost of a motor omnibus. Even although the motor omnibus—just as even although the electrification of the railway—might result, perhaps, in a higher operating cost, yet one was entitled to look above that to see what would be the effect upon the traffic which it served in the way of securing a larger amount of annual net profits. It, therefore, appeared to him that in the case of motor omnibuses one could not argue this question solely and purely upon general grounds of operating costs. There were some districts in London where one factor might be the chief factor in influencing people to travel by a particular mode of transport, while in other districts an entirely different factor might be the chief influence in inducing traffic. For example, if we took a route running along and into the west of London, one of the most important factors was the convenience afforded by the motor omnibus being able to pull up alongide the side of the streets where a person could board or alight from an omnibus with the least possible trouble, and to that class of traffic the question of being able to board the omnibus easily, and to get out at precisely the point of most convenience, was the factor that mainly influenced choice of transport. Therefore it seemed to him that, so far as traffic was concerned in the central west end of London, the motor omnibus would be able to play a most important part in the transportation of passengers, because, as regards traffic of that kind, their chief advantage was that a passenger can board the car wherever he liked, and probably get a faster journey by means of the motor omnibus than by the tramcar. But if you came to other districts—for example, in the east of London and in the north-east of London—he would suggest that motor omnibuses in those districts would not play the same important part that the tramcar plays.

Mr. P. V. McMAHON thought that both the tramway and the motor omnibus had each their own field, and that it was a good deal a question of traffic density which would determine whether a motor omnibus was the right thing or not. In small towns or sparsely-populated districts the motor omnibus deserved very careful consideration, and in most cases it would be found that the thing would pay. All things considered, and each method of transit chosen under the best conditions, perhaps the electric car would hold its own in the question of cost. Coming to the question of unreliability, he would like to bring Mr. Manville back to the early days of tramcars, not so much perhaps from the point of reliability of supply as reliability of the motor itself. In the early days we all suffered from the fact that the motors were too small for their work; if one could collect the statistics as to the percentage of breakdowns from motors alone, the percentage would be far higher than we had had lately in connection with motor omnibuses. In fact, tramway engineers were rather likely to overlook the early days of motors, and that arose from the fact that the present electric motor came from America almost in its present state. In America they had had their early troubles with the street cars, and very great troubles, too. About 16 years ago the City & South London Railway, who were the pioneers of heavy railway electric traction, had more than their share of trouble, and had to work out their own salvation in the way of motors, and he could safely say from experience that the breakdowns from motors pure and simple were certainly very much more than we had in the present motor omnibuses. He remembered in the very early days that on one occasion out of 14 locomotives they had nine breakdowns in two days.

Mr. E. SCHENK had occasion recently, in connection with a town where it was impossible to run tramways, to consider seriously the question of introducing a service of motor omnibuses, and with that object he obtained the best report he could possibly get in London from an expert from a motor-omnibus point of view. He took the average mean daily mileage as 120, and that he believed was a fair statement. He then proceeded to give the average number of days of work per annum performed by a series of about 10 different types of motor omnibuses, the result of which was that the annual average mileage performed during last year by a large number of those omnibuses in London was about 30,000 miles. He put the annual charges for motor omnibuses at £1,266, working out per omnibus-mile at 10·130d., exclusive of administration charges. Wages were given at 1·503d. per omnibus-mile; fuel (petrol, which he took at 7d. per gallon), 0·928d.; lubrication, 0·320d.; tyres, 2d. per mile; maintenance and repairs, 2d.; lost mileage, 0·172d.; depreciation, 1·360d.; insurance, 0·400d.; garage, 0·800d.; cleaning, 0·120d.; lighting, 0·080d.; supervision, 0·400d. On the point of tyres, this was his statement: "One firm is offering to contract for tyre maintenance at 1¾d. per car-mile. Those who have done it for 2d. per car-mile have hitherto lost money, but the experience gained has enabled them to say that it can be done at this price." Finally, he suggested that the comparative costs shown by motor omnibuses hitherto were hardly fair, inasmuch as most of them were under-powered, and many of them ill-designed, but that the omnibuses being made to-day were of higher power (which he put at 28-40 H.P.), and were likely to have a five years' instead of a three years life, and to give distinctly better results. Mr. Schenk also had in his hand the accounts of the Yorkshire (West Riding) Electric Tramways, in which the expenses per car-mile were as low as 3·768d.

Mr. BURFORD did not think that the motor omnibus would at any time replace the tramcar—only under certain conditions. His theory had always been that motor omnibuses should simply be feeders to the trunk lines of tramways. He criticised the way in which some motor omnibus concerns had been started without proper organisation and suggested that under improved conditions the results would compare very favourably with any of the tramway results brought forward.

Mr. W. L. MADGEN was of the opinion that if the petrol engine was the better motive power, the ultimate solution to the question would be to place it in a vehicle running on rails.

Mr. W. A. HARPER mentioned a case where the operating costs per omnibus-mile averaged 8d. and the average receipts throughout the year were 10d. per omnibus-mile. He thought there were great difficulties in comparing motor omnibuses and tramways on general lines.

Mr. GEORGES DE PRELLE spoke at some length, giving details of the running of a line of motor omnibuses with which he was connected and the organisation of his overhauling department by which he claimed to be able to keep 91 per cent. of the cars on the road.

NOTES ON BOOSTER DEVELOPMENTS.*

BY A. H. KELSALL.

Instead of automatically working an end-cell switch, the modern practice is to employ a booster, and do away with end-cells altogether. The booster may be simply a small shunt-wound dynamo worked in series with the main generator to give across the battery the higher voltage required for charge. It is, nowadays, usual to make the booster reversible, in which case the battery can be discharged at pressures *below* the line voltage, the booster making up the excess of 'bus bar voltage over battery voltage, instead of the excess of battery voltage over 'bus bar—that is to say, the voltage across the booster brushes can be dropped away from a maximum in one direction down to nothing, and then built up to a maximum in the opposite direction. This is effected by exciting the field on what is known as the potentiometer principle. This is the most obvious use of the potentiometer method of field excitation, but the system justifies itself also for excitation only in one direction where it is desired to get down to very small excitations. For if we do not adopt this principle, but connect resistance simply in *series* with the field, we must have infinitely high resistance to get infinitely small field. We therefore use the potentiometer method instead, and on an ordinary switch, having one long contact, and a single row of buttons, we get excitations as small as desired with quite moderate resistances.

But to return to the question of having the booster field reversible, the usefulness of this is best brought out by an example. Taking 1·7 volts per cell as the minimum on discharge, and 2·7 volts per cell as the maximum on charge, we might, with a non-reversing booster, install a battery of 141 cells for a 240 volt supply, and these would require a voltage of 380 volts for charge—that is, an addition of 140 volts from the booster. Supposing, however, we make our booster reversible, the cells at their lowest ebb will be assisted by the booster, and we shall obviously require fewer of them. To get the fullest use out of our reversible booster, we must arrange to require as many volts boost in one direction as in the other, but the difference between lowest voltage on discharge and highest on charge is, as before, 1 volt per cell, and a booster, therefore, with a range of ½ volt per cell in each direction is what is required. At the bottom of discharge the 1·7 volts per cell will be, therefore, boosted up to 2·2, and, to still maintain 240 volts, we only require 240/2·2 cells—that is, 109 cells instead of 141. And to charge these we require 109 × 2·7 volts—*i.e.*, 295 volts; that is, 55 volts above the line pressure. The required booster voltage is, therefore, 55 volts, instead of 140, so that the saving is very marked both in the number of cells required and in the size of booster.

That, then, is the modern hand-regulated reversible booster, a most useful piece of plant for getting full value out of a battery at any time of the day, for rapid handling of the battery, simplification of the switchboard, dispensing with end cells and end-cell connections, with all their attendant battery troubles and reduction in the number of cells.

Further developments have mostly been in the direction of making the booster changes *automatic*, more particularly for very varying loads, such as traction systems, where the variations in demand are a very large percentage of the total, and come and go with such rapidity as to make it impossible to meet them by hand regulation.

Under the heaviest working conditions the motor of a booster set is driving the booster, which is acting as a generator in series with the main generator or with the battery; but in the cycle of duty of every reversible booster, whether hand-regulated or automatic, there come times when the booster is tending to run as a motor. This tendency may be so slight that it is only sufficient to supply the losses, but, on the other hand, it may be sufficient to result in the machine, whose function is usually to *drive* the booster, doing quite an appreciable *generating* load. This is, of course, the state of affairs when commencing to discharge from a fully-charged battery whose voltage is well above the 'bus bars, and again when commencing to charge a battery whose voltage is well below the 'bus bars. In the second case both current and voltage of the booster are in the opposite direction from what they are in the first, leaving no doubt that it is also a motoring case. These are, of course, runaway conditions, the restraint on the motoring booster being solely due to the generating motor, but, fortunately, they are also conditions when the motor's current (now generating) is very small, and it is very unlikely to come off the line from blowing its fuses or bringing out its circuit-breaker.

And so it comes about that the biggest chances of a runaway occur when the booster is not really in the runaway condition; that is to say, the booster is generating, not motoring, and, therefore, if the motor comes off the line when doing heavy work, and no safety device has been provided, the set slows down to rest, and if the current in the booster persists sufficiently (as it probably will do, especially if it is a *discharging* current) the booster has no reason to do anything but start up in the opposite direction as a motor; attaining a speed depending of course on its excitation and the conditions at the time, but a speed which may often become *excessive*, to say the least of it.

In the ordinary hand-regulated booster, where the chances of a runaway are not considered sufficiently great to justify any special interlocking devices, there are one or two simple expedients well worth adopting. One is to take the motor current through the battery fuses, and have none but main circuit fuses in the motor circuit, so that in the event of a short on the motor the fuses which blow are also the battery and booster fuses, and the current which might cause motoring in the booster is interrupted. This arrangement has been adopted, and would appear to get over the difficulty quite satisfactorily with a booster on a two-wire system; or a single booster on a three-wire system, where as a consequence of working with a single booster there is no middle-wire connection to the battery. It does not, however, eliminate danger if the system is a three-wire system with two boosters. For in this case the motor takes its supply at each side, either through the fuse between it and the line (this occurs when charging) or through the fuse between it and the battery (this occurs when discharging). In the event of either of these alternative paths failing, due to the fuse blowing, the motor will continue running, because it will take its supply through the other path, but if that fuse also goes, disconnecting the motor on one side and the booster on the same side, both these machines are eliminated as motors, but the booster on the *other* side is still able to get up speed as a motor, the circuit being completed by the middle wire.

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* Abstract of a Paper read before the Glasgow Local Section of the Institution of Electrical Engineers on April 10th.

Another device, therefore, which, as far as I know, is original, is to take the excitation for the booster fields from across the motor brushes, so that as the motor slows down the booster excitation dies away, and when at rest the booster has no field wherewith to start up in the opposite direction, and the brushes being at the neutral position, no field due to the armature current. This arrangement seems to have the additional advantage that the set slows down more gradually.

The author then gave a very clear description of the Lancashire automatic booster (see *The Electrician*, Vol. LIII., p. 303), after which he proceeded as follows:—

In many cases where the battery is not justified on the score of expense and attendance, the "Lancashire" automatic booster may be used in conjunction with a shunt or, preferably, compound machine coupled only to a heavy flywheel, the combination of machine and flywheel taking the place of the battery worked on alternations of charge and discharge of one or two minutes' duration. The field of the flywheel machine is excited across the mains, and the armature works in series with the booster armature across the mains. The flywheel machine can be run up to speed off the mains, and if the demand is just at the time average the flywheel runs at a speed corresponding to the voltage of the mains. Now, if the load drops away the booster voltage rises in a charging direction, increasing the voltage across the flywheel machine, and so using the surplus of demand in storing extra energy in the flywheel by speeding it up to a maximum speed approximately proportional to the sum of the 'bus bar and maximum booster voltages. If, now, a peak comes on of about equal area to the recent valley, the flywheel set supplies the surplus, dropping to the normal speed again. But if the demand is protracted it drops further, giving out energy to supply the surplus demand until the demand again falls below the average, when the flywheel again speeds up. The bottom speed limit is similarly proportional to the difference of 'bus bar and maximum booster voltage, and the range of speed variation of the flywheel set is, therefore, proportional to twice the maximum booster voltage.

The current the flywheel machine must carry depends upon the difference between maximum and average demand, and the size of booster set depends solely on the fluctuations in flywheel speed we propose to adopt. If, for the sake of utilising a good fraction of the total energy of the flywheel, we propose big fluctuations in speed, we are, of course, reducing the cost of the flywheel and increasing that of the booster. Exactly what fluctuation in speed gives the smallest capital expenditure I cannot say—it depends on many things; but the energy being proportional to the square of the speed, it is certainly not worth while to reduce the speed *very* far. A 1 per cent. drop in speed gives us, of course, approximately 2 per cent. of the energy; but 64 per cent. of the energy is probably a rather poor return for the trouble of dropping the speed 40 per cent We extract half the energy by dropping about 30 per cent., and this is probably about a suitable percentage for practice.

Taking a level compounded machine coupled to a flywheel built up from steel plates 11 ft. diameter; the maximum working speed for this diameter would be 840 revolutions. Suppose we run up to 750 revolutions, and assume a maximum working drop of 30 per cent.—that is, to 525 revolutions. If the supply voltage is 500, the speed of the flywheel machine with no boost being 638 revolutions, the maximum working boost is about 88 volts in each direction. The stored energy of this wheel's rim, if made of plate rings 11 ft. outside diameter, 5 ft. inside diameter, and total thickness 6 in., is 32,700,000 ft.-lb., 16,700,000 ft.-lb. being extracted in dropping 30 per cent. in speed. This is, say, 500 H.P. for a minute, or, what may be of more practical use, 200 H.P. for 2½ minutes—that is to say, that this flywheel machine could deal with a *rectangular* peak 200 H.P. above the average demand, and lasting 2½ minutes, or the same peak of purely triangular shape extending over five minutes, or say the peak of the shape of average practice extending over from three to four minutes. The weight of the flywheel rim c[illegible]ted is only between 8 and 9 tons.

DISCUSSION.

Mr. **ROBERTSON** said they had 36 cars in Greenock, two or three of which only were run during the lightest load. These were increased to 12 about the middle of the day, and eventually to 36 in the evening. Their load varied from 50 to 1,000 amperes, and before they installed their booster they had to run a 300 kw. set constantly and at the heavy part of the day they had to run an additional 150 kw. set, while sometimes on holidays and other occasions they had to run two 300 kw. sets. Since installing the booster and battery, however, they were able to take their load all day on a 150 kw. set till night time. He had to take exception to Mr. Kelsall's remarks regarding the generator current being kept constant, as he thought it must have fluctuations of something of the order of from 3 to 5 per cent. He thought the weakness of the Lancashire booster was the number of coils they had on the magnets. The efficiency must be low, and he had found from tests on their shunt booster that the loss was 8·7 per cent. of the units generated.

Mr. **PARSONS** (Govan) said he would like Mr. Kelsall to give some figures of the amount of energy the motor took to drive the booster, as in his case he had found the motor to take 26 per cent. of his battery current.

Mr. **McWHIRTER** thought that the question of efficiency was a very important one, and would like Mr. Kelsall to give some figures.

Mr. **KELSALL**, in reply to Mr. Robertson, said he did not consider that the choice of a booster rested entirely on the question of efficiency and the rapidity with which it responded to changes in load, but thought that absolute reliability should be placed first. With regard to Mr. Robertson's remarks relative to the generator current, he thought anybody would be satisfied with such a small variation as 3 per cent. or even 5 per cent. He admitted that the number of coils in the Lancashire booster was a weak point and meant that the magnet frame had to be large in comparison with the output. Replying to Mr. Parsons regarding the energy required to drive the booster, it depended entirely, of course, on the size of the booster, and he was not surprised at the figure Mr. Parsons had given, seeing that his machine was capable of taking the whole power of the station. With regard to efficiency he thought that that could be brought up to 80 per cent. at top load.

ELECTRICITY SUPPLY IN PARIS.

We have before us another long report on the electricity supply question in Paris. The present position is that the concessions granted to the six companies which are supplying in that city expire at various dates from April 8, 1907, to December 11, 1908. At the date of the termination of each of these concessions, the distribution network in question becomes the property of the municipality, but not the generating stations, and yet no arrangements have been come to for providing for a continuity of supply.

The municipality has got so far as to decide that it will not erect a generating station itself, and has received tenders from several firms for the continuance of the supply. The first batch of proposals were published in our issue of December 8th and one of these was recommended for acceptance by the Prefect of the Seine acting on the advice of his engineers. This tender was from the Société d'Etudes pour l'Exploitation de l'Energie Electrique à Paris—a syndicate formed by the two large electrical companies Schneider & Co. and Mildé & Co., and the terms were set forth at some length in our issue above referred to. Briefly the syndicate offered to take over each concession from the existing companies as it expired and undertook to provide a continuous service until the year 1938, paying the municipality 8 per cent. of the gross receipts from the sale of currrent, *plus* 45 per cent. of the yearly profits, and these payments were to amount to a minimum of £160,000 per annum.

The Municipal Council decided to invite further proposals, however, and these are dealt with by the Prefect of the Seine in the present report. Eleven offers have been received from the following: M. Koszarski, La Société Civile des Services Publics, M. Aboilard, MM. Dubois, Lhuillier and Génard, M. Faget, the Lahmeyer Company, M. Victor Popp, La Société d'Electricité de Paris, M. Nave, M. Sciama, and M. Coizeau.

The first four offers are set aside because they are either incomplete or do not offer acceptable financial or technical guarantees. Among these, the tender of MM. Dubois, Lhuillier and Génard is the most interesting, as the firm proposes to utilise a H.T. continuous-current system—6,000 amperes at 25,000 volts. A hundred sub-stations were to be connected in series by a loop of single cable, and each of these was to contain a storage battery permanently in series in the H.T. circuit and supplying the L.T. network through a 1 : 1 continuous-current converter. The firm responsible for the tender offer to supply a battery suitable for this remarkable service.

M. Faget proposes to act as middleman, buying the electrical energy in the best market and distributing it to the consumers, and this is rejected as an incomplete scheme.

The tenders of the Lahmeyer Company and the Société d'Electricité de Paris are to supply "in bulk" to the municipality, in the former case from a new station and in the latter case from the new St. Denis electricity works, which would be extended for this purpose. The prices are, respectively, 12c. (1·2d.) per kilowatt hour at the secondary terminals of the sub-stations, and 7·2c. (0·7d.) per kilowatt-hour at the H.T. terminals of the sub-stations, *plus* 115fr. (£4. 12s.) yearly per kilowatt demanded. As this would mean that the municipality would incur the risk of a financial loss in distributing the current, neither of these is recommended for acceptance.

MM. Popp and Nave do not give the financial guarantees required, and MM. Coizeau and Sciama's offers are also considered unsatisfactory, because they do not embrace the "transitional" period immediately following the expiry of the various existing concessions and for other reasons.

The offer of the Schneider-Mildé syndicate is, therefore, once more recommended for acceptance.

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MOTOR OMNIBUSES AND TRAMWAYS.

The notion that there is an essential antagonism between tramways and motor omnibuses as means of passenger transport is a false one, mainly due to the flamboyance of sensational journalists and the interested productions of company promoters. Responsible men acquainted with the technical and commercial conditions affecting the economical carriage of passengers along public highways know very well that the question is quantitative, not qualitative. The best way to carry a given traffic must depend upon the nature of the traffic. To deliver a ton of coals by parcel post would be obviously silly. What kind of traffic can be best dealt with by each of the contrasted methods evidently depends upon the particular advantages which each possesses and what these advantages amount to in economy and convenience.

The Paper read before the Automobile Club by Mr. E. MANVILLE attacked the question by the method of concrete example, and showed pretty conclusively that in the case selected the electric tramway has an overwhelming advantage, expressed in financial terms. That conclusion was not seriously contested by the motor 'bus advocates who took part in the discussion. It is an arithmetical deduction from indisputable facts, and can be very simply stated. Taking only the financial side, the tramway requires a larger capital expenditure, in return for which the operating expenses are notably smaller, and so long as the capital charges plus the operating expenses per unit of service rendered total less than those of the motor omnibus, the tramway has the economical advantage. In the case at Leicester, as presented by Mr. MANVILLE, the line is drawn at a 13 minute service—that is, for any less frequent service the omnibus would have the advantage. This is not necessarily a general truth, because the capital expenditure upon a route mile of tramway will be to some extent dependent upon the traffic expected. For such a service as 13 minutes a single line with three or four turnouts per mile would suffice, instead of a double line throughout, and the economical limiting service would be something less frequent. Probably a 20 minute service is the smallest that can be remuneratively carried on an electric tramway in this country under average conditions of construction cost.

If the cost of working motor omnibuses diminishes, as may be expected with further experience, the limit of equal costs will move towards the more frequent service. The working costs of the omnibus cannot be brought down to the tramway level until the road surface is such that the tractive effort needed is no more than with a steel tyre on a steel rail, and the smoothness of running is also equalled. Until this point is reached the question of motive power does not arise. Whatever can be used on an omnibus can be used on a tramcar; but the converse does not hold, as the tramway benefits by the substitution of one large power house for a number of small engines running under the uneconomical conditions of a highly-variable load. We can leave the "trolley omnibus" out of consideration. Hence, ultimately, wherever a large traffic has to be carried along a defined route, the economical question reduces itself to the relative costs of providing a railway on the street surface and of providing a street surface equal in quality to a railway. What the latter would cost is a little hard to guess, but it seems improbable that the work will be done at the public expense for the benefit of the shareholders in omnibus companies. At present the provision of 16 in. of rail width suffices for the public passenger traffic on most routes.

The omnibus advocates leave out of their cost estimates the capital and maintenance expenditure upon the roads and streets which they use, but the tramways are charged not only with such expenses upon their own proper road, the rails, but also maintain a paved surface used by other traffic, and pay rates which are partly devoted to general road maintenance. In considering the question, a local authority must, therefore, ascertain the whole cost of a motor omnibus service, and the item of road maintenance must be included, just as it is included in tramway accounts, but the rates paid by tramways should be deducted from the tramway working expenses, for such payments are merely extra rates or tolls levied upon tramway passengers for the benefit of the general body of ratepayers by a legal anomaly. To what extent rubber-tyred vehicles damage road surfaces is at present indeterminate, but the general opinion of road authorities is that macadam suffers severely. The dust clouds seem sufficient proof. The effect upon wood, asphalte and granite will take time to ascertain, and be somewhat difficult to observe without special experiments, which it is, at present, nobody's business to make. Until the horse is done with as a tractor, the best pavement for self-propelled vehicles cannot be adopted on ordinary roads; possibly special motor roads will be constructed before that day arrives.

The discussion on Mr. MANVILLE'S Paper brought out very clearly the claims made on behalf of the motor omnibus on account of greater elasticity of service, greater safety and convenience to the other users of the road, and various virtues difficult to appraise by the rules of finance and arithmetic. Some of these are matters of opinion. The elasticity of the service is really only stating in another way what we have put forth above. Where traffic is from whatever cause insufficient to pay the capital charges on a tramway, the motor omnibus may find a useful sphere. This is especially the case with intermittent traffic, such as that to holiday and sporting resorts, and even the morning and evening business traffic may provide a suitable field for such vehicles, especially as gatherers or distributors from railways and tramway termini over thinly populated suburbs. But it will be clear that for such work to be remunerative the aggregates of the different variable traffics must give the omnibuses a good "load factor," or the working expenses and capital charges will not be covered. In districts where the passenger traffic has a sufficient "diversity factor" it may be possible to do very well by diverting vehicles from one route or district to another to suit the changing needs. On the other hand, it is a commonplace of transport experience that nothing encourages traffic like a regular and punctual service, and the flexibility of the omnibus may be over-exercised.

The greater safety to other users of the streets claimed for the omnibus is at present a matter of opinion, but no doubt comparable statistics will presently be available. The Home Secretary stated, in answer to a question in the House of Commons a few days since, that, within the Metropolitan Police area, the reported accidents due to motor omnibuses during the months of January, February and March amounted to nearly 900, which seems a fairly large number for the relatively few vehicles in use. The "overtaking power" and power of getting through traffic which are claimed as virtues and elements of speed and safety may be elements of risk, and certainly inspire a certain amount of fear in other users of the road. Smell, noise, side-slip and fire risks may doubtless be reduced by the march of invention and the teaching of experience; and in this connection we may quote Mr. BURFORD'S views as expressed in the discussion of Mr. MANVILLE'S Paper: "I think it is fatal to the industry that this rapid development has taken place. The demand made on motor manufacturers during the last 12 months must of necessity bring hurt to the whole industry." Any vehicle which carries its own power station through the streets has potentialities of mischief which only experience will reduce to negligible proportions. The recorded fate of an Edinburgh 'bus last Saturday shows that the risks are real enough, so long as petrol is the predominant motive agent.

The discussion at the Automobile Club and that which followed Mr. MACDONALD'S Paper at the last meeting of the Tramways and Light Railways Association make instructive reading; but naturally the opinions expressed need weighing as well as counting. If those newspapers which have so eloquently preached the imminent supersession of the tramway could summarise the facts presented, and put before their readers the views of the responsible automobile men as prominently as they have announced the coming end of the tramway, and have advertised the prospectuses of too many motor 'bus companies, they might yet save the money of many innocent investors, and relieve the motor manufacturers from the uncomfortable pressure which they now suffer.

In conclusion, we would repeat that the electric tramway holds its own as the most economical, convenient, and generally useful means of carrying a large passenger traffic along definite routes. Prophecy in these matters is rash, but we do not think we incur any serious risk in predicting that at least our existing tramways in populous places will have ample opportunity to wear out before they are superseded.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

The Mechanical Engineering of Collieries. By T. CAMPBELL FUTERS. (London: The Chichester Press.) Vol. II. Chapter V. Winding. 7s. 6d.

The second volume of this work, consisting of a series of articles which have appeared in the *Colliery Guardian*, maintains the high standard of excellence set by its predecessor (see *The Electrician*, Vol. LV., p. 224). Dealing as it does with both steam and electric winding, it is of particular interest on account of the recent discussions which have taken place on this subject. After entering very fully into the details and design of steam winding plants, the author briefly reviews the pros and cons of electrical methods. For main-shaft winding, he says, electric winding is in the experimental stage, and each particular case must be considered on its own merits. For small auxiliary winding plants, however, either on the surface or underground, the author states that without doubt it would prove economical to take out an existing steam winding engine and replace it with an electric motor. He points out that the chief advantage in favour of electric winding is that of economy in steam consumption, and remarks that the relative advisability of installing steam or electric winding depends, to a great extent, on the cost of fuel at the colliery and the required capital outlay. If the fuel is of marketable quality the adoption of electrical winding will no doubt, though entailing greater capital outlay, justify the expense. Again, where an electric power company can deliver current at a really cheap rate, both capital outlay and working expenses may be reduced.

Following these general considerations we have descriptions in some detail of various types of electric winding plants ranging from small gear-driven machines with single motors to the large sets on the Continent with Ilgner flywheel motor generators, an arrangement which has now superseded batteries for dealing with the starting peaks of the load. Two remarkable installations with Koepe pulleys and winding motors at the top of the head gear are described.

The remainder of the book is devoted to safety appliances, such as detaching hooks for the prevention of overwinding and other mechanical details of cages and winding equipment. An index would add to the value of the volume, but we presume that this will be provided when the forthcoming portion of the work is completed.

The School Magnetism and Electricity. By R. H. JUDE. (London: W. B. Clive.) 3s. 6d.

The object of this book is sufficiently indicated by the fact that matters of "primary importance for a thorough mastery of the London Matriculation" are printed in large type, smaller characters being reserved for those of "secondary importance." The work is founded on the author's *First Stage Magnetism and Electricity*, and the treatment of the subject is mainly based on the conceptions of potential and potential gradient. In common with most elementary text books, the earlier portion of the book is mainly devoted to "frictional" electricity, and it is not until the student has plodded through some two-thirds of the volume that he is introduced to the ampere. We cannot help thinking that the reverse order of things tends to much less confusion in the mind of the beginner, and that the conceptions of potential gradient given him by a preliminary consideration of the so-called "Voltaic electricity" would be found to form a better groundwork for his electrical studies than what may be described as the "pith ball" portion of the subject. Again, we cannot see that any useful purpose is served by such descriptions as tend to make the student believe that the ordinary source of E.M.F. in a laboratory is still a Grove cell. These little matters are, however, probably not entirely the fault of the author, but are doubtless due to the academic conventions of those who frame the examinations for which the book is intended. The author had a difficult task to combine the two objects of examination-passing and of observing a due sense of proportion in the presentation of his subject, but he has produced a clearly written volume, which should be useful to those to whom it is dedicated.

The Energy Chart. By Capt. H. RIALL SANKEY. (Rugby: A. Frost & Sons.) 10s. 6d.

Capt. Sankey treats chiefly in this book with the applications of the much-discussed entropy-temperature diagram, or, as he names it, with the addition of volume lines, the energy chart, to reciprocating steam engines. He also introduces a "quality line," by which the chart became applicable to a greater range of practical cases. The thermodynamics of a perfect gas are only considered in so far as they relate to steam engines, and a large portion of the book is devoted to the consideration of $\theta\phi$ diagrams prepared from indicator diagrams and their use in steam-engine design. Superheated steam is considered, and a short chapter deals with the SO_2 engine. An appendix gives useful formulæ, and the work concludes with a short bibliography of the subject.

Handbook on British Patents for Inventions. (London: Day, Davis & Hunt.) 6d.

This handbook contains in compact form an exposition of the present law and practice affecting the obtaining of British patents, describing the procedure necessary on the application for and granting of a patent, with notes on the granting of licenees and assignments. Some remarks and advice addressed to inventors are added, followed by a tabular statement of the numbers of applications in various periods since the year 1617, and a list of foreign countries in which patents are obtainable. The information is clear and succinct, but the handbook does not, of course, in any way pretend to enable anyone to dispense with the services of a skilled patent agent.

The Engineer's Pocket Dictionary—French-English. By M. LVOFF. (London: Percival Marshall & Co.) 1s. 6d. net.

This handy little technical dictionary, measuring about 6 in. by 2¾ in., and less than ¼ in. thick, cannot, of course, claim to be complete, but certainly contains a great number of words in common use in mechanical and electrical engineering and motor-car and cycle construction, which are not generally found in ordinary dictionaries. A point conducing to conciseness is the omission of such words and expressions as are so much alike in the two languages that there is no necessity to consult a dictionary to ascertain their meaning. This, however, has not been carried too much to extremes. The provision of a thumb index facilitates the use of the little book.

"Elektrische und Magnetische Messungen und Messinstrumente." By H. S. HALLO and H. W. LAND. Based on van Swaay's "Magnetische en Elektrische Metingen." (Berlin: J. Springer.) 15m.

The task which the authors of this volume have set themselves has been to prepare a treatise intended primarily for technical college students and for engineers with a "technical college education" (Hochschulbildung). As far as the first class of readers is concerned, it may be said at once that the authors would appear to have succeeded admirably. The engineer, however, in spite of a "technical college education," has often a pronounced preference for graphical and commonsense methods of arriving at results rather than by the use of the calculus, and he might possibly resent the authors' laudable endeavour throughout the book to subordinate "instruction" to "education." He might maintain, for example, that it did not require a formula to convince him that the probable observation error in a voltmeter with an open scale was less than in one with a close scale, or that an instrument whose indications were proportional to the square of the current would be free from wave-form errors, but perhaps, after all, it is really the engineer who does not know what is good for him.

The chapter on Units and their derivation is extremely good, and the student is skilfully pilotted past the many obstacles which beset his path at this point. In the next two chapters galvanometers and resistance measurements are dealt with, and these chapters, which occupy nearly one-fifth of the whole book, are certainly among the best. It is a subject which the authors appear to have made particularly their own, and several little practical hints which they give are extremely valuable. The theory of both dynamometer and induction wattmeters, particularly the latter, is very clearly and concisely given, as are also the various methods in use for obtaining the much coveted 90 deg. lag. On the other hand, the chapters on ammeter, voltmeter and wattmeter calibration and testing are hardly so full as one could have wished, and insufficient space has certainly been allotted to instrument transformers, polyphase power-factor indicators and moving-iron instruments (which the authors apologetically call "electromagnetic"). Various forms of supply meter are dealt with fairly fully and successfully—though the entire absence of electrolytic meters is curious—and full use is made of the 50 pages allotted to magnetic measurements. The sphere of usefulness of the book has unfortunately been enormously reduced by the unaccountable absence of any index.

Turbinen Anlagen. By Wilhelm Wagenbach. (Berlin: Julius Springer.) 15m.

Herr Wagenbach's book contains descriptions, clear and to the point, of a large number of up-to-date water-power schemes. Not a few are of special interest to the electrician, such as the power stations at Rheinfelden, Chèvres, near Geneva, Lyons, Kykkelsrud (Norway), Niagara, St. Maurice (from which station continuous current at 20,000 volts is transmitted to Lausanne), Neuhausen, &c. The text is illustrated with numerous clear drawings, and over 50 folded sheets at the back of the book contain details of the water turbines of all types and sizes dealt with in the descriptive part of the book. Although the descriptive matter takes up by far the largest portion of the work, the author has not omitted to include a simple and eminently practical theory on water turbines to enable readers who are not expert water engineers to determine the type, speed and chief dimensions of a water turbine for any given set of conditions. A short table of contents is given at the beginning of the book, but the search for any particular subject would have been greatly facilitated if a regular index had been provided. The printing of the engravings and the general finish of the book leaves nothing to be desired.

HOMOPOLAR SINGLE-PHASE MACHINES.

The following is an abstract of the English patent specification No. 8,569 of 1905, granted to the British Thomson-Houston Co. for single-phase motors and generators of the homopolar type :—

We have discovered that a machine of the unipolar type may be adapted, by laminating its field structure and properly proportioning and arranging the several parts, for efficient commercial operation on alternating-current, either as generator or motor. In a generator thus arranged, the speed at which the armature is driven has no effect upon the frequency of the currents produced, but only upon the voltage. Such a generator possesses advantages for operation at ordinary frequencies as compared with machines of the usual construction, since there is no danger of its falling out of synchronism, as it has no synchronous speed, but will operate at any speed, delivering currents of a frequency determined by the frequency of the current supplied to its field coil. Such a machine is particularly advantageous for use with steam turbines, since it renders it possible to obtain the usual commercial frequencies with as high a speed as desired. Furthermore, such a generator possesses the great advantage of rendering it possible to obtain commercially alternating currents of exceedingly low frequencies such as three or four cycles, frequencies which have been commercially unattainable with machines of the usual type. Similarly, as a motor, the machine may operate on a current of any frequency and at any speed. As a motor the machine will start under load, and will operate sparklessly for all loads and speeds.

In its broadest aspect we claim as our invention an alternating-current dynamo electric machine, comprising a laminated unipolar field structure provided with a field winding adapted for connection to a source of alternating current, and a plurality of armature conductors arranged to be traversed by the flux of said unipolar field and relatively movable thereto. Fig. 1 shows a cross sectional side elevation of a machine arranged in accordance with our invention; Fig. 2 shows a cross section of the field structure on line 2—2 of Fig. 1; Fig. 3 shows an end elevation of one of the armatures; and Fig. 4 shows a diagrammatic development of the armatures and brush connections. In the drawings A represents the field structure, which is composed of laminations of magnetic material. In order that the field structure may be readily assembled, we form it of a plurality of sections, as shown in Fig. 2, each section consisting of a body of parallel laminations arranged in planes parallel with the shaft. These sections at their inner extremities are in contact with or near to each other, so as to form a substantially continuous magnetic ring. This ring may be broken at one or two places as indicated at *a′* in Fig. 2 in order to prevent the circulation of eddy currents, as will be hereinafter explained. The several sections, of which there are shown four in Fig. 2, extend radially outward, diverging from each other, and are held together by the frame pieces *aa*. The spaces between the sections afford convenient access to the collecting brushes, as will hereafter appear. BB′ in Fig. 1 represent the field or magnetising coils. The bearings *ee′* are made of non-magnetic material, so as to prevent leakage of the field flux through the shaft. Secured to the shaft near its opposite ends are the two armature hubs or bodies CC′. The hub C is provided with two clamping rings *c* between which are clamped the armature conductors D, which are suitably insulated from the clamping rings. The construction of the armature which we have shown resembles somewhat that of the commutator on a direct-current machine. This construction is shown in end elevation in Fig. 3. The armature conductors D are sector-shaped and radially arranged in a solid mass, and are made of magnetic material, such as iron or steel. With the laminated field body A, the armature conductors form a nearly closed magnetic circuit for the flux of the field coil B. A similar path through the armature conductor D′ is formed at the opposite end of the machine for the flux of the field coil B′. Since the air-gaps between the armature conductors D and the field structure A are radial, they may be made much shorter than in a machine as ordinarily constructed, since it is unnecessary to provide for wear of the bearings which, in the usual type of machine, if the air-gap were made too small, would soon bring the armature in contact with the field structure.

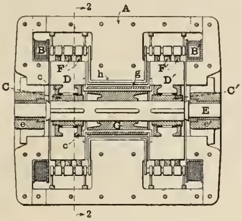

Fig. 1.

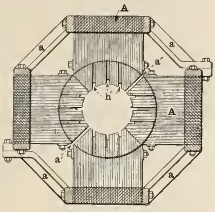

Fig. 2.

The flux passes through both sets or armatures D and D′ in an axial direction, so that the E.M.F. induced by rotation is in a radial direction. If the field coils B and B′ are properly connected, the E.M.F. induced in the conductors D may be radially inward at the instant that the E.M.F. induced in the conductors D′ is radially outward. Consequently it is possible to place a conductor D in series with the conductor D′ by connecting their inner ends. Such connections are shown at *g* in Fig. 1. These conductors may be supported in a member G keyed to the shaft. In order to reduce magnetic leakage from the field structure A to the shaft, this member may be made of non-magnetic material. F and F′ represent brushes bearing on the outer ends of the conductors D and D′ respectively, all collecting devices intermediate the conductors, and the brushes being dispensed with in the arrangement shown. Since the conductors D and D′ are connected in series, as has been heretofore explained, an E.M.F. exists between the brush F and the brush F′ bearing in the corresponding conductors equal to the E.M.F. of two conductors. The terminal voltage of the machine may be made as high as desired by connecting brushes at opposite ends of the machine in series. This connection is preferably made by means of conductors *h*, which are placed in holes or slots at or near the inner periphery of the field structure A. The conductors *h* and *g* serve mutually to neutralise the other's self-induction. The inner periphery of structure A is shown slotted in Fig. 2 at *h′* in order to receive these return conductors.

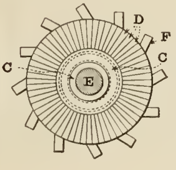

Fig. 3.

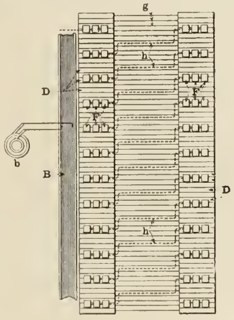

Fig. 4.

Fig. 4 shows a development of the two armatures and their connections. The field coils are indicated at B and in this case are shown connected to an auxiliary exciter *b* supplying alternating current. The two sets of armature conductors are represented at D and D′, and F and F′ represent the brushes bearing on the periphery of the conductors. The connections *g* permanently connecting opposite conductors, are shown in full lines, while the return conductors *h* supported by the frame are shown in dotted lines. Twelve sets of brushes are shown on each armature. Since the brushes are all connected in series, a terminal voltage equal to 24 times the induced voltage of one conductor is obtained. The terminal voltage may be varied as desired by varying the relative connections of the brushes. For the sake of simplicity each return conductor in Fig. 4 is shown connecting a brush to the brush next to its opposite brush on the other armature. This arrangement obviously produces such a distribution of potential on each armature that the maximum voltage of the armature exists between the two adjacent brushes. This would be undesirable in practice, and accordingly the connections would ordinarily be arranged so that the maximum potential would exist between opposite or nearly opposite points on each armature. Such a change in the connections will be obvious to those skilled in the art. A machine of the character described may be self-excited or separately excited, and if self-excited may be shunt, series or compound. When self-excited, it of course requires, like other asynchronous generators, a synchronous machine connected to the same system to determine the frequency. While only a portion of the armature conductors are at any instant in circuit, the current density for this reason may be high, so that the same output per unit of weight may be obtained as if all the armature conductors were all the time in circuit. It will be seen that since the armature conductors are all revolving in a uniform field, the E.M.F.s induced in all the conductors will be equal. Consequently, there can be no short-circuit currents under the brushes at any time, and sparkless operation is therefore secured. Moreover, the variations in current in adjacent conductors in passing under a brush are such that the self-induction is mutually neutralised.

Since the field flux is parallel to the shaft it is essential, in order to prevent eddy currents, that the electric continuity of all conductors surrounding the shaft would be interrupted. Thus, for instance, if collector rings are employed between the conductors and brushes, the electrical continuity of the rings must be interrupted. It is for this reason that the continuity of the ring forming the unipolar field is interrupted by air-gaps a^1, as shown in Fig. 2. Since the revolving disc armatures are formed of separate conductors, eddy currents are prevented by suitable insulation placed between adjacent conductors, as in the construction of an ordinary commutator.

The specification has six claims and is dated April 20, 1905.

THE COST OF ELECTRICITY PER UNIT FROM PRIVATE ELECTRICAL PLANTS.

The following is an abstract of the discussion which took place upon Mr. Wilson Hartnell's Paper on the above subject read before the Leeds Local Section of the Institution of Electrical Engineers on February 15th. An abstract of the Paper itself was published in *The Electrician*, April 6th, p. 1021.

Mr. W. EMMOTT said there was a difficulty in inducing manufacturers and others in Yorkshire, in particular who have their own plants, to see that in many cases it would pay them better to take an outside supply. In very few instances is any debit made to the electricity account for power, either in regard to coal or proportion of maintenance charges on engine and boilers. He had found many instances where the only debit made was for a renewal of lamps, and this was entered in the accounts as the cost of lighting.

Mr. DICKINSON wished to emphasise the fact that the figures of costs given were much too low. Regarding example No. 8, he had taken out the load factor for a similar factory, at present working from the Leeds supply mains, and found the load factor only 5 per cent., whereas Mr. Hartnell's figures worked out at 10 per cent. load factor. The oil, according to Mr. Hartnell, worked out at 0·025d. per unit, which he thought was too low considering the load factor. By correcting the load factor and making some slight correction for oil and maintenance, the cost he thought should be nearer 3·56d. than 1·6d. We regard to No. 10, with Mond gas plant in duplicate, his figures were also much too low. He had some figures for a similar sized plant, given by gentlemen who were considered to be authorities on gas plants, as follows: Maintenance for a plant of this size, 0·092d.; oil, 0·084d. The estimate, therefore, with the above correction, instead of being 0·619d., works out at 0·756d. Since they had started in Leeds they had changed over a number of private installations, some of them with large plants, and are still going on changing, which they would not be doing if the figures given were correct. If they could produce electrical energy at even 1·6d., they would not pay 4d. per unit for it as at present.

Mr. WOODHOUSE considered that the value of the examples generally was vitiated by the units being estimated, and picked out several examples where costs had, in his opinion, been taken too low. He compared the maintenance cost of 0·017d. per unit, given in case 10, with the Walthamstow gas-driven station when the engines were still in the makers' hand, which a maintenance cost of 0·1d. per unit, and which itself was an excellent figure for such plant. He also quoted a case of a suction gas plant in which the cost per horse-power-hour worked out at 1·388d. This plant was for an engineering shop, and the horse-power-hours used per annum were taken as one-quarter of what the plant could supply if working at full load during the whole of the working hours.

Mr. PREECE said that there was no disputing what Mr. Hartnell had quoted in his Paper from a manufacturer's point of view. The central station engineers has spoken in their own way of thinking, as they were in a totally different position. When a manufacturer lights his works by electricity, or drives a portion or the whole of it by electricity, he uses his existing engines, boilers, buildings, and everything appertaining thereto, as in the majority of cases the land and buildings are his own property. If new engines and boilers are required new engines and boilers are put in, whether he operates by electricity or mechanical means, or by both. Many manufacturers have the large main engine operating on three-quarter load; the spare power is generally used for lighting the mill or transmitted to some other part of the works electrically, and small wasteful engines are replaced by motors. The cost of management, staff, land and buildings is a very small charge indeed on the portion of the works lighted or operated by electricity. He knew of many cases where there had been a reduction of the staff. He knew for an absolute fact places where electricity was generated and a liberal allowance made in every respect which was working out at ½d. per unit. Of course, there were many instances where the saving is a substantial one when supplied from outside. If time permitted he could give many instances in support of both sides. But in adopting electricity the financial results must certainly be decided by the man that has to pay the bill.

Mr. ROSLING said he thought that Mr. Hartnell should have allowed something for the switchboard in his capital costs, as a generator board was more expensive than a mere main switch and fuse. In his opinion the point mentioned by Mr. Hartnell of the value of capital employed was of the very greatest importance, the active working machinery had to provide the gross profit to pay the net profit and all other charges, and it was only when the money sunk in electrical plant was debited with a similar percentage that the real cost per unit was obtained. In the examples given he considered the items for depreciation, interest and maintenance were too low and the output in kilowatt-hour too high for typical cases; in the last example of a private house plant, it was quite impossible to obtain 4,500 kw.-hours at the accumulator terminals from 160,000 cubic ft. of gas; with 25 cubic ft. of gas per brake horse-power-hour and an overall efficiency of belt generator and cells of 50 per cent., 3,200 kw-hours was the maximum output and in ordinary practice for a plant of this size 2,250 kw.-hour might be considered good practice. This would make the cost 8d. an hour even with the extremely small depreciation figure assumed; from his own experience he was convinced that when running on cells 75 cubic ft. of gas was not too much to allow per kilowatt-hour output from the cells, and the interest and depreciation should be from 17½ to 20 per cent. He thought the most valuable feature in the Paper was the striking way the relative values of fuel and capital charges were shown in the Tables B and C; in really economical plants the fuel cost was a mere trifle compared to the capital charges, and it showed how the oft-repeated advertisement of 10 B.H.P. hours for one pennyworth of fuel was quite misleading, unless the capital charges per brake horse-power-hour were also given.

Mr. A. CAMPBELL said that the figures given in the Paper and also those of the dissentients from those figures struck him as being extreme figures in both cases, and he thought the truth, as is usual, lay in the average of the two. In his own firm's case the substitution of motors for engines was done to meet increasing demands for power owing to extensions, and this gave them an opportunity to consolidate their works and shelve the whole question of generating at the works for a few years, during which time the economical production of electrical energy would develop and more definiteness on the subject would be arrived at.

Mr. W. HARTNELL, in reply, said, regarding Mr. Emmott's remarks, a very useful Paper might be written on the advantages of purchasing electricity from a public company; but this is not the subject of this Paper. Mr. Dickinson had presumably based his load factor on the maximum lamps fixed; in most of these examples the dynamo must be overloaded to supply all the lamps. In example 10 the oil used per set per 12 hours was 1½ gallons each at 1s. 6d. per gallon. £18 should have been £48. With regard to Mr. Woodhouse's remarks, he trusted that on re-reading the Paper Mr. Woodhouse would perceive that the word "cost" was restricted to the *increment* of cost (or the addition to the previous total costs) which had been incurred by supplying electricity on the premises. This applies also to the assumed increase in the coal bills. This increase in example 2 was estimated from experiments made at Thames Ditton. The units have not been estimated from the rated output of the dynamos. Experience has shown that in many cases the use of electricity increases, and that dynamos in private firms are often overloaded to the utmost they will bear. In reference to Mr. Rosling's remarks as to private plants, 4,500 units were the estimated output of the dynamo—not more than 3,000 units would be used—the cost per unit would be about 10d. Presumably, no householder would install a private plant if a public supply were available.

LIFTS AND HOISTS.*

BY H. C. CREWS.

This subject embraces an extensive and very debatable matter. Fifteen years ago electric lifts were novelties. Since then they have come, been seen, and conquered. At least five of the leading English lift firms are to-day turning out three-quarters of their machines electrically equipped. They recommend same as of equal reliability to their hydraulic types, and are prepared to enter into practically similar maintenance contracts. The subject is purposely dealt with more in a commercial than a technical manner, in the hope that, at this stage in the development of the electric lift, actual figures and particulars may be of some use beyond the immediate scope of this meeting. No attempt will be made to unduly glorify the electric lift at the expense of its older hydraulic rival. The writer has been responsible for adoption of hydraulic as well as electric types, and thoroughly appreciates the simplicity and mechanical excellence of the former in its latest types, as turned out by high-class makers.

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* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers.

Full investigations and tests have recently been made on an equal number of actual hydraulic and electric lifts or hoists, as to general particulars, energy and maintenance details, total costs, &c. All tests have been taken during ordinary working hours and with machines under normal conditions.

Table I.—*General Particulars* (*Hydraulic Examples*).

Actual example. No.	Type.	Approx. prime cost, 1906 prices.	Rated full load in cwts.	Actual full travel in feet.	Average speed in ft per min.	Annual duty in 100,000 ft.-cwts
1*	C	£500	10	69·0	315	176
2	A	460	9	84·0	190	91
3*	A	270	7	62·0	170	74
4	B	260	6	43·0	168	33
5	C	500	10	38·2	160	75
6	B	180	7	55·0	160	29
7*	A	250	7	44·0	120	48
8	D	500	8	35·2	85	20
9	E	320	9	46·5	42	27
10	F	250	15	53·5	172	22
11	F	200	12	59·0	139	37
12	F	150	15	59·0	120	72
Average		£320	9·5 cwts.	54·0 ft.	153	58

* Now Nos. 21, 23 and 27 respectively, adapted to electric working.

Reference to Hydraulic types.

A.—High pressure, suspended, passenger. Variable power, two rams balanced. B.—High-pressure, suspended, passenger. Single ram, balanced. C.—High-pressure, direct ram, passenger. Hydraulic cylinder balance. D.—Low-pressure, suspended, passenger. Top and bottom open tanks and pump. E.—Low-pressure, direct ram, passenger. Ordinary weight balance. F.—High-pressure, suspended, goods. Single ram, balanced.

Nine hydraulic lifts and three hoists in all are tabulated; nine existing machines and three lifts which nearly a year ago were each adapted to electric working. These adapted machines were all first-class, and by no means out-of-date, examples. No. 1, a two-year-old high-pressure direct ram one, with hydraulic balance, by a leading firm; Nos. 3 and 7, both high-pressure fully-automatic variable power lifts, by one of the most experienced first class makers

Table II.—*General Particulars* (*Electric Examples*).

Actual example. No.	Type.	Approx. prime cost, 1906 prices.	Rated full load in cwts.	Actual full travel in feet.	Average speed in ft. per min	Annual duty in 100,000 ft.-cwts.
21*	BD	£350	7	69·0	210	176
22	TD(*s*)	375	12	53·5	170	315
23*	TD(*s*)	350	7	62·0	190	74
24	BD	375	7	36·0	155	74
25	BD	400	7	59·0	155	68
26	PB	380	7	35·0	86	33
27*	TD(*r*)	300	7	44·0	160	48
28	PB	450	7	21·0	100	3
29	TD(*r*)	300	7	46·5	126	7
30	GE	220	15	45·0	105	36
31	PE	160	7	42·0	95	90
32	GE	250	15	45·0	60	74
Average		£326	8·7 cwts.	46·5 ft.	134	83

* Formerly Nos. 1, 3 and 7 Hydraulic Examples respectively.

Reference to Electric Tests.

P.B. (push button).—Suspended, passenger. Direct-worm gear. Top or bottom, drum or sheave, drive. Fully-automatic push-button control.

T.D. (*s*) (top drive).—Suspended, passenger. Direct-worm gear. Drum or sheave drive. Car switch control.

T.D. (*r*) (top drive).—Suspended, passenger. Direct-worm gear. Drum or sheave drive. Hand-rope control.

B.D. (bottom drive).—Suspended, passenger. Direct-worm gear. Drum or sheave drive. Car-switch or hand-rope control.

G.E. (goods electric).—Suspended, goods. Direct-worm gear. Drum or sheave top drive. Hand-rope control.

P.E. (power electric).—Suspended, light goods. Single spur gear. Top sheave drive. Belt driven from continuous-running motor.

Good average hydraulic practice should be fairly exemplified with types taken, much in the proportion in which they are actually in use throughout the country. The various examples chosen cover most usual duties from a quiet 40 to a busy 1,200 journeys of varying travel per day.

The number of electric lifts not connected with public supplies is quite small, and all electric examples included in this Paper are, therefore, merely of usual types suitable for such connection.

Nine electric lifts and three hoists have been taken almost at random—only as in hydraulic examples avoiding bad local conditions.

Specially-advantageous electrical examples have, as a matter of fact, not been sought, otherwise Nos. 28 and 29 might have been substituted by similar ones working under busier conditions. Electric examples are merely included much in the proportion in which they actually exist throughout the country in a similar manner to hydraulic examples taken. Although their numbers are steadily growing, two electric press-button types are perhaps a large percentage to include after this assertion. As a set-off against this, however, all *but* two of the hydraulic types are high-pressure examples, whereas for every single town with a high-pressure supply available there are in this country nearly 100 towns without such advantages.

Table III.—*Energy Details, &c.* (*Hydraulic Examples*).

Actual example No.	Floors served.	Average ft.-run per single trip.	Load factor.	1,000 ft-cwts. obtained per 100 gallons.	Average price per 100 gallons.	Energy cost per 100,000 ft.-cwts.
1	3	42	0·20	3·0	3·4d.	£0·46
2	8	40	0·14	2·5	3·7d.	0·67
3	6	29	0·25	4·0	6·1d.	0·63
4	4	38	0·16	2·7	7·1d.	1·08
5	4	34	0·28	3·4	6·0d.	0·73
6	6	30	0·23	1·8	6·5d.	1·54
7	5	27	0·28	5·6	7.6d.	0·57
8	4	29	0·25	0·04*	0·13d.	1·28
9	4	30	0·33	0·20*	0·68d.	1·25
10	6	23	0·28	5·1	9·8d.	0·70
11	6	30	0·08	1·6	5·9d.	1·50
12	6	35	0·33	7·4	6·4d.	0·36
Average		32ft.	0·23	3·7	6·2d.	£0·89

* Low pressure, not included in totals of these two columns averaged.

Prime costs of all examples are taken at to-day's prices, based on recent actual quotations from respective makers. A considerable proportion of total first cost when installing a lift or hoist *of any type* is often due to structural causes, particular ideas as to safety gates, ornamentation of cage, enclosures, &c. Prime cost values scheduled are, therefore, exclusive of all building work or enclosures, but otherwise include reliable equipments with ordinary cages, safety gears, and everything necessary, fixed complete under moderately straightforward conditions.

Speed has been expressed in *average*, not maximum, feet per minute. Such average speed includes starts and stops on all usual trips demanded in each particular case.

Table IV.—*Energy Details, &c.* (*Electric Examples*).

Actual example No.	Floors served.	Average ft.-run per single trip.	Load factor.	1,000 ft.-cwts. obtained per B.O.T. unit.	Average price per B.O.T. unit.	Energy cost per 100,000 ft.-cwts.
21	3	42	0·28	7·5	1⅞d.	£0·10
22	5	25	0·29	7·8	1⅞d.	0·10
23	6	29	0·25	3·9	1⅞d.	0·20
24	4	27	0·28	3·9	1⅞d.	0·20
25	6	37	0·25	6·6	1⅞d.	0·13
26	4	24	0·28	4·0	1⅞d.	0·19
27	5	27	0·28	4·3	1⅞d.	0·17
28	3	16	0·24	5·4	1⅞d.	0·16
29	4	28	0·35	6·7	1⅞d.	0·11
30	5	29	0·20	8·7	1d.	0·04
31	5	32	0·28	3·4	1⅛d.	0·15
32	5	26	0·11	8·4	1⅞d.	0·09
Average		28 ft.	0·25	5·8	1·739d.	£0·13

The writer has made comparisons of lifts duties with a formula including a speed element, but thinks it better, for commercial reasons, on this occasion to merely adopt *net foot-cwts. actually demanded*, as useful work—both up and down—tabulating separately average speed at which such work is done and other essential conditions. For purposes of comparison in all cases the weight of lift attendant has been ignored. The writer thinks that he should be considered part of the balance load, and more or less counterweight arranged accordingly. All general items tabulated have been obtained either by the writer personally or by other qualified persons not directly interested in manufacturing either or both equipments. Absolutely all tests have been made recently, by the writer only, under average conditions of everyday use. Results have been carefully checked, and tests as a rule averaged over an ordinary week's work. This was the main reason for tabulating 100,000 ft.-cwts. as a standard of duty, being in some of the earlier examples investigated equal to a week's duty on a fairly busy 7 cwt. lift. Larger and busier subsequent examples have, however, increased this average somewhat. Hydraulic and electric energy have been measured by the respective public supply meters in each example taken.

The ratio of average net to full-rated (unbalanced) load, it may perhaps be permissible to refer to as load factor—not including the time element so important to station engineers and others. Including all raising and lowering trips, such load factor averages rather less than one-quarter; or raising only, approximately one-third of full load in the 24 examples given. With an increased number of hoists, or larger lifts, included, these fractions would probably be still smaller and relatively more advantageous to electric equipments. This unavoidable condition of working is—more than has yet been generally realised—one of the chief causes of electric working being nearly always so much cheaper than hydraulic.

Electrical energy in all examples averages less than one-sixth cost of all high-pressure hydraulic energy per 100,000 ft.-cwts. of duty as defined. The single ram hydraulic lift for its usual average, quarter to third, load condition, always consumes full load energy. The electric lift—as users are slowly realising—only requires energy in proportion to the actual load each single trip. Another important factor affecting economy is the one more generally realised—*i.e.*, the extra counterweighting which it is practicable to adopt in electric equipments, with motor driving, when necessary, both down as well as up journeys.

"Duty obtained per 100 gallons" or "Energy cost per 100,000 ft.-cwts." demanded, at a particular speed, are in similar hydraulic equipments, it should be noted, merely questions of load factor and average price paid per gallon. Cost of power water has been tabulated in 100, instead of the more familiar 1,000 gallons, to form a nearer basis of comparison with the unit of electricity. "Average feet run per single trip" is unimportant in hydraulic work, but a most important consideration in electric working, which should not be overlooked in comparing energy efficiency of various lifts. More electrical energy is used in overcoming inertia and accelerating many journeys than for remainder of even fairly long trips.

Table V.—*Maintenance Details (Hydraulic Examples).*

Actual example. No.	Gear ratio.	Age. Years.	Thousand single trips per annum.	Rope cost or allowance per annum.	Repairs, stores and inspections per annum.	Maintenance total per 100,000 ft.-cwt.
1	(Ram)	2	209	..	£12·0	£0 06
2	4 : 1	9	194	£6·7	10·0	0·18
3	4 : 1	7	139	3·0	2·0	0·06
4	4 : 1	10	68	1·8	16·2	0·54
5	(Ram)	11	71	..	10·0	0·13
6	6 : 1	7	61	2 0	10 2	0·42
7	4 : 1	8	88	2·5	10·0	0·26
8	2 : 1	10	39	4 0	5·0	0 45
9	(Ram)	15	30	..	5·0	0·18
10	4 : 1	2	22	2·5	2·5	0·22
11	6 : 1	6	124	1·5	8·0	0·25
12	4 : 1	7	41	1·5	6·0	0·10
Average		7	90	£2 8	£8·0	£0 23

Table VI.—*Maintenance Details (Electric Examples).*

Actual example No.	Drive.	Age. Years.	Thousand single trips per annum.	Rope cost or allowance per annum.	Repairs, stores, and inspections per annum.	Maintenance total per 100,000 ft.-cwts.
21	V sheave	1	209	£4·0	£2·5	£0 03
22	Sheave S	2	260	8·0	29·0	0·11
23	V sheave	1	139	2 0	2·0	0 05
24	Sheave S	3	145	3 0	7 2	0 13
25	V sheave	5	104	7·0	3·3	0·15
26	Sheave .	1	70	2·0	8·0	0 30
27	V sheave	1	88	2 0	6·0	0·16
28	Drum ..	3	13	1·0	1 0	0 66
29	V sheave	6	10	1·0	1·0	0 28
30	V sheave	1	42	0 5	3·0	0 09
31	Belt....	9	140	0·5	1·7	0·02
32	Drum ..	3	40	4·4	8·0	0 16
Average		3	113	£2·9	£6·0	£0·18

"Duty obtained per unit of electricity" is dependent mainly on efficiency of gear with similar speed, weight, drive and load factors. Safe self-sustaining conditions are sometimes for this reason sacrificed to efficiency in worm gear, without sufficient brake control. The writer thinks that, if higher efficiency gear is generally adopted by makers in this country for busy electric lifts, a second brake will become imperative.

Maintenance cost is, in the writer's opinion, more a question of local conditions, attention received, drive, speed, and duty than whether hydraulic or electric equipment is adopted. The class of any lift in first case, of course, also enters largely into this question. Thus the relatively cheap hydraulic machine exemplified in No. 6 is much more expensive to maintain than the dearer high-class one exemplified in No. 10.

Drive adopted enters very largely into any suspended type's maintenance cost. The writer knows of two exactly similar hydraulic lifts installed some time ago by same leading firm in same town, at same date, for two important hotels. Owing to structural difficulties a slightly twisted drive had to be used in one case, whilst in the other a clear lead for all ropes was obtained. In the first case ropes have cost £40 during 10 years. For about same duty in the second case, not more than one-quarter that sum has actually been expended, even with less skilled attention than the other lift received. A good top-driven arrangement in an electric machine often results in 15 to 20 per cent. more economical working than any bottom-drive will effect. Lift makers thoroughly realise the economy of a simple and direct drive, but architects and users generally have not yet realised its importance.

For electric lifts, whenever local conditions allow adoption of a top-drive requiring only one sheave, and this is of large diameter, having properly designed V-grooves, thus obtaining a clear lead to both cage and counterweight, there is no doubt that rope renewals are a minimum, and cost less for equal duty than with any hydraulic suspended arrangements. The latter, with their numerous bends round multiplying sheaves, and often a damp well, have clearly worse conditions for steel ropes than average electric equipments entail, even allowing for U-grooves against V ones in sheaves. If, however, for structural reasons, accessibility of motor, &c., or slightly steadier working, a bottom electric drive is adopted, rope costs are usually, in writer's experience, but little better than hydraulic figures.

No hard-and-fast rules can be laid down, all that can be definitely stated is that leading lift firms selling both equipments are agreed that, under average equivalent conditions, electric generally do not exceed hydraulic working costs for ropes.

High pressure direct ram hydraulic lifts with balance cylinders are, for anything but short travels, higher in first cost than any electric equipments. Their only advantage over latter is a slightly increased factor of safety, against which may be set the fact that they are more costly in lubrication than any other type. Lift No. 1 actually averaged £5 per annum for such purpose alone, or cost of enough energy to run same duty, somewhat slower electrically, for more than three months. Electric example No. 21, which replaced No. 1 over nine months ago, has, for exactly similar duty and in same attendant's hands, only cost 10s. for machine oil and 3s. for a change of castor oil in its worm box. Repairs must be considered in connection with "wages chargeable to lift" in the total cost tables, and in fact at all times, because a skilled attendant will execute trifling repairs as necessary, whilst a cheaper unskilled man often entails more outlay with makers or others.

No. 26 is an example of the usual rather slow speed, fully automatic, electric press-button lift, and has been at work for nearly a year in quite a public situation. Its electrical action is as follows: A switch under the cage floor rises and falls imperceptibly on springs when empty or with the weight of a passenger respectively. By this arrangement the act of stepping into the cage breaks contact to all landing buttons. After stepping out the floor springs up again, and remakes landing push-button common feed circuit. Spring gates are provided and usual mechanical and electrical locks, the latter in series with feed circuits. Opening of any gate breaks circuit both to the cage and landing push-button feeds.

An ingenious patent three-contact relay is provided for each floor. Pressing a button momentarily for a certain floor energises the solenoid of its particular relay—with which it is in series—through centre contact. This relay at once rises, first makes a holding-on circuit on top contact, to maintain its own energy, and almost simultaneously breaks circuit of its push-button on relay side at centre contact. The other side of push-button is fed by a common lead, connected in series through all relay bottom contacts. Thus any relay in use or sticking up disconnects both sides of its corresponding, and one side of all other, push-buttons, preventing complications. A floor-finding device is connected in series on end of floor relay winding, opposite to push-button end. The floor-finding device sets the direction in which the lift has to travel by means of revolving make-and-break arm switches drum driven direct from cage by wire cord. According to whether cage is above or below floor on which button is pressed, the floor-finding device will be in up or down position.

Suppose the cage is at bottom floor, and the second floor button is pressed, the corresponding switch on the floor-finding device would be standing in "up" position This would allow feed current to pass to the ordinary small up main relay, bringing the larger coil of the controller up side into action and starting the motor. When cage is thus within a few inches of the second floor, the floor-finding device will open feed circuit, allowing the up main relay to fall and break circuit on main panels of controller. The controller consists

Table VII.—*Total Annual Costs (Hydraulic Examples).*

Actual example. No	9 per cent. capital charges on prime cost.	Wages chargeable to lift.	Energy.	Maintenance.	Total.
1	£45·0	£39·0	£82·1	£12·0	£178·1
2	41·4	50·0	61·1	16·7	169·2
3	24·3	26·0	46·6	5·0	101·9
4	23·4	52·0	35·7	18·0	129·1
5	45·0	65·0	54·7	10·0	174·7
6	16·2	52·0	44·8	12·2	125·2
7	22·5	70·0	27·5	12·5	132·5
8	45·0	26·0	25 7	9·0	105·7
9	28·8	8·7	33·9	5·0	76·4
10	22·5	72·8	15·5	5·0	115·8
11	18·0	78·0	55·4	9·5	160·9
12	13·5	39·0	26·0	7·5	86·0
Average		£48·2	£42·4	£10·2	£129·6

Over-all average total costs = £2·23 per 100,000 ft.-cwt.

Table VIII. *Total Annual Costs (Electric Examples).*

Actual example. No.	10 per cent. capital charges on prime cost.	Wages chargeable to lift.	Energy.	Maintenance.	Total.
21	£35·0	£39	£18·2	£6·5	£98·7
22	37·5	39	31·2	37·0	144·7
23	35·0	26	14·7	4·0	79·7
24	37·5	52	14·8	10·2	114·5
25	40 0	30	8·9	10·3	89·2
26	38·0	Nil	6·5	10·0	54·5
27	30·0	70	8·6	8·0	116·6
28	45·0	Nil	0·5	2·0	47·5
29	30 0	13	0·8	2·0	45·8
30	22·0	39	1·7	3·5	66·2
31	16 0	78	13·5	2·2	109·7
32	25·0	26	6·9	12·4	70·3
Average		£41·2	£10·5	£9·0	£86·4

Over-all average total costs = £1·04 per 100,000 ft.-cwt.

of three panels—one for the up journey, one for the down journey, and the other for cutting out the resistance in armature circuit. The down side is used as return for the up side, and up side as return for the down side, so that in the event of one of these panels sticking up it is not possible to put current into the motor in the opposite direction. There is also a safety switch, which ensures the starting rheostat being in the off position before either side of the controller or starting solenoid will rise. Thus the whole system is well interlocked.

No. 28 example is typical of the moderate-speed fully-automatic electric press-button lift of the other system best known in this country. It has been working for nearly three years in a semi-public position, with very low maintenance cost, even for the small duty demanded. Its electrical action is as follows: The landing doors, with the usual mechanical and electrical locks, being closed, momentary pressure of any button, either on the landing or in the car, actuates a corresponding relay in the motor room, completing an operating circuit through a floor-finding device and the magnet of a reversing switch. The closing of this switch completes the circuit of the motor, gradually starting the armature in the direction required, according to the position of the floor-finding device corresponding with the locality of the cage. This floor-finding device is in the form of a drum, carrying long-rubbing contacts and revolving with the winding gear, from which it is chain-driven. The operating circuit is thereby maintained until the brush or contact on the floor-finding device reaches an insulated point on its path, at which moment the circuit is broken, the reversing switch released, and the motor stopped. Previous to reaching the landing, however, the device, by a short extra contact arrangement, passes current through an additional magnetic switch. This switch closes, causes the field winding to the motor to be strengthened, and thereby slows up the motor. This system results in the cage arriving at landings at a graduated slow, instead of at a fast, speed, rendering the automatic stopping more gentle, and ensuring accuracy of level. In connection with the relays is a special compound-wound breaking magnet, through which the common feed circuit to the various push-buttons passes. Normally, this circuit is closed so that any button may be operated; the moment, however, that any relay closes, this magnet opens its contact, thereby cutting off the supply to all other buttons. When operating from the cage a further special magnet is called into action, which, by closing a contact, effectually cuts off supply to all the landing buttons, and is only released upon the opening of a gate or door. This prevents the lift—after it has been operated from the cage—from being called away again upon reaching its destination and whilst the passenger is still in the cage, even though latter is stationary. By this means the operation of the cage from the landings is prevented until the passenger has left the cage and closed the gate behind him. Whenever the reversing switch closes in one direction, it automatically breaks circuit of the magnet which controls its movement in the opposite direction. This provision is arranged against the remote contingency of two buttons being simultaneously pressed to operate in opposite directions. Should such a thing occur, the movement of the reversing switch in either one direction will immediately break the circuit of the other relay and throw it out of action. This avoids a sudden reversal, which would otherwise be possible if the two circuits remained closed. The starting resistance of the motor is controlled by a magnet coming into operation as the motor accelerates, and electrically cutting out the starting resistance in a few steps. This magnet acts entirely automatically, and is not dependent upon any control from the passenger, or to any mechanical time factor, as in usual dashpot sliding contact arrangement. The accelerating magnets are fitted with braking contacts placed in the controlling circuit, so that the operation of the accelerating magnets disconnects the operating circuit of the push buttons, thereby making it impossible for the motor to be started until all resistance is in circuit. In this manner after the cage, being called, has reached its required landing, should a passenger at that moment press a button on another landing, the motor will not reverse or restart until starting resistance is reinserted.

The slightly greater liability to stoppages that press-button and ordinary electrical equipments involves, as against hydraulic ones, is mainly due to trifling details not yet generally understood by users' servants. The possibility of any such disadvantage decreases almost daily. Many hydraulic lifts—both high and low pressure good-class ones—are to-day being converted to electric working, but a conversion vice versa is almost unknown.

The final tables include total capital charges of 9 per cent. on hydraulic and 10 per cent. on electric, full prime costs respectively. These allowances include 4 per cent. interest in all cases, and 5 per cent. general depreciation on all hydraulic types. The writer has approached depreciation on electric lifts and hoists from the following point of view. Whatever type is considered, approximately two-thirds of its value represents ordinary fixtures or durable materials, for which 5 per cent. depreciation on prime cost, as allowed for hydraulic, is fair allowance. The remaining third of first cost represents moving parts, subject to heavier depreciation—probably 8 per cent. included on this portion is ample. This allows a life of about 12 years to breaking-up value. There are a number of electric lifts in the country still working with satisfaction after 10 years' use of original working and other parts. One of electric examples is 9 years old, and still quite sound. Thus 5 per cent. on two-thirds, plus 8 per cent. on one-third, first cost, works out at 6 per cent. over all on full prime cost as a fair depreciation on electric lifts and hoists. With maintenance charges, including provision for new ropes also scheduled separately, it is, however, doubtful whether so high an allowance as 8 per cent. depreciation is really necessary on electric lift working parts.

The first and last tables, Nos. 1 and 2, 7 and 8, are the essential ones on which comparisons should be based between hydraulic and electric equipments and from these it will be seen that actual duty as required, in all examples taken, averages £2·23 with hydraulic and £1·04 annually with electric equipments per 100,000 ft.-cwt. of useful work actually demanded. This is equivalent to a total saving of well over £1 per week, on the usual average lift, by adoption of electric working.

Unless, therefore, the contention throughout this Paper can be disproved—*i.e.*, that electric machines scheduled as typical examples are, generally speaking, not relatively more favourable samples of their kind than are the hydraulic ones, a strong case for the electric lift should be fairly proved.

RECENT ADVANCES IN ELECTRIC FURNACES.

The following is an abstract of three short Papers on electric furnaces which were read before the Faraday Society on April 10th:—

Signor Ernesto Stassano communicated a Paper on "THE ROTATING ELECTRIC STEEL FURNACE IN THE ARTILLERY CONSTRUCTION WORKS, TURIN."

The furnace described in this note is one of the three, of 1,000 H.P., 200 H.P. and 100 H.P. capacity respectively, which the "Forni Termoelettrici Stassano" Company is installing at Turin in the Artillery Construction Works of the Italian War Office. The works are expected to be in a state of complete activity during the coming spring. The furnace absorbs 140 kw. electric energy between the electrodes, the current being three-phase with 80 volts between each phase. The furnace is principally used for refining pig-iron and smelting scrap.

Usually, the charge is made up as follows: (1) 200 kg. of pig-iron turnings mixed with sufficient ore to supply the oxygen necessary for removing the impurities of the pig-iron, and with the required proportion of lime for the slag; (2) 200 kg. to 300 kg. of iron and steel scrap; (3) some ferro-silicon and ferro-manganese in the ordinary proportion, to deoxidise the charge and to introduce the required amount of manganese.

The product ordinarily made is steel to be used for artillery projectiles, containing 0·3 to 0·4 per cent. carbon, 1·2 to 1·5 per cent. manganese, and 0·03 to 0·04 per cent. phosphorus. When necessary, however, other types of steel, soft or hard, can easily be made. Samples taken from projectiles made as above have an average breaking stress of from 90 kg. to 95 kg. per square millimetre (57 to 60 tons per square in.), and an expansion of from 14 to 12 per cent. on a length of 150 mm. The loss in the weight of the metal during the smelting is almost nothing, and the consumption of electrodes is always under 5 kg. per ton of steel. The consumption of electric energy varies between 1·1 and 1·3 kw.-hours per kilogramme of steel produced. The cost for renewing the refractory covering of the furnace is about 10fr. per ton of metal made, and the average durability of a refractory covering of good quality is about 30 days. The daily yield of the furnace (24 hours) is 2,400 kg., equivalent to 1·4 kg. per kilowatt-hour. Six men are required for the working of such a furnace. As already stated, the three furnaces will mostly be used for refining pig-iron and melting scrap. But it is also intended to demonstrate the commercial possibility of making iron and steel in one operation direct from the ore—an operation which is, in fact, the essential and characteristic feature of the writer's process.

A Paper on the "ELECTROTHERMICS OF IRON AND STEEL" was communicated by Ch. A. Keller.

Since the visit of the Canadian Commission in August, 1904, I have been actively engaged in the perfection of the industrial production of iron and steel by the electric furnace at the Livet Works of the Keller, Leleux Co., and will indicate briefly in this Paper the new results obtained in 1905. For the Canadian report[*] has covered the general part of this subject so completely, that there is no need to refer to it here.

Electrothermic Production of Steel.—The results obtained at Livet led Messrs. J. Holtzer & Co. to instal in their works at Unieux (Loire) an electrical steel plant which has now been completed. The following is a description of this installation: A Dujardin steam engine of 1,500 H.P. drives a Westinghouse alternator, capable of supplying 20,000 amperes. It will be used for one furnace. The process adopted at Unieux consists in using the electric current exclusively as a deoxidising, refining and heating agent. The steel obtained at Unieux in a Siemens-Marten furnace is run into the electric furnace immediately after the oxidising melt, where the remaining operations are completed by the current; 8,000 kg. of metal can be dealt with at one time, the operation being repeated three or four times in the 24 hours. The furnace at Unieux weighs about 50,000 kg.; it rests on a steel cradle, and can be tilted. All the mechanical and electrical operations are performed by auxiliary hydraulic motors. The steel produced by this furnace is intended for cannon and projectiles.

The Keller furnace has an advantage over the blast furnace in the easier variation of the silicon and carbon content. This particular property of electric reduction would prove of great utility in the production of soft castings and castings specially for mill work. The higher percentage of carbon and silicon obtained by the use of the electric furnace over the blast furnace gives the founder a wider choice in the selection of his material. To demonstrate definitely the importance of the electrothermic reduction of iron ore, I have set up at Livet an electric furnace of 2,000 H.P., which will be capable of producing about 20 tons of castings in 24 hours. The current strength will be 25,000 amperes, which is, I believe, the greatest used hitherto in electrometallurgy.

A note on "RECENT DEVELOPMENTS IN THE GIN ELECTRIC STEEL FURNACE" was communicated by Gustave Gin.

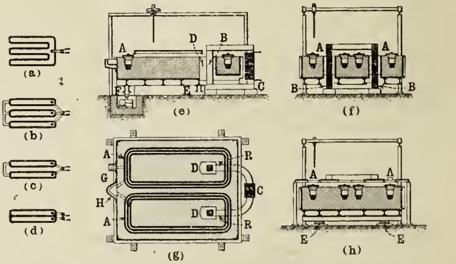
The author's canal-type furnace is now installed at the Plettenberg Works (Westphalia). These works were founded by M. Brüninghaus, who is associated with the Deutsche Elektrische Stahlwerke.

Gin Furnace with Canals and Chambers.—In the furnaces in which the canal is bent upon itself, the narrow cross-section of the canal is not convenient for the introduction of ore or scrap. Moreover, heavy currents at low potentials give rise to induction and other effects. To avoid these drawbacks I cause the electrothermic heating and refining to take place separately, the refining taking place in chambers which communicate with each other and with the leads to the canals for heating. When the metal has reached the required composition, a certain quantity of the finished steel is tapped, and the liquid metal filling the various parts of the furnace moves towards the tap-hole. The volume of metal withdrawn from the last chamber is replaced by a equal volume of metal heated to a high temperature in the canal adjoining it. Finally a quantity of metal equal to that withdrawn is charged into the chamber furthest from the tap-hole. Several chambers are necessary to make a complete furnace, for it is difficult to raise the temperature in the canals above 1,850 deg. without running risk of softening the refractory walls. As finished steel is tapped at about 1,600 deg., the calories carried into the chambers from the canals by the metal are those which correspond to a cooling of the metal between 1,900 and 1,600 deg., that is, about 75 calories per kilogram removed. The number of chambers can be reduced to two if producer gas is used in addition to the electric current. The furnace combines all the advantages of the Martin and Talbot furnaces, and the separation of the operations makes exact control of the composition of the alloys possible. A difficulty which at present prevents the practical application of this furnace is finding a material for the bases sufficiently solid to prevent short circuits between the branches of the canals and the chambers

The Combination Gin Furnace combines the simultaneous and continuous working of the complete processes for the production of steel: fusion, oxidation of the impurities, reduction of the dissolved oxide of iron, and recarburetting or introduction of the elements constituting the final steel. It consists essentially of: (1) A melting and oxidising crucible; (2) a deoxidising and recarburetting compartment; (3) a final mixing chamber.

The electrodes of compartments (1) are united to one of the current terminals, and the electrodes of compartments (2) and (3) are united in parallel to the other terminal. Current passes from the electrodes to the metal through a layer of scoriæ, the resistance of which causes a generation of heat. The baths of metal communicate by openings which are sufficiently reduced in section to prevent the metal ever getting solid. The lining of each compartment depends upon its purpose and upon the nature of the impurities in the metal dealt with. Portions of the walls in contact with the slag should be neutral.

Induction Furnace.—The possible disadvantages of steel leads or electrodes can be obviated by the use of induced currents. As described in Ferranti's English patent of 1885, the crucible is ring-shaped, the contents forming a closed circuit. Illustration *a* above shows a furnace with a duplicated canal and a single inducer, whilst in *b* and *c* there are several inducers with a common core; the points O being at the same induced potential, can be connected. This would prove a distinct advantage if there are several successive reactions to be carried out in the same furnace. Illustration *f* shows a furnace with three canals and two inducers and cores. The two cores are wound to the same extent, but in opposite directions. Hence the induced currents traversing the side canals become superimposed in the central canal. Illustrations *e*, *f*, *g* and *h* show the practical arrangement of the furnace represented in Fig. *c*. It consists of a refractory base enclosed in a metallic case. The canals AA are cut out of this. The plates of the magnets B are united at C, and form the single core for the primary winding. The vertical branches of the inducer pass through the chambers D. Trunnions E are provided so that the furnace can be oscillated. If steel is being produced, the oxidation can be carried out in one canal, and the reduction in the other. The refined metal is tapped at G, whilst the opening H remains closed. The tapping being finished, the tap-hole is plugged and the communicating channels H opened, allowing the metal in the first canal to flow into the second. The furnace is brought into the horizonal position and the first canal charged with material.



DIAGRAMMATIC SKETCH OF THE GIN INDUCTION TYPE OF FURNACE.

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[*] *The Electrician*, Vol. LIV., pp. 180, 876, 919, 961, and 1,003.

New Type of Induction Furnace.—In the induction furnaces, on account of the small calorific conductivity and of the slow diffusion of the molten substances, it is difficult to obtain a uniform distribution of heat and of the reactions. A sensibly more complete effect is obtained by means of a continuous circulation of the molten substances causing a mixture of all their particles to take place and constantly renewing the contact surfaces with the reactive, gaseous, liquid or solid bodies. This circulation is obtained by forming the channel crucible of a succession of open channels or flues, the bottom of which are longitudinally sloping, and by connecting these flues by means of laterally closed conduits connecting the deep end of each channel with the shallower beginning of the following channel. The Joule effect varying in inverse ratio to the sections, the molten mass is less hot in the deep portion of the open channels. As the two liquid masses which communicate through closed conduits have different densities on account of the difference of temperatures, an upward motion of the particles in the closed channels is produced, a displacement which is further reinforced by the heating in the conduit itself. From this partial displacement, a general and continuous circulation results and is established in the whole molten mass filling the channels.

ELECTRICAL ENGINEERING AND INDUSTRIAL REDISTRIBUTION.

During the last few years there has been a gradual shifting of the centre of the electrical industry. Until recently London was undoubtedly the centre of electrical affairs. The great majority of the manufacturing works were within a comparatively short distance of the metropolis, and although some large works were established in the North of England, London was undoubtedly the point at which the activity of the electrical industry was concentrated. One works after another, however, have found it economical to move away from the district in which rents and rates are highest and labour is dearest, so that at the present time the Midlands and the North have become the real electrical engineering country. In addition to these reasons, the possibility of obtaining cheaper electric power has been in some cases an important factor in deciding the managers of works to take this step, for electric driving is now an essential feature in all modern works, and even a slight difference in the price paid for electrical energy means an enormous reduction in total expenditure. These considerations are equally important in connection with other industries, and the movement is one that should be encouraged by all electrical engineers; for in addition to the electrical manufacturing works being benefited directly by removal to a more suitable position, the similar policy followed by works connected with other industries increases the amount of electric power used and the number of motors and accessories that have to be supplied, so that the indirect advantage gained by the electrical manufacturer is one that can hardly be overestimated.

Realising that the time has come for such industrial redistribution on a large scale, the North Eastern Railway Co. which is working hand in hand with the Newcastle-upon-Tyne Electric Supply Co., has organised a "Commercial Agent's Office" in York with the object of placing before manufacturers and promoters the advantages of the district served by this railway and assisting them in the selection of sites for works and other industrial purposes. Cheap coal, cheap electric power, proximity to the sea coast and facilities for transportation generally are among the inducements held out to manufacturers; even the agricultural side of the question is not forgotten, as there is much free land available for the agricultural industry in the 7,000 sq. miles served by the railway, and electrical power is already appreciated by large dairy owners and farmers in some few instances when it is available.

The arrangements for supplying information as to the resources of the district are very complete. Figures have been tabulated, and statements as to the resources of the line have been collected and arranged in such a manner as to demonstrate clearly to an inquirer the alternative places upon the line, which are correctly situated from an economic and geographical point of view for the particular industry which he contemplates establishing. Information as to climate, subsoil, labour, housing, rating, land and innumerable other subjects, all of which are potent factors in enabling a would-be manufacturer to come to a decision, are collected, tabulated and kept up to date in the new department. Needless to say, this office is also a bureau in which all information as to railway rates, siding questions, train service, land questions, &c., can be obtained The co-operation of the Newcastle-upon-Tyne Electric Supply Co. in the scheme will render easily accessible figures and data as to the cost and supply of electric power in their area to the north and south of Newcastle, where electric power is the cheapest in the United Kingdom.

NEW SINGLE-PHASE RAILWAYS IN AMERICA.

The increasing favour which is being accorded to single-phase equipment for interurban railways in the United States is exemplified by the fact that within the last few weeks two more companies have adopted the single-phase system for the equipment of their extensions. In the case of the Central Illinois Construction Co., 80 miles of extensions are being equipped, consisting of two 40 miles, one connecting Bloomington and Peoria, and the other between Springfield and Lincoln. The present equipment of the companion lines is continuous-current, consisting of heavy suburban type cars each equipped with four 75 H.P. motors. The new cars will run over the existing C.C. part of the system, and some alterations and additions will be required to deal with the increased traffic. The pressure of the H.T. feeders will be raised from 13,200 to 33,000 volts, and a second power house is to be constructed.

According to the *Street Railway Journal*, the rolling stock equipment comprises 10 75 H.P. A.C. compensated motor-car equipments, made by the General Electric Co., together with necessary sucstations, overhead line material, generating station, equipment, &c. Each car equipment consists of four 75 H.P. motors with Sprague General Electric system of multiple-unit control adapted for use on A.C. circuits. These are so arranged that they will permit tap control when running on alternating current, and series-parallel resistance control when running on direct current. In addition to the motors and control apparatus, complete air compressors will be installed, as well as arc headlights adapted for use on 25 cycle alternating current. The trolley will be of the pantagraph type with rolling contact, raised and lowered by compressed air.

The equipment just outlined will take care of the passenger service, but for hauling freight the operating company will employ a single-phase locomotive equipped for service on the same roads as the regular motor cars. This locomotive will be of the eight-wheel type, equipped with four General Electric 125 H.P. compensated A.C. motors. The total weight of the locomotive complete will be 50 tons, with a draw-bar pull of 20,000 lb. It will haul its train at a speed of 20 miles per hour with a current supply of 3,300 volts and 25 cycles. In common with the motor cars for passenger service the locomotive will be equipped with the Sprague General Electric multiple-unit control for operation on both direct and alternating currents. It will also be supplied with complete air brake equipment, comprising an A.C.-D.C. motor-driven air compressor with the straight air brake apparatus.

To furnish additional power for this new rolling stock, the present generating station at Riverton will be supplemented by a 2,000 kw. Curtis steam turbine, furnishing current at 25 cycles, and the new power house at Peoria will be equipped with two 2,000 kw. Curtis turbines. Additional machines will be installed as soon as other lines, now under consideration, are constructed. The generator and high-tension distribution system will be three-phase and will feed the present rotary converter sub-stations, and also the 80 mile section of track operating with alternating current.

The A.C. trolley will be 3,300 volts of the well known catenary type, suspended from brackets in the interurban sections and cross-suspended through the small towns. Feeding the trolley, there will be four A C. transformer sub-stations. Each sub-station will contain two 200 kw. single-phase transformers with complete controlling high-tension and low tension switchboard apparatus. These sub-stations will be placed approximately 20 miles apart, and are so arranged that trouble in any sub-station will automatically cut out that station without affecting operation on the rest of the line.

A NEW TYPE OF REPULSION MOTOR.

According to Mr. F. Punga in a recent article in the *Elektrotechnishe Zeitschrift*, the repulsion motor is superior to the single-phase series motor in all cases in which the working speeds are not required to vary very much from synchronous speed, for at this speed the commutation of a repulsion motor is better even than that of the equivalent continuous-current motor, and the iron losses in the rotor are nearly nil. Where a wide speed variation is required, the series motor is to be preferred, because the commutation of the ordinary repulsion motor rapidly deteriorates as the speed increases or decreases beyond synchronous speed. At synchronous speed, the transformer flux and the field flux are of the same order, but at a speed of, say, twice synchronous speed, the transformer flux is theoretically twice as large as the field flux. Hence the stator of the repulsion motor is not utilised to its full capacity. In order to overcome this difficulty, Mr. Punga proposes the motor shown diagrammatically in Fig. 1. In such a motor, as is easily seen, it is possible to regulate the transformer flux quite independently of the speed and field flux. Let M_y denote the transformer flux and M_x the field flux. Assuming a sinusoidal distribution of

M_y and M_x along the air-gap, the E.M.F. induced in the rotor by rotation through M is

$$E_x = \frac{4}{\sqrt{2}} s M_x N' 10^{-8} \text{ volts},$$

in which s = armature turns in series between the brushes and N' = number of pole pairs multiplied by the revolutions per second.

The other E.M.F. in the rotor is induced by the alternating transformer flux M_y, and is equivalent to

$$E_y = \frac{4{\cdot}44}{\pi\sqrt{2}} s' M_y N 10^{-8} \text{ volts},$$

in which s' = the number of turns which are interlinked with the transformer flux and N = frequency of the alternating supply. For the ordinary repulsion motor $s' = s$, but for the new motor of Fig. 1, $s' = s + s_o$, in which s_o denotes the turns on the stator between A and B; s_o may be positive or negative according to whether the E.M.F. between A and B opposes the armature turns or assists them. Neglecting leakage and ohmic resistance, E_x and E_y must be exactly equal in value but opposed in sign. Hence,

$$\frac{4}{\sqrt{2}} s M_x N' = \frac{4{\cdot}44}{\pi\sqrt{2}} s' M_y N, \text{ or } \frac{M_y}{M_x} = \left(\frac{N'}{N}\right)\frac{s}{s+s_o}.$$

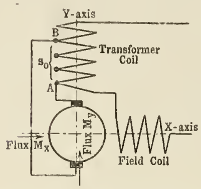

Fig. 1.—Diagrammatic Sketch of New Repulsion Motor.

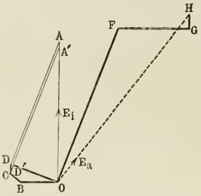

Fig. 2.—Vector Diagram of New Repulsion Motor for Speeds below Synchronous Speed.

Introducing $N'/N = b$ = ratio of actual speed to synchronous speed, we get $M_y/M_x = bs/(s+s_o)$. For the ordinary repulsion motor $M_y/M_x = b$.

Hence, for the ordinary repulsion motor and for the compensated repulsion motor (Winter-Eichberg-Latour), the ratio of transformer flux to field flux is only dependent on b, whereas for the new motor this flux ratio can be regulated independently of the speed.

For instance, if the turns s_o are made equal to the rotor turns in series between the brushes, then, for a motor speed twice synchronous speed, $M_y/M_x = bs/(s+s_o) = 2s/(s+s_o) = 1$ or $M_y = M_x$. This means that we obtain at this high speed a rotating field in the stator as perfect as in an ordinary repulsion motor at synchronous speed. It can also be shown that the commutation (at any given speed) is as perfect as in a repulsion motor running at synchronous speed if the number of turns between A and B is made equal to $s_o = (b^2 - 1)s$. For instance, if it is desired to run a motor at 1½ times synchronous speed under the best commutating conditions, the turns between A and B would have to be made equal to $s_o = (1{\cdot}5^2 - 1)\, s = 1{\cdot}25s$. The transformer winding on the stator is, as will be seen, equivalent to an auto-transformer. It is stated that the motor of Fig. 1 can easily be designed for a primary voltage of anything up to 750 volts. In an alternative design, Mr. Punga proposes to use a separate small transformer, the secondary of which takes the place of the winding AB in Fig. 1. Such a design is useful for high voltages and for traction work.

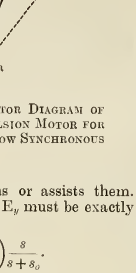

Fig. 3.—Vector Diagram of New Repulsion Motor for Speeds above Synchronous Speed.

In the vector diagram, Fig. 2, in which account is taken of the C^2R losses in the stator, but of no other losses, OA represents the field flux produced by the current flowing through the field winding on the stator. The E.M.F. induced in the rotor by rotation through this field may be represented by E_i, in phase with OA. Let E_a (which is in phase with the terminal voltage) be the voltage which is introduced into the rotor winding by the auxiliary transformer (Fig. 1). These two voltages must be balanced by counter-E.M.Fs. induced in the rotor by the transformer flux which oscillates along the Y axis. Hence the transformer flux (OC) must be composed of the two components OB and BC at right angles to E_i and E_a respectively. OC may also represent the ampere-turns necessary to produce the transformer flux OC; similarly, OA may stand for the ampere-turns of the transformer coil on the stator. The rotor ampere-turns (A′C) are obtained by adding vectorially OA′ ($= v'$OA, v' denoting the leakage coefficient) and OC. OD represents the tranformer flux which penetrates the stator, and is the resultant of A′D′ ($= v''$A′C, v'' being the corresponding leakage coefficient) and OA The terminal voltage OH may be resolved into OF (at right angles to OD), FG (at right angles to OA), and GH (which takes account of the voltage drop in the stator winding and is parallel to OA). The component OF has to compensate the E.M.F. in the transformer winding on the stator, while FG is required to counterbalance the E.M.F. in the field winding. In the case of Fig. 2 the flux M_y has been increased by the action of the auxiliary transformer, and this case is suitable for starting and for speeds lower than synchronism. Fig. 3 represents the case in which M_y has been reduced in order to obtain good commutation at speeds higher than synchronous speed.

FIRE AND "DEFECTIVE ELECTRIC CIRCUIT."

Dr. F. J. Waldo held an inquiry at the City Coroners' Court on Wednesday into the circumstances of a fire which occurred on April 3 at 38, St. Andrew's-hill, City. The inquiry was an inquest under the City of London Fire Inquests Act of 1888, there having been a suspicion that the fire originated through a defective electric circuit.

The premises in question are very old, are lighted with gas, and are used for a bookbinding business. On the ground floor, however, there was an 8 H.P. electric motor supplied from the 440 volt circuit of the City of London Electric Lighting Co., from which belts are run on to shafting, and various machines on the upper floors are thus driven. The electric cable enters the building in the basement, and is first connected to the company's fuses, then through the meter, and through two consumer's fuses. The cable then runs through iron barrel attached to the roof of the basement to the back, where it is carried through the floor to the main switch of the motor on the floor above, a distance of 15 ft. or 20 ft. from the fuses. The motor switch, it was noticed on an inspection of the building, was attached to the matchboarding of the wall. This switch was close to the motor.

Evidence was first called as to the opinions formed by the owner, employés and fire brigade officials as to the origin of the fire, and the general feeling was that there had been some defect at the motor main switch, and that the fire had been aggravated by the presence of a lift quite close and which had acted as a flue. It was possible, however, according to the fire brigade officials, that the rubbish which was about the floor might have been smouldering through a dropped light, it having been admitted that smoking took place, although against the rules of the firm. It was further stated that some workmen engaged temporarily in altering machinery were also smoking during the day on which the fire took place. The owner of the business said he paid for a quarterly inspection of the motor installation. There was a general condemnation of the method of fixing the motor main switch. The building was insured for fire in the Northern and Sun offices.

Technical evidence was then called from the London County Council and the City of London Electric Lighting Co., but no expert was sent by either of the insurance companies.

Mr. R. F. STUBBS, an assistant in the electrical department of the London County Council, said he had inspected the premises in question, and had made a report to Mr. T. P. Gunyon, the chief of the London County Council Electrical Department. In this report he had expressed the opinion that the fire was apparently caused by a defect in the electrical apparatus. The main switch and the starting switch and resistance were fixed to a wooden wall which formed part of a lift. The motor appeared to be sound after the fire, and also the starting resistance. He thought, however, that there had been a defect on the feed side of the double-pole main switch, for the switch was "off" at the time of the fire. Since hearing the evidence that smoking was carried on in the premises, where, by the nature of the business there was a large quantity of inflammable material about, he would add as an alternative that the fire might have been caused through the dropping of a lighted match. At the same time he thought the double-pole switch for the motor ought to be fixed on a brick wall, because he did not consider the thin asbestos sheet between the switch and the wooden wall was sufficient to prevent a fire. If there had also been a double-pole switch close to the company's fuses in the basement any possibility of accident from the electrical apparatus could have been avoided. He did not think the Board of Trade regulations had been too strictly adhered to, nor had those of the electric lighting company. Competition was sometimes responsible for installations being passed when they should not be, but he did not suggest it in this case. The effect of the fire in this case had been so disastrous as to destroy all traces of its origin, and it could only be conjectured.

Mr. F. W. MOORE, installation inspector to the City of London Electric Lighting Co., said the main switch of the motor referred to, which was fixed to the wooden wall, was in very good order after the fire. He admitted that the regulations of his company had not been strictly conformed with, for they recommended the placing of a double-pole switch close to the point of entry of the cable into the building. But this was only a recommendation, and could not be enforced. Sometimes consumers would not comply, on the score of expense, and the company could not refuse to connect up. Being only a very small installation the company had not tried to enforce the regulation. He repudiated the views expressed as to the unsafe condition of the motor switch, by reason of the fact that the live conductors were mounted on porcelain 1 in.

thick; behind that there was solid cast iron as a base ¼ in. thick, and behind that, again, was a sheet of asbestos. Of course, if the matchboarding had not been there the arrangements would have been safer. His opinion was that the fire was caused by some means other than electric fusion, because there was no evidence of the latter. If there had been a short-circuit on the short ends of cables exposed from the iron barrel there would have been globules of copper formed, but no signs of these were present. If the short-circuit had occurred in the iron barrel, the pipe would have shown signs of heat, but this was not so. At the same time he agreed that it would be better to have a main switch in the position suggested by Mr. Stubbs. As to Mr. Stubbs' suggestion that competition sometimes led to poor installations being passed, he said he did not think that a supply company would run risks for the sake of connecting up an 8 H.P. motor.

The CORONER, in briefly reviewing the evidence, said that as a result of the visits which he made to the scenes of various fires he strongly suspected that short-circuits were responsible in many cases which were not reported as such through lack of evidence.

The Jury finally returned the following verdict: "That the cause of the fire has not been proved. We are, however, of the opinion that the electric installation was defective inasmuch as the main double-pole switch was not placed sufficiently near the point of entry. We recommend that the regulation as to fixing this apparatus be according to the Institution of Electrical Engineers' rules, and that the provisions for the exit of the employés were inadequate"

CORRESPONDENCE.

ECONOMIC CONSIDERATIONS IN THE EMPLOYMENT OF STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has just been drawn to the interesting leading article in your issue of April 6th on the Paper read by Mr. Salter, which is also published in the same issue, and while I fully appreciate the fair comments that you make, I would like to add a few remarks on some important points that have been overlooked. Some of these points were raised in the course of the discussion, which is only very incompletely reported, and others have occurred to me since I have had an opportunity of considering the Paper more fully.

The first portion of the Paper deals with generalities, which are largely a matter of opinion, though many facts could be brought to prove, for instance, that the use of a battery as a stand-by cannot be lightly ignored, but the principal interest in the Paper lies in the details of the actual test carried out in a power station with which Mr. Salter is connected; the figures that are given and the results deduced therefrom have a tendency to show that the use of a battery cannot be justified if regarded only on economical grounds, but while there is no reason whatever to doubt the accuracy of the figures, I propose to prove that the inferences to be drawn from them are exactly the contrary of those given by Mr. Salter.

It was already pointed out during the discussion that the cost of the booster was exceptionally high, but to this I may add that modern prices for a battery plant are much lower than those paid by the concern in question; even allowing a large margin for contingencies, the capital value of the plant should not exceed £5,200 instead of £7,300. Calculating the annual charges on the same basis for each item as that given in the Paper, they would amount to £530 instead of £730. This would represent a cost per unit of 0·052d., whereas the saving per unit in running costs was 0·059d.; a net *saving* of 0·007d., equivalent to £50 per annum, would thus be realised, instead of a *loss* of £150 per annum, as shown by Mr. Salter.

These figures assume that the present battery plant is of the correct size for the load of the station, but it is obvious that, if a smaller battery plant could be used to give the required output, the capital charges would be correspondingly reduced, without affecting the saving in running costs; in fact, the saving might be greater, as the booster would have a better efficiency. I have no actual figures enabling me to state what size of battery could be used in this case, but judging from the number of cars and other indications in the Paper, I consider that the size could be so reduced that the annual capital charges would not exceed £320; there would then be a saving of 0·028d. per unit, equivalent to £260 per annum.

Another important point to which attention was drawn in the discussion was the cost of coal, and Mr. Salter owned that in this respect the station to which he referred was exceptionally situated, the price being, I believe, 6s. 6d. per ton; it is evident that in other parts of the country the saving I have already shown would be enormously increased—for instance, with coal at 13s. it would become 0·07d. per unit, or £700 per annum.

The second case cited by Mr. Salter, which is very difficult to follow, is of far less interest, as it does not give any actual figures obtained by running with and without a battery, and it appears to simply make inferences from certain arbitrary arrangements as to accounts entered into between a tramway and lighting authority.

I do not wish to trespass further on your space by criticising other statements in the first portion of the Paper, with very few of which I agree, but the interest of the subject to all electrical engineers is such that it has seemed to me of very great importance that the general views based by Mr. Salter on this single test, which is one of the most interesting of its kind that has ever been published, should not be allowed to go unchallenged.—Yours, &c., E. S. JACOB.

119, Victoria-street, Westminster, S.W., April 17.

LEGAL INTELLIGENCE.

Telephone Agreements.

At Lambeth (London) County Court last week, before Judge Emden, the National Telephone Co. sought to recover £7. 0s. 6d. from a Mrs. Groom for one year's telephone rental.

DEFENDANT said she had offered to pay £6. 15s., the amount due, less 5s. 6d. stamp duty on the contract, which plaintiffs argued was repayable to them by her.

COUNSEL FOR PLAINTIFFS put in the contract signed by defendant, and pointed out that it contained a clause to the effect that the stamp duty was repayable to the company by the hirer.

Judge EMDEN, having examined the document, said the clause would not do, as it was printed in extremely small print in one corner of the document, and it seemed more like an imprint than a binding clause. Being in such minute type the hirer in all probability would not see it. The company should alter their contract form in that respect. Such a clause should be in bold type, and ought to be put in the body of the conditions. There would be judgment for £6. 15s., the amount tendered by defendant, and he should make no order as to costs.

Tramway Award.

The award of the Board of Trade arbitrator (Mr. H. Graham Harris) appointed to inquire into the value of the tramways and light railways in Dudley has been issued. There are five separate awards, and that relating to *Dudley and Stourbridge* tramway states that the value—exclusive of any allowance for past or future profits or any compensation for compulsory sale or other consideration—of so much of the tramways constructed under the authority of the Dudley Order of 1881 as are within the district of the Corporation, and of all lines, works, materials and plant of the company suitable to and used by them for the undertaking was £26,072. The arbitrator has not included the value of the Dudley depot, and has not taken into account any sum in respect of any other depot belonging to the company or in respect of the generating station at Hart's Hill, or any other contents of the same, respectively. He also determined that the number of cars which are suitable to be used for the purposes of the undertaking within this district are 16, and that their value was £6,885. The total purchase money in connection with this undertaking is, therefore, £32,957.

The *Netherton* tramway (or No. 5 light railway) is treated as a "special case," the amount of the purchase money having yet to be fixed by the Board of Trade on the basis of the arbitrator's award. This states that the price of the railway upon the basis put forward by the Corporation was £16,548, and that this price did not include the value of any other than the permanent way and overhead equipment; that the price of the railway upon the basis put forward by the company was £32,576, and that this included not only the permanent way and overhead equipment, but the value of 10 single-deck cars to be selected by the Corporation and to become the property of the latter.

In regard to the *Birmingham & Midland Tramway Co.* the award determines that the value of so much of the tramways constructed within the district of the Corporation, and of all lines, buildings, works, materials and plant suitable for the undertaking was £8,645, and that the value of the three cars was £1,986.

Dealing with the *Dudley, Sedgley & Wolverhampton Tramways Co.*, the award states that the value of all lines, buildings, works, materials and plant of the company suitable to and used for the undertaking authorised by the Order of 1880, was £7,405. The net value of four cars to be taken by the Corporation was £1,681.

The remaining award relates to the small section of tramway along Stafford-street, which the arbitrator fixes at £2,200.

The total purchase money for the five tramways, &c., is, consequently, £71,422. If, however, the price of the Netherland tramway is fixed by the Board of Trade on the basis of the company's figures, the total purchase money would be £87,450.

Smith & Co. (Ltd.) v. Llandudno & Colwyn Bay Electric Traction Co. (Ltd.) and Others.—This case, which has been postponed several times with a view to a settlement, was down for trial before Mr, Justice Lawrance on Saturday, when Mr. Langdon, K.C. (for defendants) announced that the parties had come to terms.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Messrs. Mills, English & Co., Swansea, require a thoroughly experienced electrical engineer, to take complete control of electrical department. See an advertisement.

There is a vacancy for a premium pupil at the Canterbury electricity works. See an advertisement.

Messrs. Drake & Gorham, 66, Victoria-street, London, S.W., advertise for a works foreman, who has held a responsible position in switchboard manufacture, to take charge of a factory in London.

Messrs. Thos. Smith & Sons, steam and electric crane works, Rodley, near Leeds, require a good draughtsman, accustomed to crane work. See advertisement.

Two additional assistants are required in the electrical engineering department of the Central Technical College, Exhibition-road, London, S.W. Salaries £300 and £150 per annum respectively. Applications to Prof. W. E. Ayrton. See also advertisement.

Erdington District Council require a clerk of works in connection with the construction of electric tramways. Applications by 25th inst.

Mr. Lawrence J. Kettle, of the Oerlikon Co., has been appointed by Dublin Lighting committee station superintendent of their electricity works.

Mr. M. H. Adams, reserve shift engineer at Islington (London), has been temporarily appointed constructional engineer at £160 a year, the appointment to be made permanent at the end of six months.

Amalgamated Society of Engineers.—The membership of this Society is now 100,075.

Ardsley.—The Council have asked the Board of Trade to allow the electric lighting order of 1902 to remain in force until the Yorkshire Electric Power Co. are in a position to supply electric current.

Argentina.—The "Review of the River Plate" says Mr. S. H. Pearson and Dr. Louis M. Drago have been elected president and vice-president respectively of the local Tramway Association for the ensuing year.

The plans of the first section of the tramway scheme of the Cia Tranvias Electricos del Sud (from Barracas Bridge to Banfield) have been approved by the Government.

The construction of the electric tramway system for the northern and western suburbs of Buenos Ayres, under the concession granted to M. Gaston Roux and afterwards acquired by the Cia Belga-Argentina, has been commenced.

In view of the large number of trailers used on Sundays and holidays on the tramways of Buenos Ayres there have been demands for an improved fender between the motor and trailer cars, and it is now announced that a suitable fender has been invented by Mr. J. K. Forrest, of La Capital Tramways Co., and that its use has been approved by the municipal authorities.

Australasia.—The Electrical Association of Victoria, which was formed in October last, held its first annual meeting in Melbourne on the 9th ult., Mr. J. A. Newton presiding.

It was reported that there were 36 members and associates, and the fee for associates was reduced from £1. 1s. to 10s. 6d. per annum, and in future candidates are to be admitted provided they are in any way connected with the electrical profession. A vote of thanks was passed to the ex-secretary, Mr. T. L. Coleman, who has been succeeded by Mr. H. Clements Newton. Mr. Henry Noyes was elected president, and Messrs. A. U. Alcock and J. A. Newton, vice-presidents.

The chief electrical engineer to the Commonwealth (Mr. J. Hesketh) will in future be stationed at Melbourne.

In regard to the proposals for united action for the construction of tramways by the local authorities of various suburbs of Melbourne, Malvern Council have decided that they will proceed to construct a length of tramway if a decision by the Councils interested in the proposed Kew and St. Kilda lines be not arrived at within six months. Malvern Council favour the formation of a trust to borrow the necessary moneys and to construct the inter-suburban lines.

Ayr.—Recently a large gas engine at Messrs. Girdwood's bakery broke down, and, on the Corporation electricity department being appealed to, cables were promptly laid and a local firm (Messrs. Reid & Co.) fitted up an electric motor on temporary scaffolding over the engine, and the whole of the plant was running again in a few hours. Messrs. Girdwood were so much gratified by the result that they are fitting up a permanent electric power installation, and electric motors are to be employed in future for driving all their machinery.

Birmingham.—The new Lodge-road route (2¼ miles) of the Corporation tramways was opened for traffic on Saturday.

Brighton.—The Lighting committee recommends that the alternative flat rate of charging for electric current supplied to places of worship be reduced from 4d. to 3d. per unit.

The traffic receipts of the tramways department for the year ended March were £50,148.

Colombia.—Into the port of Santa Marta in 1905, 17,831 kilos of "electrical materials" were imported, of which Germany supplied 16,360 kilos and the United States 1,495.

Coventry.—The borough electrical engineer (Mr. Joseph A. Jeckell) recently prepared interesting statistics relating to the use and development of electric current for power in the district. The 1905 return gives the following particulars with respect to motors let on hire by the Electricity committee :—

Sale of current, motor hire and rents :—

Cycle firms	£1,787	15	3
Engineering firms	1,369	4	11
Motor firms	914	13	2
Textile firms	117	10	6
Printing firms	26	5	7
Other firms	254	6	9

The total of £4,469. 16s. 2d. compares with £2,099. 4s. 8d. in 1904; and £435. 9s. 10d. in 1903. In 1903 there was a loss on motor hiring of £49. 15s. 8d., and of £13. 4s. 1d. in 1904; in 1905 there was a profit of £100.

Revenue from motors purchased outright by consumers :—

Cycle firms	£92	7	7
Engineering firms	137	19	8
Motor firms	45	12	3
Textile firms	95	18	7
Printing firms	104	18	6
Other firms	29	7	1

The total of £506. 3s. 8d, compares with £597. 19s. 1d. in 1904; £436.12s.10d. in 1903; £313.17s 11d. in 1902; £183. 6s. 3d. in 1901; £44. 12s. 4d. in 1900; and £18.5s.6d. in 1898-9 (15 months).

Messrs. Wood, Drew & Co., of London, have been appointed auditors of the electric lighting accounts at 40 guineas per annum.

Croydon-Crystal Palace Tramways. — The extensions of Croydon tramways from South Norwood to the Penge and Upper Norwood entrances of the Crystal Palace were opened last week.

Crystal Palace Engineering School.—The "Wilson" premium for the best Paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to F. W. Slane for his Paper on "The Construction and Maintenance of a Railway." Other Papers read during the session were "The Evolution of the Telegraph," by C. S. Saunders; "Flying Machines," by A. D. Villares; "The Survey and Project for a Railway," by H. M. Hardinge; and "Slide Valves," by P. K. Turner. The premium was presented by Sir Alex. R. Binnie, president of the Institution of Civil Engineers, on the occasion of the hundredth distribution of certificates on the 11th inst. An abstract of Sir Alex. R. Binnie's speech on the occasion appeared in our last issue.

Customs Decisions.—Under a recent decision of the New Zealand customs authorities, electric torch, dental and surgical lamps are dutiable at 20 per cent. ad val., and the batteries for use with these lamps, in their cases, are rated as electric machinery and appliances at 10 per cent. ad val.

Under the revised customs duties of the Argentine Republic carbons for electric arc lamps bear a duty of $0.20 per kilog. gross, and incandescent lamps a duty of $0.80 per kilog. gross.

Darwen.—The electricity department have arranged a hire-purchase system for the supply of electric motors. Purchase money is payable in 20 quarterly instalments.

Dunfermline.—The Board of Trade have granted the Dunfermline electric lighting provisional order, which will permit of the supply of electric current to Pittencrieff Glen and other areas outside the burgh. No generating station is to be erected within 400 yds. of the Glen or Palace Ruins.

Electric Motor Cars in Hyde Park.—Licences and badges will be issued by the Commissioners of Works for the admission of electric carriages to Hyde Park between 4 p.m. and 7 p.m. in May, June and July.

Electric Power in Canada.—Last week the Premier of Ontario (Mr. Whitney) received a deputation from municipalities of provinces which favour the public development of power at Niagara for provincial towns. It was understood that the Government proposed to take over the existing plants of companies, but it has now been suggested that the Government themselves should instead erect great power works at Niagara. The Niagara Falls Council and other bodies are opposed to the latter proposal, but it is stated that the influence behind the scheme supported by the deputation is so strong that the Government will probably be compelled to give its adhesion.

The Dominion Government have, it is stated, decided to exercise strict control over the exploitation and exportation of water-power generated electric current generated on Canadian soil. The Minister of Public Works (Mr. Hyman) recently stated that any permission to export power would be revocable at short notice, that no claims would be entertained against the Government for the revocation of any authority given for exportation, and that any company seeking permission to export must conform to all Government rules and regulations formulated on the subject.

Electricity in Mining.—The use of electricity as a motive power at Lake Superior Copper Mines is extending rapidly, and in a short time in all the rock houses at the Calumet & Hecla Mining Co.'s Calumet conglomerate, Kearsage and Osceola amygdaloid mines electric motors will supplant steam. Electric power is used for operating the rock crushers, trip hammers, &c., by means of a 50 H.P. induction motor. Ultimately electric current will be used for hoisting at many of the shafts. Electric motors are installed for pumping in some of the shafts, and will, no doubt, be extended as conditions allow. These changes will effect a great saving in operating costs, and several companies are only waiting for the results at the Calumet & Hecla mines before giving out contracts for electrical plant for their undertaking.

Exhibitions.—An exhibition of electrical fittings and domestic appliances will be opened at the Library Hall, Edward's-lane, Stoke Newington, London, from Thursday, 19th, to Saturday, April 21, in connection with the Stoke Newington scheme of electricity supply, which it is announced is now available. Demonstrations will be given at the exhibition of the various lamps and appliances, and these explanations will be illustrated by lantern slides. The General Electric Co. are responsible for the display of fittings and other accessories.

It would not, we think, strike the average exhibition promoter as wise policy to open an industrial exhibition in London in Easter week, and we think the result of adopting this course has led to the tenth annual International Furnishing Trades' Exhibition and Market, which was opened on the 17th inst. at the Agricultural Hall, Islington, London, being somewhat overlooked, and to be even less forward than usual for exhibitions of this character on the opening day. As the exhibition remains open until the 27th inst. this state of unreadiness may be remedied. We were surprised on visiting the exhibition to find nothing of particular interest in the electrical line. An "International" Furnishing Trades' Exhibition and Market minus a fairly good display of electrical fittings and furnishings appears to us to be an odd event at this time of day, and we suggest to the promoters that such an omission was unbusinesslike. There is nothing particularly international about the present exhibition, and we are not able to chronicle that advance which might reasonably be expected in an exhibition supposed to represent the progress of a branch of industry in which great strides have been made in recent years. There is, of course, much to interest the general public in the exhibition, which we hope will be well patronised, but this patronage would, we feel assured, be more certain were the display of a more comprehensive character. There is little or nothing to indicate that electricity for illumination, for heating, for cooking, and for other domestic purposes occupies absolutely the front place in connection with house, hotel, office and general furnishing at the present time. This is incongruous to a degree, and leads us to suggest that, as in the case of other trade exhibitions and markets, this exhibition being made an annual fixture is a tactical error.

The State Premiers have decided to instruct the Agents General in London to formulate a scheme for a combined Australian exhibition, a travelling one preferred.

It is intended to hold an international exhibition at Jamestown, Virginia, U.S.A., in May, 1907, to celebrate the 300th anniversary of the first English settlement of the United States of America. According to a report from the British Consul at Baltimore (Mr. Fraser) the project has every appearance of being a great success, the president of the exhibition having been to Europe to enlist the co-operation of various Governments, with gratifying results. In many of the States commissions have been appointed, and large sums of money have been voted. The State of Maryland has set aside between £20,000 and £30,000 for the purposes of the exhibition.

Goods Traffic on Tramways.—Mansfield & District Light Railway Co. propose to start a goods service, to be limited between 8 p.m. and 8 a.m.

The company intend to use electric locomotives with trailers, each capable of carrying 10 tons, the maximum number of trucks hauled at one time being six. Hand-operated brakes are to be fitted to the trucks, and two men are to be in charge of the train, one in the front driving, and in charge of the brakes on the loco., the other at the back, who will act as brakesman.

The Board of Trade have intimated that they see no objection to these arrangements, except that if one brakesman only is to be employed it will be preferable at first that there should not be more than four 10-ton waggons in a train, and that the rear truck should be provided with a platform and brake handle at the trailing end for the use of the brakesman. The Board propose to make their consent subject to these conditions, and to have an inspection of the general working arrangements by an officer of the Board.

The Mansfield Light Railways sub-committee recommend that the traffic be restricted between 8 p.m. and 8 a.m.; that the Board of Trade, before coming to any decision, be asked to inspect the routes, &c.

Mansfield Council will discuss the matter this (Friday) evening.

Gravesend.—Sanction has been received by the Council to a loan of £7,000 for electricity supply extensions.

Halifax—The receipts of the Corporation tramways for the year ended March 31 were £80,488, an increase of £6,036 over the previous year.

Hanley.—A recommendation of the Electric Lighting committee to take over Fenton Council's electric lighting order and to pay the cost of obtaining the order has been referred to the Council in committee. Under the proposed arrangement Fenton Council would have the right to acquire the undertaking at any time at its "fair market value," without additions for goodwill, &c., upon giving six months' notice.

The Council decline to sanction the supply of electricity in their district by Stoke-on-Trent Corporation to the N. Staffordshire Railway electrical department.

Hindley.—As the Council cannot transfer their Provisional Order (1901) to the Lancashire Electric Power Co., a year's extension has been applied for.

Huddersfield.—The tramway receipts for the year ended March 31 were £74,495, and expenses £39,872, leaving £34,622 as gross profit. After providing for interest, sinking fund and depreciation, the deficiency will be £1,131.

Inquest.—At Wednesbury, last week. an inquest was held on Harry Jenkins, lamp trimmer, who was killed on the previous Tuesday at the Old Park Works of the Patent Shaft & Axletree Co.

It appeared that deceased and a fellow workman had to look after about 90 arc lamps used at the works, and it was their duty to switch the current on and off as required. Deceased was seen to ascend a ladder to attend to one of the lamps, to which he was noticed to be apparently clinging. It was then found that the switch controlling the current was only partially turned off, and immediately current was switched off deceased fell to the ground, when life was found to be extinct.

Mr. Andrews, electrical engineer to the company, said the switches controlling the current were in a cupboard, which was not locked, but no one had ever tampered with them. It was customary for the cleaners to recarbon the lamps and to see they were in order. He thought deceased failed to properly turn off the switch though under the impression he had done so.

A verdict of accidental death was returned.

Islington (London).—Consumers who require daytime supply of electricity for lighting in addition to the ordinary supply are to be allowed the option of taking this at the existing rate (5d. and 2d. per unit respectively) or at a uniform rate of 3½d. per unit. Main extensions are to be carried out at an estimated cost of £115, and two additional flame lamps are to be erected at an estimated cost of £80.

Italy.—At the port of Genoa there are now installed no less than 105 pieces of loading and discharging apparatus, and of these 25 are electric cranes. Immense bonded warehouses and similar buildings for the storage of grain and other produce have of late years been erected, and in many of these a number of electric cranes, hoists and winches have been put in. All the quays and adjacent maritime railway depots are lighted electrically, arc lamps being the chief source of illumination.

At Spezzia a number of new industries have been recently established or are on the point of establishment, especially in connection with the motor vehicle and motor launch branch of engineering work. For some time past an electric omnibus service has been in contemplation between Spezzia and Porto Venere, and the service is now run as far as Fezzano, about half the journey. This is the longest line of railless electric vehicle service in Italy, and its working and maintenance is attracting much attention from those concerned in road vehicle services driven by power.

Turin is a town that has always been in the forefront of electric tramway traction, and the present steam tramway services connecting the chief provincial towns of the district will, it is hoped, shortly be replaced by electric services. Already the Torino-Moncalieri-Trofarello line has been electrified as part of a general scheme.

Kearsley.—The District Council give notice of intention to lease their tramways for 21 years to Farnworth Council at an annual rent of £1,400.

The Council on Thursday last approved the agreement for the transfer of Farnworth Council's tramways to the South Lancashire Tramways Co.

The Council also decided to unite with other councils in negotiating for the transfer of their electric lighting powers to the Lancashire Electric Power Co.

Kirkcaldy.—Last week the Council adopted a revised scale of charging for electric current for power drawn up by the burgh electrical engineer (Mr. O. F. Francis), and in future prices will range from 2¼d. per unit for the first 500 units to ¾d. per unit for all current in excess of 200,000 units per annum.

Leeds.—The Tramways committee recently recommended that the salary of the general manager (Mr. J. B. Hamilton) be increased from £1,000 to £1,200 a year, but Mr. Hamilton has now withdrawn his application for the present, asking to be allowed to bring it forward again at a more favourable time.

Manchester.—On Wednesday the Electricity committee considered the accounts for the year 1905-6. The total income was £330,977, or £28,171 more than in 1904-5. For the current year it was estimated that there would be increased new business on lighting sales of 22 per cent. and on power sales of 40 per cent. It was estimated that there would not be much variation in generation and distribution costs, and that management expenses were not likely to differ greatly from the estimate. The total estimated income for the year is £341,300, and the surplus to be transferred to reserve £13,480.

Municipal Free Wiring.—At a special meeting of the Brighton Ironmongers' Association and the electrical engineers of the town, on April 10, a resolution was considered as to the advisability of either opposing or requesting the Corporation to reconsider a resolution passed by the Council on April 5, as follows :—

> "That the Municipal Electrical Association be requested to consider the advisability of requesting the President of the Board of Trade to introduce a bill into Parliament authorising all municipal corporations carrying on electrical undertakings to wire consumer's premises."

It was unanimously resolved by the meeting that the necessary steps should be taken to, if possible, get the Corporation to withdraw the proposed application to the Municipal Electrical Association for the following principal reasons :—

> 1. That municipal trading, as opposed to private trading, is a serious mistake from a ratepayer's point point of view.
>
> 2. That, although the chairman stated in Council that the above proposal had met with the approval of the wiring contractors, the matter had never been put before them, and they were all very much opposed to the Corporation interfering with private enterprise in any way, even though they were to give the work to and pay contractors, as there is no doubt that the money would eventually come out of the ratepayers' pockets, or that they must act as guarantees for any loss incurred.

It was suggested that the Corporation could, no doubt, create a much larger demand for the use of electric current by reducing the flat rate to 3d. instead of 4d., and by giving a further rebate to very large consumers, as is now being done at West Ham and other towns. It was decided, if necessary, to get the matter taken up and fought by the whole of the trade in the United Kingdom.

Municipal Telephony.—Portsmouth Telephone committee reported to the Corporation last week that

> The Local Government Board had sanctioned the borrowing of £16,262 and £2,253 for the municipal telephone service, but with regard to the proposal to borrow £1,467 for further works, comprising additional junction lines to Gosport, Fareham, Cosham and Emsworth, and the completion of the remaining section of the central switchboard, the Board were of opinion that there was not sufficient evidence submitted at the inquiry to justify them in sanctioning the loan at present.
>
> On the proposition of the chairman of the committee (Councillor Dittman) it was agreed that it should be left to the chairman and the vice-chairman, with the consulting engineer (Mr. A. R. Bennett) and the manager (Mr. C. M. Gardner) to get out particulars to justify an application to the Board for a loan for the additional junction lines.

Municipal Tramways Association.—Leeds Tramways committee have invited this association to hold its next annual conference in Leeds. This year's president is Mr. J. B. Hamilton, general manager of Leeds tramways.

Ormskirk-Southport Light Railway.—It is announced that the Board of Trade have withdrawn sanction to the construction of this light railway, as the promoters have been unable to satisfy the Board that they intended to construct the line within reasonable time.

Sale.—Work was commenced on Tuesday on the construction of the electric tramways from Sale towards Altrincham.

Spain.—A concession has been granted to the Nueva Montana Soc. Anon. del Hierro y Cicero de Santander for the construction and operation of an electric tramway between Santander and Astillero.

Sweden.—The British Legation at Stockholm reports that a bill has been introduced into the Riksdag to provide for the purchase of a number of the principal waterfalls in that country, and for the establishment of a power station for the generation of electric current at the Trollhätten Falls. 5,000,000 kroner (about £277,000) is scheduled for the purposes of this project, the main object being to construct works to generate electric current to operate the State railways electrically. It has been calculated that 250,000 H.P. is the minimum amount of such power available for this and other industrial purposes if the Swedish waterways are brought under proper control and organisation.

Switzerland.—A concession has been granted to Rudolf Fürst and Guido Meyer, of Oerlikon, for the construction and operation of an electric railway between Uster and Pfäffikon. Other concessions of a similar character have been granted to MM. Kunz & Hess, of Maur, for an electric railway between Schwamendingen and Uessikon; to the Montreux-Oberland Bernois Co., of Montreux, for an electric railway between Zweisimmen and Lenk; to M. Dr. G. Reali, of Lugano, for an electric railway between Lugano and Dino; and to M. H. Pfyffer, of Lucerne, and M. Dr. C. Odermatt, of Stans, for an electrical funicular railway between Matt and Bürgenberg.

Taunton.—The Council have been authorised to borrow another £5,000 for electric lighting extensions.

Victoria Falls Power Scheme.—It is announced that Messrs. Armstrong and Jones, who have been two months in Johannesburg investigating the local features of the scheme for the transmission and supply to the Rand of electric power generated by the famous Victoria Falls on the Zambesi, have completed satisfactory contracts, and are returning to London.

It is also reported that negotiations are in progress between the Allgemeine Electricitäts Gesellschaft and the British South African Co., Wernher, Beit & Co., and other British companies for the exploitation of the Victoria Falls water power scheme. The A.E.G. is to be entrusted, it is stated, with the building and installation contracts.

Whitehaven.—Last week the chairman of the Parliamentary committee (Ald. J. G. Dees) informed the Council that the negotiations with the promoters of the West Cumberland Electric Tramways and the Cumberland Electricity & Power Gas Co.s were progressing satisfactorily. The latter company seemed disposed to acquire the municipal electric lighting undertaking.

Mr. T. S. Bell, assistant electrical engineer, has resigned.

Willington (Durham).—The District Council will withdraw opposition to the County of Durham Electrical Power Distribution Co.'s application for a provisional order, provided :—

> (1) The company receive no authority to sell to any other person or company their rights under the order; (2) that there will be nothing to prevent the Council from taking and paying for a supply of electric current from any private person or persons for lighting; (3) that there will be nothing to prevent Messrs. Straker & Love or any other private persons or company from supplying their workmen or any other person or public body with electric current, or charging such prices for it as may be agreed upon, but that there will be no power to break up public streets for providing such supply.

Windsor Castle.—Two paintings of life-size figures in the Van Dyck room of the castle are now each illuminated by four clusters of incandescent electric lamps concealed by gilt metal reflectors. Should the experiment prove successful other large pictures will be similarly illuminated. Electric lamps are being fitted in the corridors and electric lifts have recently been put in.

Workhouse Lighting.—Buckingham Guardians have asked the local electric light company to submit a scheme for lighting the workhouse.

Electrical Engineers Ball, 1906.—The ball given on Jan. 19 last was again a financial success, and the Benevolent Fund of the I.E.E. will receive £25. It is hoped that the fund may benefit by even larger sums in succeeding years.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Govan Corporation invite tenders for the yearly supply of stores for their electricity department, including engine room stores, oil, &c., cables and cable accessories, bitumen, meters, house fuse boxes, wrought-iron tubes and fittings, cast-iron pipes, arc lamp carbons, joint boxes, motors and motor starters, coal, timber, &c. Schedules, &c., from the burgh electrical engineer, Mr. T. C. Parsons, Helen-street, Govan. Tenders to the town clerk, Mr. J. A. Houston, Town Hall, Govan, by 30th inst. See also an advertisement.

Willesden District Council invite tenders for supply and delivery of direct-current motors for letting to consumers on hire or on the hire-purchase system. Specifications from the resident electrical engineer (Mr. J. G. Bruce), Salusbury-road, Kilburn, N.W. Tenders to the clerk (Mr. Stanley W. Ball), Council Offices, Dyne-road,

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

Kilburn, London, N.W., before 10 a.m. May 1. See also an advertisement.

Willesden District Council also invite tenders for supply of arc lamp carbons for the ensuing 12 months. Specifications from the resident electrical engineer (Mr. J. G. Bruce). Tenders to the clerk (Mr. Stanley W. Ball) as above by 10 a.m. May 1. See also an advertisement.

Glasgow Corporation invite tenders for supply of (1) main cables, (2) small cables and wires, (3) electricity meters, and (4) carbons for 12 months from the 31st prox; also for cast-iron joint boxes and other stores and materials. Tenders to the town clerk (Mr. A. W. Myles) before 23rd inst.

Glasgow Corporation also want tenders by 30th inst. for about 70,000 tons of coal. Forms of tender from Mr. W. W. Lackie, 75, Waterloo-street, Glasgow.

St. Pancras (London) Borough Council invite tenders for supply of arc lamp carbons for 12 months. Tenders to the town clerk (Mr. C. H. F. Barrett) Town Hall, Pancras-road, N.W., by noon April 30

Poplar (London) Borough Council want tenders by 10 a.m. May 8 for supply and erection of overhead bunker and coal-handling plant. Form of tender from the borough electrical engineer, Glaucus street, Bromley-by-Bow, E.

Tenders are invited for supply and erection of two turbine water wheels, two c.c. dynamos, two pumps, &c., at *Belfast* District Lunatic Asylum, Purdysburn, near Belfast. Tenders to S. M. Macrory (Ltd.), Limavady, by May 10.

Southampton Corporation invite tenders for reconstructing their tramways in the Avenue. Tenders to the town clerk (Mr. R. R. Linthorne) before 2 p.m. 23rd inst.

South Shields Corporation want tenders by noon 27th inst. for supply of machinery and tools to tramcar sheds. Particulars from Mr. J. Wilson, tramway depot, Dean-road.

Tenders are wanted for the erection of works and offices at *Doncaster* for the Rhodes Electrical Mfg. Co. Quantities, &c., from Mr. P. Fox, 14, Manchester-road, Bradford.

Hull Electric Lighting committee want tenders by noon 26th inst. for 12 months' supply of machinery oils.

The Gas and Electricity Works at *Aarhus* (Denmark) invite tenders for supply of about 250,000 Danish lbs. (about 280,000 lbs. avoirdupois) of sulphuric acid. Conditions and forms of tender can be obtained at the Belysningsvaesnets Kontor, Aarhus, where tenders are to be sent by noon of April 23. A copy of the conditions (in Danish) can be seen at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

In our last issue we gave particulars of the tenders accepted by West Bromwich Corporation for a 400 kw. turbo-generator, alterations and additions to exhaust pipes, &c. The following is the list of tenders submitted, set out according to the amount of tender (though no figures have been published) :—

C. A. Parsons & Co. (*accepted*), British Electric Plant Co., General Electric Co., Richardsons, Westgarth & Co., Brush Co. and Siemens Bros. & Co.

For alterations and additions to exhaust pipes: C. A. Parsons & Co. (*accepted*), Richardsons, Westgarth & Co., Brush Co., John Spencer (Ltd.), General Electric Co. and Siemens Bros. & Co.

Gravesend Corporation have accepted the following tenders for annual stores: General Electric Co., carbons; Siemens Bros. & Co., incandescent and tantalum lamps and arc lamp globes; Drake & Gorham, Nernst lamps; Ferranti Limited and General Electric Co., meters; W. H. Willcox & Co., J. Stone & Co, Croager Bros., F. Bird & Co., Hobdell, Way & Co. and Lindley & Co., engine-room stores, &c.

In addition to the tenders set out in our last issue (p. 1066) Fulham Council have accepted the following tenders for stores: J. Gibb & Co., tools, bar iron, steel springs, ironmongery, &c.; Middlesex Iron Foundry Co., castings; Middleton Bros., oils, turpentine, paints, varnishes, oilman's sundries, &c.; Phœnix Brush Co., broom, brushes, &c.; Municipal Supplies Co., drain rods.

Sunderland Electric Lighting committee have accepted the tender of the General Electric Co. for a steam alternator (Belliss engine), also for a transformer and an air compressor. 22 firms submitted 47 tenders. The committee have also accepted the tender of E. Le Bas & Co. for pipe work. For this latter contract six tenders were submitted.

The following tenders have been accepted by Londonderry Corporation. Ferranti Limited, meters; Reason Mfg. Co., demand indicators and house fuse boxes; W. H. Keys & Co., bitumen, &c.; Western Electric Co., cables; Dee Oil Co., oils; General Electric Co., carbons.

The Guardians of Aston Union recently received 23 tenders (varying in amount from £108 to £336. 10s. 3d.) for a telephone installation to connect the various blocks of buildings forming the workhouse, and the lowest, that of Richardson and Carlmark, has been accepted.

Weston-super-Mare Council have accepted the tender of the local electric light company for wiring the sewage pumping station at £350 and £17. 10s. per annum for maintenance and inspection.

Dartford Council have accepted the tender of the E.P.S. Co. for the maintenance of the traction battery for five years at £75 per annum.

The Paterson Engineering Co. have recently supplied two exhaust heaters and softeners (each of 33,000 lb. hourly capacity) for the Derbyshire and Notts. electric power generating station, to the order of Davey, Paxman & Co. Heckmondwike electricity works have also recently been supplied with a condensation water purifier of 3,000 gallons hourly capacity, and London County Council with two water purifiers and grease eliminators.

Salford Corporation have accepted the tender of Electromotors (Ltd.), Openshaw, Manchester, for electric motors from ½ H.P. to 5 H.P. for 12 months.

The tender of Babcock & Wilcox has been accepted by West Bromwich Corporation for an additional boiler and high-pressure steam piping.

Walsall Corporation have accepted the following tenders: Thos. Parker (Ltd.), a 350 kw. dynamo; Belliss & Morcom, a 500 H.P. engine; Stirling Boiler Co., boiler, £922; G. & J. Weir, feed pump, £95.

Whitehaven Corporation have accepted the following tenders: Callender's Co., bitumen cable; Siemen Bros. & Co., armoured cable: E.P.S. Co., repair of storage battery.

Lowestoft Corporation have accepted the tender of the Crypto Electrical Co. for supply of a motor-generator at £22.

BUSINESS NOTICES.

In another part of this issue of "The Electrician" appears an illustrated article dealing with the Oerlikon Co.'s new system of single-phase traction. We may call attention here to the fact that inquiries regarding this system may be addressed to Mr. G. Wüthrich, who represents the Oerlikon Co. in this country, at Oswaldestre House, Norfolk-street, London, W.C.

Mr. E. F. Iohnson has entered into partnership with Mr. C. R. Heap, and in future these gentlemen will carry on business as dealers in electrical and mechanical appliances at 28, Hatton-garden, London, E.C., under the style of Heap & Iohnson. Telegrams "Unisonally London"; telephone 6602 Central.

Andrew Perricord & Reginald W. Whaley (trading as the Victoria Electrical Co.), 47, Victoria-street, Westminster, London, S.W., have dissolved partnership. Debts by Mr. Perricord.

Bernard Page Scattergood & Claude Hornor Johnson, electrical engineers, 7, Cookridge-street, Leeds, have dissolved partnership. Debts by Mr. Scattergood, who continues.

Pope's Electric Lamp Co., Hythe-road, Willesden, N.W., have appointed Mr. E. A. Marx as representative for Pope lamps.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against Ernst E. Donat (trading as Donat & Co.), engineer, &c., formerly trading at 21, Spring-gardens, Manchester, to be sent by April 28 to Mr. J. G. Gibson, Byrom-street, Manchester.

The discharge of Jas. S. Blackwell (trading with W. A. Charles as the Central Electrical & Engineering Co.), 74 and 111, Churchgate, Leicester, and 22, Kennington-road, London, S.E., has been suspended for two years.

In consequence of the death of Mr. Chas. B. Hahn, Mr. Emanuel Williams is now acting as sole liquidator of the Delafon Batteries Synd. (Ltd.)

The General Luxfer Prism Co. (Ltd.) is being wound up voluntarily. Mr. D. F. Basden, 33, St. Swithin's-lane, London, E.C., is liquidator.

The Wallace Lamp Synd. (Ltd.) is being wound up voluntarily. Mr. S. Worley, 37, Lime-street, London, E.C., is liquidator.

The Patent Electric Carbonising Co. (Ltd.), is being wound up voluntarily. Mr. M. S. S. Roberts is liquidator.

Plant, &c., for Sale.—A 6 B.H.P. Crossley gas engine (with fly-wheel, tanks, &c.) is advertised for sale.

The Brown Hoisting Machinery Co., 39, Victoria street, London, S.W., advertise for sale a Weston ammeter with shunt, and voltmeter; also insulation tester.

Business for Disposal.—An art metal and general smith's business in the south-west of London is advertised for sale by Messrs. Maxwell-Draper & Barker, 3, Bucklersbury, London, E.C.

Premises to Let.—Light workshops and offices are advertised to let at 219, Goswell-road, London, E.C.

Messrs. R. D. & J. B. Fraser, Princes-street, Ipswich, advertise a spacious factory to let.

A factory at Holloway, London, N , is advertised to let.

Workshops with private house, suitable for electricians and motor engineers, are advertised to be let.

Catalogues, &c.—Elliott Bros., Lewisham, London, S.E., have ready a number of new circular lists (Nos. 67, 68, 69, 70, 73 and 77) dealing with a wide range of alternating and continuous-current ammeters, voltmeters, wattmeters, &c. Besides illustrations and particulars of the construction of these instruments, diagrams of dimensions and a full list of prices are given.

Electrically-driven grinding tools (on which subject an article appeared in *The Electrician* recently) are listed in a new pamphlet (No. 192) issued by the British Thomson-Houston Co. Several examples of these machines are illustrated. A second pamphlet (No. 193) issued by the same company deals with the latest designs of knife switches manufactured by the British Thomson-Houston Co.

"Aston" auxiliary motor regulators and "Han-grip" power fuses for switchboards and power distribution boxes are respectively described in pamphlets Nos. 529 and 530 issued by Veritys Limited. In pamphlet No. 531 automatic arc lamp clutches and contacts are dealt with.

The Electrical Co., 121–125, Charing Cross-road, London, W.C., have a new circular list ready of aluminium rectifiers for charging any class of accumulator direct from alternating mains of any periodicity or voltage.

The Electrical Co. have also ready a new list of multiple Nernst lamps, which includes illustrations of examples of these lamps for indoor and outdoor use.

The Tudor Accumulator Co., 119, Victoria-street, Westminster, London, S.W., have ready a new catalogue of stationary Tudor cells, and the company notify that they are now giving special attention to the subject of small batteries and are not confining themselves to the same extent as formerly to central station battery work. The list contains a number of excellent illustrations and much information concerning Tudor cells, besides setting out guarantees and other commercial particulars.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on April 11 and 12, with the ports of destination:—

Aden, £252 (telegraph material). *Africa*—Alexandria, £139 (including £93 telegraph material); Durban, £1,233 (including £453 telegraph material); Port Said, £10 (telegraph material); Suakim, £160 (telegraph material). *Argentina*—Buenos Ayres, £2,005 (including £735 telegraph material). *Australasia*—Auckland £166; Christchurch, £142; Lyttelton, £15; Melbourne, £68 (including £15 telegraph material); Perth, £47; Wellington, £81 (including £69 telegraph material). *Belgium*—Ostend, £8. *Canada*—Montreal, £74. *China*—Shanghai, £20. *Cuba*, £103. *France*—Bordeaux, £120; Boulogne, £100; Le Treport, £45. *Holland*—Amsterdam, £261. *Hong Kong*, £225. *India*—Bombay, £1,115; Calcutta, £1,422. *Japan*—Nagasaki, £10; Tokyo, £374. *Portugal*—Lisbon, £7. *Russia*—Kurch, £2,656. *Siam*—Bangkok, £21. *Straits Settlements*—Penang, £26; Singapore, £19. Total (for two days), £10,924, against £26,151 for seven days last year (April 12 to 18).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Water Softening and Treatment. By William H. Booth. (London: Archibald Constable & Co.) 7s. 6d. net.

"Proceedings of the Royal Society." Series B. Vol. LXXVI. No. B519. Biological Sciences. (London; Harrison & Sons.) 3s.

Technical Dictionary in Six Languages English-German, French-Italian, Spanish-Russian. By Kurt Deinhardt and Alfred Schlomann. Vol. I. The Machine-Elements and Tools for Working in Metal and Wood. Together with an appendix and edited by P. Stülpnagel. (London: Archibald Constable & Co.) 5s. net.

"Physical Chemistry for Electrical Engineers." By J. Livingston R. Morgan. (London: Chapman & Hall) $1.50.

"Lexikon der Elektrizitat u. Elektrotechnik." Edited by Fritz Hoppe. Nos. 6 to 10 "Einsteckkontakt" to "Kontaktbügel." (Leipzig: A Hartlebens Verlag.) 50ph. each.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

March 5, 1906.

5,289 Lancashire Dynamo & Motor Co., Wood & Mason. Apparatus for controlling and reversing the direction of motors to directly-driving machines.
5,300 Horsnaill. Magnetic clutches for conveying rotary motion.
5,303 Leisser. Storage of electricity.
5,304 Hill. Electric alarums.
5,314 Hughes. Magnetic compasses for motor boats and yachts.
5,325 Potter. Electro-magnetic power generators. (Date applied for, April 3, 1905.)*†
5,343 Brockie. Regulating gear of arc lamps.
5,371 Howarth. (Holman, U.S.) Electromagnets.*
5,373 Saunders & Sweetser. Telephone switches or cut-outs.

March 6, 1906.

5,380 Young. Fittings for supporting electric lamps.
5,450 Walker. Collection of current from direct-current dynamos.
5,465 Vickers, Sons & Maxim & Lindley. Brush-holders for electrical machines.
5,468 Gregson. Electrical illuminated discs for advertising or other purposes.

March 7, 1906.

5,508 Brown. Machines for laying telegraph poles and the like.
5,555 Brockie. Regulating mechanism for electric arc lamps.
5,566 Duflos. Sparking plugs for internal combustion engines.*
5,573 B.T.-H. Co. (G.E. Co., U.S) Electric motor control systems specially operating for bulk-head doors and the like.
5,575 B.T.-H. Co. (G.E. Co., U.S.) Lightning arresters.

March 8, 1906.

5,592 Bowring & Whiteley. Means for taking up slack in trolley ropes.
5,599 Daniel. Electrical automatic bolt.
5,602 Burleigh. Dynamo-electric machinery.
5,627 Orling. Electro capillary recording apparatus.
5,629 Goolding. Insulators.
5,652 Ekström. Common battery telephone systems. (Date applied for, Sept. 13, 1905.)*†
5,656 Caton & X Electric Accumulator Co. Secondary batteries.

March 9, 1906.

5,676 Bevis & Krause. Wall plugs and sockets for electric circuits.
5,685 Colquhoun. Wall switch for regulating electric currents.
5,693 Wilkinson & Lynch. Ships' telegraphs.
5,699 White. Magneto ignition gear.
5,729 Prideaux. Motor commutator.
5,744 Siemens & Halske A.G. Working telegraphic installations composed of rapidly and slowly working lines. (Date applied for, March 11, 1905.)*†

March 10, 1906.

5,794 Lucas. Starting and operating mercury-vapour lamps and rectifiers.
5,801 Gross. Arc lamps.
5,811 Lamb. Electric vehicle trolleys.
5,812 Russell & Gritton. Electrically lighting, controlling and extinguishing gas or vapour lamps.
5,819 Elieson & Biliotti. Dynamos for maintaining constant potential at varying speeds.

5,826 Cuthbert. Tramway rail.
5,853 Tingley. Ventilation of dynamo electric machines. (Date applied for, March 17, 1905.)*†
5,856 Drake, Jones, Evans & Jandus Arc Lamp & Electric Co. Electric arc lamps.
5,857 Drake, Jones & Jandus Arc Lamp & Electric Co. Electrodes for arc lamps.
5,862 Brockie. Arc lamps.
5,893 B.T.-H. Co. (G.E. Co., U.S.) High-tension switches.
5,894 Fry. Method of and apparatus for producing electricity.

March 12, 1906.

5,912 Ewart, Davison & Stewart. Arc lamps.
5,930 Brewer & Foster. Combined rail, slot and conduit and electrical system for electric tramways and railways.
5,945, 5,946 and 5,947 Stratton, Claremont, Beaver & Tanner. Troughs for electric cables and the manufacture thereof.
5,952 Field & Ferranti Limited. Electro-magnetic switches, &c.
5,957 Dawson & Buckham. Electro-magnectic firing mechanism for breach loading guns.
5,964 Bray & Bray, Markhan & Reiss. Regulating and other resistances.
6,006 B.T.-H. Co. (G.E. Co., U.S.) Switches.
6,008 Morres. Medicated electric battery adhesive plaster.
6,010 Woodhouse. Conduit for electric conductors.
6,020 Berlin. Control of electric motors.

March 13, 1906.

6,024 Thomas & McGowan. Using a dynamo and motor instead of a clutch and change speed gears on self-propelled vehicles.
6,045 Blaker. Trolley heads for electric tramcars.
6,061 Davidson. Surgical lamp adapter with rheostat
6,079 Vontobel. Automatic regulating device for pneumatically controlled collectors supplying current to trains or road-cars. (Date applied for, March 14, 1905.)*†
6,088 B.T.-H. Co. (G.E. Co., U.S.) Electrodes.
6,089 B.T.-H. Co. (G.E. Co., U.S.) Resistance material.
6,099 Boult. (Wardwell, U.S.) Devices for detecting faults in insulation of conductors.*
6,105 Gibson. Incandescent electric lamps.

March 14, 1906.

6,155 Collins. Electric circuit closing devices.
6,180 Robinson & Co. & Robinson. Anti-vibration device for electricity meters.*
6,193 B.T.-H. Co. (G.E. Co., U.S.) Resistance units.
6,194 and 6,195 B.T.-H. Co. (G.E. Co., U.S.) Dynamo electric machines.
6,200 Hardingham. (Felten & Guilleaume Lahmeyerwerke A.-G., Germany.) Lead-sheathed cables.
6,201 Perry. Separators for batteries.
6,216 Société Ch. Mildé fils et Cie. Luminous electric bell indicator. (Date applied for March 14, 1905.)*†
6,217 Poulsen. Signalling in wireless telegraphy.*
6,218 E.A.G. vorm. W. Lahmeyer & Co. Starting compensated mono phase commutator motors. (Date applied for, March 16, 1905.)*†
6,219 Sahulka. Transmitters for electro-magnetic waves.*
6,223 and 6,224 Hunt & Sandycroft Foundry Co. Alternating-current machines.

March 15, 1906.

6,262 Boddam. Electrically-operating hydraulic apparatus.
6,268 Leadbetter. Lifeguards for tramways.
6,283 Kuihnrich. Electric furnaces.
6,286 Fitzmaurice. Obtaining radium, preparatory treatment of pitchbleude or other base.
6,299 Brockie. Arc lamps of the flaming arc type.
6,300 Brockie. Regulation of enclosed arc lamps.
6,316 B.T.-H. Co. (G.E. Co., U.S.) Transformers.

March 16, 1906.

6,344 Turner. Carriages for conveying drums of cable.
6,362 Tate. Plug for paralleling purposes.
6,400 Levis. Building composite mica plates.*
6,412 Marconi & Marconi's Wireless Telegraph Co. Condensers.
6,423 Canedy. Sparking plugs. (Date applied for, March 16, 1905.)*
6,426 Hadfield. Treatment of magnetic materials.*
20,175a/05 Just, Hanaman, Landesberger, Salzmann & Vereinigte Electricitäts A.-G. Incandescing bodies for incandescent lamps. (Date applied for, Oct. 5, 1905.)

March 17, 1906.

6,441 Electrical Improvements & Hacking. Electrical ignition of gas lamps.
6,446 Percival. Supports and controlling devices for flexible electric pendants.
6,452 Simpson. Method of laying tramway rails.
6,454 Lea. Measuring and recording the flow of liquids or gases of mechanical and electrical quantities.
6,476 Wood. Electric light and bell fittings.
6,477 Hollington. Apparatus for winding wire.
6,490 Harris. Automatic electric locking for trains.
6,496 Roothaan & Ferranti Limited. Circuit breakers.
6,510 Brockie. Arc lamps.
6,515 Kufferath & Mafquart. Arc light carbons.*

SPECIFICATIONS PUBLISHED.

1904 Specifications.

26,986 James & Marples. Electrically controlled variable speed gear.

1905 Specifications.

1,951 Townsend. Automatic block signalling for electric railways.
2,694 Henri Léon Maillard. Ignition devices. (Date applied for April 7, 1904.)
2,695 Henri Léon Maillard. Sparking plugs. (Date applied for, Dec. 8, 1904.)
4,783 B.T.-H. Co. (G.E. Co., U.S.) Prepayment meters.
4,845 Union Elektricitäts-Ges. Alternating-current motors. (Date applied for, March 12, 1904.)
4,892 Chitty. Electric power generators.
5,143 Harfield & Routledge. Electrically driven stearing gear for ships.
5,357 Bastian. Hermetically sealing electrical conductors into glass.
5,490 Creed & Coulson. Telegraphic apparatus.
5,662 Thompson & Merchant. Electric signalling for railways.
5,899 Mather & Platt, Hopkinson & Frith. Electric motors.
5,983 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
6,089 Hutchins. Magneto-electric generators.
6,468 Soc. Electro-Metallurgique Francaise. Electrical production of cast iron. (Date applied for, March 25, 1904.)
6,946 Francombe. Electric fire alarms.
7,148 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems for electric vehicles.
7,359 Lamb & Newton. Automatically regulating the resistance on a switchboard for electrical driven machines or lights in conjunction with the governor of the engine.
7,419 B.T.-H. Co. (G.E. Co., U.S.) Signalling apparatus.
7,596 Berry. Supplying or distributing alternating currents.
7,720 Leitner. Accumulators.
7,819 B.T.-H. Co. (G.E. Co., U.S.) Coil winding machines.
8,002 Bourne. Winding coils and bobbins for electrical purposes.
8,028 B.T.-H. Co. (G.E. Co., U.S.) Electric motor controlling switches.
8,541 Rees, Iles & Armistead. Regulation of electric circuits subject to rapidly fluctuating loads.
8,569 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
10,320 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current generators.
10,446 Dronsfield & Huntley. Trolley poles of electric tramcars.
10,509 Tourtel. Coin-freed electricity meters.
10,609 Job. Electric advertising signs.
10,610 Job. Switching devices applicable to electric flash advertising signs.
11,424 Frisby. Apparatus for controlling electric currents.
11,470 Bacon. Cables.
11,705 B.T.-H. Co. (G.E. Co., U.S.) Arc lamps.
11,967 Crompton & Co. & Abbott. Hoisting gear for arc lamps.
11,995 Howell. Armoured casing for electrical wiring.
12,024 Penrose. Electrical switch.
12,598 Horvath & Utility Co. (Ltd.) Incandescent electric lamps.
12,518 Richmond & Clare. Automatically recording the number of times a telephone is used.
12,964 B.T.-H. Co. (G.E. Co., U.S.) Arc lamps.
13,163 Johnson. Dynamo-electric machines.
13,976 B.T.-H. Co. (G.E. Co., U.S.) Potential indicators.
14,759 Caslake. Holder for screwing on or off shade carrier rings.
14,978 Herz. Switch. (Date applied for, Oct. 7, 1904.)
15,880 Lamkin. Sparking plug for internal combustion engines.
15,969 Hikeley & Newcastle-upon-Tyne Electric Supply Co. Coin-freed apparatus for supply of current.
16,063 Craig. Rheostats, controllers, and starting switches for electromotors.
17,402 Stern & Engisch. Galvanic batteries.
17,957 Birnbaum & White. Step-by-step switches especially applicable as line selectors.
18,037 Poulsen. Receivers for the wireless telegraphy. (Date applied for, Sept. 17, 1904.)
18,427 Lester. Purification of water by electrical means.
19,285 Rebora. Arrangement of relay and fusible cut-out for protecting circuits. (Date applied for, Sept. 23, 1904.)
20,237 Melaun. Imbedding tramway rails in pavement constructed of liquid or plastic materials. (Date applied for, Oct. 17, 1904.)
20,687 Giraud. Supports and safety devices for overhead conductors. (Date applied for, Oct. 31, 1904.)
21,437 Kother. Electrodes for use in the manufacture of bleaching liquor.
22,162 Niehoff. Igniting devices for exploding projectiles.
22,901 Pagnall. Electro-plating vats.
23,878 Bastians. Locking device and electric coupling for arc lamps. (Date applied for, Jan 6, 1905.)
25,058 Land-und-Seekabelwerke A.-G. Electric cables. Date applied for, Dec. 2, 1904.)
25,393 Elektrizitäts A.-G. vorm. W. Lahmeyer & Co. Limiting the speed of compensated series alternating-current motors. (Date applied for, Dec. 27, 1904.)
26,086 Körting. Arc lamps.
27,290 Horstmann, Horstmann, Horstmann, Horstmann & Edgar. Time mechanism for controlling the supply of electricity.

1906 Specifications.

342 Watson & Smith. Tremblers of induction coils.
378 Siemens Bros. & Co. (Siemens & Halske A.G.) Electric signalling.
418 Schuer. Casings for electric arc lamps.
1,242 Veritys Limited & Gott. Parts of switches.
1,738 Allison (Empire Electric Stage Lighting Co. (Inc.)) Switches.
1,810 Davies. Tumbler switches.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.)

The sixty-ninth ordinary general meeting was held on Wednesday, Mr. Charles Parish presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting and also the auditors' report.

The CHAIRMAN said: Gentlemen, Our report covers the six months ending Dec. 31, 1905, and records what I believe you will consider a fairly satisfactory state of business. Our receipts amountad to £13,151 and the interest on investments to £1,496, giving a total of £14,647. There is an increase in the traffic receipts of £1,205 as compared with the second half of 1904, but during that period there was an interruption to our cables, and although we were always able to maintain our communication, we may have suffered somewhat from this cause; but, generally speaking, I should say we have had a better business in 1905 than in 1904 as far as the July to December half is concerned. Our interest from investments has fallen £375, which is the result of our having sold some of our securities to pay for the new cables. But taking the total receipts together there is an actual increase of £833, and to this we have to add a reduction of expenditure of £2,111, so that altogether there is an improvement of £2,944 upon the half-year's working. The expenses during the six months under review amount to £6,257, and may be regarded as about a normal outlay, while during 1904 heavy payments were incurred for the use of land lines, for as I explained at that time we were determined to keep up our communications and the good name of our Company under very difficult circumstances. We were quite sure that this action on our part would earn the full and complete approval of our shareholders. Our increased balance of revenue allows us to transfer £1,818 to reserve fund. It is not a large amount, but it brings up the total reserve to £87,000, and it is the more welcome for we have not been able to add to the reserve since Dec. 31, 1903, when it stood at £155,000. We have to provide £3,000 for the half-yearly dividend on the preference shares, and propose to you a dividend at the rate of 5 per cent. per annum, free of income tax, on the ordinary shares. After making these payments there will remain a balance of £5,603 to carry forward to the present half-year. You will see from the balance-sheet that capital expenditure has increased from £214,309 to £215,571, or by £1,442. For many years there has been no addition to our fixed investments in Cuba; but since our last meeting we have thought it advisable to purchase a house in Cienfuegos which will supply permanent and good accommodation for our important office there. Amongst the other items in the balance-sheet is the £8,174 claim against the American Government. It appears on both sides of the account, and in future we shall leave it out in our half-yearly reports. The claim is fully represented in the Company's books and we are still trying to recover it; although I regret to say the United States Government do not at present show any desire to meet us. Curiously, however, Mr. Root, the Secretary of State, has quite lately recommended that the French Cable Company's claim should be liquidated, which was also for damage done during the War, so we are again asking our Government to press our claim afresh; and the Secretary of State has been kindly telegraphing to Sir Mortimer Durand, His Majesty's Ambassador at Washington, to do all he can for us. In reference to our lawsuit against the Cuban Government (which is the other skeleton we have in our cupboard) for the payment of the subsidy due to us for the coast lines, I am sorry to inform you that we have to-day received a telegram from our representative, Mr. Mendoza, that the case has been given against us in the Superior Court, and that we shall now have to appeal to the Supreme Court, where I hope we may be more successful. To our minds we are fairly entitled to the subsidy, and it seems very extraordinary that any responsible Court should have taken an opposite view. I am glad to say our cables are working well, and the heavy expenditure we have made upon them is, I hope, proving to the public, as well as to our allied companies, that our policy and intention is to supply the best service possible. I will now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded the motion, which was, after a short discussion, carried unanimously.

A resolution approving the dividends for the half-year at the rate of 10 per cent. per annum (less tax) on the preference shares, and 5 per cent. per annum (tax free) on the ordinary shares was also carried unanimously, and a very cordial vote of thanks to the Chairman and Directors terminated the proceedings.

BRITISH ALUMINIUM CO. (LTD.)—Profit for 1905 was £93,296. 12s. 8d. £20,000 is written off for depreciation, £20,588. 1s. 6d. is deducted for interest, leaving £52,708. 11s. 2d. £13,177. 2s. 9d. has been applied in purchasing and cancelling debenture stock, leaving £39,531. 8s. 5d. After paying the balance preference dividends a dividend of 7 per cent. is declared on the ordinary shares for 1905. The contract for the development of the Loch Leven power scheme was let to Sir John Jackson (Ltd.) in July, and immediately afterwards the contractors commenced operations. The amount of power which will be developed will be considerably in excess of the directors' original anticipations, and should the demand for aluminium continue to expand, it is intended to utilise the whole of the power in the production of that metal. The increased power will necessitate a greater outlay than was foreseen, but owing to the greater amount to be obtained the capital cost per horse-power will be reduced. To meet increased expenditure and provide for extensions of works and other outlays, the board advises the creation and issue of 20,000 conversion shares of £10 each.

CITY OF BIRMINGHAM TRAMWAYS CO.—After providing £12,000 for interest and £12,083. 6s. 8d. for preference dividend to Dec. 31, the surplus is £72,722. 15s. 8d., from which is deducted £2,104. 14s., interim dividend at 5 per cent. per annum on the ordinary shares for half-year to June 30, leaving £70,618. 1s. 8d. A balance ordinary dividend at the rate of 5 per cent. per annum and a bonus of 5 per cent. (making 10 per cent. for year) is declared, £64,303. 19s. 8d. is carried to reserve. The capital expenditure during the year amounted to £26,202. 3s. 10d., and comprised the purchase of new electric cars, electrical equipment and additional plant for Coventry-road tramways, &c. As stated in last report, arrangements have been concluded with Birmingham Corporation for the purchase by them of the Balsall Heath tramways as from Dec. 31 next for £20,000, and also of the Kyott's Lake-road depot for £16,000. An arrangement has been concluded with Birmingham Corporation for running powers over the lines in John Bright-street from Jan. 1, 1907, until June 30, 1911, when the leases of the Bristol-road and Pershore-road tramways expire. The right of King's Norton Council to purchase the King's Heath and Moseley steam tramways arises at Dec. 31 next, when also the lease of the connecting lines within the city expires. The Council desire to have the option of reconstructing for electric traction the lines within the district during the present year, and an arrangement is being considered whereby the company's interests may be purchased by the Council, so as to enable them to reconstruct the tramways during the company's tenure. The purchase by Aston Manor Corporation of the company's lines and depot has now been completed, the price (£26,045) which was fixed by the arbitrator having been paid. The lines which are being worked by the company under agreement have in part been reconstructed for electric traction by the Corporation, but delay has arisen through the carrying out of sewerage and other works simultaneously with the reconstruction of the tramways. The agreement with Erdington Council, ander which the council were to grant a lease for 21 years to the company of the tramways when constructed to Erdington, has been cancelled by mutual consent. A scheme for the mutual insurance of the third party risk has been entered into by the company jointly with other associated companies of the British Electric Traction Co., and the arrangement has been found advantageous.

GRAVESEND & NORTHFLEET ELECTRIC TRAMWAYS (LTD.)—The directors' report states that the total revenue for 1905 was £12,320. 1s. 9d. Deducting expenses (including £1,800 for interest) the profit is £1,102. 7s. 5d. After paying preference dividend to March 31, 1905, the balance is £683. 3s. 11d., and the directors propose paying the balance of the preference dividend due to June 30 last.

SOUTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)—Mr. C. S. B. Hilton, at the meeting yesterday, said a considerable reduction in expenses had been effected, almost every item being less than it was last year. They expected to complete the sale of the lines and depot at Wednesbury to Wednesbury Corporation almost immediately. The purchase price was £28,920, of which £20,000 was payable to the lessee company for reconstruction of lines at Tipton.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

DUCHY DEVELOPMENT ASSOCIATION (LTD.) (88,362)—Reg. April 10, capital £20,000 in £1 shares, to carry on the business of a power supply company, electricians, electrical, metallurgical, mechanical and chemical engineers, manufacturers of and dealers in apparatus used in connection with the generation, distribution, supply, accumulation and employment of motive power, &c. Reg. office, 89 and 90, Cheapside, London, E.C.

LONDON ELECTROBUS CO. (LTD.) (88,381.)—Reg. April 11, capital £100 in £1 shares, to adopt an agreement with the International Motor Traffic Synd. for the acquisition of certain options, contracts and properties, and to carry on the business of motor car, omnibus, van and cab proprietors, carriers of passengers and goods, manufacturers of motors, motor cars, carriages, &c. Reg. office, 17, Cockspur-street, Pall Mall, London, S.W.

UNIVERSAL TELEGRAPHEX & TELEGRAPHONE SYND. (LTD.) (88,355.)—Reg. April 9, cap. £35,000 in 34,900 ordinary shares of £1 each and 2,000 deferred shares of 1s. each, to acquire certain patents for inventions relating to improvements in electric telegraphy and telephones, and to carry on the business of a telephone, telegraph and electricity supply company. Reg. office, 22, Cullum-street, London, E.C.

MORTGAGES AND CHARGES.

F. W. DICKINSON (LTD.)—A 5 per cent. debenture for £100 dated April 4, 1906, charged on company's property present and future, including uncalled capital, has been registered. Holder, J. Gordon.

ELECTRICAL INSTRUMENT MANUFACTURERS (LTD.)—£500 5 per cent. debentures, created Dec. 16, 1905, and dated March 24, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

TONYREFAIL & GILFACH GOCH ELECTRIC LIGHT CO. (LTD.)—Issue on March 27 of a £100 5 per cent. debenture, part of series created Dec. 6, 1904, to secure £15,000, charged on company's property, present and future, including uncalled capital. Holder, H. Morgan. No trustees. Previously issued of same series, £835.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	AGGREGATE, No. of weeks	AGGREGATE, Amount.	AGGREGATE, Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 14	1,338	+ 189	46	61,561	- 447
Airdrie	" 6	225	+ 31	14	2,981	+ 311
Anglo-Argentine	" 15	15,584	+ 1,325	15	221,545	+ 22,979
Ashton-under-Lyne Corpn.	" 7	894	+ 119	2	695	+ 88
Ayr Corporation	" 7	2.0	+ 7	47	13,308	- 79
Baker St. & Waterloo Ry.	" 14	1,221	...	5	7,549	...
Barnsley	" 6	168	+ 7	14	2,122	+ 10
Barrow	" 6	222	+ 11	14	2,807	+ 208
Bath Electric Trams, Ltd	" 11	745	+ 163	15	9,661	+ 1,389
Birkenhead Corporation	" 15	1,212	+ 190	15	15,222	+ 213
Birmingham Corporation	" 14	830	+ 13	2	775	+ 45
***Birmingham & Mid.**	" 6	1,479	- 381	14	18,859	- 4,970
Blackburn Corporation	" 11	935	+ 88	¶2	2,185	+ 166
Blackpool Corporation	" 12	552	+ 130	1	552	+ 130
Blackpool and Fleetwood	" 14	632	+ 411	15	3,398	+ 388
Bolton Corporation	" 15	2,889	+ 1,063	2	5,064	+ 713
Bournemouth Corporation	" 11	1,451	+ 460	†2	2,157	+ 487
Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	" 15	1,082	+ 202	2	2,023	+ 217
Bristol Trams & Carriage	" 13	5,358	+ 751	9	43,014	+ 2,409
Buenos Ayres & Belgrano	" 15	3,806	+ 288	15	53,225	+ 4,311
Buenos Ayres Elec. Trms.	Mar. 17	1,333	- 128	11	15,553	+ 3,562
Burnley Corporation	April 14	1,595	+ 557	2	2,878	+ 718
Burton Corporation	" 15	302	+ 15	§2	620	- 82
Bury Corporation	" 8	1,051	+ 517	§1	1,051	+ 517
Calcutta Tramways Co.	" 14	R42,205	+ R3,196	15	R661,183	+ R64,290
Camborne-Redruth	" 14	120	+ 18	24	2,574	+ 69
Cardiff Corporation	" 7	1,953	+ 55	1	1,953	+ 55
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	" 6	77	+ 23	14	652	+ 115
Central London Railway	" 14	5,690	- 1,071	15	102,971	- 4,155
Chatham & Dist. Lt. Rys.	" 12	659	+ 33	†15	8,531	- 179
***City of Birm'gh'm Tram Co.**	" 6	5,444	- 304	14	71,300	- 3,224
City & South London Rly.	" 15	2,326	- 433	15	43,943	+ 3
Colchester Corporation	" 12	160	- 5	35	6,592	- 1,525
Cork Electric Trams Co.	" 12	497	+ 65	15	6,127	+ 23
Derby Corporation	" 14	848	+ 187	2	1,575	+ 150
Devonport & Dist. Trams	" 6	465	- 35	14	5,568	- 380
Dover Corporation	" 14	274	+ 87	2	478	+ 77
Dublin & Lucan Railway	" 13	132	+ 28	§15	1,379	- 62
Dublin United	" 14	4,550	- 70	‡15	66,780	+ 1,297
Dudley—Stourbridge	" 6	777	- 14	14	10,289	+ 209
Dundee Corporation	" 11	1,162	+ 297	§47	44,520	+ 4,466
East Ham Council	...	...	...	...	...	...
Gateshead & Dist. Trams	" 6	941	+ 49	14	12,558	+ 608
Glasgow Corporation	" 14	16,945	+ 1,881	46	703,681	+ 47,734
Glossop	" 7	125	+ 13	14	1,711	+ 188
¶ **Gloucester Corporation**	...	...	...	...	...	...
Gravesend—Northfleet	" 6	220	+ 15	14	2,707	+ 97
Gt. Northern & City Rly.	" 14	1,671	+ 11	15	27,174	+ 948
Greenock & Port Glasgow	" 6	644	+ 53	14	7,888	+ 587
Halifax Corporation	" 11	1,494	+ 246	2	2,339	- 29
Hartlepool Tramways	" 6	265	+ 28	14	3,465	+ 140
Hastings Elec. Trams Co.	" 12	618	...	15	5,631	...
Huddersfield	...	...	...	...	...	...
Hull Corporation	" 14	2,368	+ 288	2	4,535	- 113
Ilford Dist. Coun.	" 14	563	+ 154	2	1,031	+ 122
Ipswich Corporation	" 15	470	+ 72	2	843	+ 106
Isle of Thanet Co.	" 14	509	+ 157	27	7,452	+ 503
Keighley Corporation	" 13	146	+ 7	41	5,672	...
Kidderminster & District	" 6	94	- 7	14	1,240	- 22
Kilmarnock Corporation	" 15	160	+ 5	48	7,824	...
Kirkcaldy Corporation	" 11	209	+ 8	6	1,209	- 15
Lanarkshire Trams Co.	" 12	874	+ 241	†15	12,265	+ 2,832
Leamington	" 6	177	+ 124	14	1,830	+ 715
Leeds Corporation	" 7 " 14	5,854 6,946	+ 863 + 804	2	12,091	+ 1,251
Leicester Corporation	" 14	2,323	+ 811	14	30,350	+ 3,438
Leith Corporation	" 7 " 14	474 482	+ 260 ...	47	17,946	+ 12,552
Liverpool Overhead Rly.	" 15	1,399	- 134	15	20,730	- 1,404
Liverpool Corporation	" 7	10,611	+ 220	14	143,130	+ 4,558
***London County Council**	" 7	15,424	+ 2,019	1	15,424	+ 2,019
London United	" 13	7,276	+ 2,322	†15	74,114	+ 3,662
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	" 12	103	- 8	2	201	- 14
Manchester Corporation	" 14	13,917	+ 1,771	2	26,828	+ 8,002
Mersey Railway	" 14	1,737	+ 101	15	25,615	+ 1,414
Merthyr	" 6	191	+ 3	14	2,419	- 22
Metropolitan Dist. Railway	" 15	6,812	- 390	15	119,968	+ 5,936
***Metropolitan Elec. Trams**	" 6	3,331	+ 1,163	14	38,510	+ 11,726
§**Middleton**	" 6	317	+ 9	14	3,884	+ 207
Nelson Corporation	" 14	196	+ 57	..	...	...
Newcastle-on-Tyne Corp.	" 14	3,649	+ 405	2	7,850	- 326
Newport (Mon.)	" 14	664	+ 80	2	1,257	+ 149
Northampton Corporation	" 13	415	+ 89	...	...	...
Oldham, Ashton & Hyde	" 6	532	+ 17	14	7,102	+ 243
Oldham Corporation	" 15	1,955	+ 4[illegible]1	3	5,383	+ 294
Perth (N.B.) Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	" 13	1,502	+ 44	‡15	22,844	+ 1,196
Peterborough	" 6	102	- 8	14	1,329	- 106
Pontypridd District Coun.	" 14	178	+ 10	2	351	- 19
Portsmouth Corporation	" 14	2,123	+ 438	2	3,793	+ 488
Potteries	" 6	1,819	+ 123	14	23,903	+ 1,832
Rochdale Corporation	" 14	1,319	+ 791	2	2,118	+ 8
Rothesay	" 6	81	+ 23	11	709	+ 68
Salford Corporation	" 9 " 16	4,223 5,515	+ 558 + 1,629	2	10,801	+ 1,[illegible]25
Sheerness	" 4	50	- 12	14	642	- 119
Sheffield Corporation	" 15	5,255	+ 706	3	15,281	+ 936
Southampton Corporation	" 11	1,368	+ 54	‖1	1,363	+ 54
Southport Tramways	" 6	280	+ 20	14	3,222	- 6
S. Staffordshire Trams.	" 6	839	+ 162	14	10,587	+ 1,648
Stockport Corporation	" 6 " 13	858 1,079	+ 870 + 612	2	1,725	+ 875
Swansea Trams	" 6	770	+ 223	14	9,844	+ 3,440
Swindon Corporation	" 11	181	...	¶1	279	...
Taunton	" 6	41	- 9	14	564	+ 5
Tynemouth and District	" 6	200	+ 4	14	2,239	- 149
Wallasey District Council	" 14	771	+ 83	2	1,471	+ 112
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	" 12	2,288	+ 1,194	2	4,421	+ 2,141
Weston-super-Mare	" 4	44	- 11	14	894	- 21
Wolverhampton Corpn.	" 11	737	...	2	1,478	...
* **Wolverhampton District**	" 6	834	+ 29	14	5,140	+ 417
* **Worcester**	" 6	254	- 25	14	8,207	- 327
Wrexham	" 7	186	+ 41	14	1,287	- 2
Yorkshire W.R. Trams	" 15	925	+ 272	15	10,567	...
Yorkshire Woollen District	" 6	871	+ 249	14	11,178	+ 8,543

(a) These comparisons are with the corresponding period last year. † Minus 8 days. Minus 2 days. § Plus 2 days. ‖ Plus 4 days. ¶ Plus 3 days. * Partly electrical.

CITY NOTES.

◆

MEMORANDA (April 19).—Bank rate 3½ per cent. (since April 5, 1906). Price of silver $29\frac{13}{16}$d. per oz. Consols $90\frac{7}{16}$—$90\frac{9}{16}$ for money, $90\frac{9}{16}$—$90\frac{11}{16}$ for account; 2½ per cent. annuities 89⅜—89⅝. Consols Pay Day, May 4. Stocks and Shares Continuation Days, April 24 and May 9; Ticket Days, April 25 and May 10; Pay Days, April 26 and May 11; Mining Share Carry-over Day, April 23.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The fifteenth (and final) drawing for payment of this company's 4 per cent. mortgage debentures (177) will take place on May 1 at the offices, Electra House, Finsbury-pavement, London, E.C.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared a dividend of 8½ per cent. for 1905, compared with 8 per cent. for the previous year.

KABELFABRIK-ACTIEN-GESELLSCHAFT (LATE OTTO BONDY) VIENNA.—The gross receipts for 1905 were 1,686,238kr. After meeting interest, depreciation, taxes, insurance, &c., the net profit was 262,656·97kr. A dividend of 8 per cent. has been declared (compared with 7 per cent. for 1904).

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of 5,000 £5 fully-paid ordinary shares of the *Chelsea Electricity Supply Co. (Ltd.)* to be quoted. The committee have been asked to grant quotations to a further issue of 16,300 £1 fully-paid ordinary shares, 32,600 £1 fully-paid 7 per cent. cumulative preference shares and £51,708 first debenture stock of the *South Metropolitan Electric Light & Power Co. (Ltd.)*.

COLONIAL AND FOREIGN INVESTMENTS.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., April 18.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS, 8 DAYS TO APRIL 18.	
						High-est.	Low-est.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	† Anglo-Argentine Ord. Shares	8⅝–8⅞	4 10 0	Ap, Oct	8⅞	$8\frac{11}{16}$
5	2/9	Do. 5½% Cum. Pref.	5⅞–6⅛	4 10 0	—	..	..
St.	6%	Do. Permanent 6% Deb. Stock	141 —144	4 3 3	—	142	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	..	..
5	..	Brisbane Electric Trams. Invest Ord.	⅞–1⅛	..	..	$1\frac{1}{32}$	..
5	2/6	Do. 5 per Cent. Cum. Pref.	[illegible]⅞–4⅛	6 1 4	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	3 —16	4 13 9	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	20 —1[illegible]3	4 17 6	—	-	..
St.	5%	Do. Pref. Ord. Stk	110 —113	4 8 4	—	..	..
100	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	10[illegible]½	107½
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	101%—103%	4 7 3	—	..	—
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 0	—	..	..
5	8/0	† Buenos Ayres and Belgrano Ord.	[illegible]⅜–[illegible]⅝	5 7 6	—	$3\frac{7}{16}$	$3\frac{13}{32}$
5	3/0	† Do. 6 per Cent. "A" Cm. Pref	5⅝–5⅞	5 2 6	—	..	..
5	8/0	† Do. "B"	5 —5½	5 7 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	101 —103	4 17 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	102 —106	5 4 3	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	103 —105	5 14 0	..	..	..
5	4/6	† Calcutta Tramways (Nos. 1 to 105)	9⅛–9⅜	4 5 8	—	$9\frac{5}{16}$	9⅛
5	2/6	Do. Nos. 105,001 to 137,610	8¾–9¼	..	..	9⅛	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 8	—	..	..
1	0/6	Cape Electric Tram Shares	⅝–⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	102 —104	4 16 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	96 —98%	5 2 0	..	9[illegible]½	[illegible]7
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 — 93	..	..	..	..
St.	..	Do. 5% "B" Ditto	83 — 88	..	..	8[illegible]½	85
1	..	Lisbon Elec. Trams Ord.	1½–1⅝	..	..	$1\frac{9}{16}$	..
1	0/7½	Do. 6% Cum. Pref.	1⅛–1¼	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	103 — 106	4 14 8	Ja, Jul	105⅜	..
100	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	101 —103	4 17 0	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —108	4 12 6	..	-	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	145 — 148	..	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	99½	[illegible]¼
		ELECTRICITY SUPPLY.					
5	3/	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	.	—
5	3/8	Calcutta Elec (1-50 000)	9⅛–9⅜	4 5 4	—	$9\frac{5}{16}$	9¼
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
1	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½– 3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	7¾–8¾	—	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	92 —94	5 6 8	..	9[illegible]¼	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	111 — 114	5 5 0	..	..	..
1	5 88d	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞–1	6 0 0	—	..	..
1	1/0	Rand Electric	$1\frac{5}{16}$–$1\frac{7}{16}$	..	—	..	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}$–$\frac{11}{16}$	..	..	⅝	..
1	1/2[illegible]	Do. 6% Non. Cum. Pref	$\frac{15}{16}$–$1\frac{1}{16}$	..	..	.	—
St.	5%	Do. 5% Deb. Stock	101 — 103	4 17 0	..	10[illegible]½	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
5	2/6	Do. (12,001-20,000)	5⅛—5⅜	3 6 6	..	..	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	..	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 —103	4 17 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., April 18	Rate % Yielded.	Dividend Due	Business, 8 Days to April 18. Highest.	Lowest
		ELECTRICITY SUPPLY.		£ s. d			
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 –12	5 16 6	..	11⅛	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅜–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	11¾	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 8 8	..	..	–
5	3/6	†Bromley (Kent) El. Lt. & Power Shares	6⅛–6⅝	4 18 0	..	..	–
St.	4½%	Do. Do. 1st Debs	103 –105	4 5 0	–	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾–9¼	5 8 6	–	..	..
5	3/6	Do. 7 per Cent. Pref.	8¼–9¼	3 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 –105	3 16 8	–	..	..
5	2/6	CharingCross(W.End&City)El.Sup.Co.	4 –5	5 0 0	Feb, Aug	4⅝	4¼
5	2/3	Do. 4½ per Cent. Pref.	4⅜–4⅞	4 12 6	Feb, Aug	4⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –103	3 17 6	–	102½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 –4½	5 0 0	–	..	..
5	2/3	Do. Do. (1903)	4 –4½	5 0 0	–	–	..
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 –109	4 2 6	Jn, Dec ..	..	–
10	7/0	City of London Electric Lighting Ord.	10½–11	5 9 0	Feb, Aug	10 11/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 6	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 8 0	..	..	..
5	4%	†County of Durham Elec. P.D. Ord. £3 pd.	2 31/32–3 1/32	4 0 0	April, Oct	3	..
5	5%	† Do. Do. 5% non cum. pref.	5⅛–5⅜	4 15 3	April, Oct	5 3/32	..
10	6/0	County of London Elec. Supply Ord.	8 –9	5 11 0	–	8¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾–12¼	4 18 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 –112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –103	4 7 6	..	..	..
5	3/6	†Folkestone Electricity Supply Co. Ord.	6⅛–6⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 6	–	..	..
5	5/0	†Hove Electric Lighting Ord.	8¼–8¾	5 5 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 –103	4 7 5	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¼	4 18 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
3	2/4	London Electric Supply Ord.	2 –2½	4 0 0	–	2 1/16	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5 1/16	5
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 –101	3 19 2	Mr,Jn,S,D	..	..
5	10%	Metropolitan Electric Sup. Ord.	8½–9½	5 5 0	April, Oct	8⅞	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	Jan. July	5 13/32	5⅜
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 8	–	96½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 –103%	4 7 4	–	102	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11⅛–11⅜	6 0 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –104	4 6 6	Jan, July	102	..
5	8%	Newcastle Elec. Supply Ord.	7⅜–7⅝	5 6 8	Feb, Aug	..	..
5	5%	† Do. 5 per Cent. Non. Cum. Pref.	5¾–6	4 5 1	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	99 –100	4 0 0	Jan, July	100	..
1	8%	†Northern Counties Elec. Sup.	⅞–29/32	3 6 8	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	101 –102	4 7 6	Jan, July	–	–
10	9/0	Notting Hill Electric Ord.	13 –14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½–7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –101	3 19 0	–	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	9 –10	6 5 0	Feb, Aug	9¾	9½
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	7 1/16	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 –98	3 12 0	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼–2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 –80	5 0 0	–	..	..
5	4/0	South London Electric Supply Ord	3 –3½	5 14 0	..	..	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	..	..	..	–
1	0/8¾	Do. 7% Cum. Pref.	1¼–1⅜	5 2 0	..	1¼	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	4¼ 4¾	5 5 0	–	–	..
5	2/6	Do. 5% Cum. Pref.	4 13/16–5 1/16	4 14 0	–	5	4⅞
St.	4½%	Do. 4½% 1 Mort. Deb.	102 –104	4 6 6	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	9½–10½	6 4 0	Mar, Sept	10	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16–5 9/16	4 10 0	..	..	..
5	..	Do. Issued at 7/6 premium all paid	5 5/16–5 9/16	..	..	–	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	100 –102	3 18 6	..	100¾	100
1	–	Bath Elec. Trams Pref. Ord.	15/16–1 1/16	..	..	..	–
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 12 3	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 –103	4 7 3	–	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 –103	4 7 9	..	..	–
10	8½%	Bristol Tramways and Carriage Ord.	15¼–15¾	5 15 2	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	10 –10¼	3 18 0	..	..	–
St.	4%	Do. 4 per Cent. Debs.	103 –105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	6 –7	4 5 8	–	6¾	6½
10	6/0	Do. 6 per Cent. Cum. Pref.	9 –9½	6 6 0	Feb, Aug	9¼	9 1/16
St.	5%	Do. 5 per Cent. Perpetual Debs	111 –114	4 8 11	..	112¼	111½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	96½–98½	4 11 10	..	97½	..
St.	4%	Central London Ordinary Stock	90 –92	4 7 0	June, Dec	92½	90¾
St.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 6	..	..	..
St.	4%	Do. Deferred Stock	82 –85	4 14 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 3	..	112	111½
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	95 –97	4 2 6	..	93½	..
5	2/6	†City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	–
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	–	..	..
St.	1¾%	City and South London Rly. Con. Ord.	41 –43	4 7 0	Feb, Aug	42¼	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	115 –118	4 4 8	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 –109	3 13 4	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½–15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	4 –4½	9 8 2	..	..	..
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8 –9	4 8 11	–	..	..
St.	4½%	†Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 –12½	4 17 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	107 –108	4 8 0	Jan, July	–	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2¼–2¾	9 8 6	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 –85	4 14 0	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16–8 7/16	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9½–10	5 0 0	–	[illegible]	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	95 –98	4 2 6	–	98	..
St.	..	Mersey Con. Ord. Stock	4 –6	–	–	4½	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	–	–	7¼	..
1	–	Metropolitan Elec. Trams Def.	6/32–7/32	..	–	–	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	–	⅞	..
St.	4½%	Do. 4½% Deb. Stock	103 –105	4 5 6	–	104	101¼
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	†Potteries Electric Traction Ord.	8 –9	5 15 0	..	–	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 –9½	5 5 0	Feb, Aug	–	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 0	–	–	–
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 –96	5 4 0	–	..	..
..	5%	Underground Elec. Rys. Co. of London	98 –100	5 0 0	–	..	..
St.	3½%	Waterloo and City Ord.	101 –104	3 2 6	June, Dec	..	..
St.	4½%	Yorkshire W.R. El. Trs. Co. 4½% 1st Debs.	95 –97	4 13 0	–	..	..

Shre.	Last Dividend	Name.	Price Wed., April 18.	Rate % Yielded.	Dividend Due.	Business 8 Days to April 18. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.		£ s. d.			
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅝–⅞	5 6 6	–	–	..
1	10½d.	Aron El. Met. 6% Cm. Pf.	15/32–17/32	..	–	..	..
1	1/7½	Babcock & Wilcox Ord.	4⅛–4⅜	4 17 9	..	4 3/32	4
1	7½d.	Do. Pref	1 7/16–1 9/16	3 16 10	..	..	–
5	4/0	British Insulated & Helsby Cables Ord	6½–7	5 14 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6¼	4 16 0	Jan, July	6⅛	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 –106	4 4 11	..	–	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞–2⅜	..	..	2⅛	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 –85	4 14 0	..	..	..
2	1/0	†Brush Electrical Engineering	¾–1	..	March	..	..
2	2/4¾	† Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	1¾	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	–	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 –86	5 4 6	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10½–11½	4 7 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6	4 3 4	Jan, July	..	–
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½–110½	..	Nov, May	–	..
1	4½d.	Castner-Kellner Alkali Co.	1 –1⅛	5 6 6	..	1 3/32	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	–	..	..
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	..	1 5/16	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 –2¼	3 9 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%–98%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1¾–1⅞	5 8 0	Sept	–	..
5	3/0	Do. 6% Cum. Pref.	1¼–1⅜	4 7 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 –106	4 5 0	..	–	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅝–1⅞	–	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½–3	–	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 –88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾–4¼	3 4 6	H'lf-yearly	4	3¾
5	3/0	Do. 6 per Cent. Cum. Pref.	5 –5½	5 9 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 5 0	–	103¾	103½
2	1/7½	Electric Construction Co.	1 9/16–1 13/16	9 6 0	July	..	..
2	2/9¾	Do. 7 per Cent. Cum. Pref	2 –2½	5 12 0	July	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 –92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅜–9⅞	5 3 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 –98	4 1 6	–	..	..
5	10/0	Henley's Telegraph Works Ord.	12½–13½	5 11 0	Feb, Aug	13⅝	..
5	2/3	Do. 4½ per Cent. Pref.	5⅜–5⅝	4 1 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 –111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½–59½	–	..	59	–
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17½–18½	2 14 6	Feb, Aug	–	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 15 0	..	1	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 –101	4 10 0	..	..	..
12	24/0	Telegraph Construction & Mainten'ce.	33 –35	5 2 6	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –103	3 17 6	Jan, July	102¼	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2½–2⅝	5 14 3	..	2 9/16	..
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1¼	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	117 –120	4 0 0	–	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	105 –107	3 14 8	..	106½	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 –108	4 3 8	–	–	..
5	–	Willans and Robinson Ord.	1¾–2¼	–	Apr, Oct	–	–
5	–	Do. 6 per Cent. Cum. Pref.	3½–4	–	Apr, Oct	3½	–
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 –85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	98½–101½	3 18 6	Jan, July	..	..
10	–	Amazon Telegraph	3¾–4¼	..	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 –88	..	..	..	..
St.	15/0	†Anglo-American	64 –66	4 18 0	F,My,Ag,N	66	..
St.	10/0	† Do. Preferred	111½–112½	5 7 0	F,My,Ag,N	112¼	111½
St.	10/0	Do. Deferred	20⅞–21⅛	..	F,My Ag,N	20⅝	19⅞
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97 –99	4 1 0	Jn Ap,Jy,O	97¾	97
10	5/0	Cuba Submarine Ord.	8½–9	5 11 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	3 7/16	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	–
60	4½%	Do. 4½ per Cent. Deb.	100%–103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable.	16½–16¾	4 5 0	Ja,Ap,Jy,O	16⅝	16⅜
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..	..
St.	25/0	†Eastern Ordinary	144 –147	4 16 0	Ja,Ap,Jy,O	145½	145
St.	17/6	† Do. 3½ per Cent. Pref. Stock	89 –91	3 7 6	Ja,Ap,Jy,O	90½	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 8	May, Nov	108⅞	..
10	2/6	Eastern Extension	14¾–15¼	4 11 8	Ja,Ap,Jy,O	15	14⅞
St.	4%	Do. 4 per Cent. Deb. Stock	105 –107	3 14 8	Feb, Aug	106½	106
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 3	Feb, Aug	..	–
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–103%	3 18 8	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 66	40 –42	5 15 0	Jan, July	40¾	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	12/6	Indo-European	58 –60	5 8 0	May, Nov	60	58¾
100	$1	Mackay Companies Common	66⅝	3 0 6	Jan, July	–	..
100	4%	Do. Preference	75 13/16	5 5 6	Ja,Ap,Jy,O	..	–
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	1 9/32	1¼
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 –103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	–
2½	–	West Coast of America	⅝–¾	..	–	23/32	..
100	4%	Do. 4 per Cent. Debs.	100 –102	3 18 3	Jan, July	..	..
10	–	West India and Panama	½–⅝	..	May, Nov	17/32	7/16
10	6/0	Do. 6% 1st Pref.	8¼–8¾	6 6 8	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	6 –7	..	May, Nov	6 11/16	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 16 0	Jan, July	–	..
10	8/0	Western Telegraph	14 –14½	4 17 6	Mr,Jn,O,D	14 7/16	14 5/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –103	4 17 0	June, Dec	..	–
St.	4%	Do. 4% Deb. Stock (red.)	100 –103	3 18 6	..	102½	102
		TELEPHONES					
–	..	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	96 –98	..	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 –103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	8 –8¼	4 17 0	August ..	–	..
1	0/9⅜	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	–	..
1	1/0	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	108 –110	5 9 0	–	110	109
St.	5%	Do. Def. Stock	110 –112	4 9 6	–	111½	110⅝
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	–
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–6½	4 11 0	Feb, Aug	5 15/32	5⅜
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99 –101	3 9 8	June, Dec	100	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 –105	3 16 8	–	104½	103¾
1	0/7½	Oriental	1⅜–1½	4 0 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 7 0	–	1 9/32	..
St.	24/7¾	Do. 4% Red. Deb. Stock	98 –100	4 0 0	..	99¼	–
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 –106	4 4 9	..	..	–
5	3/0	United River Plate	7 –7½	5 6 8	July	7 11/32	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 7 0	June, Dec	–	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 –112	4 9 3	June, Dec	..	–
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾–5¼	5 14 0	–	..	..
10	2/0	Globe Telegraph and Trust	10⅞–11⅛	4 16 6	Ja,Ap,Jy,O	11 1/16	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅜–14⅞	4 0 6	Ja,Ap,Jy,O	14 11/32	..
10	6%	†Submarine Cables Trust (Cert.)	126 –129	4 18 0	April, Oct	..	–

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

◆

AT the meeting of the Institution of Electrical Engineers last night, the following list of nominations for the Council for next Session were announced :—

As President.
*Dr. R. T. GLAZEBROOK, F.R.S.

As Vice-Presidents.
*Mr. F. Gill.
Mr. W. M. Mordey.
Mr. W. H. Patchell.
*Mr. C. P. Sparks.

As Members of Council.
Mr. W. A. Chamen.
Mr. W. Duddell.
*Mr. S. Evershed.
*Mr. H. E. Harrison.
Mr. J. S. Highfield.
Mr. H. Hirst.
Col. H. C. L. Holden, R.A., F.R.S.
Mr. Walter Judd.
Mr. Gisbert Kapp.
*Mr. J. E. Kingsbury.
Mr. C. H. Merz.
*Mr. M. O'Gorman.
*Mr. G. W. Partridge.
*Mr. A. A. C. Swinton.
Mr. C. H. Wordingham.

As Associate Members of Council.
Mr. Albert Campbell.
Mr. T. Mather, F.R.S.
*Mr. J. Hunter Gray.

As Hon. Auditors.
Mr. F. C. Danvers.
Mr. Sidney Sharp.

As Hon. Treasurer.
Mr. Robert Hammond.

The names marked with an asterisk are those of gentlemen nominated to fill vacancies in the Council in accordance with Article 45 of the Articles of Association.

These nominations are made by the retiring Council, and if no alternative nominations are made by the membership before Thursday next, the new Council will be considered duly elected in accordance with the Articles of Association. Any two full members, supported by eight other full members of the Institution, may propose an alternative name to any of the above, either as President, Vice-President or ordinary member of Council, by accompanying their new nomination with the written consent of their nominee to accept office if elected, and sending it to the Secretary by the date mentioned.

◆

IT has been a tradition for a long time that the proposal of any alternative names—especially for President or Vice-President—is tantamount to proposing a vote of want of confidence in the retiring Council, but we fail to see that this serious view need be held. When the whole work of the Institution centred around London, it was certainly to be expected that the Council should be thoroughly well acquainted with the exact wishes of the membership. But things are different now: The Institution is far larger than it was; its members are no longer, as it were, a small family circle, and if the Council has been mistaken in interpreting their general wishes, the correction can be made without the implication of any censure.

◆

WE feel strongly that the nomination for the Presidency is unfortunate. Dr. GLAZEBROOK has done valuable service to electrical science, and we have the strongest regard and admiration for him as one of our leading physicists. Dr. GLAZEBROOK is not an engineer, however,—he does not profess to be one,—and we cannot but think that the head of the Institution representing the electrical industry should be an engineer before all things. There are leading electrical engineers who have been on the Council longer than he, and who possess the necessary qualification of having been Vice-Presidents, and we suggest that one of these be invited by a committee of ten of the most influential engineering members to stand as a candidate for the Presidency. As director of the National Physical Laboratory, Dr. GLAZEBROOK is in a position to exert a beneficial influence on the electrical industry, and his acceptance of a seat on the Council of the Institution of Electrical Engineers was welcomed; but, in spite of his high attainments, he is not the right man to elect as the leading representative of electrical engineering in this country.

◆

THE announcement which we make this week of the election of Sir ALEXANDER B. W. KENNEDY as President of the

Institution of Civil Engineers will, on the other hand, be received with satisfaction by every member of the engineering profession, whether on the civil, mechanical, or electrical side. It falls to the lot of few men to attain such high honours in all branches of engineering, as well as in the world of pure science, as have been deservedly bestowed upon Sir ALEXANDER KENNEDY, for in addition to being a Fellow of the Royal Society, he has been President of the Institution of Mechanical Engineers, of which he is now an honorary life member, has served on the Council of the Institution of Electrical Engineers, and is also a member of the Institution of Naval Architects. To electrical engineers Sir ALEXANDER is best known for his design and supervision of the undertaking of the Westminster Electric Supply Corpn., his work in connection with the Waterloo–City Railway, the Central Electric Supply Co., and the London County Council tramway system, and for his consulting work for the Manchester, Edinburgh, and a host of other large municipal authorities. In many other directions, however, there is ample evidence of his great versatility, for Sir ALEXANDER KENNEDY is President of the Machinery Designs Committee of the Admiralty, was a member of Lord GOSCHEN'S Naval Boilers Committee, and has done good service upon the Research Committees of the Institution of Mechanical Engineers dealing with marine engine trials, riveted joints, &c.

◆

THE prospectus has now been issued of the company which is being floated under the name of "The London Electrobus Company," to run in large numbers on the streets of London electric omnibuses similar to the vehicle which we described last week. After setting forth the advantages which an ideal electric vehicle might be expected to have over the present form of petrol omnibus, the prospectus states that the company has secured a seven years' monopoly for use within 15 miles of Charing Cross of the electrically driven 'bus which is protected by Patent No. 3,653 of 1902. We note also that the sum which is to be paid by the company for these rights is £20,000, in addition to deferred shares nominally worth £5,000. In view of the high value set on this patent and the apparent absence of items of startling novelty revealed in our inspection of the actual omnibus, we have referred to the patent specification itself. We find that the subject matter of the patent relates entirely to the arrangement of the chassis, and does not cover any point in connection with either the motor, the controller, or the cells. The only matters upon which the claims are based are the design of the live back axle, the particular type of sliding coupling used in the Cardan shaft, and the combination and application to a motor vehicle of these two items. Neither of these mechanical details are in any way indispensable to the success of the vehicle. Equal and in our opinion even better ways of applying the electrical equipment to drive an omnibus could readily be found, without having recourse to these devices, for the use of which such an enormous sum is to be paid.

◆

THE success or failure of any electrical omnibus at the present day depends, as it has always done, upon the battery. Given a suitable battery, sufficiently light and durable, any engineer can build an efficient electrical vehicle without further ado, and without paying heavy sums for patents and promotion money. All that the company's consulting electrical engineer, Mr. CRAMPTON (not to be confused with our very old friend Col. CROMPTON), says on that subject is that this item is determined by contracts offered by responsible manufacturing firms, but the sum set down in the estimate of running costs is the ridiculously small figure of 3d. per mile. It is to be regretted that the names of these responsible firms who are prepared to guarantee what has hitherto been considered impossible have not been made public.

◆

THE letter which the Swansea Corporation have received from the Postmaster-General should be a severe lesson to those Local Authorities who have started telephone exchanges and have refused to accept our warning that the periods for which their loans had been sanctioned was undoubtedly far longer than the life of the telephone plant, and that in consequence large amounts should be set aside yearly for depreciation. A few weeks ago the Postmaster-General offered the Swansea Corporation a sum of £17,000 for their telephone system—*i.e.*, about 63 per cent. of the total capital outlay of £27,000. To this the Council replied, offering the system for the full sum of £27,000, and subject to the conditions that the present low tariffs should be maintained until the Post Office had also taken over the National Telephone Co.'s system in the town, that the staff should be taken over on specified terms, and that intercommunication should be arranged with the National Telephone Co. To this offer the Postmaster-General has replied that the depreciation which he has allowed is by no means excessive in the circumstances, and that he will not guarantee to maintain the present tariffs for more than two years, while he gives no reply at all to the other conditions. We understand that this letter is to be placed before a joint meeting of delegates of the Brighton, Portsmouth, and Swansea telephone committees, who, we presume, all desire to sell their municipal exchanges to the Post Office, and it should have a salutary effect.

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CORRESPONDENCE is raging in *The Times* on the etymology of popular electrical terminology, and litterateurs and philologists are endeavouring to come to an agreement as to a suitable and euphonic expression consistent with the established usages of linguistics to replace the objectionable words "electrocute" and "electrocution." The controversy is mainly over the suitability or otherwise of the word "electricide," proposed by Mr. J. CHURTON COLLINS, but this is objected to by Mr. JERRAM and others on the ground that, considering the analogy of such words as homicide and regicide, the word proposed should signify "that kills electrum," and cannot correctly mean a person or agent that kills by electricity. Mr. COLLINS admits that in these and other English compounds terminating in the syllable "cide" the first half of the word refers to the object, but cites a host of Latin and Greek examples in which the first part of a word of similar construction is from a root, signifying the instrument by which the action indicated by the latter portion is performed. The use of the word, both as noun and as a verb, is, he says, perhaps open to objection, but is amply supported by such examples as "blockade" or "murder." It is easy to invent new words and argue on their merits, but in our opinion no separate word is needed to denote killing by electricity, as the event occurs so infrequently. If word-coiners must murder the English language, let them not at any rate call in electricity to their aid. In any case we wish to add our protests to those who have already objected to the application of a slang Americanism indicating a revolting form of putting criminals to death to those rare cases of accidental death by electric shock.

The late M. Curie.—At the meeting of the Institution of Electrical Engineers last night, on the motion of Mr. Patchell, seconded by Mr. Mordey, a vote of condolence was passed (by the members rising in their places) with Madame Curie on the unfortunate loss of her husband. An obituary notice by Prof. J. J. Thomson appears on another page of this issue.

Swedish Telephones.—A Reuter telegram from Stockholm on Saturday last states that the Swedish Government proposes to purchase the telephone system of Stockholm, at present owned by a private company, for 16 million kroner (£888,890).

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Jamaica—Colon	Jan. 10, 1905	—
Cadiz—Teneriffe	July 20, 1905	—
Tangier—Cadiz	Feb. 17, 1906	—
Trinidad—Demerara	April 10, 1906	April 20, 1906
Paramaribo—Cayenne	April 20, 1906	—
Sydney—Nelson	April 26, 1906	—

Obituary.—We regret to record the death in Brussels from heart disease at the age of 74 of Mr. Montefiore Lévi. The deceased, who belonged to a well-known family, was born at Streatham, but became a naturalised subject in Belgium in 1882, representing Liége in the Senate till 1900. Amongst the many scientific and philanthropic objects to which his munificence was directed was the Montefiore Electrotechnical Institute of Liége, of which he was the founder.

Siemens-Schuckert Meter.—The *London Gazette* for Saturday, April 21st contains a notification of the approval of the Board of Trade of the Siemens-Schuckert alternating-current meter type W2.

Locarno-Bignasco Single-phase Railway.—The Oerlikon Company has recently secured the order for equipping this railway on the single-phase system. This line is 17 miles long, of metre gauge and includes a maximum gradient of 3·3 per cent. Single-phase current at 5,000 volts is to be supplied to the trolley wire by two 350 kw. alternators (driven by water turbines), which are to be installed in a power station approximately at the centre of the line. The overhead equipment and the current-collecting gear are to be of the well-known Oerlikon type. Motor cars having two bogies are contemplated, and each of the four axles of a car is to be driven by a 40 H.P. single-phase motor.

Overcrowding on Railways.—A private member's Bill is being introduced into the House of Commons by Mr. W. H. Dickinson with the object of diminishing overcrowding on railways. It is proposed to empower the Board of Trade to make inquiry into cases where they have reason to believe that insufficient accommodation has been provided and to refer the matter, if necessary, to the Railway and Canal Commission, which may, if they think fit, order the companies concerned to provide further accommodation. If a company neglects to comply with such an order it is to lose the benefit of the Cheap Trains Act, 1883, and be liable for the variation in passenger duty provided for by that act. Also, if any employé of a railway company refuses or neglects to prevent overcrowding of any railway carriage he is to be liable to a fine of £5.

The Care and Management of Electrical Machinery.—This is the title of an instructive little book published by the Vulcan Boiler & General Insurance Co. (Ltd.) for the use of dynamo attendants and power users generally. It includes an elementary treatise on electricity, electric dynamos of the continuous-current and alternating-current types, switch gear, and so on. The letterpress is accompanied by many serviceable sketches of machine parts, diagrams of connections, &c., and some illustrations of broken-down motors are inserted as a warning of what may happen if proper care is not given to the machinery. Not the least valuable feature of the book is at the end, where will be found the Vulcan Boiler & General Insurance Co.'s rules for the efficient running of dynamos and motors, the Home Office rules for the installation and use of electricity in mines, and the Home Office draft regulations for the use of electricity in factories. The book is well worth the shilling asked for it, and the only important subjects not dealt with are accumulators and measuring instruments.

The Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers on Tuesday, the result of the ballot for the election of officers was declared as follows :—

President : Sir Alexander B. W. Kennedy, LL.D., F.R.S. *Vice-Presidents :* Mr. W. R. Galbraith. Mr. William Matthews, C.M.G., Sir E. Leader Williams and Mr. J. C. Inglis. *Members of Council :* Lieut.-Col. W. P. Anderson (Ottawa, Canada), Mr. B. Hall Blyth (Edinburgh), Mr. John Benton, C.I.E. (India), Mr. C. A. Brereton, Mr. R. Elliot-Cooper, Col. R. E. B. Crompton, C.B., Mr. Joseph Davis (Sydney, N.S.W.), Dr. G. F. Deacon, D. Francis Elgar, F.R.S., Mr. M. Fitzmaurice, C.M.G., Mr. R. A. Hadfield (Sheffield), Mr. G. H. Hill, Mr. Walter Hunter, Mr. J. H. Johns (Johannesburg), Mr. G. R. Jebb (Birmingham), Sir William T. Lewis, Bart. (Aberdare), Sir George Livesey, Mr. A. G. Lyster (Liverpool), Sir Andrew Noble, Bart., K.C.B. (Newcastle-on-Tyne), the Hon. C. A. Parsons, C.B., F.R.S. (Wylam-on-Tyne), Mr. A. Ross, Mr. A. Siemens, Mr. J. Strain (Glasgow), Sir John I. Thornycroft, LL.D., F.R.S., Prof. W. C. Unwin, B.Sc., F.R.S., Mr. A. F. Yarrow.

Among the awards for Papers read and discussed during the past session, the following are of electrical interest :—

"The Steam Turbine," by the Hon. C. A. Parsons and G. G. Stoney (Watt Gold Medal) ; "Widnes and Runcorn Transporter Bridge," by J. J. Webster (Telford Premium) ; "Heat Economy in Factories," by H. A. Mavor (Telford Premium).

Wireless Telegraph Notes.—In view of the conflicting reports regarding what has been accomplished in wireless telegraphy across the Atlantic, a statement has appeared in the American Press to the effect that the De Forest Company have succeeded in reaching a point on the southern coast of Ireland, but only as an experiment. A number of words in code were "intelligently" sent from the company's station at Coney Island to Lord Armstrong's castle in the south of Ireland, and the success of the experiment was intimated by cable. Each code message was sent at five minute intervals, each time in a different pitch, in order to find the wave length most suitable to the distance. This statement of the De Forest Company does not state how much of the message was correctly received, but only that the experiment was successful. It is, however, reported by the *Western Electrician* that 572 out of a total of 1,000 words were successfully transmitted.

The *Daily Mail* states that the German Government have informed the Powers concerned that they propose to hold an International conference on wireless telegraphy at Berlin on June 28, 1906. Delegates from the British Board of Trade, Post Office, Colonial Office, Foreign Office, India Office, Admiralty and War Office will attend, and the following countries will also be represented : France, Italy, Austria, United States, Russia, Spain, Portugal, Denmark, Belgium, Bulgaria, Norway, Holland, Montenegro, Monaco, Sweden, Roumania, Turkey, Egypt, Argentina, Japan, Mexico, Siam, Uruguay, China, Chili, and Peru.

The Seasoning of Telephone Poles.—According to *Telephony*, the United States Forest department has been studying the preservative treatment and seasoning of wooden telegraph and telephone poles, with a view to checking the annual demand upon the forests for renewals by lengthening the useful life of the poles. It has been found that the poles at present used last on the average for 12 years, but the trees from which they are made take about 60 years to grow, thus, in order to maintain a continuous supply, five times as many trees must be growing in the forests as there are poles in use. The question of seasoning was studied in relation to the time of cutting, and it has been found that poles cut in the winter dry more regularly than those cut in other seasons, and also show a greater loss in moisture at the end of six months' seasoning. Poles cut in winter are, therefore, less liable to crack, and also entail a saving in freight owing to their lighter weight. Another point investigated was the degree of shrinkage in circumference during air seasoning. This was found to vary from 0·5 to 0·6 per cent. Experiments were also carried out which showed that poles soaked in water for two to four weeks subsequently season at a materially increased rate. Liability to cracking was found to depend largely on the care exercised in cutting. Tests are also in progress on the value of various preservative treatments.

Electricity in Steel Works.—A lecture on this subject was delivered by Mr. Kenneth R. Stuart before the Society of Engineers and Metallurgists in the department of applied science of Sheffield University last Monday. The lecturer enumerated the advantages of electricity for driving rolling mills, live rolls, &c., in iron and steel works, and described a few representative installations. At the iron and steel works of Messrs. V. Demerbe & Co., for instance, a set of roughing down and finishing rolls were driven by a 400 H.P. three-phase motor, whose speed could be regulated between 180 and 280 revs. per min. by a special liquid resistance. The roughing down rolls were belt-driven. They had a diameter of 18 in., and ran at from 60 to 90 revs. per min. The finishing train, which was directly coupled to the motor, had five housings, and the rolls had a diameter of 10½ in. Both rolls were provided with heavy flywheels, which assisted the motor in coping with the large overloads which necessarily occurred when the material to be rolled first entered the rolls. The raw material, weighing from 65 lb. to 165 lb., and up to 5⅞ in. thick, after passing through the roughing down rolls, was finished in round, flat, tee and angle sections.

Single-phase Railway at the Milan Exhibition.—The Milan Exhibition, which is shortly to be opened, is built on two separate pieces of ground, but facilities of getting from one part to the other are provided by a double-track single-phase railway built on a wooden structure at a height of about 16½ ft. from the ground, and nearly 1 mile in length. The gradient is 0·9 per cent. practically all the way, but at one end the track lies in a curve of a radius of some 300 ft., the gradient here attaining 3·5 per cent. Single-phase current at 2,000 volts and 15 ~ per second is obtained from a motor-generator set (600 H.P. 3,600 volt 42 ~ three-phase motor and single-phase generator) in a small station at one end of the line, and is fed directly into the two overhead trolley wires which are suspended centrally over the tracks by means of wooden poles and the customary span wire construction. According to *Elektrische Bahnen & Betriebe*, trains are to be made up of four cars. The end cars are equipped with transformers for reducing the trolley voltage down to 120 volts as a minimum, and are driven by two 30 H.P. Finzi single-phase motors. The two inner cars have only one motor each. A train weighs about 56 tons when carrying its full number of passengers—viz., 250.

A Novel Mountain Lift.—According to *Elektrische Bahnen & Betriebe*, a novel kind of lift, which is now nearing completion, has been built in Switzerland for conveying passengers to the top of the Wetterhorn in two stages, each of a height of about 2,000 ft. The passenger cages, of which there are two, are guided in their up and down travel by two pairs of steel cables. Each cable has a diameter of 44 mm. (1·73 in.) and a tensile strength of 330 tons (the maximum actual tension is stated not to exceed 30 tons). These two pairs of cables are separately anchored at their upper ends to the rock, and they slope down nearly vertically to the bottom, where they are anchored to an arrangement of counterweights which keeps the tension of the cable constant under all conditions. The two cables constituting each pair are arranged vertically, one beneath the other, and, since both are embraced by the guiding arrangement on top of the car, the latter is prevented from falling even if one of the ropes should fail. Suitable devices are also provided for applying the brake at once in the event of a cable breaking. The two fixed pairs themselves run parallel to one another at a distance of 26 ft., and they terminate at the bottom in a kind of station. The cars hang vertically from the guide ropes. They are drawn up or let down by means of a single running rope, which is wound round the drum of the electrically-driven winding plant at the upper terminus, and whose two ends are attached to the two cars. Each car is stated to weigh 5½ tons and to provide accommodation for 20 passengers. A speed of about 5 ft. ⅞ per second is to be employed.

A Single-phase Railway Driven by Gas Engines.—The railway which has recently been opened between Warren and Jamestown is right in the heart of the American natural gas district, and, according to the *Street Railway Journal*, is the first single-phase railway to be driven by gas engines. Power is transmitted at 22,000 volts, and is fed to the central trolley section at 3,300 volts, and to the terminal sections within the city at 550 volts single phase. The inter-urban line is 22½ miles in length and the city lines in Warren consist of about 9 miles of track. The power house contains two 260 kw. 380 volt 25 cycle alternators, driven by horizontal gas engines running at 150 revs. per min. Each gas engine has two double-acting cylinders in tandem, the inlet valves being placed on the top of the cylinders and the exhaust valves underneath, the external appearance resembling steam engines of the Corliss type more than gas engines. Starting up is effected by compressed air. The two sets run in parallel and space is left for a third set of the same output. The gas obtainable averages from 1,000 to 1,100 B.Th.U. per cubic foot. The 22,000 volt feeders are supplied through step-up transformers and are carried on wooden poles to the two step-down transforming stations. In each of these two 150 kw. oil-immersed transformers are provided with the necessary switch gear, feeding the line at 3,300 volts. Three 75 kw. auto-transformers, mounted on poles, step down to 550 volts for feeding the city sections. A No. 000 figure 8 trolley wire is used on the 3,300 volt section, hung by a catenary suspension from a 7/16 messenger cable. The low-tension trolley line is supported from span wires. In Warren the cars run over the tracks of the older direct-current street railway, and the two trolley wires are suspended side by side from the same span wires. The cars are each equipped with four Westinghouse No. 108 50 H.P. single-phase motors, connected permanently in parallel, and are operated by the hand-control system by means of taps from an auto-transformer. The controllers are of the drum type, closely resembling those of continuous-current practice, though occupying less space. A bow trolley in the centre of the car is used on the 3,300 volt section, ordinary wheel trolleys being used on the 550 volt sections. A change-over switch is arranged to cut-out the bow trolley, and transfer the connections of the wheel trolleys from the low to the high voltage service taps of the auto-transformer, so that, in case of accident to the bow trolley, the wheel trolleys can be used on the 3,300 volt sections of the line. The change from the high voltage to the low voltage trolley is effected by the motorman releasing an air valve, which causes the bow to be lowered and locked in place. After passing the section insulator, the conductor places the wheel trolley on the line in the usual way. This change-over can easily be made without stopping. The passenger cars are 52 ft. long and seat 59 passengers each, weighing without load about 29½ tons each.

The "Wolfram" Lamp.—The following information on the "Wolfram" lamp, which, as may be remembered, is the invention of Dr. Alexander Just and Herr Franz Hanaman, is taken from a recent issue of the *Elektrotechnischer Anzeiger* So far, the lamp has been made for voltages not exceeding 110 volts. In the 110 volt, 32 c.p. pattern, there are three exceedingly thin filaments of pure tungsten, the filaments being held in place by suitable stays of aluminium oxide or of a mixture of other suitable oxides. In size and form the new lamp is stated to be almost identical with the ordinary 110 volt 32 c.p. lamp. According to the inventors, pure tungsten cannot be made to melt, but at the highest temperatures obtainable it volatilises without passing through the liquid state. In this respect it is analogous to carbon, the difference being that the temperature at which carbon volatilises is considerably lower than that for tungsten. It is stated that the average life of a

110 volt 40 c.p. lamp, when run at an efficiency of 1 watt per candle-power (Hefner unit), is 1,500 hours. It would appear that the illuminating power of the lamp remains unaltered during its entire life, and that it is not at all sensitive to fluctuations in the supply pressure.

Recent Developments in the Construction of Suction Gas Producers.—A Paper was read on the above subject before the Junior Institution of Engineers on Friday last by Mr. W. A. Tookey. The Paper dealt more particularly with the various designs of suction plants offered by manufacturers of to-day, but was prefaced by a few notes on the original "pressure" plant of Dowson invented in 1878, the improvements of Benier and Taylor in Paris, when the waste heat of the generated gas was utilised to make steam, and the further pioneer work of Körting, Pintsch and others on the Continent and the early Crossley and Tangye suction plants in this country. The extreme importance of correct proportioning of the grate and depth of fire to the size of the piston is pointed out, and a useful table of fuel consumptions of various sizes of well-known types is given. The remainder of the Paper deals in detail with practical points of design of the various parts of the producer, including the storage and distilling bells, fuel base, gas outlets, charging hoppers, ash pits, grates, vaporisers, arrangements for regulation of water supply, steam admission, coolers, scrubbers, water seals, sprinklers, pressure regulators, purifiers and starting fans. All the points discussed are illustrated with references to producers actually on the market, and an excellent series of sectional drawings of some 28 distinct types of producers are given.

Submarine Cables.—A Paper on "Submarine Cables" was read by Mr. W. Smith at a meeting of the Birmingham and District Electric Club on Saturday last. For electric light and power conductors under the sea, the author recommended vulcanised rubber insulation. Telegraph cables, he explained, on the other hand are almost universally insulated with gutta-percha, and cables made at the present time differ but little from those made in the early days of ocean telegraphy. The conductor, insulated with gutta-percha, is taped, then protected by some fibrous material, sheathed with galvanised iron or steel wires and finally finished off with a serving of yarn and tape. The author mentioned the various grades of armouring, the deep-sea, intermediate and shore-end, with over-all diameters of about 1 in. upwards. As a protection from the ravages of certain small marine animals, he said, powdered silica is often mixed with the compound applied when serving the cables, and as a further protection a wrapping of brass tape is sometimes applied. He next mentioned the "All-British Pacific" cable, opened to the public in December, 1902, of which the section between Fanning Island and Vancouver is the greatest length yet laid in one piece—about 4,000 geographical miles. This particular portion of the cable is made in a rather different manner to the remainder; the conductor consists of five strands, the four outers being closed round the central wire in such a manner that while retaining the advantages of a strand, there is almost as much copper as in a solid conductor of equal diameter. Thus, without much loss in conductance, the capacity is considerably reduced. Various forms of light, that is, of low specific gravity, cables had been employed, he continued, but apparently with little success. In order to keep down the weight it had been suggested to protect submarine cables with a layer of aluminium tape, but it was doubtful whether this would be satisfactory, considering the rapid action of chlorine on aluminium. He next referred briefly to "loading" telephone cables with inductance. It did not appear feasible to use an alloy for the conductor, he said, as alloys had a higher resistance than their constituents when taken separately. If inductance coils were introduced, iron must be very carefully employed or sounds were not clearly transmitted. Any such apparatus, although comparatively easy to attach to underground lines, would, he thought, be difficult to use in the case of a submarine cable lying in a depth of some 3,000 fathoms. Air spacing (which he stated incidentally did not appear to have been a success on some underground lines) could hardly be suggested for deep-sea cables. As well as transmitting the sound, some means were required to rectify the tendency of the sound wave to distortion; not only was it necessary to have amplitude, clear articulation was also required.

Economies in the Energy Consumption of Electric Tramcars.—In the tramway system of Frankfurt-on-the-Main, the energy consumed per car-mile had been steadily increasing until about a year ago, when a stringent control of the energy used by each car driver was introduced. Such a control was all the more necessary as the cost of energy represented a considerable portion of the total costs. A variety of electricity meters were first tried, but they were not satisfactory, as their readings differed after a very short time. A clockwork arrangement was then adopted to indicate the time during which the motors of the car were taking current. These clocks were fixed in the several hundred cars of the Frankfurt tramway service towards the end of May, 1905. They are of Hartmann & Braun's manufacture, and run 300 hours at a time. Since the clocks are only in operation for about one-third or one-fourth of the running time, they need only be wound up about every 45 days. The clock has a minute and hour hand, and its dial is of the usual kind. As long as no current flows through the motor equipment, the escapement of the clockwork is arrested by a miniature braking arrangement, but when the motors are switched into circuit, this brake is released by an electromagnet, whose winding is connected in parallel with the motors and starting resistances. It is stated that the electromagnet is designed to work satisfactorily for any voltage between 350 and 600 volts. A resistance is inserted in series with the coil of the electromagnet. As soon as the driver switches on, no matter to what stop he has moved his handle, the clock begins to register the time and stops again when the current is shut off. It was not found necessary to spring-suspend the clock. The greatest economy in consumption is effected, as is well known, by accelerating rapidly and letting the car coast until near to the stopping place, when the brakes are applied. Quick acceleration also means a saving in resistance losses. Hence, the time indicated by the clock is a comparative measure for the efficiency of the car driver on a particular route. Differences in the weights and equipments of cars, &c., may be taken account of by multiplying the time indicated by the clock by a certain coefficient. The booking of the readings, &c., is left to the car conductor, who enters on a sheet the clock readings before the car leaves the shed in the morning and subsequently every time before leaving a terminus. In addition, the conductor enters on his sheet the date and day, the driver's number, the car number, the number of trailers (if any), the state of the weather and the receipts. The clock reading is multiplied each time with the coefficient alluded to above, and the monthly average of these corrected figures is taken as a measure of the driver's efficiency. If the average figure of a particular car is repeatedly above the average, the car is first examined, and, if found in order, the car driver in question has to undergo special instruction. According to the *Elektrotechnischer Anzeiger*, the energy consumption has been reduced by 13 per cent. (from 870 watt-hours to 755 watt-hours per car-mile) since the introduction of this checking device, and the consumption is reported to be still falling. Moreover, there is an incidental saving in the brake shoes, and the cars run more punctually.

ARRANGEMENTS FOR THE WEEK.

MONDAY, April 30th.

TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

3 p.m. Visit to the works of the Charing Cross, Euston and Hampstead Railway. Meet at Charing Cross station forecourt.

WEDNESDAY, May 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

7:30 p.m. Meeting at 92, Victoria-street, Westminster, London. Paper to be read: "Single-phase Railways," by H. W. Taylor.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. Paper to be read: "Submarine Signalling," by J. B. Millet.

FRIDAY, May 4th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on: "The Steam Turbine on Land and at Sea," by the Hon. C. A. Parsons, F.R.S.

THE FERRANTI WORKS.

We recently had an opportunity of visiting Messrs. Ferranti's works at Hollinwood, which have been entirely reorganised during the past two years. The firm, having discontinued making engines and generators, has been able to devote the whole of the large works to switch-gear, meters and other electrical instruments, and the shops all show signs of great activity. The general arrangement of the works is shown in the ground plan, Fig. 1, from which it is seen that the switchboard and meter shops occupy almost equal space, and so great has been the extension of this latter department that there is quite enough work to fill it.

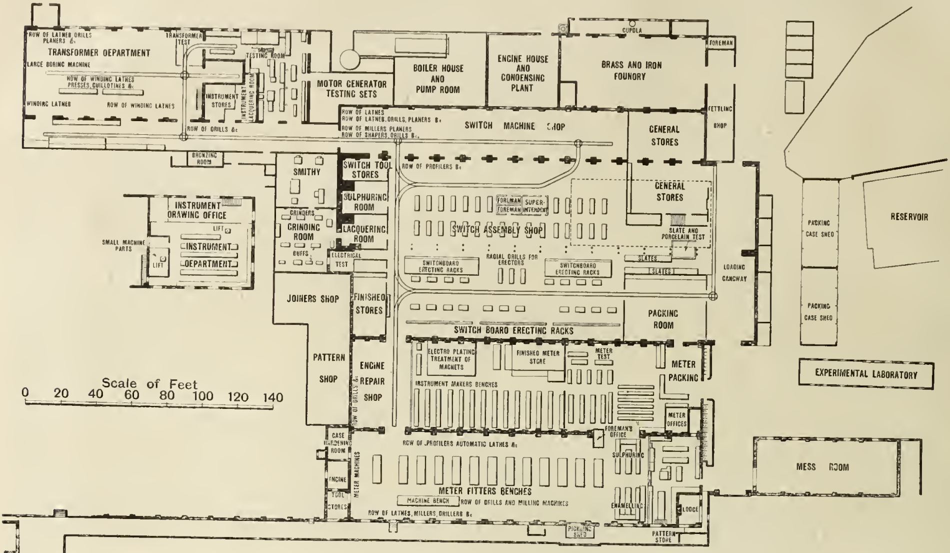


Fig. 1.—Ground Plan of Works.

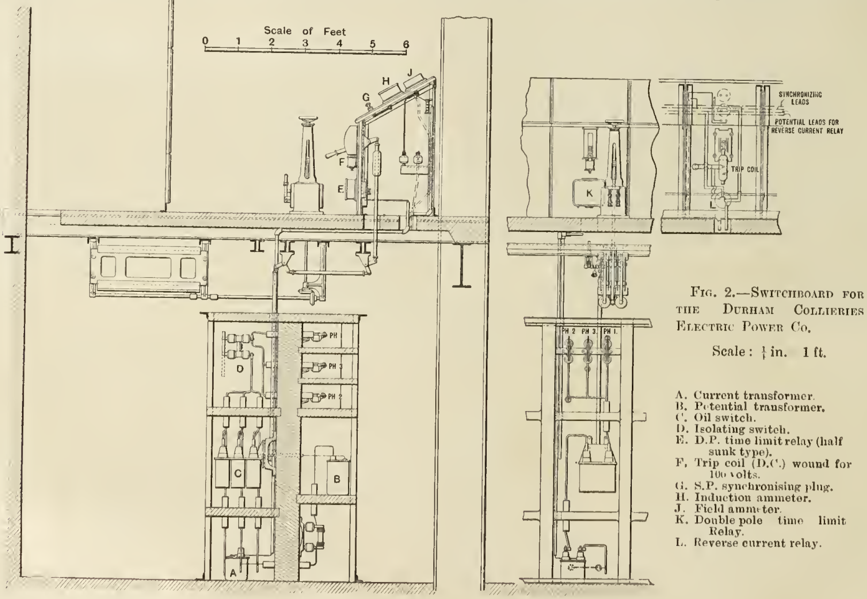


Fig. 2.—Switchboard for the Durham Collieries Electric Power Co.

Scale: ½ in. 1 ft.

A. Current transformer.
B. Potential transformer.
C. Oil switch.
D. Isolating switch.
E. D.P. time limit relay (half sunk type).
F. Trip coil (D.C.) wound for 100 volts.
G. S.P. synchronising plug.
H. Induction ammeter.
J. Field ammeter.
K. Double pole time limit Relay.
L. Reverse current relay.

The material comes in to the general stores at the end of the switchboard machine and erecting shops. It is essential that the proper quality of slate and porcelain should be used, and a careful test is made of each piece delivered before it is taken into stock. For this reason the slate and porcelain-testing department is close to the general stores for the raw material. A portable transformer is employed for this purpose, and the test is simply a pressure one to see if the material has metallic veins, cracks or flaws and will withstand a voltage considerably in excess of that to which it is to be subjected in practice. The switchboard machine shop is as other machine shops, but it is evident that considerable care has been exercised in the arrangement of the various machine tools. As is usual, the lathes for cutting from rod are placed at an angle with the wall so as to economise in the free space between the machines. The machines are driven from shafting through belts. Inverted motors are clamped to girders above the machines at several points along the line of shafting, and individual drive is only employed in the case of one or two of the largest tools. It is in a long bay by itself, next to the "Assembly Shop," in which the parts are assembled, after which they proceed to the finished stores and thence to the switchboard erecting shop. After leaving the machine shop the finished parts pass to the assembly shop, of which Fig. 3 gives a good view. There is a line of rails serving this shop and two others serving the machine shop and erecting shops respectively, and also overhead cranes, so that the work is moved on with proper despatch.

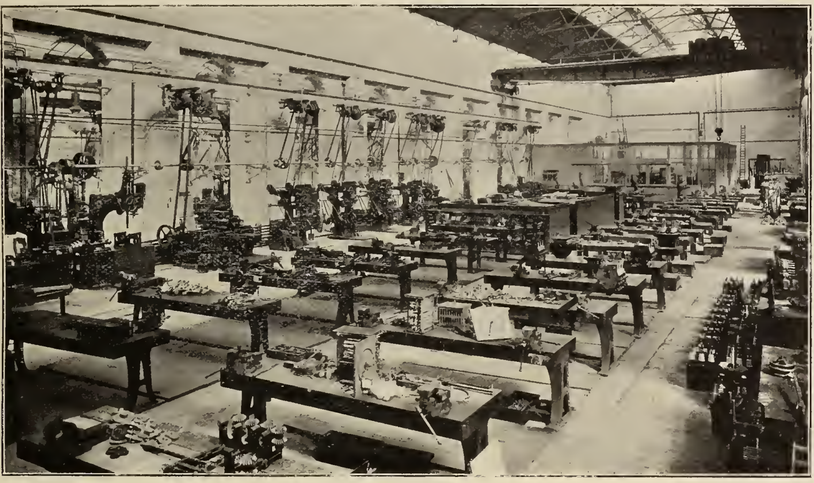


FIG. 3.—SWITCH ASSEMBLY SHOP.

In the switchboard-erecting shop there is a good deal of large work in progress. A switchboard for Japan is seen in the foreground of Fig. 4, and on this the heavy motor-starter is particularly noticeable. The charging gears for the Great Western Railway power house are also passing through the shops. Another large board which is also in hand is one for the Durham Collieries Electric Power Co., and as this is typical of one of Messrs. Ferranti's latest patterns of remote-control boards we give a detailed drawing of it showing a section of the generator panel (Fig. 2).

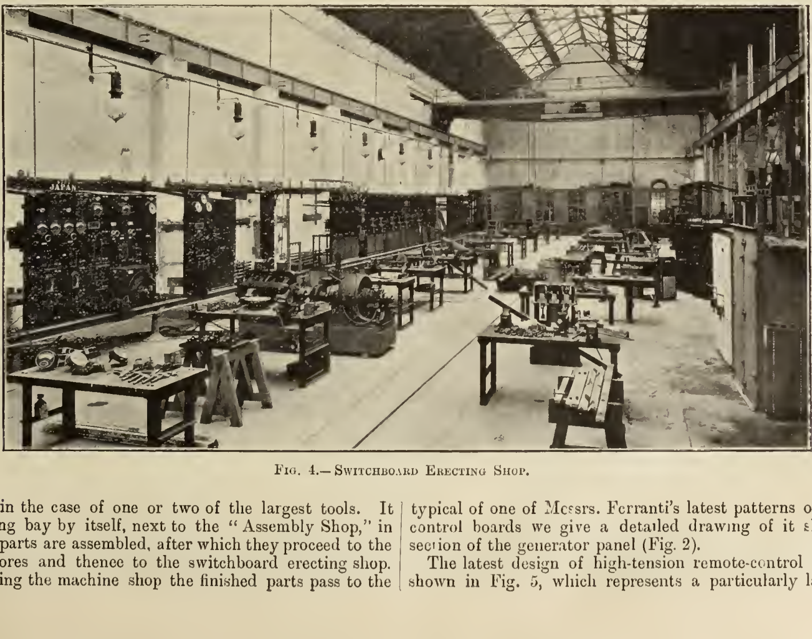


FIG. 4.—SWITCHBOARD ERECTING SHOP.

The latest design of high-tension remote-control switch is shown in Fig. 5, which represents a particularly large one destined for the Glasgow Corporation electricity works. Among the modifications in design since the description of these switches which appeared at the time of the Olympia Exhibition in London (*The Electrician*, Vol. LVI., p. 5), it will be noticed that the cables are brought in at the side instead of at the top, which facilitates considerably the leading in, and that there is a cast-iron box enclosing the terminals, with a door at the side. The tank is now supported from a slate base, instead of being held up by insulated bolts. 20 of these switches, each capable of dealing with 6,000 kw. at 6,500 volts are in hand for Glasgow. Another board that may be mentioned in passing is a low-tension sub-station board, three of which are destined for Dublin. In this the circuit fuses are placed on three sloping shelves one below the other, fixed to the wall by brackets, which is a convenient arrangement where the head-room is limited. This arrangement forms a backless board, while connections on both sides of the slabs are readily accessible.

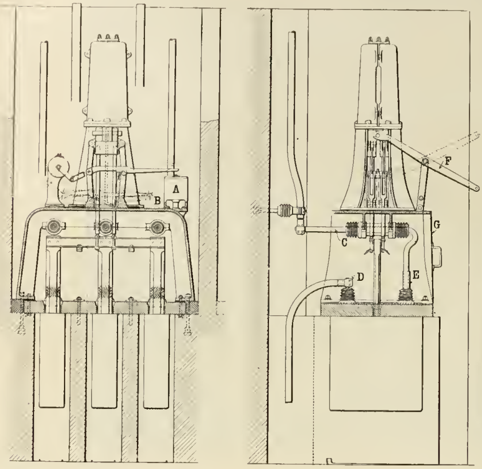


FIG. 5.—6,000 KW. 6,500 VOLT REMOTE CONTROL SWITCH FOR THE GLASGOW ELECTRICITY WORKS. Scale: $\frac{3}{8}$ in. = 1 ft.

A. Trip coil. **B.** Off position of links. **C.** Solid rod (insulated). **D.** Insulation cap to be placed over terminal. **E.** Insulation sleeve. **F.** Attachment for hand operation only in case of emergency—ordinarily removed. **G.** Removable cover.

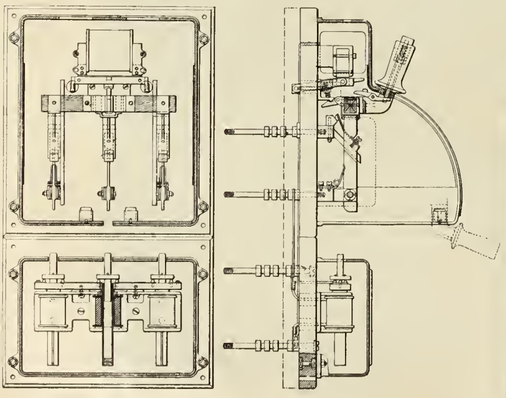


FIG. 6.—THREE-PHASE MOTOR SWITCH WITH NO-VOLTAGE AND OVERLOAD RELEASE. Scale: $1\frac{1}{2}$ in. = 1 ft.

A useful switch, for which there should be considerable demand, is shown in Fig. 6. It is an entirely new pattern, and is hardly yet on the market. Although starting switches for shunt continuous-current motors of medium size are almost invariably fitted with no-voltage release, for some reasons the ordinary three-phase motor switch used in works driving and similar situations is not equipped with this device. Yet it should be almost as important, for if the current is switched off through any cause and the motors are left with their load on, at the moment the mains are charged again heavy currents would flow through the rotors of the motors and burn-outs might result. Mr. M. B. Field has therefore designed the circuit-breaker illustrated, which is intended to replace the main switch. The retaining coil, seen at the top of the figure, holds up the switch lever by means of a catch which is released when the voltage fails. An arrangement has been contrived for the purpose of preventing the humming and chattering which is the ordinary defect of switches of this class. On the lower part of the same base is an overload relay which acts in the ordinary manner.

(*To be concluded.*)

THE SAINT-DENIS ELECTRICITY WORKS.

One of the largest, if not the largest electric generating station in Europe is now being completed by the Société d'Electricité de Paris at Saint Denis, on the Seine near Paris. This company is largely controlled by the company which runs the Métropolitain Railway in Paris. The new station will ultimately contain twelve 6,000 kw. turbo-generator sets. At present three sets are in working order, but it is hoped that 10 sets will be running by the end of this year. In view of the fact that the station is to supply electric energy for light, power and traction, and furthermore, that there exist already a number of single and two-phase networks which it is intended to feed later on, it was decided to generate three-phase current at 10,250 volts and 25 ∽ per second (chiefly for traction purposes), two-phase current at 12,300 volts and $41\frac{2}{3}$ ∽ per second (for power and light), and continuous current at 230 and 550 volts for auxiliaries and lighting in the station and traction purposes in the immediate neighbourhood. Current is to be supplied in bulk to a number of consumers, amongst whom may be mentioned the Métropolitain Railway and the Société d'Eclairage et de Force.

The main building, which contains only the engine room, is approximately at right angles to the Seine (see Fig. 1) and its nearest corner is about 250 ft. from the river. It is 65 ft. wide and 40 ft. high inside, and will measure about 250 ft. in length when finished. At present about half this length has been built. The switchboard and the electric controlling gear is installed in an annexe parallel to one side of the engine room. This subsidiary building is much shorter and narrower than the main building and there is no partition between the two. Adjoining the other long side of the main building are situated the three separate boiler houses; each of these measures 124 ft. × 138 ft., and a passage $6\frac{1}{2}$ ft. wide separates them from the engine building. A part of each boiler house is partitioned off and contains the feed pumps and the water meters to measure the quantity of condensed steam. Behind the boiler houses, at a distance of about 55 ft., are three buildings containing the coal bunkers of 4,000 tons capacity each. The other buildings which are to be erected later on include workmen's dwellings and offices.

Most of the coal is brought to the station by barges, but the works can also obtain coal by way of the Chemin de fer du Nord, with whose system they are linked up. The quay is large enough to allow two barges to unload simultaneously, and this will be effected by two electric cranes in conjunction with the coal conveying arrangements described below. So far only one electric crane has been erected. This lifts the coal from the barge and drops it on to an endless-belt conveyor which runs parallel to the quay. From the belt the coal falls into the buckets of a double-bucket conveyor capable of transporting 80 tons of coal per hour. The works and quay are separated by a road, and the bucket conveyor referred to crosses this road at a high level and passes in front of the three coal bunkers, where the coal is discharged into one of the two hoppers of each bunker. The coal is guided by the hopper into the buckets of a smaller distributing bucket-conveyor, which is arranged at right angles to the main conveyor. After distributing the coal in the bunkers, this second conveyor descends vertically at the back of the bunker, proceeds beneath the bunker in a horizontal passage (where it is filled with coal through adjustable apertures from the bunker above) and rises again in front of the building. The coal picked up in the horizontal passage is now discharged into another hopper, which feeds the coal to the crusher and the automatic weighing and registering apparatus. From here the coal is carried by a third bucket conveyor above the boilers and discharged into bunkers of about 800 tons. From these bunkers the coal falls by gravity through the hoppers on to the grate. After discharging into the bunkers, the conveyor descends vertically at the wall of the boiler house nearest to the engine room, and passes horizontally beneath the boilers to the front of the coal bunkers again, where it rises vertically. In the horizontal passage the ashes are shovelled into the returning buckets and are subsequently discharged into ash pits, whence they may be carted away or fed into the returning buckets of the main conveyor. The coal conveying and distributing system just described is of the Hunt system and was supplied by Messrs. Babcock & Wilcox.

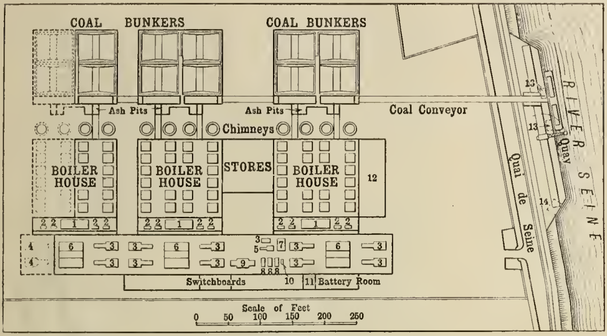


Fig. 1.—General Lay-out of the Saint Denis Electricity Works.

1. Boiler feed pumps. 2. Water meters. 3. 6,000 kw. turbo-alternators. 4. 6,000 kw. sets, to be installed later on. 5. 300 kw turbo-generator. 6 Condenser pits. 7. Condenser pit for the 300 kw. set. 8. Motor-generators. 9. Motor-generator for three-phase, two-phase and continuous current. 11. Office. 12. Lavatories, offices, &c. 13. Intake of water supply. 14 Water outlet.

Each of the three boiler houses is to contain ultimately 24 boilers, arranged in four parallel batteries of six boilers each, the rows being at right angles to the engine building. So far, only one boiler house has been built and is already provided with 20 Babcock & Wilcox boilers, the remaining four being erected at the present time. The boilers are of the marine type and capable of evaporating from 18,000 lb. to 22,000 lb. of steam per hour each at a pressure of 225 lb. per square inch. They have a heating surface of 4,540 sq. ft. each and are fitted with two chain grates fed with coal from two hoppers. The quantity of coal burnt and the thickness of the fire are regulated in the customary manner by varying the speed of the chain grate and by allowing more or less coal to fall on the grate. This is accomplished by regulating the opening through which the coal falls from the hoppers. Each of the two boiler grates has an area of 121 sq. ft. A motor of about 12 B.H.P. is installed at one end of every battery of boilers and drives the shafting from which the grates are actuated. Each boiler is fitted with two Babcock & Wilcox superheaters of a heating surface of 1,850 sq. ft. and designed to raise the temperature of the steam within the limits of 250°C. and 350°C. at all loads. Each boiler is also equipped with a Green economiser having 160 tubes of a total heating surface of 1,725 sq. ft. Boiler, superheater and economiser are arranged one above the other. The four chimneys of each boiler house are in a line at the side of the boiler house facing the bunkers, and the temperature of the gases entering the flue is stated to be not more than 130°C. The chimney draught is regulated from the pump house. To this end the temperature in the chimney flue is indicated on a small switchboard in the pump house, by electrical means, so that the operator can regulate the shutter in the chimney flue according to the temperature observed. This operation is also performed electrically. After leaving the boilers, the steam is conducted through four pipes to a cross-connecting steam main in the pump house, whence it is distributed through separate pipes to each turbine. In order to minimise the loss of heat from radiation, comparatively small pipes (having an internal diameter of 11$\frac{5}{16}$ in.) have been adopted throughout with the exception of some short lengths of piping between the cross header in the pump house and the turbine, which have a somewhat smaller diameter than the rest. Of course, this saving in radiation losses has to be paid for in the drop in pressure, and it has been calculated that the drop in pressure and temperature between the boiler and the turbine at full load will amount to 59 lb. per sq. in. and 50°C. respectively. To reduce the radiation losses still further, the steam pipes are lagged with a non-conducting material called diatomite.

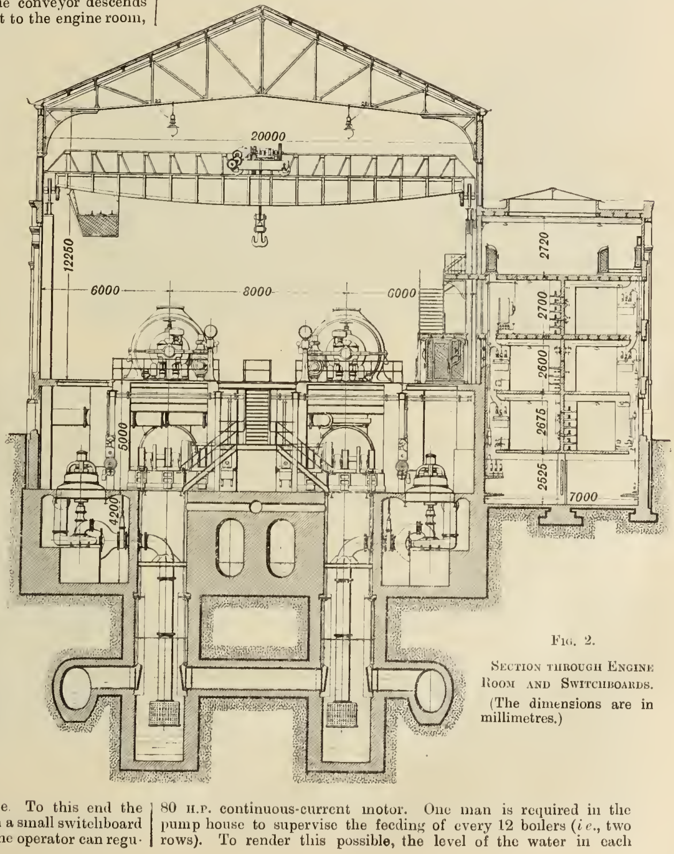


Fig. 2.

Section through Engine Room and Switchboards.

(The dimensions are in millimetres.)

The larger part of the boiler feed water consists of the water returned from the condensers. This water, which need not be purified, passes from the condensers through water meters (four of which are in each boiler house) and is stored—together with the purified make-up water from the river—in tanks holding 27,500 gallons each, of which there are four to each boiler house. From the tanks the water is forced into the boilers by two three-throw plunger pumps and two centrifugal pumps. Each pump is driven by an 80 H.P. continuous-current motor. One man is required in the pump house to supervise the feeding of every 12 boilers (*i.e.*, two rows). To render this possible, the level of the water in each of the boilers is indicated electrically in the pump room, the indicators being arranged side by side on the wall. As already mentioned, only three 6,000 kw. generating sets are now running. A fourth set, however, is now being erected, and it is hoped that seven three-phase and three two-phase sets will be in working order by the end of this year. Each set is 47½ ft. long, 13½ ft. wide, and 11½ ft. high overall. The turbines are of the Brown-Boveri-Parsons type, and their steam consumptions—at a pressure of 177 lb. per sq. in and steam superheated to 300°C.—were guaranteed not to exceed 15·1 lb per kw.-hour at full load and 18·3 lb. at half load. We understand that actual tests have been made, and have given results which are considerably better than the guaranteed figures. In addition to the ordinary governors, the turbines are also provided with an emergency device which cuts off the steam completely should the speed increase by more than 15 per cent. beyond the normal. The turbine spindle inside the cylinder is 3,200 mm. (10½ ft.) long, and has three steps. The blades, of hard bronze, are from 20 mm. to 25 mm. long and 10 mm. broad at the high-pressure end, but from seven to eight times as long and twice as broad at the low-pressure side. After the blades have been cut from long lengths of drawn or rolled material, they are provided with two grooves at one end The grooves in the cylinder wall and turbine spindle are slightly dovetailed, and the blades are fixed securely therein and at a proper distance from one another by soft-metal pieces, which are hammered out after being inserted between the blades. The alternators, which are directly driven by the turbines, are also by Brown, Boveri & Co. Fig. 3 shows one of the 6,000 kw. turbo-generators. At starting up the sets, the lubricating oil is supplied under pressure to the bearings by auxiliary steam-driven oil pumps, each pump supplying two 6,000 kw. sets When the sets are running, however, the oil is supplied by pumps which are driven from the turbine shaft. In order to secure absolute reliability, each turbine is provided with two such pumps.

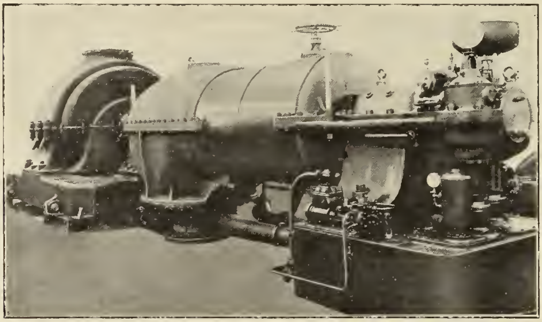


Fig. 3.—6,000 kw. Turbo-Generator at the St. Denis Electricity Works.

Four turbo sets form a group, one set being at each of the four corners of a rectangle. The four condensers of each group of turbo sets are placed in the corners of a rectangular pit in the centre of each group. Four intercommunicating shafts are sunk from the pit (as indicated in Fig. 2) These shafts are filled with river water through two longitudinal canals of about 21½ sq. ft. section, which extend the whole length underneath the engine room floor For safety, each canal has been made large enough to deal with the whole supply of water for the station. The cooling water is raised and conducted to the condensers by means of a centrifugal pump, driven by a 120 h.p. electric motor with vertical shaft (see Fig. 4). Brown, Boveri & Co. also supplied these condensers, which are of the surface type, with 2,600 tinned brass tubes each. The air pump belonging to each condenser is directly driven by a 50 h.p. 220 volt continuous-current motor. From the condensers the water flows through two canals, on a higher level than the canals previously mentioned, back to the river Seine. A view of the electrically-driven pump is given in Fig. 5.

Between the first and the second of the generating groups there are a number of smaller sets, which serve for generating continuous current and for converting three-phase to two-phase and vice versa. First of all there is a 300 kw. turbo-generator set, running at 2,700 revs. per min., and generating continuous current at 230 volts. A special condenser is provided for this set, but the arrangements are made for running non-condensing if required. Current from this set is only used for exciting the alternators when the station is started up, excitation and continuous current for auxiliaries being normally taken from three 375 kw. motor generators. Each of these sets consists of a 10,250 volt asynchronous motor, running at 375 revs. per min., coupled to a 230 volt continuous-current generator. The generators are connected in parallel to a Tudor battery, consisting of 126 cells of 1,500 ampere-hours capacity at the two hours discharge rate, and a motor-driven booster for 660 amperes and 110 volts is used for regulating the charge. These 375 kw. motor-generators are started from the continuous-current side. A mixed motor-generator set, comprising a 10,250 volt 25 ∿ three-phase alternator, a 6,150 volt 42 ∿ two-phase alternator, each of 1,500 kw. capacity, and two 750 kw. 550 volt continuous-current generators, all connected in line, is now being installed, the continuous-current generators being at the ends of the set. The set runs at 500 revs. per min., and permits any kind of current being converted into any other. An alternative means of converting three-phase current to two-phase current, or vice versa, is afforded by a 1,500 kw. transformer.

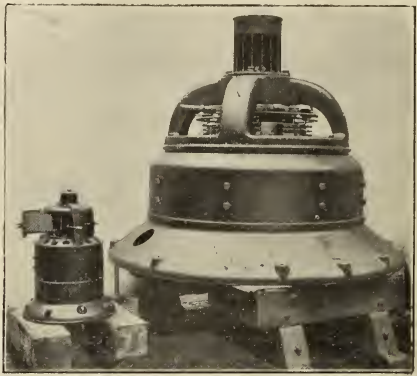


Fig. 4.—120 h.p Motor with Vertical Shaft for driving the Circulating Pump. Speed from 260 to 310 revs. per min.
7 h.p. Motor for the Fire Pump. Speed from 2,000 to 2,300 revs. per min.

The H.T. switch gear is contained in brick compartments, arranged in four rows, one above the other, in the switchboard room a section of which is given in Fig. 2 The H.T. cables from the turbo-alternators are first led to a compartment in the basement of the switchboard room. From here they pass to the main switches in the brick compartments immediately above, and thence the circuit is taken, by way of a further series of switches, to the 'bus bars, which are also mounted

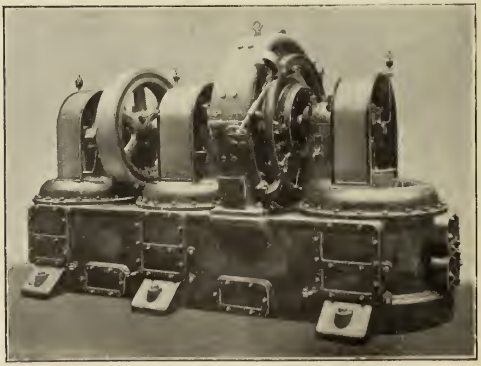


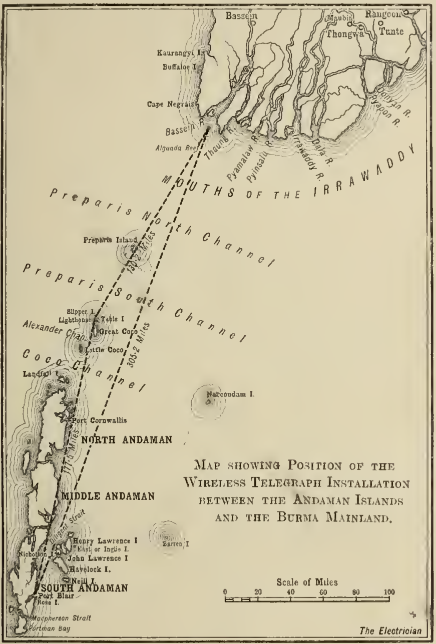
Fig. 5.—Electrically-driven Air Pump at the St. Denis Electricity Works.

in brick chambers. The feeders from the 'bus bars, after passing through their switches in another row of brick compartments, are led to the last row of compartments, whence, finally, they leave the building. All the H.T. switches are of the oil-break type, and are mostly motor operated Lightning arresters are also provided. The operating floor, to which access is gained by a double staircase from the engine room, is situated above the four tiers of brick compartments. It is equipped with a number of small desk-type control boards, from which the attendant operates the H.-T. switch gear.

WIRELESS TELEGRAPHY FROM THE ANDAMAN ISLANDS TO THE MAINLAND OF BURMA.

We are enabled to publish the following report relating to an installation for wireless telegraphy from the Andaman Islands to the mainland of Burma :—

1. Towards the end of August, 1904, operations commenced for linking up the Settlement of Port Blair in the Andaman Islands with the general telegraph system of India by establishing wireless telegraph stations at Port Blair and at Diamond Island, which is already connected by a short cable to the mainland. The distance to be spanned is 305·2 miles. Between Port Blair and Diamond Island is situated Table Island, on which is a lighthouse and close to which ships pass on the voyages Rangoon and Colombo, and Calcutta to the Straits. It was therefore decided to take the opportunity of establishing a station on Table Island which it was hoped would prove useful to the shipping and to the Meteorological Department. This distance from Diamond Island to Table Island is 130·2 miles and from Table Island to Port Blair 177·5 miles. A map is attached which shows the positions of the stations.



Map showing Position of the Wireless Telegraph Installation between the Andaman Islands and the Burma Mainland.

The Electrician

2. The system chosen was the Lodge-Muirhead, with which we had already experimented for three months in the early part of 1904. For this system four masts are required at each station, and as the distance to be spanned was over 300 miles it was thought advisable to use 150 ft. masts. From the previous experiments there were left one mast at Amherst, one at Elephant Point, one at Diamond Island, one at Table Island and one not erected at Port Blair. On September 1, 1904, orders were issued to the Superintendent of Workshops to make up seven more 150 ft. masts, and at the same time arrangements were made for dismantling the masts standing at Amherst and Elephant Point and removing them to Diamond Island.

3. The new masts made in the workshops were made of Oregon pine and built on the principle of a ship mast. They have been found to answer their purpose well and were comparatively easy to erect. Three of the masts were completed and shipped on the ss. "Maharajah" by October 7, 1904, or just five weeks after the receipt of the order for manufacture. The other four were ready a few days afterwards and were sent to Rangoon for distribution to Diamond Island or Table Island as required.

4. I left Calcutta on October 8, 1904, with Mr. J. N. Parker, assistant superintendent, one signaller and native staff. By the same steamer went the three masts and all instruments and stores required for the station at Port Blair. The steamer arrived on October 11th, and the erection of the masts and fitting of the station was proceeded with at once.

5. The Chief Commissioner of the Andaman Islands wished, if practicable, to have the wireless station on Ross Island, where are located the headquarter offices of the Settlement, but unfortunately there is no suitable site on that island on which to erect the requisite aerial, though a site could be made with a little expenditure of time and labour by reclaiming a portion of the reef at the north of the island. The site eventually decided on was on the mainland at Aberdeen just immediately to the north of the female jail, and it is proposed to connect the wireless telegraph office here to Ross Island by telephone,

6. The Chief Commissioner placed at my disposal for the erection of the masts the services of Mr. Bonig, assistant harbour master, with the requisite convict labour. The work was carried out by him with great expedition, and all four masts were erected complete by October 28th. The engine and dynamo were then fixed in position in their tent and the charging of the batteries started. The whole station was completed on November 11th and worked well with a temporary station erected on R.I.M.S. "Minto" which was lying up the harbour and was separated by a fair-sized hill.

7. Leaving Mr. Parker in charge of operations at Port Blair, I left on November 7th for Diamond Island, where I arrived on the 13th. I found that the four masts had been erected by Mr. Buckley, sub-assistant superintendent, on the site which I had previously selected when on the island in May. The installation here was completed on November 20th, and attempts were made to communicate with Port Blair from the 20th to the 23rd, when a small motor broke down. As the wave measurer expected from England had not yet arrived, we were not in a position to tune the stations accurately and could scarcely hope to attain success.

8. I left Diamond Island on November 25th for Rangoon in order to take masts and stores to Table Island and to select the site for the installation. We arrived at Table Island on the morning of November 30th and remained two days landing the stores. Having regard to the disposition of the neighbouring Cocos Island, it appeared desirable to place the wireless installation as much to the west as possible. With this object I decided to place the station, not on Table Island at all, but on Slipper Island, which is a quite small island just to the west of Table Island, and connected to it at low water by a narrow strip of land. Having selected the site for the masts, I returned to Diamond Island, arriving on December 2nd, accompanied by Mr. C. Landon, assistant superintendent, who had joined me in Rangoon.

9. We now continued trials between Diamond Island and Port Blair, and, though we got occasional signals, we got nothing readable till the early morning of December 22, 1904, when for 10 minutes we received the first readable signals from the Andaman Islands to Burma by wireless telegraphy. Considering that the distance between these stations is 305·2 miles and the power used was 36 volts and about 15 amperes, or only a little over $\frac{1}{2}$ H.P., this result is a remarkable proof of the efficiency of the Lodge-Muirhead system.

10. Experiments on the direct circuit from Diamond Island to Port Blair could not at this time be continued, as Mr. Parker left Port Blair on the 22nd to come to take charge of the station at Diamond Island while I went to Table Island to complete the installation on Slipper Island. Mr. Landon accompanied me, and we arrived at Table Island on December 28th.

11. There is no landing place for a boat on Slipper Island. There are two landing places on Table Island, one on the south side, to be used during the North-East monsoon, and one on the north side, to be used in the South-West monsoon. The landing is very difficult in the bad weather and often in the monsoon is impossible. Our stores were all landed on Table Island, and had to be carried across to Slipper Island when the tide permitted. The masts for this station had already been erected, and the aerial was put up and all the instruments installed by January 11th. On January 12th messages were exchanged with Diamond Island, and communication established. This circuit continued to work well till the the middle of May, when an important piece of machinery broke down which could not be repaired till towards the end of June.

12. I left Table Island on January 17th, leaving Mr. Landon in charge of the Slipper Island installation. I arrived at Diamond Island at 7 a.m. on the morning of the 18th. The wave measurer had at last arrived, and I had just time to measure the tune of the aerial on Diamond Island before the steamer left at 10 a.m. for Port Blair, where we arrived on the 19th.

13. The permanent brick building had been erected at Port Blair, and a week was taken up in moving the engine, dynamo and instruments into it from the tents in which they had been previously installed. The next two days were spent in getting the circuits into proper tune, in which I was greatly assisted by Mr. J. C. Shields, assistant superintendent, who had arrived in Port Blair on January 27th. On January 30th we were able to receive the signals both from Diamond Island, 305·2 miles, and from Slipper Island, 177·5 miles, at Port Blair, but those offices were at this time unable to receive the signals from Port Blair, though they were in communication with each other.

14. It now only remained to put in at Diamond Island and Slipper Island the same tuning apparatus that we had installed at Port Blair. Mr. Shields took the first available opportunity of proceeding to Diamond

Island, where he arrived on February 9th, and on February 10, 1905, direct communication from Port Blair to Diamond Island was established, a number of messages being exchanged on that day. From this date on, communication had been kept up continuously, with the exception of certain interruptions to be mentioned hereafter, and the amount of traffic exchanged has been considerable, as will be seen from the statistics appended.

15. At this time we were using for sending a 20 in. induction coil worked from an accumulator battery, but it was not expected this would prove powerful enough for continuous work, and 3 H.P. engines with alternators and transformers had been telegraphed for. For receiving we used telephones operated by carbon steel coherers. At first, on the circuit, Slipper Island to Diamond Island, we used the Lodge-Muirhead coherer, operating a syphon recorder and giving signals on a tape, but our signallers, being always accustomed to read by sound, much preferred to read from the telephone, and the signals in a telephone operated by a carbon steel coherer were preferred by them to those in a telephone operated by the Lodge-Muirhead coherer.

16. On February 20th the new 3 H.P. engines with alternators and transformers sent out by Messrs. Muirhead & Co. arrived in Rangoon, and arrangements were made to get them out to the three wireless stations as soon as a steamer was available. They were landed at Diamond Island on March 4th, Slipper Island on the 5th and Port Blair on the 6th. The engines and alternators were set up and running at Diamond Island on March 6th and Port Blair on the 10th, and a marked improvement at once resulted in the signals, both on account of the increased loudness and improved tone.

17. About this time occurred the first serious interruption, Diamond Island was unable for four days (March 10th to 13th) to read the signals from Port Blair owing to atmospheric disturbances. During this time Port Blair was able to read Diamond Island signals quite well; but on a previous occasion (March 6th) the reverse was the case, Diamond Island being able to read the signals from Port Blair, but Port Blair could not read the signals from Diamond Island. No serious trouble in working was experienced during the rest of March, but it was noticed that atmospheric disturbances came on nearly every afternoon, often making work difficult.

18. Since April statistics were kept of the traffic exchanged; and a copy of the records for the months of April, May and June is appended. The installation was only opened in a limited degree for State traffic, and the actual number of messages tendered and dealt with in April was only 55 sent from Port Blair and 39 received for Port Blair, but a great deal was sent in addition to these messages and the traffic during the month amounted to nearly 10,000 words, and more could easily have been done had it been required. It will be noticed there were no interruptions during the month of April.

19. During the month of May traffic exchanged amounted to nearly 14,000 words. During this month communication was entirely interrupted for two days and was so imperfect for five other days as to be almost interrupted. The two days' interruption was due to a cylonic storm that passed over Diamond Island about May 30th, destroying all the tents which contained apparatus. On the other days on which communication was interrupted or imperfect, Diamond Island complained of severe atmospheric disturbances, and was unable to receive; but usually Port Blair was able to read the signals from Diamond Island.

20. During the month of June much trouble was experienced from storms and lightning. The office at Diamond Island, which was still in a tent, had to be shut down entirely on five days, and on portions of other days, owing to severe lightning or stormy weather, it was found impossible to work on account of the noise and the rain blowing through the tent. Towards the end of the month, the alternator and transformer on Diamond Island were damaged by lightning. The alternator could, fortunately, be repaired locally, but the transformer must go to England for repair. The traffic disposed of during the month was about 12,000 words.

21. During the months of May and June a great deal of interruption, due to the prevalence of atmospheric disturbances, would not have occurred if the office on Slipper Island had been in good working order and able to assist in passing the traffic. The alternator on Slipper Island, however, had broken down in the middle of May and could not be repaired till towards the end of June. Mr. Shields spent a fortnight on the Island in June and put the whole plant in order, and since then Slipper Island has been passing the traffic at such times as Diamond Island finds that atmospheric disturbances render communication difficult direct with Port Blair. The result has been that from June 28th up to the end of September the working of the traffic has been done with greater ease than ever before, while, in spite of atmospheric disturbances, there has been no interruption up to date (November 30th) except one due to a cyclonic storm endangering the safety of the mast at Diamond Island on July 23rd to 25th. The traffic during July, August, September, October, and November has amounted to 18,542, 21,286, 21,408, 27,398, and 26,938 words of actual messages. More could, of course, have been dealt with had it been tendered.

22. It appears certain that atmospheric disturbances are more prevalent at Diamond Island than at Port Blair. The interruptions, however, to communication caused by them would have been greatly reduced, both in frequency and duration, if everything had been nice and quiet. Up to nearly the end of June the apparatus at Diamond Island was installed in a tent, and there is no doubt the signallers had to work under very great disadvantages. A perfect din was caused by the public works party erecting the permanent office building, which is fortunately completed now.

23. Though enormous advances in the art of wireless telegraphy have been made of recent years, no one acquainted with the subject would assert that finality has yet been even approached. The position has been well summed up in a recent work, "Telegraphy" (1905) by Sir William Preece and Sir James Sivewright where, on p. 474, we read: "Wireless telegraphy is still in its experimental stage, but great progress has been made and undoubtedly will be in the near future. The sea is its domain. Here it is practical, and even commercial, but not reliable for continuous periods. It has not yet been proved effective over land excepting for comparatively short distances where the earth is moist. Secrecy is impractical and attainable only by codes. It is still complicated, and it needs skilled experts at each end."

24. Just as a land line is subject to occasional interruptions from falling trees, floods and other physical causes, so a wireless installation of whatever system is subject to occasional interruption from electrical causes. And as in the former case experience has shown us how to so

Record of Work done during the Month of April, 1905.

Day of month	Sent traffic.			Received traffic.		
	Messages.		Approx. No. of words sent in addition to actual messages.	Messages.		Approx. No. of words recivd. in addition to actual messages.
	Total No. sent daily.	Words contained.		Total No. received.	Words contained.	
1	2	55	150	Nil	..	150
2*	Nil	..	..	Nil	..	..
3	3	124	150	4	91	150
4	Nil	..	130	4	86	130
5	1	16	180	2	90	180
6	4	170	100	1	27	150
7	3	180	150	Nil	..	150
8	3	62	50	3	96	150
9*	Nil	..	..	Nil	..	..
10	3	80	100	Nil	..	100
11	4	87	150	1	43	150
12	Nil	..	100	Nil	..	180
13	2	76	150	1	27	130
14	1	21	120	Nil	..	150
15	6	165	100	1	23	80
16*	Nil	..	..	Nil	..	..
17	9	259	100	3	102	130
18	Nil	..	100	2	100	100
19	2	68	120	4	120	160
20	1	22	100	1	14	180
21	Nil	..	40	1	36	20
22	1	37	130	1	22	160
23*	Nil	..	..	Nil	..	...
24	2	92	160	Nil	..	120
25	2	101	180	Nil	..	170
26	Nil	..	190	2	33	170
27	1	46	150	4	122	150
28	2	97	120	2	55	160
29	3	68	120	2	71	400
30*	Nil	..	..	Nil	..	..
	55	1,826	3,140	39	1,158	3,770

* Sunday. 9,988 words.

May, 1905.

1	8	236	250	5	226	420
2	7	220	180	1	15	450
3	1	23	220	7	150	400
4	3	191	150	2	56	340
5	4	144	160	1	19	100
6	3	62	200	4	106	380
7*	3	81	80	4	193	85
8	3	80	180	Nil	..	60
9	1	23	150	7	238	100
10	Nil	..	Nil	Nil	..	60
11	Nil	..	Nil	2	43	70
12	Nil	..	Nil	Nil	..	Nil
13	Nil	..	11	5	118	210
14*	Nil	..	Nil	Nil	..	10
15	14	364	100	11	572	150
16	1	25	150	11	638	100
17	2	53	130	8	368	50
18	2	63	100	2	211	100
19	1	27	150	1	107	100
20	Nil	..	18	Nil	..	40
21*	Nil	..	..	Nil	..	..
22	Nil	..	..	Nil	..	..
23	Nil	..	..	Nil	..	20
24	10	250	150	2	98	230
25	9	270	130	5	221	180
26	2	107	100	Nil	..	30
27	2	46	180	1	43	80
28*	5	150	30	Nil	..	30
29	2	57	100	5	153	100
30	1	25	100	9	299	100
31	1	25	100	2	128	150
	85	2,522	3,119	96	4,002	4,145

* Sunday. 13,968 words.

Record of Work done during the Month of June, 1905.

Day of month	Sent traffic. Messages. Total No. sent daily.	Sent traffic. Messages. Words contained.	Sent traffic. Approx. No. of words sent in addition to actual messages.	Received traffic. Messages. Total No. received.	Received traffic. Messages. Words contained.	Received traffic. Approx. No. of words recivd. in addition to actual messages.
1	Nil	..	100	3	54	150
2	Nil	..	..	2	50	200
3	3	75	10	Nil	..	100
4*	Nil	..	..	1	45	60
5	3	78	13	4	139	160
6	Nil	..	..	..	..	100
7	1	25	7	5	180	300
8	Nil	..	..	1	22	160
9	6	139	100	Nil	..	250
10	9	248	150	6	274	200
11*	2	46	45	2	64	50
12	1	25	130	7	297	200
13	2	41	150	5	207	250
14	Nil	..	..	Nil	..	90
15	3	71	..	3	66	250
16	Nil	..	..	Nil	..	50
17	Nil	..	..	1	20	140
18*	Nil	..	..	Nil	..	20
19	5	109	80	Nil	..	200
20	3	95	100	1	41	280
21	8	195	60	6	212	230
22	3	72	37	6	238	200
23	2	41	33	1	22	180
24	3	67	57	5	179	200
25*	Nil	..	..	Nil	..	150
26	1	25	30	Nil	..	320
27	3	79	40	9	320	230
28	6	197	100	5	180	240
29	2	108	120	6	465	120
30	16	592	130	6	270	130
	82	2,328	1,492	85	3,345	5,160

* Sunday. 12,492 words.

improve the methods of construction and maintenance of the land lines as to minimise the interruptions in number and duration so it is to be expected that experience will show us how to improve our methods of wireless telegraphy to attain a similar result.

25. The present installation we have must be regarded as being as fully reliable as an ordinary land line of about 300 miles erected through forest, and it could, I think, successfully challenge comparison with any other wireless installation of similar length in respect to regular continuous work.

26. It may be of interest to note that the usual speed of working is from 17 to 20 words per minute. In fact, it is limited only by the skill of the operator.

27. I should like to bring specially to notice the services of Mr. J. C. Shields, assistant superintendent, who has practically been in entire charge since February 16, 1905, and whose readiness of resource has enabled him to keep the three stations running in spite of the inexperience of the staff under him. I should also like to specially mention Signaller H. Chapman, who has worked steadily and well throughout.

(Signed) M. G. Simpson, Electrician,
Calcutta, December 21, 1905. Government Telegraph Department.

LONG FLAME ARC LAMPS.*

BY LEONARD ANDREWS.

Until comparatively recently, all tests and experiments made with arc lamps appeared to show conclusively that to obtain the highest efficiency the length of the arc should not exceed 3 mm. or 4 mm. Mrs. Ayrton† shows that "almost the whole of the increased power that has to be supplied to the arc when it is lengthened is swallowed up by the mist, and is practically wasted." The following table of comparative efficiencies appears to show, however, that, whilst increasing the length of the arc beyond 3 mm. or 4 mm. does tend to reduce the efficiency of arc lamps with coaxially arranged pure carbons, this rule does not apply to many of the long flame arc lamps having inclined downward-feeding carbons which have now begun to be very generally used.

Table I.

Type.	Amps.	Volts.	Watts.	Mean hemispherical c.p.	Authority.
Ordinary open arc	..*a*	..*a*	440	400*b*	Dr. Wedding
Ditto	..*a*	..*a*	476	633*c*	Westminster Elec. TestingLaboratory
Ditto	10	45	450	830	Calc. from Fig. 1
Enclosed arc ..	6·6	71	459	360*d*	U.S.A. Photometric Committee
Ditto	..*a*	..*a*	485	338	West. E. T. Lab.
Carbone H.T. arc	9·3	89·1	820	2,080	Dr. Wedding.
Chem. carbon arc	..*a*	..*a*	382	1,325*c*	West. E. T. Lab.
Ditto	10	46	460	2,750	Excello pamphlet

a Not specified. *b* Mean spherical candle-power. *c* Tested with opalescent globe. *d* Tested with opalescent inner and clear outer globes.

Taking the mean of the results given by different authorities, and reducing them all to a common basis by making the necessary corrections for globes and different standards of illumination, it appears that the relative efficiencies expressed in mean hemispherical British candle-power of the different types of lamps are approximately as follows:—

Table II.

	C.P. per amp.	C.P. per watt.
Ordinary open arc	82	1·54
Enclosed arc	55	0·77
Carbone H.T. arc	200	2·24
Chemical carbon arc	259	5·80

Whilst it is the usual and, for some purposes, more useful practice to specify the efficiency of an arc lamp in candle-power per watt, it is thought that the candle-power per ampere may also be a useful figure. It will be remembered that in the discussion that took place a few years ago on the question of changing the pressure of supply from 100 to 200 volts, a favourite argument used by those opposed to the change was that the majority of tradesmen using arc lamps required two lamps only, and that, should the pressure be doubled, these consumers would be forced either to alter their wiring and install four lamps where they only required two, or to absorb over 50 per cent. of the total energy in useless resistance. The introduction of the high-voltage enclosed arc lamp, however, overcame this difficulty, and in spite of its low efficiency *per watt* its use has now become very general. In considering improvements in arc lamps it is necessary, therefore, to bear in mind that, for many purposes, low-voltage lamps cannot be used to the greatest advantage.

Returning to the question of long arcs versus short arcs, it is an interesting fact that all the very marked improvements that have been made in arc lighting during recent years have been effected by the use of arcs of from 10 mm. to 15 mm. in length, and investigation shows that the great improvement in efficiency is directly or indirectly due to this increased length.

The improvements effected may be briefly summarised as follows: (*a*) The formation of the positive crater in such a position that none of the light emitted by it is obstructed by the negative carbon. (*b*) The impregnation of the carbons with metallic salts, thereby rendering the flame highly luminous.

Engineers who attended the demonstration of electrical apparatus at Hastings about three years ago will remember that considerable attention was attracted by an arc lamp, of exceptional brilliancy and whiteness, which was then exhibited. An ammeter connected in series with this lamp showed that it was taking the same current as an ordinary 10 ampere arc lamp burning by its side, but the new lamp appeared to be giving between two and three times the light. It was noted, however, that a voltmeter across the terminals of the new lamp recorded a pressure of about 85 volts. As the arc was giving a remarkably white and steady light, and was not burning in an enclosed globe, this high voltage excited considerable interest. As Mr. Carbone, the inventor of the lamp, had, however, not then completed all his patents, he would only allow the results he was able to obtain to be seen from a distance. Since that time, however, the new lamp has been commercially developed in Berlin, where it appears to be finding great favour with all users, and the author has succeeded in obtaining from Mr. Carbone, and from other sources, sufficient information to enable him to explain some of the principles of the invention.

It is well known that the maximum illumination obtainable from a pure carbon arc lamp in any direction is proportional to the area of the positive crater visible in such direction, plus the light emitted by the red-hot portions of the carbons, the white spot on the negative, and the flame or arc mist; and since the area of the crater is approximately proportional to the current and is not appreciably increased by an increase of voltage, it would appear at first sight that to expend energy on an increase of voltage must tend to decrease the efficiency. It must be remembered, however, that for all practical purposes it is not so much the actual area of the crater that determines the useful efficiency of an arc as the area visible at any angle below the arc. Mr. Trotter has shown that if none of the light from the positive crater is intercepted, then the candle-power from this source at any angle may be represented by the radius vectors of a circle drawn to such a scale that the diameter of the circle is proportional to the candle-power measured directly facing the crater. To be able to calculate and plot the candle-power from the area, the intrinsic brilliancy of the positive crater must, however, first be determined. This has been found by three different authorities* to be 146 c.p., 158 c.p. and 170 c.p. respectively per square millimetre, and as the mean of these results is 158 c.p. per square millimetre, it appears reasonable to take this figure for calculating the candle-power of the positive crater from its area. There is, however, also to be taken into consideration the fact that the intrinsic brilliancy of the soft core portion of the crater is considerably less than that of the hard carbon portion, and probably does not exceed 100 c.p. per square millimetre.

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* Paper read before the Institution of Electrical Engineers last night. (Slightly abstracted.)

† "The Electric Arc," p. 371.

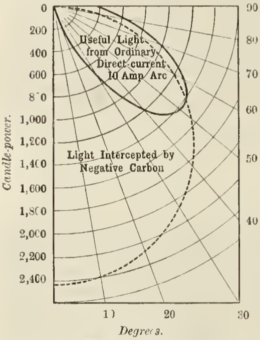

Fig. 1.—Mr. A. P. Trotter's Curve, showing Total Light from Positive Crater.

Mrs. Ayrton found the total area of a 10 ampere 45 volt crater to be approximately 18 sq. mm., of which 7 sq. mm. were soft core and 11 sq. mm. were hard carbon. The total maximum candle-power emitted by a 10 ampere positive crater, calculated on the above basis, would appear to be, therefore :—

Hard carbon, 11 sq. mm. × 158 = 1,738 c.p. ; soft carbon, 7 sq. mm. × 100 = 700 c.p. ; total, 2,438 c.p.

Fig. 1 is a reproduction of Mr. Trotter's well-known curve constructed to such a scale that the maximum radius vector is proportional to the maximum candle-power emitted by the positive crater of a 10 ampere arc—namely, the 2,438 c.p. derived as explained above, and inasmuch as the apparent area of the crater viewed from any other angle is proportional to the cosine of the angle, each radius vector of the dotted circle is proportional to the candle-power from the crater measured at any angle.

To ascertain the total available or useful light from an arc lamp with carbons arranged coaxially, a length proportional to the candle-power intercepted by the negative carbon must be deducted from each radius vector of the dotted circle from all angles of less than 50 or 60 deg., and a length proportional to the light from the negative crater or white spot, red hot carbons and flame must be added to each radius vector at all angles from which these sources of light are visible. This gives the well-known polar curve of a direct-current arc shown full in Fig. 1. Objection has been raised to the use of polar curves, such as Fig. 1, for showing the efficiency of an arc, on the ground that the mean spherical candle-power cannot be calculated directly from these curves. It is, however, even more impossible to determine the useful efficiency of an arc from knowledge of its mean spherical candle-power only. For instance, the mean spherical candle-power of a direct-current arc would be approximately the same, whether the positive crater were at the top or at the bottom, whereas it is well known that in the majority of cases the *useful* efficiency is enormously reduced by what is known as connecting up the lamp the wrong way.

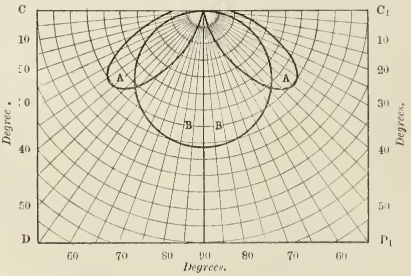

Fig. 2. Polar Curves for Two Different Sources.

The mean hemispherical candle-power is a more useful figure, but this gives insufficient information for many purposes. For instance, the respective polar curves A, A and B, B, Fig. 2, show the candle-power at any angle below the horizontal from two different sources of illumination. It will be found on plotting the mean hemispherical candle-power from each of these curves by Rousseau's well-known method that the results are precisely the same. If, therefore, the energy consumed by each illuminant is equal, it might be claimed that the efficiency must be the same in each case. If, however, the illumination be measured directly below the arc on a given floor space of a diameter D, D_1, it will be found that the average candle-power per square foot is $2\frac{1}{2}$ times greater when illuminated by B, B than it is when illuminated by A, A. On the other hand, wall spaces C, D and C_1, D_1 will be 29 per cent. better illuminated by A, A than by B, B. It is obvious, therefore, that a polar curve giving the candle-power at any angle is the more useful guide to an engineer selecting arc lamps for any given purpose than is the bare information that a certain type of lamp has an efficiency of a certain mean spherical candle-power per watt.

Returning to Fig. 1, it is seen that not only is a very large proportion of the total light emitted by the positive crater intercepted by the negative carbon, but that the waste from this cause occurs in the direction in which, for many purposes, it can least be spared. It is evident, therefore, that a very large economy can be effected by causing the positive crater to form in such a position that, whatever angle it be viewed from, none of it shall be cut off by the negative carbon.

Many attempts have been made during recent years to solve this (at first sight) simple problem. Some of these attempts have been directed towards increasing the length of the arc of an ordinary arc lamp, with the idea of thereby allowing more light to escape. In some notes on Angold arc lamps published by the General Electric Co. it is stated "an increase of voltage lengthens the arc and decreases the shadow of the negative carbon, thus giving more light at a greater efficiency, but the practical limit is reached at 45 volts, when the unsteadiness from flaring counterbalances the improvement in light." Mrs. Ayrton shows,* however, that no useful object is attained by increasing the length of an ordinary arc beyond 3 mm. or 4 mm., as the light absorbed by the lengthened arc mist exceeds the additional light which escapes unintercepted by the negative carbon.

Various other attempts have been made to get an unobstructed positive crater by the use of inclined carbons, but all these experiments appear to have been carried out with voltages of from 40 to 45 volts across the arc, and at these pressures the crater forms on the side of the positive carbon between it and the negative, instead of at the tips, and consequently, at pressures of less that 60 or 70 volts, more light is intercepted by the negative carbon with inclined carbons than with carbons arranged in the ordinary way. Mr. Carbone appears to have been the first to suggest that the solution of the difficulty was the use of inclined carbons combined with a voltage of from 80 to 90 volts across the arc. Whilst the mere appreciation of the advantage of high voltage with inclined carbons constitutes a marked advance in arc lighting, further invention was necessary to render the system practicable. Carbone also discovered a method of controlling the long arc without flickering, and succeeded in obtaining a form or shape of flame which reduces to a minimum the absorption of the light from the crater by the arc mist.

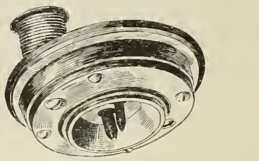

Fig. 3.—Carbone Arc Lamp complete with Economiser.

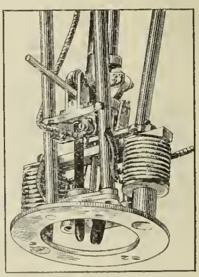

Fig. 4.—Mechanism of Carbone Arc Lamp showing Magnetic Ring Control.

Fig. 3 shows the ends of carbons and the economiser of a "Carbone" arc lamp. The arrangement of these appears to be, at first sight, precisely similar to that of all other flame arc lamps. The essential difference, however, lies in the magnetic control of the arc. Any attempt to repel the arc to the tips of the carbons by means of a moderately strong concentrated magnetic field produces an effect somewhat similar to that of a blowpipe, tending to blow the arc into a bluntly-pointed flame, extremely difficult to keep steady, and of a shape that increases the length of the arc mist to be traversed by the light emitted by the positive carbon.

The Carbone method of controlling the position of the arc is shown in Fig. 4. This consists of a closed iron magnetic circuit, the only field affecting the arc being that due to magnetic leakage from this closed circuit. The chief leakage will obviously be from the ends of the cores carrying the exciting solenoids. The magnetic circuit from the ends of these cores is completed through the iron ring. This ring, which also serves to hold the economiser in position, is fixed concentrically with the arc slightly above the plane normally occupied by the tips of the burning carbons. Holes are drilled in the ring midway between the points to which it is fixed to the core, thereby increasing the magnetic reluctance, and causing further leakage, at points approximately at right angles to the cores. The result is a weak hemispherically-shaped leakage field of just sufficient strength to maintain the craters at the tips of the carbons, the shape of the flame covering the mouth of the economiser somewhat resembling that of a soap bubble covering the bowl of a tobacco pipe under very slight pressure.

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* Dr. J. A. Fleming, "The Photometry of Electric Lamps," *Journal of Institution of Electrical Engineers*, Vol. XXXII., p. 137.

* "The Electric Arc," p. 263.

(To be continued.)

COLOGNE-BONN HIGH-TENSION CONTINUOUS-CURRENT RAILWAY.

This high-tension continuous-current railway, the larger part of which is stated by the *Elektrotechnische Zeitschrift* to be already in operation, connects the towns of Cologne and Bonn. It is altogether 17·6 miles in length and runs over a portion of the local 500 volt tramway systems in both towns. Outside the towns, however, the system has more the character of a railway, being constructed on its own right of way and partly double track. Later on the whole line is to be double track. The power house is situated at Wesseling, near the centre of the line, and contains two 330kw. 990 volt steam dynamos, two feeder boosters and a Pirani battery booster set. The line is divided into three sections. Current is transmitted to the two outer sections by feeders, while the middle portion of the line is directly fed from the power house. Two storage batteries, each capable of supplying 300 amperes for one hour, float across the supply at each of the feeding points to the two outer sections. These batteries (which are installed in a separate building) are controlled from switchboards fixed in the railway stations at these points.

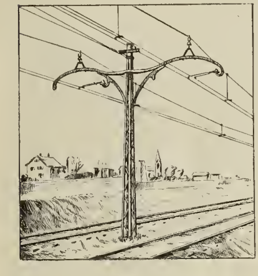
Fig. 1.—Overhead Construction of Cologne-Bonn H.-T. Continuous-current Railway.

In view of the many level crossings, it was decided to use overhead wires in preference to a third rail. Two overhead wires of 80 sq. mm. (0·124 sq. in.) section each are suspended from a messenger cable above the centre of the track, and are kept parallel to each other at a short distance apart by frequent bridging pieces, as seen in Fig. 1. The wires are doubly insulated from the steel cable by porcelain insulators, and the steel cable itself is insulated in a similar manner from the poles. Special section insulators are used between the 990-volt portion of the lines and the 500-volt portions at the extreme ends of the system. The rails are bonded at each joint by two flat copper strips of 75 sq. mm. (0·116 sq. in.) cross section each, and cross bonds are provided every 100 yds. Current for lighting the stations is obtained from the traction supply. Underground cables are used throughout for telephone and signalling purposes.

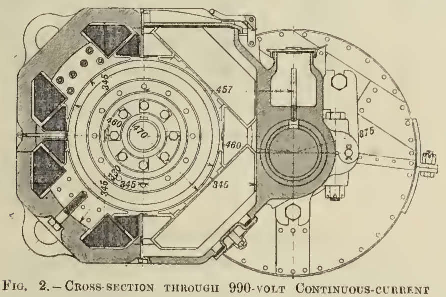

Fig. 2.—Cross-section through 990-volt Continuous-current Traction Motor. Dimensions in millimetres.

At the present time the rolling stock of the passenger service consists of 10 motor cars and 10 trailers. Each motor car has two bogies and can accomodate 28 second-class passengers and 29 third-class passengers. The trailers are not all alike; some provide second and third-class accommodation, some only third-class (in which case there is room for 72 passengers), while others have postal and baggage compartments as well. Since the longest train is to consist of two motor cars and two trailers, some 250 to 260 passengers can be carried. The entrance doors for passengers are at the centre of the cars. The end doors are only made use of by the staff for getting from one car to the other. Both hand brakes and air brakes are provided. Each motor car is equipped with two four-pole 130 h.p. 990 volt motors running at 700 revs. per min. and fitted with commutating poles (Figs. 2 and 3). The armature has a bar winding, and the bars of copper strip are secured in the open slots by wedges of hard wood boiled in paraffin. There are four ventilating ducts in the armature and the gearing has a ratio of 1 to 3·1. Driving wheels of 37 in. are used and the track gauge is standard. It is stated that two motors are capable of driving a train of one motor car and one trailer (of a total weight of about 54 tons) at a speed of 43 miles an hours. All the motors of a train are controlled on the multiple unit system from a master controller at the front end of the train. The control system is supplied with current at a low voltage from a storage battery which is fixed, together with the other chief control apparatus, underneath the car. Compressed air for the Westinghouse brakes and the whistle is produced in each motor car by a small electrically-driven compressor set. Current is collected from the overhead wires by means of two bow collectors on each motor car.

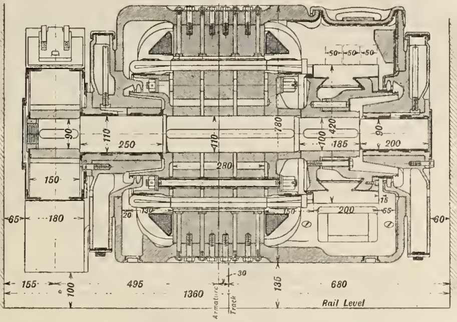

Fig. 3.—Longitudinal Section through 990-volt Continuous-current Traction Motor. Dimensions in millimetres.

A SIMPLE METHOD OF MEASURING SPARKING VOLTAGES.*

BY E. A. WATSON.

This Paper is the outcome of some experiments which have recently been made by the author in order to determine the length of spark corresponding to various direct-current voltages. The method of measurement is believed to be new, and is as follows: If a condenser be connected to a direct-current source of supply, and a spark-gap is so arranged that as soon as the condenser is charged to a certain voltage it shall spark across the gap, the condenser will automatically continue to charge and discharge so long as it is thus connected. Let the number of sparks occurring per second be noted, and also the current flowing into the condenser. If this current is divided by the number of sparks per second we have the quantity per spark expressed in coulombs. Dividing this by the capacity of the condenser, we have the P.D. at which that spark occurred, and the air broke down.

In this arrangement two condensers are used placed in series. Between the condensers is placed a galvanometer or micro-amperemeter, and the spark-gap to be tested is connected across their outer coatings; the spark-gap being connected to a Wimshurst influence machine. Across the galvanometer is placed a small auxiliary spark-gap of about $\frac{1}{100}$ in. opening, and between this and the galvanometer are placed two small choking coils, which should not contain iron. These simply consist in the author's case of 500 turns of No. 30, wound into a coil of about 2 in. diameter.

The object of the auxiliary spark-gap is as follows: When the condensers are charging, a certain quantity of electricity passes through the galvanometer, being simply the charging current of the condensers. When these discharge, there is, of course, an exactly equal flow of current, which, if it passed through the galvanometer, would give it an equal deflection in the opposite direction, so that the net reading would be zero. But the discharge from two condensers is very sudden, and generally of an oscillatory nature. It cannot, therefore, pass back through the galvanometer and choking coils, but passes entirely across the auxiliary spark-gap. Thus the galvanometer measures only the charging current, and not the discharge of the condensers, and gives a steady deflection. The galvanometer is placed symmetrically as regards both poles of the spark-gap, and is at earth potential, consequently no errors due to static charges can be introduced. In order to ascertain whether the auxiliary spark-gap had any effect upon the results, readings were made with different auxiliary gaps, and it was found that, over a range far exceeding anything which would be necessary, the error produced was certainly within 0 5 per cent.

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* Abstract of a Paper read before the Birmingham Section of the Institution of Electrical Engineers last Wednesday.

The advantages of using a Wimshurst machine for the supply is that, owing to the peculiar characteristic curve of this machine, the current output is almost entirely independent of the voltage at which it is worked. This has a double effect. First, the current being constant, we only require a calibration of the galvanometer at one point of the scale, and can hence ensure greater accuracy than if the deflection varied over a considerable range; and secondly, the charging current of the condensers does not appreciably fall off as they charge up.

The voltage is arrived at as follows: The time, T, for 100 sparks is measured by a stop-watch. Let C be the current in micro-amperes and K the capacity in micro-farads of the two condensers in series. The current in amperes will be $C \times 10^{-6}$ and the capacity in farads $K \times 10^{-6}$. The charge per spark will be $CT \times 10^{-6}/100$ coulombs, and the voltage will be $CT \times \frac{1}{100K}$.

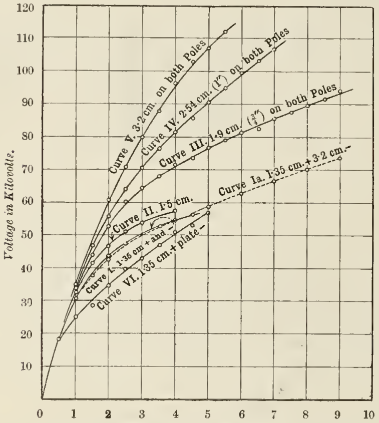

FIG. 1.—SPARK LENGTH VOLTAGES FOR DIFFERENT ELECTRODES.

The measurements were made in the University of Birmingham electrical engineering laboratory. It was found, as shown by Hertz, that when daylight fell on the negative electrode the voltage required for a given spark-length was slightly lowered. For the best results the experiments should doubtless have been carried out in a darkened room, but as this is not a condition which would occur in practice, it would have been perhaps a needless refinement. The source of supply was a 22 in. two-plate Wimshurst machine, driven by an electric motor. The condensers were two Leyden jars, whose capacity in series was 0·000352 mfd. The galvanometer used was an Ayrton-Mather moving-coil reflecting type, with universal shunt. Measurements were first made, using different sizes of electrodes, in order to determine to what extent the values were affected by their size and shape. The electrodes used were brass balls cleaned and polished The curves obtained are shown in Fig. 1, from which it will be seen what a great effect the size of the electrode has upon the voltage required to produce a spark of given length, more especially towards the higher values.

A noticeable feature is the falling over of the curve, especially for small balls, disproving the statement which is still sometimes found in books that the sparking distance is proportional to the pressure. The curve does not appear, however, to fall completely horizontal, but to become a straight line with a uniform slope upwards. This is well shown in the dotted line curve marked 1*a*, which was taken with a positive ball 1·35 cm. diameter and a negative one 3·2 cm. in diameter, and it is also shown in curve 3, which was taken with two equal-sized balls, each 1·9 cm. in diameter. In one or two cases, at very high voltages, a slight tendency for the curve to turn upwards again has been observed when using balls of unequal size. The explanation of this effect is not clear, but a similar one has been observed by Kintner.*

When using small balls—*e.g.*, 1·35 cm.—the limit of the curve was reached by brush discharges occurring. When this takes place all definite sparking ceases, and measurements cannot be taken This brush discharge always occurs on the negative ball first when they are of equal size, and if this is replaced by a larger one, the voltage and spark length can be carried much higher before brushing commences. In order to determine what was the controlling factor in such a case—*i.e.*, with balls of unequal size—measurements were made using a 1·35 cm. positive combined with various sized negatives from 1·35 cm. up to 3·2 cm. The results showed that over a considerable range the sparking voltage for any given distance was the same whatever the size of the negative electrode. Up to about 4 cm. gap the 1·35 cm. positive ball gave the same results whichever negative was used. Above 4 cm., using a 1·35 cm. positive and also a 1·35 cm. negative, brushing occurred, and the curve could not be carried further, but using a 1·35 cm. positive combined with a 3·2 cm. negative the curve was curve was carried up to 9 cm., as shown by curve 1*a*, this curve being practically a continuation of curve 1, only not fallen over quite so much. Experiments made with the polarities reversed—*i.e.*, with the 1·35 cm. ball negative and various sizes positive—showed that here again the curves agreed fairly well with the one for 1·35 cm. on both poles, although in this case, owing to excessive brushing, the voltages could not be taken up very high.

Hence the conclusion is reached that within moderate limits the sparking voltage of any gap is determined by the size of the smallest electrode, and the other one may be varied within reasonable limits without appreciably affecting the result. If unequal-sized electrodes are used it is advisable that the largest one should be placed on the negative pole, otherwise any advantage accruing from its use is lost. In fact, placing it on the positive pole is worse than having no large electrode at all, and causes brushing to commence much sooner. This conclusion, it is to be noted, cannot be carried too far; for example, with a ball and plate, the ball being 1·35 cm. diameter and on the positive pole, the plate 6 cm. diameter and on the negative pole, the curve obtained (curve 6) does not agree with that obtained by using two unequal-sized balls, the positive being 1·35 cm. diameter, whereas if our former conclusion held for spheres of infinite radius it should do so.

The curve for the ball and plate, it is noted, falls below curve 1 for the lower values when the ball is close to the plate, and approaches it when the ball is at a considerable distance. This effect is just noticeable also when using a small positive ball (1·35 cm.) combined with a large negative one (3·2 cm.), a slight falling under at low values being apparent (curve 1*a*). Still, it may safely be concluded that for sizes of one electrode varying from equal to the other up to twice its diameter, the spark-length voltage is unaffected. A table of the most important results is given below:—

Table of Sparking Voltages in Kilovolts.

Distance.	1·35 cm. balls (0·53 in.)	1·9 cm. balls (¾ in.)	2·54 cm. balls (1 in.)	3·2 cm. balls (1·22 in.)
Cm.	Kilovolts.	Kilovolts.	Kilovolts.	Kilovolts.
1·0	31·1	32·4	34·05	35·0
1·5	38·0	44·2	46·95	47·5
2·0	44·1	53·0	55·6	61·0
2·5	47·5	60·45	64·0	71·0
3·0	50·5	64·5	70·7	80·0
3·5	52·9	68·0	76·6	87·9
4·0	54·5	71·5	81·4	96·4
4·5	56 2	73·6	85·7	102·9
5·0		76·9	90·6	107·1
5·5		79·2	95·0	112·0
6·0		81·4	99·2	
6·5	Brush discharges occurred.	82·5	103·2	Disruptive discharge over condensers.
7·0		85·6	106·6	
7·5		87·4	Disruptive discharge over condensers.	
8·0		89·6		
8·5		91·5		
9·0		94·2		

ELECTRIC v. STEAM WINDING IN COLLIERIES.

We have received the following communication from Mr. W. C. Mountain, in reference to the recent discussion at the Institution of Electrical Engineers and our comments on it:—

I note that you devoted a paragraph in your paper to the discussion and conclusions arrived at in connection with my Paper on "Electric winding in mains hafts, considered practically and commercially." As I am sure that you are as anxious as I am that my conclusions should be accurately drawn, I venture to put before you the following brief tables showing the figures. In order to explain these tables I would first call your attention to what you describe as inaccuracies in my figures, and endeavour to show you what little bearing they have upon the commercial aspect of the case, and I will avoid personalities.

---

* "Measurements of High Electrical Pressures," Kintner, *Electrician*, Vol. LV., p. 702.

First. One speaker mentioned that I had made an error in the figures given of the cost of steam winding at Sherwood Colliery. This I admit, and I promised the Institution of Electrical Engineers to correct it, but this alteration has the effect of reducing the actual cost of winding per 100 tons to the following figures.

Cost per 100 tons without interest and depreciation ..	3s. 1¼d.
Cost per 100 tons with interest and depreciation	4s. 8½d.
Value of coal under boilers....................per ton	3s. 7½d.

The same speaker called attention to what he considered was an error in the figures which I gave of the winding at Messrs. Richard Evans & Co.'s colliery. It is true that the figure was omitted—viz., the weight wound without balance rope. The actual weight wound without balance rope was 1,080 tons, but with the same coal consumption we wound 1,260 tons with balance rope, and the estimate is made on the balanced results and is perfectly correct as regards the cost per 100 tons wound.

Second. Two speakers imagined that they had discovered an error in the cost of winding with Messrs. Fraser & Chalmers' compound engines on an eight hours' shift. It is true that the acceleration and retardation are incorrectly stated, but this was due—as I explained—to the fact that these figures arrived after the whole matter was in the printer's hand, and Messrs. Fraser & Chalmers sent the figures, showing an increasing rate of acceleration and retardation, and my assistant, in endeavouring to convert these figures to those on the previous tables, made an error in the speeds, but the final result as regards the coal consumption per day, cost of plant and the cost of winding per 100 tons are perfectly accurate.

One of the speakers prepared a table of his own, assuming that the error really reduced the capacity of the plant, and thereby necessitated a greater coal consumption; this table, however, has been prepared on a totally inaccurate basis.

Another speaker called my attention to the cost of winding at the Grand Hornu Mines, but the figures in my original Paper were based upon information sent by his firm, and the cost was calculated upon the figure given to me of £13. 14s. 6d. per day of 24 hours, and after this calculation the following words occur: "These figures apply to the working of No. 7 shaft winder only." I think I was justified in the assumption which I made and the basis upon which I made my estimate. I am now informed that this cost was the total cost of an output of 16,000 kw. hours in the day of 24 hours, but I am also informed that the interest and depreciation on the cost of the electric winder has not been taken into account, or the winders' wages, and, therefore, instead of the cost working out—as assumed by you—at 6s. 6d. per 100 tons, it actually works out as follows:—

Total cost of generating plant for colliery	£34,000
Tons of coal per day of 24 hours	1,860
Depth of shaft ....yards	766
Winds per hour	25
Coal per wind ....tons	2·6
Tons per hour	65
Number of tubs per wind	6
Average horse-power on rope (coal only)	233
Average kilowatts during wind	345
Average kilowatts per day of 24 hours........per hour	255

In arriving at the original cost of £13. 14s. 6d. for 16,000 kw. hours per day of 24 hours, 9 per cent. interest and depreciation was only provided; the wages of the men were taken at about 3s. per day; coal is taken at 1·8 lb. per indicated horse-power per hour, which is much too low a figure for ordinary collieries where during the night a very small output is required. Correcting these figures to 10 per cent. interest and depreciation—English rate of wages for the men—and leaving the coal at 1·8 lb. per indicated horse-power per hour, the cost works out at 0·27d. per unit; but taking a more probable figure of coal consumption—namely, 2½ lb. per indicated horse-power per hour—the cost works out at 0·3d. per unit, and this figure I have taken in considering the actual cost of winding.

The value of the winding plant, exclusive of ropes, cages, head gear, is given to me as £3,800, or, say, including the colliery labour fixing, £4,000. On this basis the cost of winding works out as follows:—

Taking the average energy per day as 255 kw. (the maximum energy during acceleration appears to run up to about 350 kw.) at 0·3d. per unit, the cost for current per 100 tons wound equals	9s. 9d.
Winder's wages at 9d. per hour per 100 tons wound equals	1s. 2d.
Oil, stores, &c.	0s. 5d.
	11s. 4d.
Assuming that the plant is running 24 hours per day at 10 per cent. interest and depreciation, the amount to be added per 100 tons is	3s. 1d.
On 16 hours' shift	4s. 2d.
On 8 hours' shift......................................	6s. 5d.

This, therefore, makes the actual cost of Grand Hornu winding—

24 hours' shift per 100 tons	13s. 6d.
16 hours' ditto	15s. 6d.
8 hours' ditto	17s. 7d.

This system of winding can only be adopted where the current is obtained either from a large generating plant or a power company with a large reserve of power, on account of the very heavy current required to accelerate, the starting current being fully twice the average running current.

I think that the remarks made respecting the Grand Hornu plant by the advocates of the balancer system were extremely unfair, as any firm carrying out the Grand Hornu scheme—and bearing in mind that three small winders are required to be run from one large generating station—would wisely adopt the direct three-phase system of winding in preference to the balancer system on account of the greatly reduced cost of the winding gears.

I am glad that my Paper led to so much discussion, but I think it would have been more to the interest of the Institution, and also greatly to the benefit of the electrical profession, if the speakers had confined themselves more to bringing forward actual figures of costs of generating and winding plants, with the cost of raising coal per 100 tons, taken from collieries where electric winding is working, rather than devoting themselves to either imagining or leading others to imagine that they had discovered errors in my Paper, which discredit the results. I am quite satisfied that the arguments advanced by these speakers will have no weight whatever with mining engineers and colliery owners. I must apologise for trespassing so much on your valuable space and I am quite sure that your well-known desire to be fair will be appreciated by your readers. As regards the conclusions to be drawn from my Paper, you seem to infer that I have changed my views since the Paper was originally read. I regret to say that my views are not changed, and my original views are expressed in the two paragraphs taken from my Paper, as follows:—

"It will be seen that these figures do not compare at all favourably with the results which have been obtained from high-class steam-winding engines, and this is largely due to the heavy first cost of the plant. It may be argued—and with a great deal of justice—that the generating plant can be utilised for other purposes during the time that it is not used for winding, and there is no doubt that the item for interest and depreciation would be greatly reduced if this plant were used during the night for coal-cutting, pumping, &c. Unfortunately the power required in collieries for night work bears a small proportion to the day work, as it is during the day that all the haulage is required in order to bring the coals to the pit bottom for the winding engines."

"The writer regrets that for heavy winding he is not able to make out a better case than is shown by the figures in this Paper, when the winding is considered on fair and proper lines—*i.e.*, in comparison with engines of equal quality to the engines which are used for driving the generating machinery in an electrical installation. It must not, however, be inferred that there is no field for the successful application of electricity to winding in small collieries or groups of collieries which are dealing with small outputs and very moderate depths, but it does appear that for really heavy work, such as described in Tables 1, 2 and 3 and 4, that colliery owners would be ill-advised to spend the large additional sum required for electric winding plant when there is so little prospect of getting an adequate return, and when they can spend their money to much greater advantage in electrifying their haulage, pumping, coal-cutting, drilling and the surface driving arrangements."

Mr. Mountain has also sent us a set of Tables setting forth his final results in comparison with those of Messrs. Clift and Hooghwinkel.

"HASKINIZED" WOOD TROUGHING.

In the case of mains laid on the "solid" system, wooden troughing is, of course, much cheaper to use than earthenware or iron ducts, but many engineers are loth to employ it owing to the uncertainty as to how rapidly the wood itself will rot when buried in the ground. To guard against this "Haskinized" wood (supplied by the Northern Wood Haskinizing Co. of Newcastle-on-Tyne) has been adopted in some places, notably in Manchester, where a large quantity is in use.

The Haskin system of treating wood consists in placing the raw timber in a large steel cylinder or treating chamber, and superheated air is applied under great pressure. The high temperature, ranging from 300°F. to 400°F., destroys the tendency to germinate, and kills all fungi, germs and insect life in the wood It is claimed by the Northern Wood Haskinizing Co. that this process produces a much higher percentage of antiseptic and preservative matter than is found in untreated timber. Owing to the high pressure employed evaporation or bubbling of the essential oils or sap in the wood is prevented, and it is thought that the chemical changes which take place as a consequence of the application of heat penetrate to every particle of the fibre. Before removing the wood from the cylinder it is allowed to cool down under the same pressure, with the result that the new compound arising from the heating of the natural fluids in the wood is consolidated with its fibre. No extraneous matter is used in the process, so that the wood is not rendered more inflammable, nor is there any reason to anticipate any damage to the cables such as occurs in the case of too freshly creosoted timber.

Tests of the transverse and crushing strength have been made of three logs of pitchpine. Each log was cut into three pieces, one of which was left in its natural state, the second Haskinized, and the third creosoted, making nine pieces available for the experiment. The tests, as certified by Messrs. Kirkaldy & Son, indicate that the modulous of rupture by transverse stress was 14 per cent. higher for the Haskinized wood than for the untreated, and 29 per cent. higher than for the creosoted wood. The crushing strength of the Haskinized wood was 4 per cent. above that of the untreated, and 7 per cent. above that of the creosoted wood. Chemical analysis showed that there was 27 per cent. of resinous preservative constituents in Haskinized wood, as compared with 10 per cent. in similar untreated wood.

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In the Board of Trade Regulations under the Electric Lighting Acts, no detailed regulations are given for extra high pressure, and it has been the custom of the Board to issue a code of regulations for each particular case in which extra high pressure was employed. As these were becoming more or less standardised, a standard set of regulations were prepared and these were issued on Tuesday. They are to be taken as a supplement to the ordinary Board of Trade Regulations, and, from the reprint of them which we publish on another page, it will be seen that they are divided under the same two headings: A.—Regulations for securing the safety of the public; and B.—Regulations for ensuring a proper and sufficient supply of electrical energy. Owing, we presume, to their supplementary character, their meaning is not in all cases so clear as the electrical regulations recently issued by the Board, and some explanatory comment will, therefore, not be out of place.

Taking the regulations in numerical order, we will begin with A3, which is the first that relates to technical matters. In this, the testing pressure for extra-high-pressure mains is given, and it may be taken, although this is not quite obvious, that the outer conductor of a concentric cable need not be tested to twice the working pressure between the conductor, but merely to twice the maximum pressure which will occur between it and earth. This is governed by the fall of pressure in the main—as it is earthed at one point in accordance

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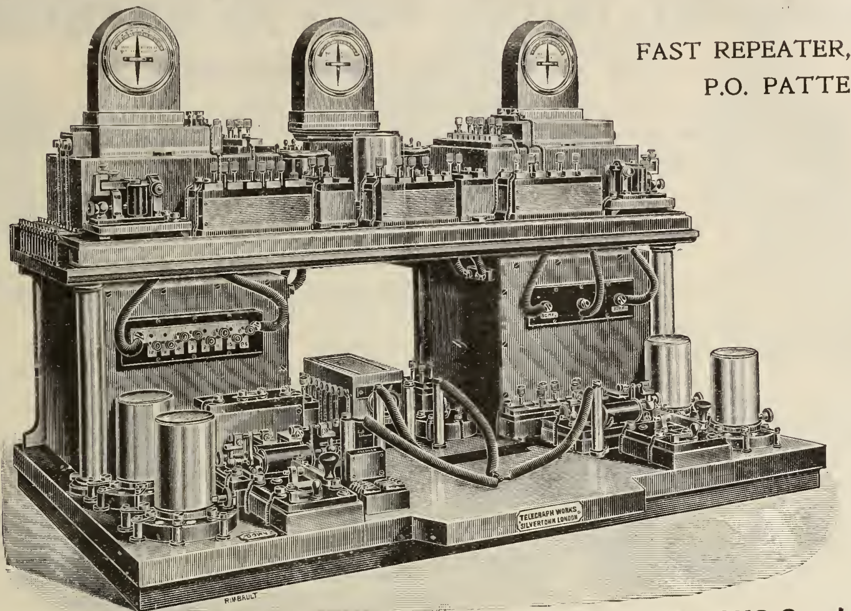

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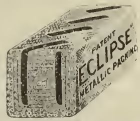

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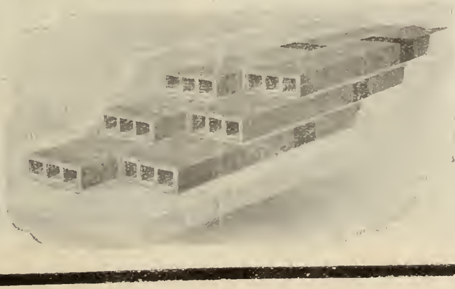

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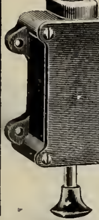

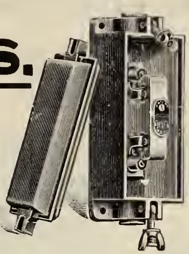

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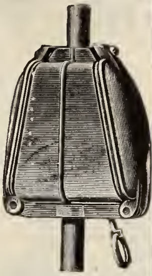

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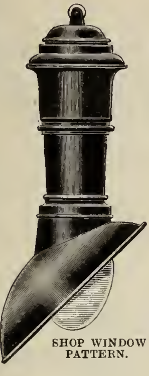
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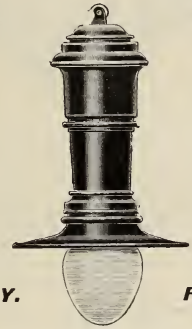
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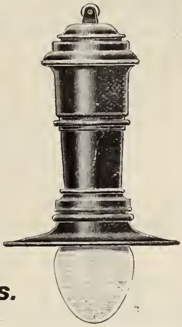
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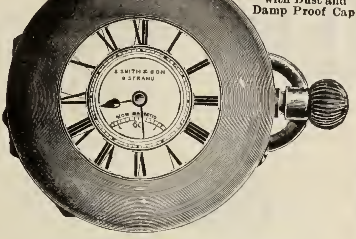

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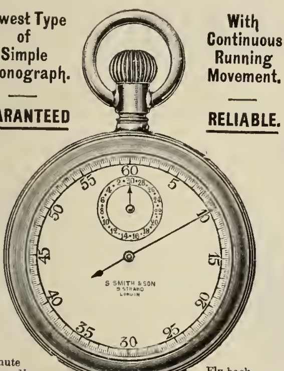

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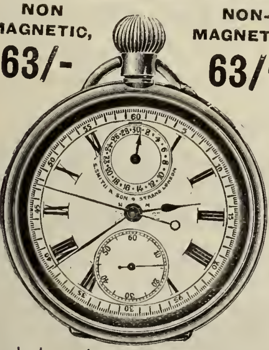

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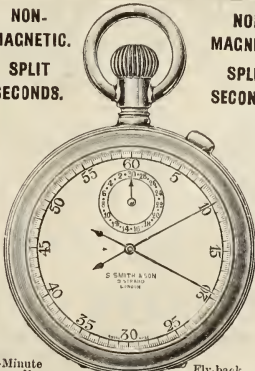

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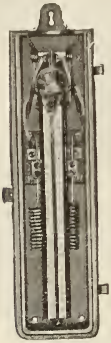

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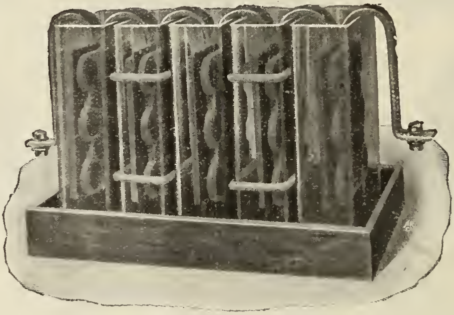

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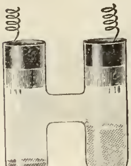

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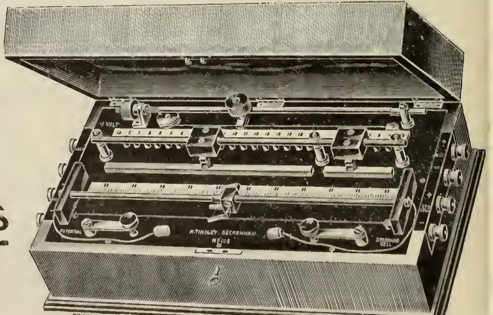

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with regulation 9—and hence by the maximum current the cable will be called upon to carry, it is rather an indeterminate quantity, and we think that it would have been better to have specified an actual pressure for the test, so that an over-zealous official might not insist on applying twice the working pressure between the outer and earth. Regulation 7 was, we believe, originally framed chiefly to meet the case of cables in subways in which other services were run, but the wording might be taken to signify that the Board of Trade will in the future refuse its sanction to overhead wires. This is not the case, for the Board is still prepared to sanction overhead wires for extra high pressures under suitable conditions. The regulation is taken bodily from the general regulations, but in them it comes under the heading "Electric lines other than overhead lines," and there is no possibility of misconception. On the other hand, the next regulation, relating to the necessity of increasing the conductance of the sheathing of cables, to allow for the event of the cable breaking down, is clearly worded. It will be noticed that the thickness of the extra copper strip under the lead sheathing is specified, and that this strip need not be used in the case of steel-wire armouring above a certain thickness. We may mention also, that in the case of lead-covered cable not sheathed in this manner, the lead sheathing itself may be regarded as sufficient without the added strip in the case of cables of very large diameter. The precautions to be used in street boxes (regulation 11) will be approved by everybody.

The section on sub-stations introduces more "conundrums." Under No. A 3 of the general Board of Trade Regulations, extra high pressure may be supplied to a mine, factory or electric traction works with the approval of the Board of Trade, but No. 12 of the present regulations specifies that sub-stations shall be in the sole occupation of the Undertakers or Authorised Distributor or in their occupation jointly. The Board, on the other hand, has been known to allow consumers who are supplied with extra high pressure under A 3 of the general regulations to erect transformers on their works, for it would be an anomaly if the consumer were given permission to use extra high pressure for his motors and yet were refused permission to use his own sub-station for supplying the remainder of his works. The same discrepancy occurs between A 21 and A 3 of the general regulations, and we must therefore take it that if the low pressure is supplied by the consumer himself and not by the Undertaker, the place where this is done is not a sub-station within the meaning of the definition attached to the general regulations. Firms which have a qualified electrical staff and object to a local authority Undertaker having access to their works, should remember that the Board of Trade will consent to their taking supply at extra high pressure if the circumstances warrant it. Regulation 14 has also been "handed down," and its meaning is somewhat of a mystery. The previous regulation 5 apparently applies to the necessity of using an earthing device or earth shields with the transformers, and we can only conclude that No. 14 is a hint to the Undertaker to keep his low pressure switch gear independent from the extra-high-pressure gear—a hint that should hardly be necessary. Regulation 17 provides for right of entry which is important from the point of view of the Board of Trade inspector, and Nos. 18 and 19 give the option to the Undertaker to earth his neutral or not.

The B regulations are largely for the purpose of safeguarding the interests of the "bulk" consumer. No. 2 would probably be observed in any case in the interests of the power company. As to No. 3, the variation of pressure allowed is high, and if advantage is taken by the Undertakers of this maximum range of $12\frac{1}{2}$ per cent., sub-stations without attendants are precluded, and the small "Authorised Distributor" who supplies lighting will be unable to use sub-stations equipped only with "statics" unless he employs variable ratio tranformers or adds boosting transformers. Still, the wider the pressure variation allowed, the less will be the cost of supplying him, and he may benefit by it. The insertion of standard frequencies of 50 and 25 in a form of regulations to apply generally is a new move which will not be welcomed by those Undertakers supplying "in bulk" at frequencies of 60 and 40 cycles per second. However, special regulations may be made and sanctions given to meet particular cases, so that hardships may be avoided. This, we trust, applies generally to the whole of these new regulations, so that the various points to which we have taken exception will have no prejudicial effect on the operations of the electricity supply industry.

OBITUARY.

PROF. PIERRE CURIE.

The tragic death of Prof. Curie, who on Thursday last was run over by a dray and crushed to death in Paris, is too terribly sad, and the loss to science too appalling, for words to express. The physicist who, with Mdme. Curie, discovered radium—the key which promises to unlock so many of Nature's secrets—has in the full tide of his power and activity been struck down, and the loss cannot be exaggerated.

Though it was not until the discovery of radium in 1898 that Curie's name came prominently before the public, he had long before published researches which had established his reputation as a physicist of the first rank. Born in Paris in 1859, his first research, made in collaboration with Desains, was published in 1880, and was on the "Wave-length of Heat Rays and the Distribution of Heat in the Spectrum." In the same year the remarkable paper by Curie and his elder brother Jacques also appeared; it was in this paper that the very important fact was announced that certain crystals become electrified under pressure. The two brothers also discovered the reciprocal effect, the strain produced in quartz by an electric field. This important result attracted a good deal of attention in this country, as Lord Kelvin at once pointed out its important bearing on the theory of the constitution of crystals. The Curies applied their discovery to the construction of an instrument, the quartz piezo-electrique electrometer, which later on was of great service to Pierre Curie in his researches on radio-active substances. They also introduced a modification of the quadrant electrometer, in which the damping of the needle was produced by means of a magnetic field which generated Foucault currents in the moving aluminium needle. Curie's next work was a theoretical one dealing with the application of the principle of symmetry to crystallography and physics. He invented about this time his extremely ingenious aperiodic balance. In 1895 his paper on the "Effect of Temperature on the Magnetic Properties of Bodies" appeared in the *Annales de Chimie et de Physique.* It contains an account of a most elaborate and careful investigation of the magnetic properties of about twenty substances, and contains the announcement of the law, often known as Curie's law, that for feebly magnetic substances the coefficient of magnetisation varies inversely as the absolute temperature. He points out and emphasises in this paper the fundamental difference between magnetic and diamagnetic substances. The magnetisation of the latter he found, with one or two suggestive exceptions, to be independent of the temperature and physical state, indicating that diamagnetism is an atomic property.

His marriage with Mdlle. Sklodowska in 1895 started a new era in his work as well as in his life. Mdme. Curie had found that pitch-blende which only partly consisted of uranium was more radio-active than uranium itself, then the only radio-active element known. It was evident that some more radio-active substance was in the pitch-blende, and Curie gave up a research on the genesis of crystals on which he was engaged, and husband and wife began the work which resulted in the discovery of polonium and radium and the establishment of their marvellous properties. The labour involved in gathering together the sparsely-disseminated fragments of radium was stupendous: fractionation after fractionation had to be made, in which the guide to the concentration was the indication of the electroscope. Precipitates were obtained whose radio-activity got greater and greater until the radium was concentrated in sufficient quantities for its atomic weight to be determined, and for Demarçay to map its spectrum. As striking as the experimental skill and ingenuity displayed in this investigation, was the indomitable courage required, with but slender resources, to carry through a research which involved the treatment of great masses of material on a large and expensive scale. In the subsequent studies of the properties of radium, the powers of these two great physicists were conspicuous. Dealing with a substance whose properties seemed magical, and having to explore a region with little but their genius to guide them, they went on without making a false step, and in a short time the properties of the rays emitted by radium, the radio-activity developed on adjacent substances, and the liberation of energy, were established by them and their fellow-workers.

It is a striking testimony to Curie's enthusiasm that these researches were done when he was burdened with an amount of teaching which would have absorbed the whole energy of any ordinary man. The admiration and affection felt for him by his pupils at l'Ecole de Physique et de Chimie Industrielles de la Ville de Paris, where he taught for more than 20 years, find eloquent expression in the article by his old pupil, the distinguished French physicist Langevin, in the "Annuaire" of the Association Amicale des Anciens Elèves de l'Ecole for 1904. This article contains a most admirable and characteristic portrait which it is to be hoped will be reproduced for the benefit of those to whom the article itself is not accessible. The esteem in which he was held by his pupils will be readily understood by anyone who ever had the privilege of meeting him; on these his simplicity, modesty and power left an impression which will not soon fade away.

We are glad to remember that one of the first public recognitions of the value of his work came from this country in 1903, when the Royal Society awarded him the Davy Medal. Almost immediately after this award he received one-half of the Nobel Prize. A professorship was founded for him at the Sorbonne, and in 1904 he was elected a member of the Academy of Science.

The discoveries of that distinguished physicist Mdme. Curie have won for her the admiration and gratitude of all workers in science; to these feelings will now be added the most sincere sympathy in the calamity which has fallen upon her.

J. J. Thomson.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

Experimental Electrochemistry. By N. Munroe Hopkins, Ph.D. (London: Archibald Constable & Co.) 1905. 12s. net.

The author of this book states in his preface that it has been his aim to produce a book that will be found useful both in the lecture room and in the laboratory. We think he has succeeded, although the student will still require, if he desire to become acquainted with analytical and preparative methods, to consult other books. Dr. Hopkins is a "whole hogger" as regards the ionic theory, and by the experimental method which he describes he makes out a very stong case for it.

In Chapter IV. very interesting, and some quite novel, experiments in *electrolytic induction* are described. The author, after showing the methods of Ostwald and Nernst, in which a frictional machine is used, asks the question: "Will a magnet induce a current of electricity in an electrolyte as it does in a metallic conductor?" and then describes an experiment which shows that it does.

Chapter V. deals with the "absolute velocity of the ions." The well-known experiments of Lodge and Whetham are described, and also several of a novel character by the author. In Chapter VI., which treats of Faraday's laws, the author discusses the passage of the electric current through aqueous solutions and through fused salts. In fused zinc chloride there are evidently chlorine and zinc ions travelling in opposite directions under the influence of the electric current. But are there any ions in glass? Dr. Hopkins describes an experiment of considerable interest in this connection. He fuses platinum wires into the opposite ends of a piece of glass rod, so that they are separated by about 1 cm. of glass. He then connects the wires with a sensitive milliammeter and through a resistance with the electric lighting mains. On strongly heating the glass rod the ammeter shows a deflection, and he concludes that with the softening of the glass the ions are free to travel.

There is an interesting account of the oxidation of atmospheric nitrogen, but it has not been brought quite up-to-date. Chapter XI. is devoted to the production and isolation of the alkali metals potassium and sodium, and also to the isolation of calcium. Here, unfortunately, the author stops with the work of Borchers, and does not even mention the commercial process of Rathenau and Suter, by which large quantities of the metal are being manufactured at Bitterfeld. The part devoted to chemical preparations and to electrolytic analysis serves more as a suggestion as to what can be done than as a working model.

The book is most suggestive and will well repay a careful study, albeit very few laboratories will contain the equipment necessary to carry out all the experimental work which is described in it.

Electricity Meters. By Henry G. Solomon. (London: C. Griffin & Co.) 16s.

The volume before us deals with most of the varieties of integrating electric supply meters in use at the present time without attempting anything like a historical sketch of the subject, which, perhaps, is just as well, as the history of the meter industry is largely a history of patent litigation. The first chapter treats of the requirements of a good meter in a general way and contains interesting comparative tables giving figures of the driving torque and weight of moving system of a number of makes of motor meters for the same range. In the next chapter, entitled "The General Principles of Continuous-current Meters," some very simple facts are wrapped up in mathematical formulæ in a way rather reminding us of German text books on such subjects. Following this, we have illustrated descriptions of a number of well-known "quantity" ampere-hour meters, including the electrolytic meters which have recently found some favour in this country, and a long array of energy or watt-hour meters of motor and other types, more than half of which are of German origin. The last chapter of the portion of the book devoted to continuous-current meters deals with battery meters, switchboard meters, and specially-mounted meters for use on tramcars. Only one type of discontinuously integrating meter is described, and it is remarked that although more meters based on this principle have been devised than any other type, they are not used at the present day. The section of the book on alternating-current meters deals almost entirely with induction type motor meters, and opens with an elaborate mathematical treatment of the subject. Here again British-made meters are in the minority. The patterns described are principally of German and American design, but the selection certainly contains some of the very latest types. The chapter on tariff systems gives an account of the "step-tariff" used in Berlin, and the Halle system, as well as the Wright maximum demand system, well known in this country. After descriptions of prepayment and tariff meters, including maximum demand indicators, the book concludes with a few notes on mechanical details of meter design and on meter testing.

Fernleitung von Wechselströmen. By Dr. G. Roessler. (Berlin: Julius Springer.) 7m.

Those equipped with a sound knowledge of higher mathematics are certain to derive much benefit from Prof. Roessler's book on the transmission of power by alternating currents—

more particularly three-phase currents. The investigations, which are of a theoretical nature throughout, are based on the sine-wave assumption, and are limited in the case of polyphase transmission to those systems in which the conductors are symmetrically disposed with regard to one another. Losses due to dielectric hysteresis and to the radiation of electric energy are not introduced into the author's equations (which are already complicated enough), but it is pointed out in what manner they influence the phenomena. The book opens with a few short chapters containing a brief exposition and the principal equations of the symbolic method of calculation associated with the name of C. P. Steinmetz. Prof. Roessler then explains the nature of the phenomena of induction and capacity, and proves mathematically that a combination of resistances, capacities and inductances, if suitably chosen and arranged, is the exact equivalent of a given cable. These preparatory expositions are followed by a number of chapters in which the author deduces formulæ expressing the interconnection between pressure, current, phase difference, &c., in alternating-current overhead lines or cables of any length, capacity, resistance and inductance, whether open at the far end or loaded. Particular attention is drawn to the fact that it is inadmissible to judge of the performance of a transmission cable or line from the behaviour of a similiar cable or line even if the length and conditions of operation are identical in both cases. Hence each case ought to be calculated on its own merits. The theoretical investigations are now and then relieved by numerical examples. The book is well illustrated with vector diagrams and characteristic curves. Although written in clear language, it cannot be read in a hurry, but the reader who has once mastered its contents will have gained an excellent insight into the complex working of alternating currents in power transmission schemes.

Die drahtlose Telegraphie und ihr Einfluss auf den Wirtschaftsverkehr unter besonderer Berücksichtigung des Systems "Telefunken." By Eugen Nesper. (Berlin: Julius Springer.) 3m.

This is a treatise on wireless telegraphy written on decidedly new lines; its plan and scope will exact the approval of the many men that have sought, in vain, the hitherto published treatises for information of a work-a-day kind. The present work, in fact, deals almost solely with the business man's side of wireless telegraphy. The scientific and historical aspects of the subject are glanced over in the first 13 pages as a preliminary, merely, to the technical description of various systems of wireless telegraphy. Then the next, the principal, section of the book deals with the constitution and the financial position of a number of the principal wireless telegraph companies. Here, unfortunately, the treatment leaves much to be desired. The Marconi International Marine Co. takes up 10 pages, devoted mainly to the reproduction of balance-sheets and directors' reports, the Gesellschaft für Drahtlose Telegraphie takes up 28 pages—a difference arising chiefly from the inclusion of inventories of typical stations and of matter of an advertisement nature. The various standard units and apparatus of this latter firm are described and are well illustrated. The National Electric Signalling Co., of Washington, is treated by means of quotations from their catalogue and by a few illustrations of pieces of the Fessenden apparatus. It is interesting to note that this company, according to its catalogue, goes beyond mere telegraphy and erects standard wireless telephone stations for ranges of 25, 50 and 100 miles. The De Forest Company is discussed in a similar manner; and some 10 other syndicates are dismissed with a few lines each, the information offered consisting merely of the names of the directors and the amounts of share capital. It will be seen that there is great unevenness of treatment of the rival firms. There is, in fact, but one firm treated at all fully—the Gesellschaft für Drahtlose Telegraphie. The great merits of this firm are thus thrown—intentionally of course—into great prominence.

There is a chapter on the present German and English law, and the regulations for German coast stations. Some suggestions for the next conference are offered. There are other short chapters giving respectively a list of the world's wireless telegraph stations and a bibliography of this and allied subjects. In the former we noticed the inclusion of a station dismantled a year or two ago (Frinton, Essex), and an omission or two—namely, certain Hawaiian and Congo stations.

The aim of the book is most praiseworthy. A work well carried through on these lines would be most valuable. We are bound to regard the present work as only an incomplete attempt, however; and above all it displays very decided partisanship.

IMPROVEMENTS IN THE MERCURY VAPOUR LAMP.

According to E. Gehrcke and O. von Baeyer in a recent issue of the *Elektrotechnische Zeitschrift*, the light from a mercury vapour lamp can be greatly improved by adding zinc and other substances to the electrodes of the lamp. Experiments were made on a lamp with a body of amorphous quartz, in which the electrodes were of zinc amalgam, the proportion of zinc to mercury being approximately as 100 to 30. After the vacuum was established, a current was sent through the lamp, and the spectrum revealed, in addition to the bright mercury lines 435·9, 546·1, 576·9 and 579·0 $\mu\mu$, also the bright zinc lines 468·0, 472·2, 481·1 and 636·4 $\mu\mu$. It is stated that the red zinc line 636·4 was especially strong. The lamp was fed through a suitable resistance from a 110-volt supply and the light emitted resembled sunlight much more nearly than that from the ordinary mercury vapour lamp. For instance, a piece of red sealing wax appeared in its proper colour, and the human skin not only lost the bluish-green tint usually produced by mercury vapour lamps, but appeared rather too rosy. Yellow articles, however, still appeared either too red or too green. This disadvantage was successfully overcome by adding a little sodium to the zinc amalgam, and the light is said to have then been comparable with that given off by many flame arc lamps. It was found advisable to add about 10 per cent. of bismuth to the above mixture of metals, as at ordinary temperatures the amalgam became solid and stuck to the interior walls of the lamp, causing the lamp to break when the temperature rose. The spectrum of bismuth, however, had very little effect on the colour of the light. The authors do not yet consider the lamp suitable for practical purposes, and are of opinion that many improvements in the design will have to be made before the lamp can hope to compete with existing methods of illumination.

In connection with the above, much interest attaches to the American patent No. 814,696, of March 13, 1906, which was granted to Mr. Peter Cooper Hewitt for an improved method of producing light. In mercury vapour lamps, mercury has hitherto been used as the material of the negative electrode, the light emitted being that of mercury vapour. The present invention contemplates the use of mercury or other suitable material for the substance of the negative electrode, and it also contemplates the association with the vapours which are naturally developed from the substance of the negative electrode during the operation of the lamp of some other gas, acting together with the generated vapour to form the vapour-conducting column or light-giving body. This added vapour may be caused to act as a conductor and to give out its characteristic colour or spectrum under the influence of the electric current, if means are provided for condensing the vapour volatilised at the negative electrode, thus preventing the vapours developed at the negative electrode from acting as the sole conductor. Such a condensation of the vapours in the vicinity of the negative electrode may be caused by providing a suitable cooling space or chamber at or near the negative electrode. The lamp will then operate with a dual light, so to speak.

BOARD OF TRADE EXTRA-HIGH-PRESSURE REGULATIONS*

1. *Construction and Effect.*—The obligations imposed by these Regulations are in addition to and not in substitution for the obligations imposed by the Regulations of . . . .† and these Regulations and those Regulations are to be read and construed together.

2. *Definitions.*—In these Regulations the expression "authorised distributors" means any local authority, company, body or person authorised by Act of Parliament or provisional order confirmed by Parliament to give a general supply of energy within the area of supply or any part thereof.

A.—REGULATIONS FOR SECURING THE SAFETY OF THE PUBLIC.

3. *Testing of Insulation of all parts of an Extra-high-pressure Main.*—An extra-high-pressure main shall not be brought into use unless, after has been placed in position and before it is used for the purposes of supply the insulation of every part thereof has withstood the continuous applica-

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* Published on Tuesday last. The Regulations are referred to in our leading article.

† The ordinary Board of Trade Regulations under the Electric Lighting Acts.

tion, during half-an-hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line to be used for a pressure not exceeding 10,000 volts twice the said maximum pressure, and in the case of a line to be used for a pressure exceeding 10,000 volts, a pressure exceeding the said maximum pressure by 10,000 volts: and the undertakers shall record the results of the tests of each main or section of a main.

4. *Circuit-breaker for Extra-high-pressure Mains.*—Every extra-high-pressure main shall be protected by a suitable fuse or automatic circuit-breaker, but in the case of a concentric main that fuse or circuit-breaker shall not be inserted in any external conductor thereof which is connected with earth.

5. *Prevention of Leakage in Transformers.*—In every case where an extra-high-pressure supply is transformed or converted to a reduced pressure, some suitable automatic and quick-acting means shall be provided to protect the reduced-pressure circuits from any accidental contact with or leakage from the extra-high-pressure system, either within or without the transforming or converting apparatus.

6. *Electric Continuity of Metal Conduits, Pipes and Casings.*—All metal conduits, pipes or casings containing any extra-high-pressure electric line shall be efficiently connected with earth, and shall be so jointed and connected across all street boxes and other openings so as to make good electrical connection throughout their whole length.

7. *Extra-high-pressure Lines Laid Above Ground or in Subways.*—Every portion of any extra-high-pressure electric line placed above the surface of the ground, otherwise than in a sub-station, or in any subway not in the sole occupation of the undertakers, shall be completely enclosed either in a tube of highly-insulated material embedded in brickwork, masonry or cement concrete, or in strong metal casing efficiently connected with earth.

8. *Prevention of Leakage from Extra-high-pressure Mains.*—Where extra-high-pressure mains for three-phase supply consist of insulated conductors laid together, provision shall be made to ensure that neither the ground nor any neighbouring electric line or conductor can become charged by leakage from any such main.

Where this provision is made by copper strip under a lead sheath, that strip shall be not less than sixteen-thousandths of an inch in thickness, and where it is made by steel wires outside a lead sheath, each of those wires shall be not less than one-tenth of an inch in diameter.

Where the mains are enclosed in a lead sheath, that sheath shall be not less than one-tenth of an inch in thickness, and shall be permanently and efficiently connected with earth.

9. *Extra-high-pressure Mains for Single-phase Supply.*—Extra-high-pressure mains for single-phase supply and all cables connected therewith shall consist either of two concentric conductors or of separate conductors. Where concentric conductors are used the insulation shall be maintained efficiently throughout except that the outer conductor shall be connected with earth at one point, and, where separate conductors are used, provision shall be made, as in the case of mains, for three-phase supply to ensure that neither the ground nor any neighbouring electric line or conductor can become charged by leakage.

10. *Completion and Control of Extra-high-pressure Lines.*—An extra-high-pressure electric line shall not be brought into use for the supply of energy before it has been completely laid, properly jointed, examined and tested, or until it is in the sole charge of the undertakers, and every such line shall during its use be in the sole charge of the undertakers.

Street Boxes.

11. *Street Boxes.*—Extra-high-pressure mains shall not pass through the same street box with other mains unless they are enclosed in strong metal casing; and street boxes containing extra-high-pressure mains shall not contain pipes for water, gas, or other service, or electric mains belonging to another undertaking, provided that any such street box may contain telephone wires belonging to the undertakers.

Sub-stations.

12. *Sub-stations.*—Sub-stations supplied at extra high pressure shall be established in suitable places, and shall be in the sole occupation of the undertakers or of an authorised distributor, or in the joint occupation of the undertakers and of an authorised distributor.

13. *Sub-stations Constructed Below Streets.*—Sub-stations constructed below the surface of any street after the date of these Regulations, to which an extra high pressure is to be given shall not contain switches or other apparatus than transformers.

14. *Transforming Apparatus in a Sub-station.*—The transforming apparatus at any sub-station supplied at extra high pressure shall be so arranged that there shall be no danger of any mains connected therewith being charged to any pressure beyond the limits of pressure for which those mains are intended.

15. *Fire Risks.*—In delivering the energy to a sub-station at extra high pressure the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

16. *Treatment of Electric Lines and Apparatus in Sub-stations.*—All extra-high-pressure electric lines and apparatus placed in a sub-station shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and any metal forming part of the electric circuit shall not unless efficiently connected with earth be exposed so that it can be inadvertently touched. All such lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

17. *Examination by Board of Trade.*—The officers of the Board of Trade shall be entitled to enter at all times any of the generating or sub-stations of the undertakers supplying or supplied at an extra high pressure, and to make any such examination and tests of the mains, machines, transformers or other apparatus in use in those stations as may appear to them necessary, and the undertakers shall afford all due facilities for any such examination and tests.

Connection of Circuits with Earth.

18. *Connection of Circuits with Earth.*—Where any extra-high-pressure circuit is connected with earth, the connection shall be made at one point only—namely, at the generating station, sub-station or transformer, and the insulation of the circuit shall, except at that point, be efficiently maintained throughout.

19. *Neutral Point of Star Winding.*—The neutral point of the star winding of each distinct three-phase circuit, used for extra high pressure, may be connected with earth, or may be insulated. If connected with earth through a resistance, that resistance shall be sufficiently low to ensure that the fuse or automatic circuit-breaker in the mains shall act.

If the neutral point is not connected with earth, a separate electrostatic voltmeter placed in a conspicuous position in the generating station shall be connected between each distinct circuit and earth; and if the indications of the voltmeters show that the insulation of any of the circuits is faulty, immediate steps shall be taken to restore the insulation.

Penalties.

20. *Penalties for Default.*—If the undertakers make default in complying with any of the preceding Regulations as to supply at extra high pressure, they shall on conviction be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The recovery of a penalty under these Regulations shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of the default.

B.—Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy.

1. *Undertakers to Provide Constant Supply.*—From the time when the undertakers commence to supply energy through any distributing main at extra high pressure, they shall maintain a supply sufficient for the use of all the authorised distributors and consumers for the time being entitled to be supplied from that main; and that supply shall be constantly maintained.

2. *Limit of Power in Extra-high-pressure Main.*—A main for an extra-high-pressure supply shall not, without the consent in writing of the Board of Trade, be used for the transmission of more than 1,000 kw. unless adequate provision is made for an emergency supply in the event of the breakdown of the main.

3. *Fixing of Declared Pressure at Consumer's Terminals.*—Before commencing to give a supply of energy at extra high pressure to any authorised distributor, the undertakers shall declare to that authorised distributor the minimum pressure at which they propose to supply energy at his terminals. Energy shall be supplied at a pressure not less than the minimum so declared and not exceeding that minimum by more than 12½ per cent.; provided that the Board of Trade may, if they think fit, allow an alteration in the minimum so declared upon such terms and conditions as they may think expedient, and after public notice has been given during a period of one month, in such manner as the Board of Trade may require, of the intention of the undertakers to apply for consent to alter the minimum so declared.

4. *Fixing of System and Declared Frequency.*—Before commencing to give a supply of energy at extra high pressure to any authorised distributor, the undertakers shall declare to that authorised distributor the frequency —that is to say, the number of complete periods per second at which they propose to supply. The frequency so declared shall be 50 or 25 complete periods per second, and shall be constantly maintained subject to a variation not exceeding 2½ per cent., and shall not at any time be altered or departed from to an extent greater than that variation except by consent of the Board of Trade, and upon such terms and conditions as the Board of Trade may impose, and after public notice has been given during a period of one month, in such manner as the Board of Trade may require, of the intention of the undertakers to apply for consent to alter the same.

5. *Penalty for Default.*—If the undertakers make default in complying with any of these Regulations as to supply at extra high pressure they shall, subject to the provisions of the order [act], be liable on conviction to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5

These Regulations are made subject to the power of the Board of Trade to make such further or other Regulations as they may think expedient; and nothing in these Regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order [act] and the principal act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order [act].

These Regulations are, so far as they relate to factories and mines, in addition to and not in substitution for any Regulations made by a Secretary of State under any act relating to factories or mines.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electricity Meters: Their Construction and Management." By C. H. W. Gerhardi. (London: "The Electrician" Printing and Publishing Company.) 9s.

"Projektierung von Elektrizitätswerken." By Fritz Hoppe. Vol. X. of "Repetitorien der Elektrotechnik." Edited by A. Königsworther. (Hanover: Dr. Max Jänecke.) 3.80m.

THE TESTING OF TRANSFORMERS AND TRANSFORMER IRON.*

BY D. K. MORRIS AND G. A. LISTER.

In order more quickly and conveniently to carry out tests of the principal qualities of transformers, the authors propose a standard test involving one set of connections, three instruments and the normal supply. This method necessitates the use of two similar transformers, and is a modification of that first described in 1892 by Ayrton and Sumpner.† It is an application of the Kapp Hopkinson or differential method of testing direct-current machines. Before dealing with the standard test in detail, it will be convenient to describe a diagram which we have found useful when dealing with transformer problems.

When the primary winding of a transformer is excited from a constant pressure supply, the secondary voltage varies with the load by an amount depending upon the copper drop in the two windings and upon the leakage flux. The resultant of these two voltages (the combined copper drop and the leakage voltage) is that which must be impressed on one of the windings in order that a current may flow when there is no external resistance in the secondary circuit. It is the "short-circuit" voltage, each component of which, and consequently the whole, is proportional to the current. A right-angled triangle can be constructed, whose sides represent the magnitude and phase of the respective voltages. We have called this triangle the *characteristic triangle* of the transformer.

In Fig. 1, AC represents the combined resultant copper drop, BC the voltage due to the leakage flux, and AB the resultant voltage. In the case of a unity power-factor load the drop is that due to copper resistance only, the effect of the leakage being to cause a phase difference between the primary and secondary volts without actual reduction of the secondary terminal volts. If the secondary current lag, then the triangle will take up the position AB′C′, in which AC′ lags in phase with respect to the secondary volts, and B′C′ the leakage volts. It will be seen that the latter now has a component in phase with the secondary voltage and tending to reduce it, the actual drop at the secondary terminals being given by AD′. Similarly, in the case of a leading current, the drop is given by AD″.

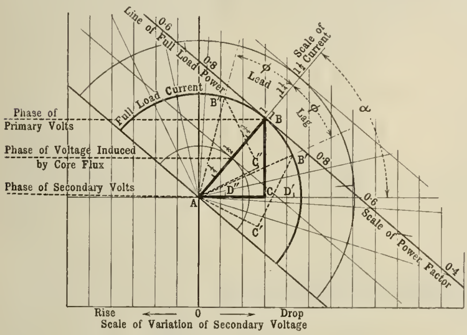

FIG. 1.—TRANSFORMER REGULATION DIAGRAM.

It is convenient to draw the triangle so that the scale of AC represents the copper drop for full-load current. A scale of current is then marked on AB. Current circles and load lines are now drawn; and also lines radiating from A to represent the various positions of the line AB for different power factors. The drop in secondary voltage which will be caused by any current or load having any power factor, lag or lead, is then immediately obtained from the figure by inspection.

Theoretically it is not correct to project the point B on to the base line, for the primary and secondary volts are not quite in phase. But in commercial transformers with moderate leakage the error is quite negligible.

The characteristic triangle of transformers is usually obtained by means of the short-circuit test due to Prof. Kapp, or if two similar transformers are used, the Sumpner method with auxiliary testing transformer can be employed.

In view, however, of certain objections to the latter, the authors propose the standard transformer test described below. The connections and method of carrying out the test are given in relation to a three-phase supply, but it can be equally well applied to a two-phase supply.

The connections are shown in Fig. 2. One of the supply points is joined through the wattmeter W_1 to the *middle point* of the secondary winding of the auxiliary transformer. The terminal pressure of one transformer is raised, and the other lowered, the average flux density of the two transformers thus remaining normal.

The primary winding of the auxiliary transformer is connected to the supply as shown through a main-current regulator. By moving the adjustable contact of the regulator, the phase of the impressed short-circuit voltage can be varied through 60 deg.

The essential instruments are the wattmeter W_1 measuring the iron losses, the wattmeter W_2 measuring the copper losses, and a variable range voltmeter for determining the supply pressure and the voltage of the auxiliary transformer. These instruments are sufficient to determine all the information necessary to carry out the standard tests. For some time past the authors have used a device in connection with these and other alternate-current tests which renders an ammeter unnecessary, and which also enables the power factor of the current to be accurately determined. It is applicable where the test is carried out on a two or a three phase supply, and may conveniently be called the *three-point wattmeter method*.*

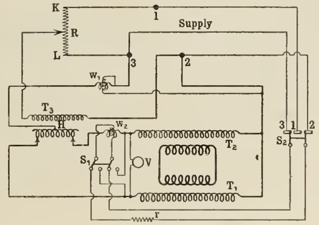

FIG. 2.—CONNECTIONS FOR DIFFERENTIAL TRANSFORMER TEST.

T_1 T_2. Two similar transformers under test.
T_3. Auxiliary testing transformer.
w_1. Wattmeter reading iron losses of transformers T_1 and T_2.
w_2. Wattmeter reading copper losses of transformers T_1 and T_2, also used to determine current and phase angle by three-point wattmeter method.
V. Low-reading voltmeter for measuring secondary voltage of auxiliary transformer.
R. Main-current regulator for varying phase angle of current.
r. Resistance for volt circuit of wattmeter w_2.
S_1. Two-way double-pole volt switch.
S_2. Three phase volt switch.

Let 1, 2 and 3 be the supply points of a three-phase delta-connected system. Let the voltages be e_1, e_2 and e_3, and let θ_3 and θ_2 be the phase angles between e_1, e_2 and between e_1, e_3 respectively. A wattmeter is connected in the phase 3·2, and a voltmeter is available for accurately measuring the voltages e_1, e_2 and e_3. A throw-over switch is arranged so that the volt coil of the wattmeter can be connected in turn to the phases 3·2, 3·1 and 1·2. Let the watt-meter readings be w'_1, w'_2 and w'_3 respectively. If the three voltages are not equal, the wattmeter readings should be corrected to the amount which they would have read had all the voltages been equal to e_1. Let these corrected readings be w_1, w_2 and w_3. Fig. 3 shows graphically these readings of the wattmeter when the current lags behind the voltage e_1 by an angle ϕ, and where the line OM represents to scale the product of the voltage e_1 and the current i.

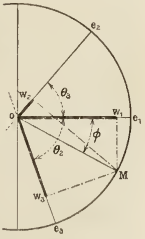

FIG. 3. THREE-POINT WATTMETER METHOD.

It can be shown that

$$\tan\phi = \frac{1}{\tan\theta_3} - \frac{w_2}{w_1\sin\theta_3} = \frac{1}{\tan\theta_2} - \frac{w_3}{w_1\sin\theta_2}.$$

The in-phase component of current is, of course, w_1/e_1; and having determined the angle ϕ, tho out-of-phase component is given by $w_1/e_1 \tan\phi$ and the total current by $i = w_1/e_1 \cos\phi$.

When all three voltages are equal, and $\theta_1 = \theta_2 = \theta_3 = 60$ deg., as will usually be the case, the out-of-phase component becomes $w_1/\mathrm{E} \tan\phi$ and the in-phase component w_1/E. The current itself may be determined without reference to the phase angle ϕ.

$$i = \frac{1}{\mathrm{E}}\sqrt{w_1^2 + \frac{(2w_2 - w_1)^2}{3}},$$

and the out-of-phase component $= \dfrac{2w_2 - w_1}{\sqrt{3}\mathrm{E}}$.

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* Abstract of a Paper read before the Birmingham Section of the Institution of Electrical Engineers last Wednesday.

† *The Electrician*, 1892, p. 615.

* The advantages of this method for measuring power factor have been pointed out just lately by J. W. Waghorn. *The Electrician*, March 16 and 30, 1906.

The following detailed descriptions show how the various qualities of a transformer may be determined.

(*a*) *Core Losses.*—The iron losses of the two transformers are read directly on the wattmeter W_1. This wattmeter only carries the magnetising current of the two transformers T_1 and T_2. The copper watts of the whole system and the iron watts of T_3 do not in any way affect the reading of W_1.

In most cases it is sufficient to note the iron watts at the normal voltage and frequency. When it is desired to separate the losses between hysteresis and eddy currents, the test may be done in two ways.

1. *Variable Frequency Tests.*—This is done by keeping the ratio of volts to frequency constant after the manner of the Kapp-Housman test on direct-current generators. The watts per cycle are then plotted against the frequency and the losses readily separated. It is important to take the frequency as low as possible in order to be able to project back to the point which will give the static hysteresis loss.

2. *Constant Frequency Test.*—It is sometimes inconvenient to arrange for a variation of the frequency of the supply, and in such cases the following test is recommended as one which will give rapidly a good approximate value of the relative amount of hysteresis and eddy-current loss.

Method of Total Index.—The test consists in varying the voltage while the frequency remains constant. The iron loss measured by the wattmeter may be expressed $w = aE^x + bE^2$, where the first term represents hysteresis loss and the second the eddy loss. The total loss, however, may not inaccurately be given as $w = cE^y$, where y and c are readily determined from two readings by the use of logarithms. Combining the above, we find that $c = aE^{x-y} + bE^{2-y}$, that is, aE^{x-y} must decrease as fast as bE^{2-y} increases. On the assumption that x is constant, therefore, it will be found that

$$\frac{w_h}{w_e} = \frac{2-y}{y-x}.$$

All the more recent determinations of x in the range covering transformer working flux densities have given the value 1·5 and not 1·6 for this index, and we have also arrived at figures approximating to 1·50 for transformer cores working at flux densities ranging, say, from 2,000 to 6,000 lines per square centimetre.

To separate the losses, then, it is merely necessary to take two wattmeter readings, w_1 and w_2 at voltages E_1 and E_2, near the required value, and find the value of y as follows:

$$y = \frac{\log w_1/w_2}{\log E_1/E_2}.$$

Then, taking 1·5 as the value of x, the ratio

$$\frac{\text{hysteresis loss}}{\text{eddy loss}} = \frac{2-y}{y-1{\cdot}50}$$

gives the required information

(*b*) *Copper Losses.*—The combined copper losses in the primary and secondary windings of the two transformers are given by the reading of the wattmeter W_2. The connections are such that the magnetising current required by the system does not pass through this instrument.

If the volt leads are connected to the actual terminals of the transformers, and there are no instruments or switches in the circuit consisting of the secondary windings, the wattmeter reading gives a true measure of the copper loss in the two transformers under test. Attention should, however, be paid to the effect of the current taken by the volt coils.

(*c*) *Efficiency.*—Since the efficiency of a transformer depends solely on the voltage and frequency of supply, and upon the current in the windings, it is not necessary to adjust the power factor. The product of the voltage e_1 and the current i may be taken as the mean circulating power, the current being conveniently measured by the three-point wattmeter method. The losses having been determined by the wattmeter readings, the efficiency of one transformer is given by

$$\eta = \sqrt{\frac{\text{circulating power}}{\text{circulating power} + \text{losses}}}.$$

It is, however, preferable to adjust the power factor to unity and connect the volt coils of the wattmeter to the supply points 2·3. The instrument then reads the mean power directly and the determination of the efficiency is thus simplified

(*d*) *Heating.*—When testing a transformer it is important to determine the final temperature which will be reached as the result of a continued application of the rated full load. An approximate idea of this temperature may be obtained by observing during the test the readings of thermometers placed in suitable positions in the transformer. When these indicate that final conditions have been reached, the resistance can be determined quite easily from the wattmeter and voltmeter readings by the three-point method already described. The authors have found this quite the most satifactory way of determining the temperature rise by resistance measurement.

(*e*) *Regulation on all Power Factors.*—It will usually be sufficient to determine the characteristic triangle of the transformers, and to draw the diagram giving the required regulation curves in the manner previously described. The triangle is best determined by adjusting the current to its full-load value and the power factor to unity, and observing the low voltage impressed on the primary circuit and the reading of the wattmeter W_2. This latter reading divided by the current will give the copper voltage. The leakage voltage is given by

$$\sqrt{(\text{short-circuit volts})^2 - (\text{copper volts})^2}.$$

The triangle thus obtained is for two transformers, half the values giving the characteristic triangle. It may be noted that the difference in the voltages of T_1 and T_2 is practically the double copper voltage when the power factor of the circuit is unity, and if the power factor be adjusted till the current is exactly 90deg. out of phase, then this difference is a direct measure of the leakage volts. On any power factor this difference will, of course, give the regulation of the transformer.

HYSTERESIS BY SLOW CYCLIC CHANGE.

The two methods already given for arriving at the loss through hysteresis alone in the transformer core are based, the one on the possibility of varying the frequency, and the other upon a knowledge of the index x. To determine the latter and generally to eliminate all the effects of rapid magnetic variation, and arrive at the true hysteresis loss, is, however, important. Ballistic methods of measuring hysteresis are impracticable, on account of the mass of iron to be magnetised. There is, however, one method available, which was proposed by C. F. Scott and appears to have been first described in a Paper by J. S. Peck, cited below.* It is the method of *constant induced voltage*. The primary current supplied from a low voltage direct-current source is varied from a negative to a similar positive value at such a rate as to keep the small secondary induced voltage constant throughout the whole change. This method, which is at once easy to carry out, expeditious and accurate, does not appear to have attracted the attention it deserves. The present authors have developed this method, and show here how by its means the hysteresis not only of large transformers, but also of small samples of transformers, iron, or rings of cast steel, may be tested for permeability and hysteresis.

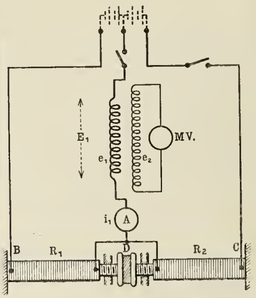

FIG. 4.—CONNECTIONS FOR MAGNETIC TEST.

To find the hysteresis loss in a transformer core working at a given flux density, the following connections are suitable: In the first place, a rheostatic device is required which will permit of a *continuous* adjustment of the small magnetising current from the value necessary to give the required flux density right down through the zero value to the negative maximum value. To effect this, a three-wire low-voltage source of current is convenient. Two light carbon rheostats are mounted back to back with their handles bound together so that when the one is tightened the other is loosened (Fig. 4). They are joined in series across the outer supply points, while the central point is led through the transformer winding to the middle supply terminal. When the rheostats are equally tight, then no current flows through the transformer. If the rheostat handle is worked so as to tighten R_1 the potential of the junction point D will tend to coincide with that of B, so that a PD will be set up across the terminals of the winding; and the current in it may then be continuously adjusted down through zero to a negative maximum.

The rate of supply of energy of the primary winding is $E_1 i_1 = e_1 i_1 + i_1^2 r$ watts.

The energy-change during any given period is

$$\int E_1 i_1 dt = \int e_1 i_1 dt + \int i_1^2 r_1 dt.$$

But e_1 is kept constant $= Ke_2$ where $K =$ ratio of transformation in transformer. Hence magnetic energy $= Ke_2 \int i_1 dt$. Plot i_1 against t for rising and falling currents. Its area in ergs divided by the volume of the iron in the core in cubic centimetres is the hysteresis loss in ergs per cubic centimetre per cycle.

It is thus merely necessary to note time readings of the ammeter or to use a recording instrument to obtain at once the hysteresis loss.

Application of Constant Induced Voltage Method to Small Samples.—The arrangement shown in Fig. 4 is used, the carbon rheostats employed having plates $3\frac{1}{2}$ in. square. The primary winding of the transformers is replaced by a *single straight length* of 19/16 cable. The sample consists of a strip, 1 in. or 2 in. wide, and, say, 4 ft. long, cut from the transformer sheet and rolled up tightly on a wooden former turned to a diameter of, say, 5 cms. A wide groove is left in the former in which the secondary, consisting of a flat coil designed to suit the indicating instrument, is placed. The sample is passed through this as it is rolled up, and the whole is then slipped on to the straight conductor. The terminals of the secondary are either joined straight on to a sensitive indicating milli-voltmeter, or an opposing E.M.F. is employed as in the transformer set. "Air lines" can be compensated for by the use of a few turns of wire suitably placed near the straight conductor. Any required number of curves of current as it varies with time are then taken by the method of constant induced voltage; and, as the dimensions of the magnetic circuit are known, the curves can, if required, be reduced to B—H curves, and all the necessary magnetic data obtained.

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* "On Testing Large Transformers," J. S. Peck, *El. World, Engineer*, New York, June 22, 1901. *Sci. Abstr.*, 1901, No. 2,014.

The flux-densities occurring in transformers are caused by fields not exceeding 2 to 4 C.G.S. units. The magnetic field along the circumference of a circle of a centimetres radius, through whose centre a conductor carrying i amperes is passed, is $0{\cdot}2\, i/a$. If $a=2{\cdot}5$ cms., then for $H=2$ and $H=4$, $i=25$ and 50 amperes. In laboratories, where the low voltage supply need not come from portable cells, these currents are readily obtainable.

Thus a sample of iron can be tested in the form of a ring without being wound at all. It has merely to be rolled up on the former. And the method of constant induced voltage is equivalent to a ballistic test, the magnetic circuit of the sample being closed. Considerable experience with this method of testing samples during the last few months has shown clearly to the authors its great superiority for ordinary magnetic testing. It is not difficult to obtain the permeability and hysteresis curves, and the Steinmetz coefficient and index for a sample in the course of an hour; a result which cannot be obtained by the ordinary ballistic method. Since the method involves only a slow magnetic process, samples of cast steel in the form of rings, which cannot be dealt with ballistically, may be tested for magnetic quality.

LIFTS AND HOISTS.

The following is an abstract of the discussion which took place upon Mr. H. C. Crews' Paper on the above subject read before the Manchester Section of the Institution of Electrical Engineers on April 10th. An abstract of the Paper itself was published in *The Electrician* of April 20th.

Mr. S. L. PEARCE was under the impression that this was the first Paper that had been given showing the relative merits of hydraulic and electric lifts, and thought that the author had made a very good case for electric lifts on several points. Some time ago he had seen figures regarding the maintenance of about 400 lifts connected to the London Hydraulic Power Co.'s mains, the average cost of which came out at about £5 per lift per annum. The author gave the average cost of 100 gallons of high-pressure water as 6·2d., but in Manchester the price received for power supplied to lifts is less than half that figure per 100 gallons. Also in the majority of cases $1\frac{1}{8}$d. per unit was given as the price for electric lifts. Many lifts, however, were worked at less than that figure where current for power was used for other purposes than for lifts.

Mr. MOORHOUSE said he thought it was unfair to the suspended high-pressure hydraulic lift to average the cost with direct-acting and low-pressure type of lifts along with it. The author should haven taken them separately. The cost of hydraulic lifts had, during the last seven or eight years, gone down 100 per cent. The cost of lifts about five years ago was £400, but now they were being put in at about £200. Generally speaking, he considered that the author had compared them very fairly, but thought that the average cost of hydraulic lifts quoted was too high. The average cost of a suspended hydraulic lift was something like £200, and electric lifts about £326. In his opinion it would have been much better to have left low-pressure lifts out of consideration altogether. Regarding the question of direct-acting hydraulic lifts he differed very much with the author. There were numerous cases where that class of lift was most suitable because of the impracticability of fixing overhead gear. They were also useful in buildings that had not been designed for installing lifts. In comparing the cost of the two types of lifts he thought the difference in capital should be taken into consideration, as if the hydraulic lift cost £200, as against £326 for an electric lift, this item would make about £10 of a difference per annum. Regarding the difference of 15 to 20 per cent. saved by having the drive fixed on top, he said that it was generally placed below, as a more solid foundation was to be obtained, and there was considerably less hum from the motors. The saving effected by having the drive fixed on top was nothing compared with the advantage to be obtained by having it below.

Mr. BURN differed from the previous speaker regarding the question of prices. The price of hydraulic lifts had gone down, but the price of electric lifts had gone down also. He agreed with the author that the placing of the motor on top saved both capital and running cost. He knew of lifts where the drive was installed on top, and they had been at work for some time, and there was no cause for complaint on account of the hum from the motors.

Dr. RHODES considered the figures given in the Paper were extraordinary, and was afraid the difference was almost too good to be true.

Mr. H. C. CREWS, in reply, said that with reference to the prices which had been criticised, they were all 1906 prices, and were not the figures of seven years ago. He had sent inquiries to the makers of the respective lifts, given full particulars, and asked their present prices for similar lifts. He agreed that ordinary high-pressure lifts could be put in for £200, but in the United Kingdom there were only six towns where a public supply was available. He had not attempted to compare an ordinary high-pressure lift alone against an electric lift, but had taken the whole country. The chairman said that in Manchester the price of hydraulic power water was less than half 6·2d, per 100 gallons, that was for a number of machines and not for single lifts. Lift No. 1 of table 3 works out to 3.4d. per 100 gallons, but that lift was on the same meter as another doing equally the same work. For hydraulic lifts the average travel was 32 ft., and for electric lifts 28 ft. If it was the other way about it would make a difference of 10 per cent. in favour of electric lifts. For electric lifts the maintenance worked out to about £6 per annum, and hydraulic lifts £8 per annum. The majority of the examples were taken and worked out at $1\frac{3}{8}$d. per unit, whereas in London current could be obtained at 1d. per unit. This would effect a saving in cost of energy of nearly 50 per cent. He considered the suspended hydraulic lift was no safer than the electric lift, and if a ram type of hydraulic lift was installed it was expensive in first cost and also in lubrication. There were some 6,000 machines in London connected to the London Hydraulic Power Co.'s mains. If one-third of these were lifts it would mean that about £64,000 per annum could be saved by electrifying them.

THE LARGEST SUB-STATION IN THE WORLD.

Toronto, Canada, now has the largest sub-station, in point of capacity, in the world, and this sub-station is to receive 30,000 kw. at about 60,000 volts from Niagara Falls. Energy for the electric light and power system at Toronto, and also for the tramway lines in and about the city, is to be supplied by the Toronto & Niagara Power Co., which has built this sub-station and the 75 mile line from the Falls, of which it is the terminal. At present two of the four 60,000 volt 10,000 H.P. circuits that are destined to enter this sub-station have been completed over a line of steel towers from the Falls, and a large part of the transforming equipment for these two circuits has been erected in the sub-station. Each circuit is to receive 60,000 volt three-phase 60 cycle current, and to deliver 10,000 electric horse-power with a line loss of 10 per cent. At this sub-station the 60,000 volt current is transformed to 12,000 volts, three-phase, for distribution to the several lighting and railway stations about Toronto.

Three transformers are provided for each transmission circuit at the Toronto sub-station, and each of these is rated to step down 2,400 kw. from 60,000 to 12,000 volts. As the sub-station is designed for four of the transmission circuits, the combined rating of their connected transformers will thus be 28,800 kw., a capacity that is probably greater than that of any other sub-station in the world to-day. Though the four 60,000 volt circuits will be connected to only 12 of these 24,000 kw. transformers at any one time, provision has been made at the Toronto terminal for 15 units of this capacity, so that there will always be one set not in use Each group of three transformers is connected in delta at both the 60,000 volt and the 12,000 volt windings, so that each transformer has the full line pressure at its high-tension coils.

Current enters the sub-station at about 60,000 volts and leaves it at about 12,000 volts, passing through a choke coil, current transformer, two 60,000 volt oil switches, 60,000 volt 'bus bars, a step-down transformer, two 12,000 volt oil switches and 12,000 volt 'bus bars, on the way. On each side of each 12,000 volt oil switch and on each side of each 60,000 volt oil switch, except where a 60,000 volt oil switch leads directly to a transformer, there is a disconnecting switch in each conductor of each three-phase circuit, so that each conductor from the 60,000 volt entry to its transformer includes three connecting switches, and each conductor from its transformer to the 12,000 volt exit includes four such switches. From this arrangement of switches and 'bus bars it results that each 60,000 volt transmission circuit may be directly connected with either group of three transformers alone, or may be connected to two or more groups of transformers in parallel.

On entering the sub-station each conductor of the 60,000 volt circuits passes into a tee connection that leads to a disconnecting switch and lightning arrester at one side, and through a disconnecting switch, choke coil, current transformer, oil switch, and disconnecting switch to a short 'bus bar from the other. Each of these 60,000 volt conductors, disconnecting switches and choke coils is mounted on three-part porcelain insulators, like those outside on the steel towers of the transmission line. Each insulator has three petticoats, the highest of which is 14 in. in diameter, and is $13\frac{1}{4}$ in. high and mounted on an iron pin. For a disconnecting switch two of these insulators are used with their centres 24 in. apart, and a metal cap cemented to the top of each carries the clips.

The lightning arrester to which each conductor of a 60,000 volt circuit is connected contains 240 air-gaps between brass cylinders and 60 carborundum rods in series between the conductor and the earth, and is mounted on insulators like the above. In the choke coil that follows the first disconnecting switch in each line conductor after it enters the sub-station, there are 19½ turns of copper wire with a diameter of 0·46 in. The current transformer, carried by each of two conductors in a 60,000 volt three-phase circuit, is 6½ in. long and 6 in. in diameter, in the enclosed part, and has 16 in. between its high-voltage terminals.

Switches designed to open a circuit carrying 7,200 kw. at 60,000 volts are not seen frequently enough to be commonplace, and those at the Toronto sub-station deserve detailed notice. Each brick and stone compartment, in which the two oil cylinders carrying the terminals of one three phase conductor are located, is 4·5 ft by 3 ft. in floor area and 7·75 ft. high, and the partitions of fire brick between the compartments are 8¼ in. thick In front of each compartment there is an iron door hung at the top. Each compartment or cell contains two cylinders mounted vertically in a common frame, and an end of one conductor of a three phase circuit enters the bottom of each cylinder. These two cylinders and the frame that carries them are made of wood, save as to four porcelain insulators that unite the legs of the frame with the part that holds the two cylinders together. Pine wood is apparently the material of which the many pieces that go to make up a cylinder are composed, and the outside is well served with shellac.

Heavy petroleum fills each of the wooden cylinders, and through a small central hole in its built up cover plunges the vertical connecting rod that is electrically connected by a metallic cross-piece with the corresponding rod of the twin cylinder. From this cross-piece a vertical wooden rod rises through the stone top of each cell to the motor-driven operating mechanism above. In diameter each pine-wood cylinder measures about 10 in , and its length is 32 in. It may be assumed that these wooden cylinders have been adopted in order to avoid the tendency of arcs to strike through the contained petroleum to the side of a metal cylinder when the circuit is opened.

Each pair of connecting rods for a conductor of a three-phase circuit, in one of the 60,000 volt 300 ampere oil switches, has a break or throw of 33 in., so that the conductor is opened by a total break of 66 in. From its oil switch each conductor of a 60,000 volt circuit passes to a connecting switch, by which it is joined to a short separate 'bus bar, and this short 'bus bar may be joined by other connecting switches either to another oil switch and then to the regular 60,000 volt 'bus bars, or else to another oil switch and then to the primary coils of its transformer. By this combination of switches with the short and the regular 60,000 volt 'bus bars each conductor of a three-phase transmission circuit may be connected, through two oil switches in series, with the primary coils of its usual group of transformers, or through a series of two oil switches with the regular 60,000 volt 'bus bars. Any group of three transformers may have its primary coils connected to the regular 60,000 volt 'bus bars, through a series of two oil switches and one of the short 'bus bars. The result is that any conductor of a 60,000 volt transmission circuit may be connected to either of the four groups of transformers, or all the circuits and transformers may operate in parallel.

Each of the 2,400 kw. 60,000 to 12,000 volt transformers is oil-insulated and water cooled, and is located in a separate pocket, of which the walls are brick and the door steel. The 15 pockets for as many transformers are ranged on the same level in a single row, and a track for the transformers runs into each pocket. Water pipes from these transformers run to inlet and discharge points and the pipes carrying oil connect with a system of storage and emergency tanks, filters and an air compressor and exhauster. All of the oil piping is of brass.

The 12,000 volt leads from the transformers go to either of two sets of three-phase 'bus bars by way of either of two sets of oil switches. Similar oil switches connect with the 12,000 volt 'bus bars the underground cables that run to the several sub-stations about Toronto. There are 31 of these 12,000 volt motor-operated oil switches for three-phase circuits, 25 of which are rated at 300 amperes, and the remaining six at 500 amperes. Each 12,000 volt oil switch is located in three brick and stone cells, similar to those above described. The break or throw of each contact rod in the oil cylinders is 20 in.

Both the 12,000 volt and the 60,000 volt 'bus bars are carried in cells of brick and stone, and in the case of the 12,000 volt 'bus bars their cells adjoin those of the corresponding oil switches. The 60,000 volt 'bus bars are located some feet distant from the switches, however, and between the rows of cells that contain the two sets of these 'bus bars there is a 13½ in. brick wall.

Construction of the cell type is provided for the other parts of the 12,000 volt and 60,000 volt circuits as well as for the 'bus bars, and each conductor of a 60,000 volt circuit is carried in a separate compartment from the time it enters the terminal station until it reaches the transformer pocket. For each conductor of a 60,000 volt circuit the compartment is about 3 ft. square, and its partitions are at least 4 in. thick and built of hard burned shale brick or of concrete.

All of the oil switches are controlled from operating boards located some distance away, but on the same floor. There are two of these operating boards, one controlling the 60,000 volt, and the other the 12,000 volt circuits. Leads from these controlling boards to the motors that operate the oil switches are run through iron conduit pipes laid in the floor. Besides the controlling switches and dummy 'bus bars, the switchboards carry switch operating relays, power-factor indicators, and wattmeters and watt-hour meters. The watt-hour meters are located behind the operating panels. A motor generator in connection with a storage battery supplies current at 125 volts for the operation of the motors of the oil switches and for lighting the sub station. For the operation of other motors about the sub-station, a bank of three 15 kw. transformers step down the 12,000 volt three-phase 60 cycle current to 110-220 volts. If the above motor-generator fails to operate, the battery is automatically connected to the lighting circuits.

Steel, brick, stone, tile and concrete are used in the construction of the terminal or sub-station in Davenport road, just outside of the Toronto city limits, and substantially no wood is to be found in any of its parts. The building measures about 61 ft. by 202 ft. on the ground, and its height includes two storeys and a basement. Architecturally the sub-station is of pleasing design, with high ashlar underpinning, brick walls pierced by numerous windows, and stone trimmings.

The sub-station is located near the main line of a steam railway, and a siding enters one end of the building at the ground level, so that cars containing the transformers or other heavy apparatus may be unloaded directly on to the first floor. On the west side of the station, at an elevation of about 42 ft. above the ground, there are four entrance hoods for the four 60,000 volt three-phase circuits from Niagara Falls. Each of these entrance hoods has three compartments, one for each conductor of its circuit, and is built up of concrete on a steel frame.

A terminal tower carrying one three-phase circuit sets close to each entrance hood, and before entering the underside of the hood each conductor is attached to a steel bracket that runs out from the station wall. In the interior of the sub-station, on its east side, a clear space about 12 ft. wide, and extending from the first floor to the roof, runs it entire length in front of the row of 15 transformer pockets. Over this area moves a travelling crane for handling the transformers, and a brick wall separates the upper part of the space from the remainder of the second storey of the station. Over this area in front of the transformer pockets the nearly flat tile roof is supported by I-beams, and the remainder of the roof is carried on steel trusses.

In addition to the two storey space in front of the transformer pockets, the first floor is taken up by these pockets, the 'bus-bar compartments and the lightning arrester passages, and the second-storey contains the oil switches and the controlling boards, and also the upper parts of these same passages. On passing through the west wall of the sub-station, each conductor of a 60,000 volt circuit enters a vertical passage, enclosed by brick partitions, that leads to the basement. In the upper part of each of these passages are the connecting switches that lead respectively to the lightning arresters and to an oil switch. Just beneath these connecting switches is the current transformer, and then comes the long bank of lightning arresters

After the 60,000 volt conductor passes below the level of the second floor, it turns into a horizontal passage and runs to a point directly beneath its oil switch. Between the first and second floor the space under the 60,000 volt oil switches is shut in by brick partitions, and is sub divided by other partitions into separate passages for each conductor. Within this same space are the brick and stone compartments for one set of 60,000 volt three-phase 'bus bars, to which the conductors from the oil switches lead. These 'bus bar compartments are built against a 13½ in. brick wall, and on the other side of this wall there is another set of 60,000 volt 'bus bars, and another space running from the first to the second floor, like that just described. On either side of the 13½ in. brick wall between these two vertical spaces there are connecting switches for each conductor.

As a result of the erection of the 60,000 volt circuits in the enclosed spaces and passages just mentioned, each conductor of these circuits is isolated from all others, and is completely surrounded with masonry, from the point where it enters the sub-station to the transformer pocket, In this way the isolation of the high-voltage conductors is, perhaps, more complete than has ever been attained before in a sub-station.

The row of transformer pockets is about 160 ft. long, and the enclosed space that contains the two sets of 60,000 volt 'bus bars with their conductors and connecting switches is of equal length. Between the row of transformer pockets and the enclosed 'bus-bar space there is a foot passageway along the first floor, and a like passageway runs between the other side of this enclosed space and the vertical compartments where the lightning arresters are located. At intervals along the walls that enclose the lightning arrester and the 'bus bar spaces there are hand holes and archways in the brickwork, so that the conductors and apparatus can be erected and the connecting switches operated. On the second floor the oil switches are in three rows. Two of these rows are made up of the 12,000 volt switches with the 12,000 volt 'bus bars in the same masonry structures, and the third row contains the 60,000 volt switches alone. Across and at one end of the second floor and in view of the oil switches are the control switchboards.

The basement extends under only about one-half of the sub-station, and this half is divided into two parts by a brick wall parallel with the row of transformer pockets. In that part of the basement that is nearer to the transformers are located their oil and water pipes, and also the oil tanks. The other part of the basement contains the lower ends of the lightning arresters for the 60,000 volt circuits, and into this part of the basement come the 12,000 volt underground cables that connect the terminal sub-station with the several lighting and railway sub-stations in Toronto.

There are two principal sub-stations in Toronto devoted to the general distribution of power for lamps and motors, and two main sub-stations for the street railway system. It is intended that these principal sub-stations and some minor ones, operating the entire electrical supply and traction systems of the city, shall distribute Niagara power to most of their loads.

The above terminal sub-station of the Toronto & Niagara Power Co. has been erected and equipped under the direction of Mr. Robert C. Brown, chief electrical engineer of the company. Plans for the complete work were from the office of Dr. F. S. Pearson, consulting engineer.

The transformers, oil switches and all of the above named electric equipment were made by the General Electric Co., or in some part by the Canadian General Electric Co.

STEEL ROLLING STOCK.*

BY GEORGE HARRISON SHEFFIELD.

The introduction of material other than timber into the construction of railway carriages and waggons exercised the minds and ingenuity of rolling stock designers as far back as 1844. At that date a number of carriages with iron underframes were placed upon the Greenwich Railway, but history does not say what measure of success attended the innovation. W. Bridges Adams and D. K. Clark, in a joint contribution upon Carriages and Waggons in 1855, advocated a combination of iron and timber in the underframes, and, on the grounds that it was difficult to get ordinary wood side panelling to resist the variations in climatic conditions and as fewer joints were required, they agreed that metallic panels in the bodies were preferable. Between 1850 and 1854 the Great Western Railway Co. built for use on the broad gauge a considerable number of six-wheeled carriages, constructed entirely of iron and lined with timber. In the underframes the outer sills and headstocks consisted of 8 in. by $4\frac{3}{8}$ in. by $\frac{1}{2}$ in. Z bars. The inner longitudinals and cross bearers were made up of 5 in. by 3 in. by $\frac{9}{16}$ in. tees and 5 in. by 2 in. by $\frac{1}{2}$ in. angles. The floor was made of $\frac{3}{16}$ in. or $\frac{1}{4}$ in. iron plating, riveted to the underframe and covered with timber in two plies each $\frac{3}{4}$ in. thick. The roofing consisted of iron plating $\frac{1}{8}$ in. thick, suitably stiffened at intervals by transverse arch bars consisting of $2\frac{1}{2}$ in. by $2\frac{1}{2}$ in. angles. The sides were also built of $\frac{1}{8}$ in plating, riveted to facing angles upon the outer sills and headstocks. All door pillars and end posts consisted of framed angles of varying sizes, and the end plating was stiffened from the frame to the roof line with $2\frac{1}{2}$ in. by $2\frac{1}{2}$ in. tees. About the same period a number of four wheeled coal waggons of 6 tons capacity were built for the London & North-Western Railway with iron sides $\frac{3}{16}$ in. thick, mounted upon timber underframes. The employment of corrugated iron sheeting for the sides of covered waggons also found some favour. All these early examples of iron bodies in waggons were, however, lacking in stiffness, and the form of mineral and goods waggons which found general favour consisted of a timber box superstructure fitted with side doors and mounted upon a separate underframe carried upon two axles. The underframe consisted of 12 in. by 4 in. side sills, middle longitudinals, cross bearers and headstocks constructed of English oak. The headstocks were bolted to the side sills by means of internal and external iron knees, and the cross bearers or transoms were tenoned and also bolted into the side sills. Except for elaboration of details and increase in weight—varying from $5\frac{1}{4}$ tons for a capacity of 8 tons, and up to $6\frac{1}{2}$ tons for a capacity of 10 tons—this particular type of waggon has remained the standard upon British railways until recent date.

A number of waggons of 10 tons capacity, with wooden superstructure and oak floors and steel underframes, have been built within recent years, but it is questionable whether the combination is economical. The author has met with several instances of rapid corrosion of iron and steel plates flitched into oak sole-bars, and of flanges and webs of steel channel sole-bars in contact with oak floors. These instances, in a large measure, may be attributed to inaccessibility for painting, and lack of precaution, in the first place, to isolate the steel from the timber by means of tarred felt or other protective medium. It is very probable that the tannic acid in the oak floors, combined with the difficulty of preventing moisture from creeping between the wood and the metal, has contributed to the rapid corrosion of steel or iron in composite underframes. On the Continent waggons were built with metallic frames and bodies in 1869, and have only lost 6 per cent. through corrosion. Waggons of 10 tons capacity, built 15 years ago with steel frames, have recently been registered to carry 15 tons when fitted with new wheels, axles and springs. The author has noticed all steel waggons of 10 tons capacity upon the Prussian State railways which have been in use from 14 to 16 years, and they appear to have suffered but slightly from the effects of corrosion.

In a well made structure the working stress may be taken at 8 tons per square inch for steel and about 0·45 ton per square inch for timber. For underframes the timber beam is inferior to the steel beam, due to the fact that the cross section is rectangular, but the material of the steel beam may be rolled into girder form, so that the moment of inertia of the cross-section is increased to double that of a plain rectangular section of equal depth and area. An oak sole-bar 9 in. deep by 4 in. wide has a moment of inertia of 243 in. units, and a weight of about 13 lb. per lineal foot; a steel joist 9 in. deep, with flanges $3\frac{3}{4}$ in. wide, weighing 20 lb. per lineal foot, has a moment of inertia of 75 in. units. The dimensions of the timber in the sole-bar would require to be increased to nearly 12 in. by 7 in. in order that its strength should be equal to that of the 9 in. joist, and its weight would be about 30 lb. per lineal foot. It is evident that the increased strength of the steel joist or channel, for a given weight, favours their use for transoms and sole-bars where considerable loads are to be carried. As before remarked, a combination of steel and timber in a framed structure is not desirable, because oak and other hard woods cause corrosion of the metal, and there is a difficulty in securing uniform elastic deflection under working stress. The weight due to the body and load averages about 0·45 ton per lineal foot on each sole-bar for 10 tons or 0·5 ton per foot for 30 ton bogie waggons, increasing to 0·6 ton per foot for 20 ton four-wheeled waggons and for 40 ton bogie waggons. Considerations of strength and deflection limit the admissible wheel base to between 12 ft. and 14 ft. when ordinary sections are employed for the sole-bars. When bogies are used the wheel base may be increased to any reasonable extent, provided the design of the sole-bar is modified to suit the increased span. Now a comparatively heavy beam trussed by rods, and proportioned only to the vertical loads, appears to be less efficient than a member formed as a complete girder, with approximate equality in the sections of its flanges and active as a whole in resisting and transmitting the longitudinal stresses due to concussion in working. These considerations, together with the conviction that there was room for reducing the tare-weight of mineral and goods waggons and increasing their capacity, led, in 1897, to the collaboration between the author and his late partner and colleague, Mr. J. D. Twinberrow, in the preparation of a series of designs of self-discharging hopper and level-floor waggons constructed entirely of steel and to carry loads of from 15 to 50 tons. It was considered advisable that all the material holding the load should contribute to the strength and rigidity of the structure. The separate underframe with the truss rods was dispensed with, and the sides were designed as plate girders. Only standard rolling-mill sections and flat plates were employed, to the exclusion, as far as possible, of special pressed shapes and expensive smithed work. It was made the rule that all material was specified by weight and not by thickness.

The author next discussed the design of self-discharging hopper waggons, an improved form of diamond-frame bogie and flat-floor bogie waggons, and illustrated his remarks with a number of wall diagrams and lantern slides. He then referred to steel passenger coaches as follows:—

It is interesting to note the growth in the weight of passenger vehicles during the last 55 years. Between 1850 and 1860 the weight of four-wheeled carriages varied from $4\frac{1}{2}$ to $5\frac{1}{2}$ tons, accommodating 18 first-class, or 32 second-class, or 44 third-class passengers; from 1860 to 1870 the weight per vehicle increased to from 8 to 10 tons, and gradually rose to $16\frac{1}{2}$ tons in the year 1890-91. The proportion of weight of vehicle per first-class passenger in 1855 was 5 cwt., per second-class passenger $3\frac{1}{4}$ cwt., and per third-class passenger $2\frac{1}{2}$ cwt. In 1890 the increase in the weight per vehicle, due to the use of six-wheeled stock, combined with heavier and larger underframes, gas lighting and automatic brake fittings, resulted in the proportion—allowing 24 first class or 40 third-class passengers—of 7 cwt. of carriage per first-class and 4¼ cwt. per third-class passenger. To continue the parallel at the present date, with the general introduction of dining and corridor carriages on all main lines, the weight has risen to from 35 to 40 tons per vehicle; assuming an average of 30 first-class or 48 third-class passengers, the proportion of weight of vehicle per passenger is about 1¼ tons first-class and ⅘ of a ton third-class. The great increase in weight of corridor stock is due largely to additional fittings for light, heat, brakes, lavatories, water service and arrangements for connecting up or vestibuling, and six-wheeled bogies. Only a portion of the weight is due to the structure, and this is the part on which, if possible, reductions may be made.

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* Abstract of a Paper read before the Tramways and Light Railways Association last night.

The ordinary compartment coaches on four-wheel bogies are between 48 ft. and 52 ft. long; they carry about 80 third-class passengers. Corridors reduce the capacity by 40 per cent. and increase the weight. The tare-weight of the ordinary bogie coach varies from 23 to 25 tons, and when vestibuled and fitted with dual brakes the tare rises to 29 tons, and is made up as follows: Two four-wheeled bogies complete, wheels, axles and brake-rigging, 10 tons; Headstock fittings, buffing and draw gear, 2 tons 10 cwt.; underframe and body, 16 tons 10 cwt. The last item approaches an average figure of ⅓ of a ton per foot of length. The main structure is in two parts, frame and body. The latter is usually, in British practice, quite separate, and rests on the former, with flexible rubber pads; it is framed in teak on a rectangular system, and is net supposed to support the load over the span of the bogie centres. Its sides are about 6 ft. 6 in. deep.

The great changes and improvements which have taken place in main line rolling stock during the last 15 years are due to the general introduction of the bogie system. As before remarked, in 1891 the main line carriage, with four first and five third-class compartments carried on six wheels, was the standard. It is as well to point out that the Midland Railway, for many years prior to this date, had provided bogie carriages, and no doubt had been largely influenced in this course through their experience, in the early seventies, with the Pullman cars introduced from America. The type of bogie equipped with equaliser beams, as used under the Pullman cars, was reproduced and placed under the Midland carriages—it is questionable whether, for moderate loads, a better or easier riding bogie has been designed for passenger vehicles. Apart from the Midland Railway, in several instances the bogie carriage was looked upon with suspicion. Our premier railways for many years refused to recognise its merits; the technical advisers even went so far as to view bogies as a probable source of danger under passenger vehicles running at moderate speeds. The application of the bogie system, with its flexibility and two series of springs interposed between the carriage underframe and the axle-boxes, is the only possible system for long-framed vehicles, and is conducive to comfort and safety when travelling at high speeds.

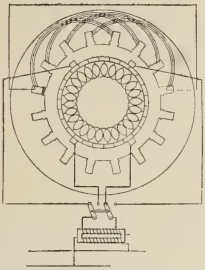
In British practice the dining corridor and sleeping carriages, varying in length from 50 ft. to 65 ft., are carried upon a substantial steel underframe, consisting of heavy sole-bars, usually channel section, about 10 in. deep—hence they would sag too much if not trussed. They usually have two posts and a round iron truss-rod, giving a total depth of about 26 in. from the top of the sole-bar to the bottom of the truss, or one-third the depth of the side of body. But other things being equal, deflection under load is inversely proportional to the cube of the depth. It is evident that the shallow frame cannot take up its proper load until all the joints of the body have been strained by loads they were never designed to carry. Experiment has proved that even when the body is very light, and the frame exceptionally stiff, the former carries half the load. In British practice the truss-rods are usually 1¼ in diameter, and until quite recently this section has been retained, irrespective of the variations in distance between the centres of the bogies, and are assumed to answer equally for weights of 15 tons or of 25 tons. In the author's opinion it is questionable whether these truss-rods are sufficient to prevent periodical sagging.

On the Continent the trussing of long underframes receives more attention than in this country, and for equal weight of body the truss-rods, under the frames of main-line carriages, upon the Prussian State railways are usually 90 per cent. heavier in section, and the depth of the truss is about 2½ times the depth of the underframe. The effect of this substantial trussing is that the frames keep their alignment better and do not call for repeated adjustment. A thorough investigation into the question of trussing underframes has been made upon the Western Railway of France, and has resulted in the introduction of corridor carriages nearly 64 ft. in length over headstocks, and their weight is only 27½ tons, or 25 per cent. less than many vehicles of similar length in England. M. Sabouret, the engineer responsible for the design, explains that an underframe sill is a beam uniformly loaded and supported upon two points—the transoms over the bogies; it must also act as a well-braced strut to resist buffing shocks. The moments resulting from the load are hogging moments over each bogie, increasing from the headstocks to a maximum at the transom landings and diminishing to zero at the point of contrary flexure. The position of the latter varies with the length of the frame and distance apart of the bogies; it is usually about 18 in. within the centre of each main transom landing for loading uniformly distributed along the whole length of the sole. It the length of overhang is considerable, and the distance between the centres of bogies only moderate, the point of contrary flexure is thrown further from the bogie, and especially so when the headstock ends are heavily loaded with vestibule connections and ponderous buffing gear. It is not unusual to find it thrown back to 3 ft. from the centre. The Continental practice of attaching the inclined ties to the lower flanges of the sole-bar on the line of the bogie centres is thus incorrect. English practice in this respect has been better, the reason being that the tie-bars had to be carried high to clear the inner corners of the bogie frame when swinging on curves, whereas the wider spacing of the Continental sole-bars keeps the tie-bars clear of the lateral movement of the bogies. Between the points of contrary flexure the sole-bar is subject to sagging moments, the intensity of which is greatest at the centre. In order that the deflections of the beam may be as small as possible under the working loads, the depth of the beam should be proportional to the intensity of the moments at the different parts. Buffing stresses necessitate the concentration of metal along the line of the buffer centres, and vertical stiffness can be conveniently assured by suitable trusses below the sole. When the latter is subject to sagging moments the tie-bars will be in tension, and the direction of their inclined ends should be such as to intersect the centre line of the sole at the points of contrary flexure. The hogging, on the other hand, requires a compression truss, descending from the point of contrary flexure to a vertical tie-bar at the bogie centre, and rising thence to support the overhang towards the headstock. If all the joints of the truss are made with pins, and if the pins in the sole-bar are place along its centre line, there will be no secondary stresses due to connections. The underframe on the Western Railway of France has been constructed on these principles, the sole-bars on each side being composed of two channels 8 in. by 2⅝ in., spaced 6 in. apart to receive the truss connections between them. The tie-rods have differential adjusting screws permitting the soles to be cambered to the exact amount needful to bring them level when the body is in place. With this system of trussing there is no sagging of the frame or bending between the bogie transoms and the headstock; consequently the superstructure is very light. Each side is framed up complete and lifted bodily into position upon the underframe. Even allowing for the light dimensions of the body framing and the stiffness of the sills, tests made on the frame alone, and on the latter when the body was complete, proved that the deflection in the latter case was only one-half of that in the former case—evidently the body was supporting one-half of the vertical load. The alternative to this method of building underframes is to increase the solidity of the body structure for the purpose of making it capable of carrying the load and transmitting buffing and draw-bar strains. The present method of concentrating weight in the underfame leads to a reduction in the strength of the body, and thereby increases the danger of collision. These facts point to the homogeneous steel structure, built on the girder system, the great depth of which renders possible a considerable space between the bogies. There obtains with this system of construction, coupled with the use of four-wheeled bogies, cars of high-carrying capacity; and it is questionable whether vehicles of upwards of 60 ft in length should exceed a tare-weight of 32 tons.

The trend of events points to modifications in the designing of railway carriages, through the introduction of all-steel cars on the electrified underground railways of London. In this case the movement is, from a humanitarian point of view, absolutely necessary, on the grounds that the all-steel car provides safety from fire, inasmuch as the high conducting power of the skin of the body is an element of safety in the case of a car falling across a conductor rail. The resulting "short" would open the circuit-breakers with minimum risk of shock to the passengers. It is singular that the electrical engineers largely responsible for forcing the hands of railway companies in the matter of electrification through tramway competition should also lead the way in introducing all-steel cars. The movement, apart from its safety, is justified on the grounds of increased strength and reduced weight.

A NEW SINGLE-PHASE SERIES INDUCTION MOTOR.

In an American patent issued March 20 to A. S. McAllister, a description is given of a motor which is stated to possess the characteristics of a compensated single-phase motor and to operate at a high power factor. As shown in the accompanying illustration, the line connecting the brushes makes a certain angle with the axial line of the field magnet coils. The current which enters the armature winding causes the formation of magnetic poles upon the armature core, and the alternation in these poles generates an E.M.F. in the field coils. The current thus produced in the field coils causes the formation of magnetic poles in the stationary field cores. The armature current which flows in the neighbourhood of the field poles thus produced gives to the rotor a torque in much the same way as with direct-current series motors. When the rotor is in motion there is generated at the commutator a counter E.M.F. which weakens the effective E.M.F., and therewith the armature current, the armature core magnetism, the field current and the field core magnetism. The generated counter E.M.F. is practically in phase with the current supplied, and, therefore, it acts as the insertion in the circuit of a resistance which varies with the speed. At negative speed the inserted apparent resistance is negative, and at a certain value of negative speed the total apparent resistance of the motor circuit is zero. At higher negative speeds the total apparent resistance becomes negative, the interpretation of which is that the machine is now being operated as a generator and is supplying power to the line. The machine, therefore, may operate as either a motor or a generator



McAllister Series Induction Motor.

If during operation as a motor at a certain speed the connections to the rotor be so changed as to tend to drive the rotor in the opposite direction, not only will a braking effort be produced by such change, but power will be transmitted from the machine to the line. Two sets of brushes are employed, placed at different angles with respect to the field coils, only one set of which is used at a given instant, in order to convert the motor to a generator so as to bring the rotor to rest.

CORRESPONDENCE.

ECONOMIC CONSIDERATIONS IN THE EMPLOYMENT OF STORAGE BATTERIES.

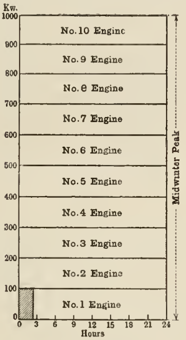
TO THE EDITOR OF THE ELECTRICIAN.

Sir: The conclusions arrived at by Mr. Salter in his Paper recently read at Manchester are so sweeping that there is a danger of their being considered to refer to *all* stations except small lighting stations.

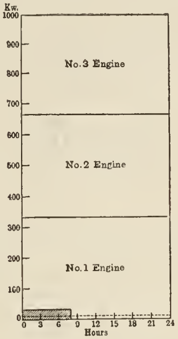
Mr. Salter's strictures may possibly be true where batteries are put down at the generating station, but, where they are put down at the sub-stations, it is, I feel sure, capable of demonstration that, in most cases where the supply of light and power is undertaken from one station, it will pay to put in accumulators. Still more would this be the case were it found practicable to instal and maintain accumulators at reasonable rates on consumers' premises. Pending any challenge of the above statement, I do not propose to devote any time to substantiating it.

I should like, however, to say a few words about the curve brought forward by Mr. Salter as connecting reduction in cost with increase of load factor. I do not know from what source he obtained it; but as he bases much of his argument upon it, it is worth inquiring as to whether it is sound in construction. To begin with, I would point out that the shape of the curve—as far, at least, as the consumption of steam (per unit) goes—is altogether too straight, and is an instance of the danger of generating from a particular case, of which he does not vouchsafe details. For instance, Mr. Salter would have us believe that the diminished cost of generation (per unit) on increasing the load factor from 1 to 10 per cent. amounts to no more than 4 per cent. I shall endeavour to show that, in the case of steam consumption alone, the reduction per unit may, under certain circumstances, reach the neighbourhood of 75 per cent., which would probably mean 80 to 90 per cent. on the coal bill.

The importance of the taking account of the varying conditions of each case will, I think, be evident if we compare two stations, A and B, supplying both light and power, and having each a precisely similar observed maximum (mid-winter) output, and consider a day's performance (in mid-winter) such that a load factor of only 1 per cent. is obtained, in either case, on a day's working. Then, in station A, we may assume that each of the engines is worked for an extremely short period, but *all* at their full load, this corresponding to a load curve having easy slopes to the peak; and we may also assume (see dotted line in diagram) that, in station B, one engine is worked for the whole 24 hours, with the exception of a negligibly short period during which *all* the sets are working at full load, this corresponding with a load curve having a single extremely sharp peak. This latter case is so extreme that I have shown (in full lines) the results for an 8 hours' run, instead of the 24 hours, increasing the average load proportionately to the reduction in time. Thus we have:—



"A."—Case I



"B."—Case I.

Station A, Case I. (see diagram).		*Station B, Case I.* (see diagram).	
Maximum observed load.	1,000 kw.	Maximum observed load.	1,000 kw.
Duration of load	2·4 hours	Duration of load	8 hours
Load factor (station) ..	1 per cent.	Load factor (station) ..	1 per cent.
No. of sets	11 (1 spare)	No. of sets	4 (1 spare)
Capacity of each	100 kw.	Capacity of each	333 kw.
Plant load factor	9 per cent.	Plant load factor	2·1 per cent.
Units generated ..	100 kw. × 2·4 hr. = 240 units	Units generated	30 kw. × 8 hr. = 240 units
Steam per unit	20 lb.	Steam per unit	80 lb.

Now let the station load factor be increased to 10 per cent. If we are comparing results for a given station, we can obviously assume either that the average load of the set under consideration is *not* altered and that the changed load factor is entirely brought about by working the set for longer hours; or, in the other extreme, that the average load of the set is increased, the hours of working, however, remaining unaltered.

Station A, Case II. (see diagram) illustrates the former; station B, Case II., the latter. All likely cases will lie between these two extremes. Thus we have:—

Station A, Case II.		*Station B, Case II.*	
Maximum observed load	1,000 kw.	Maximum observed load	1,000 kw.
Duration of load	24 hours	Duration of load	8 hours.
Load factor (station) ..	10 per cent.	Load factor (station) ..	10 per cent.
Plant load factor	9 per cent.	Plant load factor	21 per cent.
Units generated ..	100 kw. × 24 hr. = 2,400 units	Units generated	300 kw. × 8 hr. = 2,400 units
Steam per unit	20 lb.	Steam per unit	20 lb.
Saving per unit over case I.	Nil.	Saving per unit over case I.	75 per cent

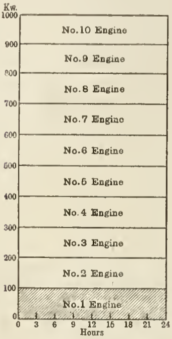
Altogether, I cannot help feeling that Mr. Salter's curve, if correct, represents only one special case, and cannot be taken as a guide.

In the above, I have spoken only of steam and coal per unit, but Mr. Salter's curve is stated to represent "generating costs" and, as such, should include wages, oil, and repairs. Now, it will be evident that anything in the nature of a "fixed charge" would very considerably steepen the early part of Mr. Salter's curve and, if such were included by him, it would seem that the cost *per unit* for coal positively goes UP, at this part of the curve, for an increase of load factor, which is inconceivable, or else that this part of the curve is not constructed from actual tests.

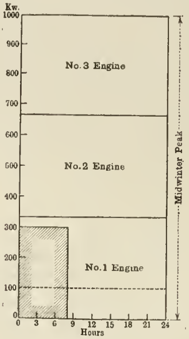
In conclusion, I would say that, in order to correctly gauge the value of a battery in a sub-station, we want—in addition to knowing the saving in generating costs—to take account of the saving in "fixed charges" (interest, &c.) on generating plant, H.T. cables, and sub-stations, as against the corresponding extra charges incurred by the use of batteries.—Yours, &c.,

A. M. TAYLOR.

Avondale, Ashfield-road, King's Heath, April 24.



"A."—CASE II.



"B."—CASE II.

MEASUREMENT OF RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

[Translation.]

SIR: On p. 1013 of your issue of April 6th there is a short abstract of my work, taken from the *Zeitschrift für Instrumentenkunde* of March, 1906. I regret that this abstract contains some incorrect data, which are evidently due to a misconception on the part of your abstracter. In the first place, the magnitude E is not the E.M.F. as stated there; in fact, as stated in the first part of my article, the E.M.F. does not enter into the formulæ at all. E is the expression $C_0 \epsilon i \sqrt{A}$ where C_0 is the standard sensibility of the galvanometer (deflection for 1 ohm with 1 ampere), ϵ the change in the resistance to be measured as fractions of the same, and i the current passing through the resistance. The sensitiveness of the measurement of resistance is proportional to E, and thus also proportional to $i \sqrt{A}$—*i.e.*, proportional to the electrical energy which is converted in the resistance to be measured. The equations were deduced for needle as well as for moving-coil galvanometers.

To go into the other inaccuracies here would take me too far. For instance, in the Thomson bridge the resistance to be measured need not be equal to the standard resistance as stated in the abstract, but it can also be measured in the ratio 1 : 10, &c. Further, the Thomson bridge is, in general, much less sensitive than the Wheatstone bridge, &c. I therefore beg you to insert this correction in your Correspondence columns.—Yours, &c., PROF. DR. W. JAEGER.

Charlottenburg, April 17.

WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue for April 21st you say :—

> A Reuter's telegram announces that a contract has been signed by Mr. Oppé, the manager of the Canadian Marconi Company, with the Dominion Government whereby the company agrees to take over and operate the wireless telegraph stations along the Labrador coast. . . .

The contract to which reference is apparently made is a new contract between our Canadian company and the Newfoundland Government. The Labrador is part of the colony of Newfoundland, not part of the Dominion.

The general system of wireless telegraphy for coast purposes in Canada, carried out by our company for the Dominion Government, comprises a number of stations, all of which have been operated and maintained by our company for several years past.—Yours, &c.,

For MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)
H. CUTHBERT HALL, Managing Director.

18, Finch-lane, London, E.C., April 25.

THE ELECTROBUS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As the manufacturer and patentee of the only electrical accumulator known in the electrical industry as the Oppermann battery, I must disclaim any connection whatsoever with the recent statements made relating to a certain battery in connection with the Electrobus Co. (Ltd.), now before the public. Such statements are calculated to lead the public to believe that the Oppermann battery mentioned in reference to that company is the Oppermann battery manufactured and patented by me.—Yours, &c.,

CARL OPPERMANN.

Electric Works, Underhill-street, Camden Town, N.W.,
April 23.

[We did not give currency to the statement in question in our columns; in fact, our representative was refused the name of the battery makers who had given the remarkable guarantee referred to. The "Electrobus" promotion is also referred to in our Editorial Notes columns.—ED. *E.*]

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have only just noticed in your issue of March 23rd, p. 912, your remarks concerning my criticism of Mr. Schoepf's Paper.

I am grateful to you for calling attention to my statement concerning the efficiency of the series motor. At the meeting in question I certainly made use of the expression "power factor" instead of "efficiency," and the error must have crept in in transcribing.

At the same time it must be conceded that it is almost impossible to keep the full-load efficiency up if the full-load power factor is down.

With regard to your remarks concerning my classification of the Winter-Eichberg motors, such a variety of forms were covered by the patentees that it is hardly possible to classify them under one heading. I think it must be allowed that some of these forms come under my heading, some under yours. In any case, as I have admitted elsewhere, this classification of these motors is at present most unsatisfactory, although Mr. Fynn's recent efforts are certainly a step in the right direction.—Yours, &c., WILLIAM CRAMP.

Manchester, April 24.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

This bill came on for consideration by a Committee of the House of Commons on Wednesday, of which Sir Lewis McIver is chairman. Mr. E. Pollock, K.C., Mr. Moon, K.C., Mr. Du Cane and Mr. Lynden Macassey, appeared for the bill, to which there is a large amount of opposition. The bill will, of necessity, have to be dealt with in sections, in conjunction with other bills, for the portion relating to tramways over the bridges is bound up, more or less, with the City of London (Blackfriars and other bridges) Bill, whilst Tramway No. 1 is competitive with the bill of the Middlesex County Council, and no decisions will be given on these sections before the other bills are heard. The Committee decided to deal with the Embankment tramways first. During the course of the preliminary discussion as to procedure, an indication was given that the omnibus proprietors of London, who have a locus standi on the ground of competition, intend to raise the question of the policy of such a great expenditure upon tramways as is proposed by this bill in view of recent developments in motor omnibuses.

Mr. E. POLLOCK, K.C., in opening for the bill, said that the present proposal was identical to its predecessors, with the exception that the position of the rails was to be changed. Instead of placing them on the crown of the road on Westminster Bridge they were to be placed 2 ft. 6 in. from the kerb on the east side of the bridge and continued on to the Embankment, and maintained at that distance from the kerb on the river side, and so over Blackfriars Bridge at the same distance from the western curb, This would have the effect of preventing crossing the traffic when the cars took the curves from the bridges on to the Embankment, and also on the Embankment itself, and leaving a clear roadway of over 40 ft. for the other traffic. The suggestion had been made by the police officials last year, and the idea had commended itself to the County Council. In further support of the proposal to run these tramways counsel said he was now able to produce a recommendation from the Advisory Board of Engineers to the London Traffic Commission, and there was this year no objection from the Home Office. The total cost of the tramways over Westminster Bridge and along the Embankment to Blackfriars was estimated at £61,700, whilst the line over Blackfriars Bridge joining up with the existing lines would be another £24,200.

Mr. MAURICE FITZMAURICE, C.M.G.,Chief Engineer to the Council, confirmed the opening statement by Mr. Pollock.

Yesterday (Thursday), Mr. E. T. HARPER, the Statistical Officer to the London County Council, went into details and figures relating to the traffic over Westminster Bridge and along the route of the proposed tramways.

Mr. A. L. C. FELL, Chief Officer of the L.C.C. tramways, said that cars carrying 72 passengers would be run over the bridges and along the Embankment. He estimated that £4,000 per annum was lost by time wasted by cars at the termini, and that the wages paid to employees at the termini were £1,000 per annum in addition. The cars would travel over the bridges at 8 to 10 miles an hour, and three or four would be crossing a bridge at one time on each track. About a quarter of the cars running over the bridges would enter the subway.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

The Hybrid Committee which has been appointed to deal with the London County Council (Electric Supply) Bill met for the first time on Wednesday. The business, however, was only formal. Mr. Luke White was selected as chairman, and the Committee will meet to take the first evidence on Tuesday next at 11:30 a.m.

The Romford and District Tramways Bill was read a second time in the House of Commons on Tuesday.

LEGAL INTELLIGENCE.

Uxbridge & District Electric Supply Co. (Ltd.)—On Wednesday Mr. Justice Buckley was asked to sanction an alteration in the company's memorandum of association to enable it to extend its business to the county of Hertford and elsewhere. At present the company had powers to supply electricity in the counties of Middlesex and Buckingham. The application was granted.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is wanted to take charge of generating station and electrical machinery at Clydebank Dock. Applications to Secretary, Clyde Navigation Trust, 16, Robertson-street, Glasgow, by May 7. See also an advertisement.

There is a vacancy for a premium pupil at the Canterbury electricity works. See an advertisement.

Two additional assistants are required in the electrical engineering department of the Central Technical College, Exhibition-road, London, S.W. Salaries £300 and £150 per annum respectively. Applications to Prof. W. E. Ayrton.

Battersea (London) Council require an electrical engineer to take entire charge of their electricity department. Commencing salary £500. Applications by midday May 15.

Leith Corporation want a first-class shop engineer superintendent for their tramway department. Salary £150. Applications to Town Clerk by 30th inst.

A vacancy occurs for a premium pupil in a large electric power station in the Snowdon district. Applications to general manager, North Wales Electric Power & Traction Co. (Ltd.), Llanberis, North Wales.

An electrical foreman is wanted for the service of the Government of India. Salary R.350 per month, rising annually by increments of R.25 to R.400 per month. Forms of application from the Director-General of Stores, India Office, Whitehall, London, S.W.

The Burton & Ashby Light Railways require an assistant engineer (salary £130 per annum), traffic superintendent (£130), chief clerk (32s. 6d.), car-shed foreman (45s.), two assistant inspectors (32s. each), linesman (35s.), two switchboard and battery attendants (15s. each) Applications to manager and engineer, Swadlincote, by noon May 3.

Mr. John Young, who was appointed general manager of the Metropolitan District Railway in 1904, is resigning the position on 1st prox., and Mr. A. Collinson, of the mechanical engineers' department of the North Eastern Railway, succeeds Mr. Young, who joins the directorate of the District Co Mr. Young was manager of Glasgow Corporation tramways department from 1892 until 1904, when he accepted the Metropolitan appointment.

Capt. Lyttelton R. J. W. Taylor, R.E., has been temporarily appointed an instructor in the Army Schools of Electric Lighting, vice Capt. W. L. Palmer, R.E., whose tenure of the appointment has expired

Mr. David Alexander, A.M.I.E.E., 43, Mains street, Glasgow, has been appointed by the Adams Mfg. Co. agent for Scotland for their motor starting and controlling appliances.

Mr. L. Andrew, junior engineer at Fulham, has been appointed (out of 39 applicants) sub-station assistant at Stoke Newington.

Arbitration Proceedings.—The arbitration proceedings in the dispute between D. Firth & Co. (Ltd.) and Cardiff Corporation, in regard to the electric lighting contract for Whitchurch asylum, were continued before the arbitrator (Mr. W. H. Patchell) at the High Court, London, on Wednesday. The earlier proceedings were reported in our issue of 13th inst. Plaintiffs claimed that they had suffered actual loss to the extent of about £1,400. Messrs. Firth's case having been closed, Mr. Arthur Ellis gave evidence on behalf of Swansea Corporation, and the proceedings were further adjourned.

Argentina.—The "Review of the River Plate" states that the Cia. Alemana Transatlantica de Electricidad and the Bahia Blanca North-Western Railway Co., Buenos Ayres, are putting down in their power stations the first turbine generators used in the country.

The United River Plate Telephone Co.'s line between Buenos Ayres and Rosario is now completed, and only awaits Government inspection.

Although the time allowed for the work has expired, several of the theatres in Buenos Ayres have not yet complied with the requirements stated by the municipality in July, 1904, with regard to placing electric conductors in iron conduits or out of the reach of the public and the abolition of wood casing.

Australasia.—Our Australian correspondent informs us that the project for the construction of the telephone line (500 miles in length) between Melbourne and Sydney has been postponed indefinitely, as the lowest tender received for the conductors, which would contain nearly 300 tons of copper, was £5,000 in excess of the estimate. The Parliamentary vote for the work was £30,000, but, with copper at its present price, this amount would be insufficient.

The Minister for Works has approved suggestions for an extension of the State-owned tramway at Watson's Bay and the construction of new lines to Erskineville and Blue's Point. The Railway Commissioners are to report on the subject.

Tourist cars, inaugurated on the Sydney tramways last October, and continued throughout the (Australian) summer, have been very successful, and special open cars are to be built for similar services next summer.

It is proposed to lay the Melbourne arc-lighting mains underground and to substitute flame arc lamps for the 1,000 open-type arcs now in use for street lighting.

The "Australian Mining Standard" says:—

> There is considerable dissatisfaction in Sydney with the decision to establish the toll system in connection with the telephone service. Meetings of the Chamber of Manufactures and of other representatives of commercial interests recently decided to petition against the innovation. At Melbourne also the Victorian Storekeepers' & Traders' Association have protested against the proposed change on the grounds that it will greatly increase the cost and worries of the system. Ballarat and Brisbane are amongst the malcontents. The new system is due to come into force at the end of the current half-year.
>
> In 1905 the revenue of the slot telephones in Sydney and suburbs was £2,913, in Melbourne £491 and in Brisbane £25. The prepayment fee per call is to be reduced from 3d. to 2d. in July next.

Bavaria.—The "Corriere della Serra," Milan, states that the Bavarian Minister of Communications (Herr von Frauendorfer) and two Bavarian Government officials, who recently made a tour of Switzerland and Upper Italy, were so much struck with the advantages of the three-phase overhead system of electric traction in use on the Valtellina Railway that the system will probably be adopted on the State railways in Bavaria.

Blackpool.—There was a profit of £6,000 on the past year's working of the electricity undertaking, of which £4,000 will be voted in relief of rates and £2,000 placed to reserve. The profit on the tramways was £6,608, of which £4,000 is to be devoted to relief of rates and £2,500 to reserve.

Bradford.—Yeadon Council have asked Rawdon Council to join them in a request for the extension of Bradford Corporation tramways to the city boundary at Apperley Bridge.

Bridlington.—An inquiry was recently held into the Council's application for sanction to a loan of £3,000 for electric lighting extensions.

The borough electrical engineer (Mr. A. J. Beckett) said the money was required for capital expenditure on public lighting, house services, meters, distributors, &c.

Brighouse.—The chairman of the Gas and Electricity committee (Ald. Geo. Healey) stated at the Council meeting on Wednesday that the deficiency on electricity supply account for the year had been £340. There was an increasing demand for electric current, greater than the present plant could supply, and during the coming year the matter would have to be taken into serious consideration.

Buenos Ayres.—A recent report of Mr. Consul Ross on the trade of the district of Buenos Ayres for 1905 states that the electrification of the tramway lines in the city led to an importation of 208 cars, and it is a notable feature that the supply of these, and of tramway rolling stock generally, which has hitherto been in the hands of the United States and German houses, is being transferred to a considerable extent to British firms. The supply of railway rolling stock and rails, the bulk of which business has always been placed with British firms, continues in their hands. It may be pointed out that the development of the trade in tramway rolling stock of British manufacture is largely due to the organisation of an agency by one of the leading British manufacturing firms.

The principal articles in demand in Buenos Ayres and district, as well as in most other parts of the Argentine Republic, include electrical fittings and accessories of all kinds.

The Buenos Ayres Great Southern Railway Co. are working a number of their short journey passenger trains by motors, but no mention is made of the driving power employed.

The number of passengers carried in 1905 on the tramways in Buenos Ayres and district increased to 168,000,000 and the receipts to £1,536,000, compared with 148,000,000 and £1,363,195 respectively in 1904, the length of track being 310 miles for both years.

Bury (Lancs.)—The total traffic receipts for the year ended March 31 were £39,820, and after paying expenses the net surplus is £3,348.

The net profit on the year's working of the electricity department was £2,600.

Chile.—In the town of La Serena, the provincial capital of Chile, electric lighting has been in use for some time as well as gas for both public and private lighting. Coquimbo is lighted by gas and the remaining townships by paraffin lamps. La Serena has 3,000 public and private lamps supplied from the electric power station. There is talk of a scheme for introducing the electric light into Coquimbo.

City of London.—The Court of Common Council on Thursday decided to oppose the various private metropolitan electric power bills; also the L.C.C. bill. They are of opinion "that the question of the supply of electricity in bulk in the Metropolitan Police area should be in the hands of a special representative body of the ratepayers."

Coventry.—On Tuesday the Electric Lighting committee recommended that application be made for sanction to a loan of £35,000 for extensions of the electricity generating plant and mains.

The chairman of the committee (Ald. West) said there was an absolute necessity for these extensions to be carried out at the earliest moment, and, after some discussion, the recommendation was carried.

The complete scheme suggested by the committee is as follows: (1) To dispose of (*a*) the 100 kw. and 200 kw. Fowler engines and alternators; (*b*) the 300 kw. alternator connected to the Belliss engine, but not the engine. (2) To replace the present single-phase alternator connected to the Belliss engine with a two-phase alternator, £500. (3) To purchase two 600 kw. sets, £13,550; concrete foundation for the two 600 kw. sets, £500. (4) Three new boilers, £3,450; steam and water pipes for boilers and engines, £750. (5) Extensions to boiler house, £1,000. (6) Economiser, £500. (7) To remove present switchboard and substitute a modern cellular switchboard, £2,000; sub-station at works, £250. (8) High-tension feeders and distributors, £7,500; meters and services, £2,000; transformers, with switch gear, £3,000—Total £35,000. The capacity of the station will thus be increased from 1,400 kw. to 2,700 kw.

Dundee.—On Monday the Electricity committee considered a communication from the burgh electrical engineer (Mr. H. Richardson) stating that it was now too late to instal at the generating station extra plant to be of service to meet next winter's load.

Mr. Richardson pointed out that there was an insufficient stand-by, and that the plant and cables were fully loaded. The plant was in the best possible order, and he would use every endeavour to be ready for all emergencies next winter.

In connection with the proposed new electricity works, Mr. Richardson was authorised to visit certain manufacturers' works dealing with the supply of plant for power on a large scale.

An arrangement has been come to between the Tramways committee and Dundee & Broughty Ferry District Tramway Co. on the question of liability for accidents. Each party will be liable for all damage caused by or attributable to their cars and motormen irrespective of the locus of the accident, and liability for accidents through defects in the permanent way or overhead equipment will fall on the owners of the permanent way or equipment in which the defect exists.

Electricity in Soap Works.—At the meeting of Edward Cook & Co. (Ltd.) on Tuesday Mr. Samuel Hall, F.I.C., said that by the introduction of electricity for driving the soap powder plant they found its advantages, and were extending its use in several directions. For instance, in the milled toilet soap room they had duplicated the drive, which had hitherto been by gas engine, and had put down a powerful electric motor capable of driving the whole of the plant, thus providing effectively for any possible breakdown.

Exhibition.—The Société d'Agriculture, Sciences et Industrie, of Lyons, will hold a competition and exhibition of electric motors, of less than 1 H.P., from July 1 to Aug. 15 next. Applications for space (which will be free) to 30, Quai St. Antoine, Lyons.

Gainsborough.—At a meeting of Gainsborough Council on Monday a letter was presented from Godden & Co., engineers, enclosing particulars of a proposal by their clients, Projects Limited, for a tramway system for Gainsborough, Morton and Walkerith. The promoters intend to make an application in May for an order to authorise the construction of the tramways. It is proposed to adopt a gauge of 3 ft. 6 in., and to employ either electricity or petrol as motive power. The Highways committee reported that they had considered the plans and the scheme so far as it was detailed, and had no objection to offer to such a scheme, but recommended that more information be obtained. The Council adopted this recommendation.

Goods Traffic on Light Railways.—Mansfield Council have decided to oppose the proposal of the Mansfield & District Light Railway Co. to utilise their lines for goods traffic between 8 p.m. and 8 a.m., and to use electric locomotives with trailers, each capable of carrying 10 tons. The company proposed to convey coal from neighbouring collieries to the town.

Halifax.—Owing to pressure of work, Mr. Jas. Parker, M.P., has resigned the chairmanship of the Tramway committee, and it is probable that Ald. J. Wade will be elected to the position.

Leeds.—An inquiry was held last week into the application of the Corporation for permission to borrow £3,471 for the erection of an electric lighting and gas depot.

Light Railways.—Maidstone Council have been authorised to extend their tramways to Loose, nearly 3 miles from the town.

Liverpool.—The Electric Power and Lighting committee recommend the Council to make a reduction in the charge for electric current for lighting and power. The revised scale has been drawn up by the consulting engineer, Mr. A. Bromley Holmes.

As from the end of the June quarter the charges for current will be: Lighting, 3½d. per unit up to 3,000 units per quarter, 3d. up to 10,000 units per quarter, and 2½d. in access of 10,000 units. Power, 2d. up to 3,000 units, 1½d. up to 10,000 units, and 1d. above 10,000 units per quarter.

Manchester.—On Tuesday the Tramways committee had before them the report of the sub-committee recently appointed to inquire into certain matters regarding the working of the department. The committee decided to let the report appear in the epitome of their proceedings, which will be sent to each member of the Council on Saturday.

Marylebone (London).—Owing to the recent issue of L.C.C. bills having been taken up at £3. 2s. 8d. per cent. per annum there will be a reduction on the electricity estimates recently submitted of £2,500 on the first six months' interest charges.

Municipal Telephony.—At Swansea Corporation meeting last week the Telephone committee reported that they had received a communication from the Postmaster-General to the effect that he was unable to offer for the purchase of the system an amount equal to the whole of the capital expenditure of the Corporation, without adequate allowance in respect of the depreciation of the plant. He was also unable to give an assurance as to the maintenance of existing rates for more than a moderate period of, say, two years, in the case of subscribers connected prior to the transfer. If the Corporation desired to discuss further the terms of purchase, subject to those reservations, the Postmaster-General would arrange a date of meeting.

A further meeting of representatives of Swansea, Brighton and Portsmouth Corporations in reference to the above subject has been arranged.

North London Tramways.—London County Council proposes to commence work on the reconstruction of the "Angel" to Highbury tramway route for electric traction in June.

Norway.—A foreign syndicate have been negotiating with Trondhjem Municipality, owners of the Lerfos waterfalls, for a concession authorising the utilisation of the water power to a sufficient extent to generate electrical energy up to 12,000 H.P. for use in projected steel smelting works, and the municipal authorities have now offered the facilities asked for at a charge equal to £1. 19s. per horse-power per annum for 50 years, on certain conditions.

Obituary.—Mr. John Thornton, founder and head of the firm of Thornton & Crebbin, mechanical and electrical engineers, Bradford, died on the 18th inst., in his 67th year.

The death of Mr. Marischal K. E. Frith, aged 30, electrical and mechanical engineer, formerly of the Central London Railway Co., occurred at Merthyr Tydfil, on the 19th inst.

Presentation.—The employés of the electricity and tramways undertaking at Farnworth, which has been transferred to the South Lancashire Tramways Co., have presented a writing cabinet to Mr. W. B. Richardson, late chairman of the Electricity committee, and a cigar holder to Mr. R. B. Leach, electrical engineer.

Railway Station Lighting.—The L. & N.W. Railway Co. are erecting a power station at Camden Town (N. London) for the supply of electric current for lighting Euston Station, offices, shunting-yards, &c.

Rochdale.—For the year ended March the profit on the electricity department was about £3,600, from which it is proposed to place £2,000 to reserve and hand over £1,600 in relief of rates.

Southend-on-Sea.—A loan of £6,974 for tramway extension to Shoeburyness has been applied for by the Council.

A proposal to obtain offers from companies to take over the tramway and electricity undertaking has been rejected.

Southwark (London).—The Council have decided not to take any action in regard to the recent communication from the London Electric Supply Corpn. offering to supply electric current for public lighting at 1½d. per unit.

Spain.—It is announced that the Sociedad General de Transportes Eléctricos has been formed at Madrid to utilise the power of two waterfalls in Salamanca for the production of electrical energy equal to 40,000 H.P.

Stoke Newington (London).—The Council decided on Tuesday to give notice to Hackney Council to terminate the present contract for the supply of electricity in bulk.

Stoke-on-Trent.—An unopposed inquiry was held here last week into the application of the Council for permission to borrow £5,748 for electric lighting extensions. £500 was included for the laying of additional mains during the next 12 months. Major Stewart (the inspector) congratulated the borough on the progress the electricity undertaking was making, and said it appeared likely to make continued progress.

Sunderland.—Councillor Summerbell, M.P., who has been chairman of the Tramways committee since the purchase of the local tramways, was presented on Tuesday, at a special meeting of the committee, with his portrait, an illuminated address and a silver snuffbox.

West Ham.—An inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £62,300 for extensions of the electricity undertaking.

The town clerk (Mr. G. E. HILLEARY) said that owing to the increased demand for electricity extensions of the plant and mains had become necessary—viz., £35,420 for plant and £26,880 for mains.

Technical particulars were given by the electrical engineer, Mr. A. Hugh Seabrook.

The inspector (Mr. H. R. HOOPER) remarked that machines, &c., amounting to thousands of pounds had already been sanctioned by the L.G. Board, and the Council had received the money. Where had this money gone? He wished to know the necessity for sanctioning the money twice.

An adjournment was agreed to in order that an answer might be prepared.

Worcester.—At a special meeting of the City Council on Tuesday it was agreed to adopt an optional flat rate of charging for electric current.

Considerable discussion took place on a recommendation of the Electricity committee to concentrate the whole of the steam generating plant at the city station, using the old Powick station only for the generation of electricity by water power.

The city electrical engineer (Mr. C. M. Shaw) reported that the whole of the steam-producing plant at Powick was obsolete, though it had been in use only 12 years, and he recommended the substitution of new plant to be placed in the city works. Plant which originally cost £9,000 he recommended should be scrapped, and, at a cost of £5,000, he proposed to so extend the equipment of the city station as to effect a saving in production of £700 per annum.

The recommendation was adopted.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Birmingham Electric Supply committee invite tenders for supply and delivery of various sizes of electric motors. Conditions, specifications, &c., from the city electrical engineer, Mr. R. A. Chattock, 14, Dale-end, Birmingham. Further particulars are given in an advertisement. Tenders to the city electrical engineer by noon of May 8.

Bedford Corporation invite tenders from cable makers for the supply of high and low tension cables for 12 months. Specifications from and tenders to the borough electrical engineer (Mr. R. W. L. Phillips), Cauldwell-road, Bedford, by noon of May 23. See an advertisement.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

Edinburgh Corporation invite tenders for arc lamp posts. Specifications, &c., after May 2 from the electrical engineer, Mr. F. A. Newington, Dewar-place, Edinburgh. Tenders to the town clerk, Mr. Thomas Hunter, W.S., City-chambers, Edinburgh, by May 14. See also an advertisement.

Govan Corporation invite tenders for the yearly supply of stores for their electricity department, including engine room stores, oil, &c., cables and cable accessories, bitumen, meters, house fuse boxes, wrought-iron tubes and fittings, cast-iron pipes, arc lamp carbons, joint boxes, motors and motor starters, coal, timber, &c. Tenders to the town clerk (Mr. J. A. Houston), Town Hall, Govan, by 30th inst.

Willesden District Council invite tenders for supply and delivery of direct-current motors for letting to consumers on hire or on the hire-purchase system; also for supply of arc lamp carbons for the ensuing 12 months. Tenders to the clerk (Mr. Stanley W. Ball) by 10 a.m. May 1.

St. Pancras (London) Borough Council invite tenders for supply of arc lamp carbons for 12 months. Tenders to the town clerk (Mr. C. H. F. Barrett) Town Hall, Pancras-road, N.W., by noon April 30.

Poplar (London) Borough Council want tenders by 10 a.m. May 8 for supply and erection of overhead bunker and coal-handling plant. Form of tender from the borough electrical engineer, Glaucus-street, Bromley-by-Bow, E.

Tenders are invited for supply and erection of two turbine water wheels, two c.c. dynamos, two pumps, &c., at *Belfast* District Lunatic Asylum, Purdysburn, near Belfast. Tenders to S. M. Macrory (Ltd.), Limavady, by May 10.

Manchester Electricity committee require tenders by noon May 2 for supply of 13½ miles of ½ sq. in. vulcanised bitumen cable. Specifications, &c., from Mr. F. E. Hughes, Town Hall.

Stoke-on-Trent Electricity committee want tenders by May 12 for steam dynamo, condensing plant and booster and balancer. Specifications, &c., from borough electrical engineer.

Halifax Tramways and Electricity committee require tenders by May 8 for equipment of 12 cars with roof covers.

Llandudno Council want tenders by May 7 for 1,211 yds. 0·25 triple-concentric feeder cable.

Blackpool Electricity and Tramways committee want tenders for 5,000 tons of coal.

TENDERS RECEIVED AND ACCEPTED.

C. A. Parsons & Co., Heaton Works, Newcastle-on-Tyne, have recently secured a number of important orders for turbine machinery, including one 3,500 kw. turbo-alternator and exciter for Newcastle Electric Supply Co.'s Carville power station; two 500 kw, direct-current turbo-generators for A. Guiness, Sons & Co.; one 800 kw. turbo-alternator and exciter, including condensing plant (through Messrs. Preece & Cardew) for Shanghai Council; one 2,000 kw. steam turbine for Vickers, Son & Maxim; one 400 kw. continuous-current turbo-generator for West Bromwich Corporation; and one 200 kw. continuous-current turbo-generator for the Morgan Crucible Co., London.

Leyton Council have received the following tenders for the supply and erection of a traction switchboard :—

Bertram Thomas (*acc.*)	£880	14	3
British Westinghouse Co.	1,223	0	0
Electric Construction Co.	1,128	3	0
Johnson & Phillips (Ltd.)	£1,070	0	0
General Electric Co.	946	16	0
Kelvin & James White	939	0	0
Elliott Bros.	883	3	0

The Postmaster-General's Department, Adelaide, South Australia, has accepted the tenders of Geo. R. Marks for conduits; Unbehaun & Johnstone for wall type and desk telephones, switches, bells, transformers, condensers, battery cells, switchboards for metallic circuits and trunk line timers; J. Bartram & Son for switchboards, metallic circuits and condenser telephones; and Rabone, Feez & Co. for cable and tinned copper wire.

St. Pancras (London) Council have accepted the tender of W. E. Baker & Co. (at £157) for three hydro extractors for the baths, to be driven by electric motors. There were five tenders, ranging from £125 to that accepted.

Exeter Town Council have accepted the tender of Westcott, Austin & White at £1,473 for the tramcar shed extension, that of E Ireland at £5,323 for track extension, paving, &c., and that of R. W. Blackwell & Co. at £609 for overhead equipment.

Bristol Docks committee have accepted the tender of Siemens Bros. & Co. for a transformer and that of Saunders & Co. for wiring and fitting in connection with the electric lighting of the tobacco warehouse.

Dundee Council have accepted the following tenders for extensions of tramways: John Fyfe, granite setts and chippings; D. B. Shaw, whinstone setts; and William Briggs & Sons, pitch and pitch oil.

Manchester Corporation have accepted part of the tender of the British Thomson-Houston Co. for 12 months' general stores and tramway spares, also B.T.-H. Edison lamps.

Swindon Corporation have accepted the British Thomson-Houston Co.'s tender for 12 months' supply of miscellaneous overhead line material.

Exeter Corporation have accepted the tender of Robt W. Blackwell & Co. for the electrical equipment of about $\frac{5}{8}$ mile route length of tramway at £609. 3s.

The British Thomson-Houston Co. have obtained from Ashton-under-Lyne Corporation a contract for the supply of electric motors for 12 months.

Islington (London) Guardians have accepted, at £32. 10s., the tender of Phillips' Commutator Grinder Co. for a commutator grinding machine.

Burnley Electricity committee have accepted the tender of the Klein Engineering Co. for a cooling tower to deal with 50,000 gallons of water per hour.

Walthamstow Council have placed an order with Frank Suter & Co. for a new panel and intruments for the traction switchboard at £74.

The contract for the construction of an electric tramway on the Dolter surface contact system on the Hastings sea front is being executed by the National Electric Construction Co.

Leyton Council have provisionally accepted the tender of Bertram Thomas for a switchboard.

Plymouth Tramways committee have accepted the tender of the Brush Co. for six demi-cars at £507 each.

Southend-on-Sea Council have accepted the tender of Callender's Co. for cable.

BUSINESS NOTICES.

Messrs. Bray, Markham & Reiss (Ltd.) have appointed Mr. Arthur Pearson, 27, Paradise-street, Birmingham, their sole agent for the Midlands. The firm are making arrangements to keep a stock of switches in Birmingham.

Monté-Callow & Co. have been appointed sole selling agents for Great Britain and the British colonies for direct-acting electric capstans for continuous and polyphase current, manufactured by M. Hillairet Huguet, of Paris.

Messrs. Bray, Markham & Reiss (Ltd.) inform us that Mr. David Alexander will cease to be their agent at the end of this month, and that they have appointed Mr. John A. Rudd, 177, West George-street, Glasgow, as their new agent.

The Electrical Co. (Ltd.) announce that Mr. Lestock-Forbes has ceased to be manager of their Newcastle branch, and is no longer in their service.

Cecil Hodges & Co., Balfour House, Finsbury-pavement, London, E.C., ask us to state that it has been brought to their notice that their "V" type switch is being copied, and inferior switches of this class are being placed on the market under the same name. The firm point out that they originated this switch many years ago to meet the demand for a switch with a large laminated contact surface of low current density, and, having spent considerable sums in perfecting the switch, they do not wish it to be confused with inferior imitations.

Liverpool Electric Cable Co. (Ltd.), Vauxhall-road, Liverpool, advertise for agents for Yorkshire and Nottingham districts.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Robt. Boyd, electrician, Plas-y-Glyn, Caroline-street, Llandudno.

A receiving order has been made against Saml. Hargreaves, electrical engineer, 2, Victoria-arcade, Buxton.

A first and final dividend of 2s. $7\frac{1}{4}$d. will be payable on May 12 at Crypt-chambers, Eastgate-row, Chester, in the bankruptcy of Harry Jones & Gwilt L. Cathrall, electrical engineers, &c., 19, Chester-street, Wrexham.

The discharge of Wm. Wenham, electrical engineer, 5, Century-buildings, London road, Croydon, has been suspended for three years.

Claims against the Telescriptor Synd. (Ltd.) are to be sent by May 5 to Mr. E. Waterhouse, 3, Fredericks-place, Old Jewry, London, E.C.

Claims against French Electric Lighting Boards (Ltd.) (in liquidation) by May 27 to Mr. W. H. Pannell, 13, Basinghall-street, London, E.C.

Sale of Old Post Office Stores.—Tenders are invited for the purchase of gutta-percha, copper, lead, brass, zinc, and iron, india-rubber covered copper-wire, tools, glow-lamp tops, &c Forms of tender, &c., from the Controller of Stores, 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. May 2. See also an advertisement.

Plant, &c., for Sale.—The Brown Hoisting Machinery Co., 39, Victoria-street, London, S.W., advertise for sale a Weston ammeter with shunt, and voltmeter; also insulation tester.

Plant for Sale.—Sunderland Corporation require tenders for the purchase of second-hand machinery, comprising two Holmes-Willans 22 kw. steam dynamos, two Crompton-Brunton 37 kw. motor-alternators and switchboard, two Berryman feed-water heaters, &c. Further particulars and tender forms from the borough electrical engineer (Mr. John F. C. Snell), Town Hall, Fawcett-street, Sunderland. See also an advertisement.

An electric lighting plant, complete with boiler, for 250 lights, is advertised for sale in another column.

Bournemouth & Poole Electricity Supply Co. have for sale a number of 100 volt Thomson-Houston meters. For further particulars see advertisement.

Messrs. Richard Sizer (Ltd.), engineers, Hull, advertise for sale two Willans-E.C.C. combined electric power and lighting sets.

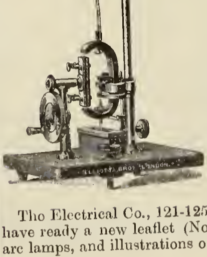
Premises to Let.—Messrs. R. D. & J. B. Fraser, Princes-street, Ipswich, advertise a spacious factory to let.

Workshops with private house, suitable for electricians and motor engineers, are advertised to be let.

Basement premises at 7, Finsbury square, London, E.C., are advertised to let.

Catalogues, &c.—The Union Electric Co., 151, Queen Victoria-street, London, E.C., have ready two new sheet lists dealing with direct-current and alternating-current "Noris-Excello" arc lamp carbons with metal cores for yellow light. It is claimed for this carbon that it is made of the purest possible material and is fitted with a very high conductivity core specially arranged to reduce the ohmic resistance to a minimum. The arrangement is patented and protected. The price list covers a large range of diameters and lengths of these carbons, and gives the equivalent in metres of each carbon and per 100 pieces.

Messrs. Elliott Bros., Century Works, Lewisham, London, S.E., have ready three new pamphlets dealing respectively with alternating-current instruments (ammeters, voltmeters and wattmeters) of the regular patterns and for use with transformers. Prof. J. A. Ewing's hysteresis tester is illustrated and described in the third pamphlet, and full directions are given for its use. It is pointed out that the operation of this instrument (which is illustrated herewith) is entirely mechanical, and requires no knowledge of electrical testing. By its use the testing of the magnetic hysteresis of sheet iron or steel can be effected in a simple and expeditious manner suitable for both workshop and laboratory purposes.



The Electrical Co., 121-125, Charing Cross-road, London, W.C., have ready a new leaflet (No. 207) relating to "Sunshine" flame arc lamps, and illustrations of the lamp with and without reflectors are shown.

The Lahmeyer Electrical Co., 109–111, New Oxford-street, London, W.C , have prepared and issued a new controller list (No. VI. E). This list has been thoroughly revised and brought up-to-date, and relates to types of controllers which have met with very great success, and have been installed by a large number of the leading crane makers in railway and dock yards. The outer case of these machines is of cast iron and each controller has a large blow-out coil, which greatly prolongs the life of the contacts. There is also listed a special design of controller for mining work, a sample of which machine, it will be remembered, was exhibited at the recent electrical exhibition at Olympia. The list under notice gives much useful information as to the rating of controllers and diagrams of connections, and will, consequently, form a useful reference list for all interested in controller work. It is very well printed, and there are a number of good illustrations provided.

The London Shafting & Pulley Co. are issuing a new illustrated catalogue of shafting, pulleys, couplings, hangers, &c.

Mr. G. Wüthrich, representative in this country of the Maschinenfabrik Oerlikon, Switzerland, forwards us the company's new turbine pamphlet in English. It is pointed out that the company's turbine department has of late been greatly developed and that units of plant are being manufactured of from 500 kw. to 4,000 kw. capacity. The new list is well illustrated, some good views of installed plant being shown.

Arthur Cort & Co., 277, Camberwell New-road, S.E., have ready a new price list of insulating hard or flexible vulcanised fibre, balata, gutta-percha and colton belts, &c.

Mr. Charles Taylor, Bartholomew-street, Birmingham, forwards illustrated particulars of Kennedy's patent bending machine, of which he is the maker. This machine enables tubes, strips and other metal sections to be bent cold to any design. Several sizes of these machines are made for bending tubes from $\frac{1}{8}$ in. to 2 in. section to any angle and measurement in one operation. The printed particulars give the method of using the machines.

Mr. Henry Tinsley, 102, Elmers End-road, Beckenham, Kent, has ready a new list of bridge wires for use with the Wheatstone Bridge, enabling residuals of resistance below the lowest coil of the bridge to be balanced and read off directly, still keeping equal ratios in the bridge coils. This greatly increases the sensibility of the whole apparatus, and keeps all coils direct reading. This bridge wire has no mercury contacts, and can be used for platinum thermometry. The list is illustrated.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on April 13 to 24, with the ports of destination :—

Africa—Alexandria, £286 ; Cape Town, £141 (including £26 telegraph material) ; Delagoa Bay, £355 ; Durban, £3,527 (including £2,896 telegraph material) ; East London, £42 ; Port Elizabeth, £816. *Argentina*—Buenos Ayres, £350. *Australasia*—Auckland £126 ; Melbourne, £1,463 (including £630 telegraph material) ; Otago, £173 ; Perth, £55 ; Sydney, £576 (including £210 telegraph material) ; Wellington, £496. *Belgium*—Ostend, £49. *Burma*—Rangoon, £151. *Canada*—Toronto, £75. *Ceylon*—Colombo, £161 (including £107 telegraph material). *China*—Canton, £228 ; Shanghai, £3,376 (including £1,241 telegraph instruments) ; Tientsin, £575. *Denmark*—Copenhagen, £290. *Fiji*, £49 (telegraph material). *France*—Paris, £768. *Germany*—Bremen, £50 (telegraph material) ; Hamburg, £111 (including £21 telegraph material) ; Stettin, £46. *Holland*—Amsterdam, £456 (including £532 telegraph material). *India*—Bombay, £2,907 (including £14 telegraph material) ; Calcutta, £2,504 (including £315 telegraph material) ; Karachi, £18. *Japan*—Yokohama, £75 ; Kobe, £25. *Malta*, £61. *Mauritius*, £1,346. *Russia*—Kurch, £200 ; Riga, £162 ; St. Petersburg, £195 (telegraph material). *St. Helena*, £134 (including £112 telegraph material). *Siam*, £30. *Spain*—Malaga, £10. *Straits Settlements*—Penang, £131 ; Singapore, £122. *Sweden*—Gothenburg, £343 (telegraph cable) ; Malmo, £103 (telegraph material). *U.S.A.*—New York, £94. Total (for 12 days), £23,353, against £18,513 for four days last year (April 19 to 22).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

March 19, 1906.

6,557 Thomas. Vapour electric apparatus. (Date applied for, 3/30/05)*†
6,559 Hewitt. Vapour electric apparatus. (Date applied for, 3/29/05.)*†
6,568 Pringle. Conductors for electric lamps.
6,602 Tudor. Automatic economisers for electric installations.*
6,614 Stewart. Electric circuit breakers. (Date applied for, 3/20/05.)*†

March 20, 1906.

6,632 Ehrich & Graetz. Alternating-current arc lamps. (Date applied for, Sept. 6, 1905.)*†
6,633 Davis. Insulated conductors for electric lighting.
6,644 Holmes. Indication at a distance of pressures in conductors of electricity supply systems.*
6,651 Mather & Platt, Chorlton & Smith. Dynamo-electric machines.
6,659 Johannesen. Mariner's compass.*
6,675 Read. System of electric wiring for internal work.
6,690 Leitner. Regulating electric circuits.
6,702 Bourne. Winding coils and bobbins for electrical purposes.

March 21, 1906.

6,780 Harrold & Jones. Means for operating tramway points.
6,803 Justice. (Deutsche Gasglühlicht A.-G. Auerges, Germany.)* Electric glow lamps.
6,815 Hoffmann. Regulators for electrically-driven compressors.
6,818 B.T.-H. Co. (G.E. Co., U.S.) Protective devices for vapour electric apparatus.
6,820 De Törley & Benk . Apparatus for generating electricity.
6,833 Bastian & Calvert. Mercury vapour apparatus.
6,838 Johnson. Electric machines.*

March 22, 1906.

6,933 Hardingham. (Hartmann & Braun A.-G , Germany.) Reed-combs for resonance measuring instruments.
6,939 Birnbaum, White & Müller. Intercommunication telephone systems.*

March 23, 1906.

6,971 Smith. Electric ignition devices.
6,976 and 6,977 Bingham. Electric furnaces.
6,978 and 6,980 Gibbs. Production of metal articles by electro-deposition.
6.979 Allen. Combined electric, oil and candle lamps.
6,984 Gross. Arc lamps.
7,021 Turner. Single or more pole electric coupling.

March 24, 1906.

7,138 Lugo. Manufacture of secondary batteries.
7,144 Wilson. Alternate-current boosters or compensators.
7,150 Pedersen. Electromagnetic relays.*
7,162 Berry. Brushes for switch and other apparatus.
7,184 Dubois. Electricity meters,
7,188 and 7,189 Bloxam. (Lux, Austria) Metallic filaments for incandescent lamps.

March 26, 1906.

7,226 Harvey. Utilising the waste heat of the arc lamp to increase the illuminating power thereof.*
7,232 Hewer. Distribution boxes for electric systems.
7,234 Dean. Influence machines.
7,248 Franklin & Seyfert. Electric motors.*
7,245 Siemens & Halske A.G. Submarine electric cables. (Date applied for, May 5, 1905.)*†
7,255 Siemens Bros. & Co. & Toplis. Cooling the commutator of a dynamo-electric machine and in constructing the commutator therefor.*
7,263 Blackwell. Switch.
7,265 Davies. Incandescent lamps.
7,275 Lugard. Systems of electrical power distribution and consumption.
7,283 Marples, Leach, Rook & Beaumont. Electric coin-freed meter.
7,292 Société Anonyme des Manufactures de Glaces et Produits Chimique de St. Gobain, Chauny et Cirey. Electrical condensers for wireless telegraphy. (Date applied for, April 6, 1905.)*†
7,293 Wise. (Tischner, jun., U.S.) Connector for electric lamps.

March 27, 1906.

16,479a/05 Lattig & Goodrum. Telephone systems. (Date applied for, Aug. 14, 1905.)*†
7,308 Waddell & D.P. Battery Co. Accumulators.
7,332 Mitchell & Gunn. Supporting electric cables, pipes, rods and the like.*
7,340 Bingham. Electric furnaces.
7,375 Basset. Generation of electricity by a primary battery. (Date applied for, March 27, 1905)*†
7,376 Siemens Bros. & Co. (Siemens & Halske A.G., Germany.) Operating conversation counters in telephone installations.*
7,397 Bertheau. Ignition devices. (Date applied for, Jan. 31, 1906.)*†
7,411 Diamant & Chiesa. Arc lamps.
7,413 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric apparatus.
7,416 Pfingst. Electric brakes.*
7,418 Lake. (Socièta Anonima Italiana, Gio. Ansaldo Armstrong & Co., Italy.) Control of electric motors.*

March 28, 1906.

7,447 Baynton. Electric tail or back lamps of motor vehicles.
7,452 Trotter. Life-guards for electric vehicles.
7,456 Von Kramer. Control of electric lifts.
7,457 Langton & Langton. Storage battery.
7,469 Phillips. Telephone receivers.
7,476 Terry. Electric goal keepers.
7,490 Conrad. Alternating-current electromagnets. (Date applied for, April 3, 1905.)*†
7,491 Jackson. Electromagnets. (Date applied for, April 3, 1905.)*†
7,504 and 7,505 B.T.-H. Co. (G.E. Co., U.S.) Arc lamps.

March 29, 1906.

7,565 Gardner. Signalling or effecting operations in local electric circuits.
7,586 Miall. Mouthpiece for telephones, speaking tubes and the like.

7,597 and 7,598 Allmänna Svenska Elektriska Aktiebolaget. Electrically-heated shaft furnaces. (Date applied for, March 30, 1905.)*†
7,626 Marshall. Electric light fittings.
7,627 B.T.-H. Co. (G.E. Co., U.S.) Electric railway systems.

March 30, 1906.

7,655 Kuzel. Increasing the electrical resistance of metals. (Date applied for, July 26, 1905.)*†
7,663 Gibson & Brooker. Electrical advertising devices.
7,668 Olive & Swarbrick. Liquid electric motor starters or controllers.
7,689 Tourtel. Electricity meters.
7,725 Rees. Construction of dynamo-electric machines.

March 31, 1906.

11,654a/05 Schanschieff. Accumulator plates. (Date applied for, Dec. 4, 1905.)*†
7,803 Bloxam. (Lux, Austria.) Tungsten filaments for incandescent lamps.
7,812 Dubois. Electric swishes.
7,821 Fynn. Alternate-current motors, generators and transformers.
7,822 Evans & Carden. Hertzian wave telegraphy.
7,823 Lafitte. Device for verifying ignition in internal-combustion engines. (Date applied for, Nov. 25, 1905.)*†
7,831 and 7,832 B.T.-H. Co. (G.E. Co., U.S.) Signalling systems for railways.

April 2, 1906.

7,836 Electric Ignition & Hall. Electric ignition systems.
7,845 Bragstad. Commutating poles for electric machines.
7,849 Bertalot. (Bonino, Italy.) Blind hand lantern with incandescent lamp.
7,860 Panton. Electric railway vehicles or locomotives.
7,869 Pauling. Processes for production of voltaic strong-current arcs.*
7,881 Dörwald & Lecoche. Dynamo Electric generators.

SPECIFICATIONS PUBLISHED.

1904 Specifications.

28,268 Higgins. Telegraph transmitting instruments.
28,301 Ferranti. Electric welding of turbine blades.

1905 Specifications.

3,867 Lomax & Tomlinson. Automatically controlling pressure of steam in boilers.
5,584 B.T.-H. Co. (G.E. Co., U.S.) Electric conveyor systems.
5,829 Brindley, Bale & Murphy. Contact maker for electrical ignition devices.
6,307 Grisson. Transforming continuous currents of electricity.
6,37[illegible] Weymouth. Control of electric elevators.
6,418 Bastian & Calvert. Effecting catalytic combinations in electrolytic electricity meters.
6,453 Bastian & Calvert. Measuring electricity with or without recording, registering or prepayment mechanism.
6,557 Siemens Bros. & Grimston. Apparatus for telegraphs.
6,567 Little. Time controlled electric switches.
6,593 Reyrolle & Schuil. Starting apparatus for electric motors.
6,690 Lowne & Lowne Electric Clock & Appliances Co. Electrically maintaining and reproducing recurring movements.
6,691 Robertson. Locking a controller in the off position until all doors of a train or car are closed. (Date applied for, May 12, 1904.)
6,691a Robertson. Indicating to a driver when doors of a car or train are closed. (Date applied for, May 12, 1904. Originally in 6691/05.)
6,752 Noeggerath. Dynamo-electric machines of the "homopolar" or "acyclic" type. (Date applied for, March 30, 1904.)
6,786 Gerard & Fiedler. Plates for accumulators.
6,825 Rhodes & Rhodes. Ignition mechanism for internal-combustion engines.
6,867 Bailey. Connecting electric conductors and supports therefor.
6,958 Burnett. Safety devices for overhead wires for electric traction.
7,004 Reynolds. Electric furnaces.
7,006 Jahr. Generation of electricity by means of earth cells.
7,075 Main. Electric device for operating valves of internal-combustion engines.
7,421 B.T.-H. Co. (G.E. Co., U.S.) Electrically-driven vehicles.
7,422 B.T.-H. Co. (G.E. Co., U.S.) Railway and like signals and mechanism therefor.
7,822 B.T.-H. Co. (G.E. Co., U.S.) Systems of control for electric motors.
7,841 Phillips. Telegraphic systems and apparatus therefor.
8,027 B.T.-H. Co. (G.E. Co., U.S.) Block signal systems for railways.
8,215 B.T.-H. Co. (G.E. Co., U.S.) Regulation of voltage of alternating-current systems and apparatus therefor.
8,568 B.T.-H. Co. (G.E. Co., U.S.) Machines for manufacture of incandescent lamps.
8,846 Baron. Electrical collector trolley head.
8,927 Berry. Switch apparatus.
8,929 Bliss. Electric train lighting system. (Date applied for, 27/4/94.)
9,181 Hirst & Collings. Electric light candle fitting.
9,652 Gallagher & Automatic Meter Co. Automatically delivering bills of electricity meters and the like.
9,940 Armistead & Tilney. Regulation of electric circuits.
12,023 Roberts. Supporting and insulating the live conductor rail.
12,337 Harrison. Metallic vapour electric lamps.
13,346 Smith. Device for testing or detecting electrical sparking.
14,457 Oppenheimer. (A.-G. Mix & Genest.) Electromagnetic annunciators acting simultaneously as choking coils.
14,511 Holden & Chamberlain & Hookham. Electricity meters.
14,582 Critchley. Low-tension electric ignition mechanism.
14,615 Crompton & Co., & Hodgson. Arc lamps.
17,957a Birnbaum & White. Step-by-step switches. (Date applied for, Dec. 13, 1905.)
18,193 Treyer. Microphones or telephone transmitters. (Date applied for, Feb. 15, 1905.)
19,379 Deutsche Gasolühlicht A.G. (Auergessellschaft.) Production of filaments for incandescent lamps. (Date applied for, Jan. 17, 1905.)
19,753 Haydock & Jones. Insulated bolts for electric tramway systems.
20,951 Otis Elevator Co. Electric lift control systems.
21,643 Kritzler. Insulating sparking plugs of internal combustion engines.
21,652 Lake (International Holding Co.). Electric motors.
23,076 Large. Electromagnetic power hammer, drop stamp or press.
24,187 Large. Switches for electro-magnetic power hammers, drop stamps, &c.
24,200 Bénard. Electrically lighting inverted gas burners. (Date applied for, Nov. 26, 1904.)
25,173 Kriéger, & Cie Parisienne des Voitures Electriques (Procédés Kriéger.) Electric propulsion of vehicles (Date applied for, May 30, 1905.)
25,283 Dolter & Mertens. Electromagnetic band brakes. (Date applied for, Dec. 6, 1904.)
25,347 Brooking & Claremont. Electric cutouts.
25,383 Schneider. Receiving apparatus for explosive submarine and land mines operated by electric waves. (Date applied for, Jan. 23, 1905.)
26,052 Baron. Storing and paying out lengths of conductors connected to apparatus.
26,691 Féry. Thermo-electric galvanometers. (Date applied for, 6/1/05.)

1906 Specifications.

374 Kelley. Thermal switch. (Date applied for, Aug. 30, 1905.)
619 Platte. Suspension of current conductors of electric railways. (Date applied for, Jan. 10, 1905).
1,927 Edison. Electrode mass for storage batteries and process of forming same. (Date applied for, March 30, 1905.)
1,925 Edison. Storage battery electrode. (Date applied for, March 30, 1905.)
3,572 Platte. Suspension of current conductors of electrical railways. (Date applied for, Sept. 28, 1905).

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The thirty-ninth ordinary general meeting of the members of this Company was held on Tuesday under the presidency of Mr. J. Herbert Tritton.

The SECRETARY (Mr. John I. Bethell) read the notice convening the meeting and the report of the auditors.

The CHAIRMAN said: The year, as far as this Company is concerned, has been, generally speaking, uneventful, with a return to more or less normal traffic. The difficulties to which a long line such as ours is exposed in traversing district difficult of access and liable to temporary disturbance, have perhaps been slightly more in evidence, but those difficulties have, as often before, been overcome by the ready help of the responsible authorities and the zeal and activity of our staff. The lines of the Company have worked most efficiently during the year. The Wheatstone system has now been in use for some three years, and the success of this automatic transmission of messages has placed the Company in a very strong position. The carrying capacity of the line has been doubled, and errors reduced to a minimum. I informed the shareholders last year that the prospects of traffic receipts for the year under review were not, perhaps, so satisfactory as we could wish, owing mainly to possible reductions in rates. From the accounts in your hands you will have seen that this forecast has been borne out. After making allowance for a certain amount of interest on cash investments, which usually appear in the revenue account but has this year been otherwise treated, there is a net decrease in traffic receipts of about £8,500. This is due principally to the further reduction of the rate to India from 2s. 6d. to 2s. per word, which came into operation on Aug. 1, 1905. In spite of the view held by many that the effect of a reduction of rates is generally counterbalanced by a corresponding increase in the number of telegrams sent, this happy result has not yet been reached in the present case. The South Russian traffic shows a most satisfactory increase in volume, but the reduction of the rate to 4½d., which has operated in the accounts for the whole year under review, as against six months for the previous year, has brought the receipts from this traffic for this year down to about the same figure as for the last year. It is probable that Indian traffic receipts may still continue to diminish during 1906, though I do not at all take a pessimistic view of the financial position of the Company generally; fluctuations in receipts are bound to occur, and we must take the rough with the smooth. The working expenses, £70,792, show a decrease of £1,137. 11s. 5d., against 1904, but these, again, are fluctuating, and certain temporary staff expenses will probably somewhat increase this heading during 1906. The Directors have during the last few weeks concluded arrangements with the Company's concessionary Governments and with the Black Sea Telegraph Co. which have enabled them from May 1 next to reduce the rate between England and Turkey in Europe and Asia, via the Company's route and the cable of the Black Sea Telegraph Co., from 11d., at which it has hitherto stood, to 6½d. per word. They have no doubt that the public will appreciate the known advantages offered by the Company's route, and that the additional advantage of direct Wheatstone working between London

(Liverpool and Manchester) and Constantinople without intermediate retransmission, which has been rendered possible by the co-operation of the Black Sea Company so far as the section Odessa–Constantinople is concerned, will attract a considerable amount of Turkish traffic, which, under the former relatively prohibitive tariff by our line of 11d. went by other routes. This traffic will, of course, be welcome as an additional source of revenue. I informed the shareholders at the last general meeting that the Russian section of the line passed to the Russian Government on Jan. 31, 1905, being thereafter leased by that Government to the Company for the period of our concession, the maintenance remaining in our hands and at our expense. The transfer of this section from the financial point is dealt with in the accounts for the year under review. The capital cost, which stood in the last balance sheet at £313,285. 5s. 5d., has been written off out of the Reserve Fund, which, after credit of interest, is reduced to £138,628. 15s. 9d. The Reserve Fund investments thus displaced have been amalgamated with the cash investments of former accounts under the new heading "Unappropriated Investments," which stand at the value of £400,580. 13s. 10d. Reference to the balance-sheet in your hands will show that there are also in respect of Reserve Fund and of Equalisation of Dividends Fund the corresponding investments duly appropriated. It is, perhaps, unnecessary to again refer to the very satisfactory position of the shareholders, as disclosed by the balance-sheet. The Directors propose the usual dividend, £14,875, and bonus, £17,000, absorbing together £31,875. They propose to add a further sum of £10,000 to the Equalisation of Dividends Fund, and to hand over a further sum of £5,000 to the trustees of the Retirement Trust Fund, carrying forward the balance of £16,698 to the credit of 1906. This payment of £5,000 to the trustees of the Retirement Trust Fund goes far to complete the required capital amount, and I am sure will be cheerfully voted by the shareholders, who have always recognised the importance to the Company and to the staff, serving under conditions such as ours, of due provision under this head. As stated in the report, the Directors do not consider it necessary to reinvest the interest accrued during 1905 upon the Unappropriated Investments and upon the Deposit of Russian Government rente, and therefore propose to make a special distribution to the shareholders from these sources of £12,750, equivalent to 15s. per share. You will have noticed in the Report the death of our esteemed colleague, Dr. H. H. Meier, of Bremen, one of the Continental Directors of the Company. Mr. Geo. Plate, president of the Norddeutsche Lloyd, Bremen, has joined the Board in his place, and the Board are pleased to have secured his services. I now move the adoption of the report and accounts.

Mr. CHARLES HOLLAND seconded the motion, which was carried unanimously. The retiring Directors, Sir Francis Mowatt, G.C.B., and Mr. Geo. Plate, were then re-elected and the retiring auditors, Messrs. C. F. Kemp, Sons, & Co., were re-appointed and a cordial vote of thanks to the chairman, directors and staff terminated the proceedings.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—The total revenue for 1905 was £122,995. 1s. 7d., compared with £112,429. 9s. 7d. for the previous year, and the traffic receipts (£121,879. 8s. 1d.) show an increase of £11,305. 15s. 3d. After deducting all expenses, including £14,255 for interest, and providing for rental and percentage of profits payable to Auckland Council (£2,683. 19s. 11d.), and setting aside £13,949. 12s. 8d. for depreciation, there remains £20,919. 14s. 9d., making with £3,098. 10s. 2d. from 1904, an available balance of £24,018. 4s. 11d., which the directors recommend shall be applied to paying a dividend at rate of 7 per cent. per annum on the share capital (£21,000), £3,018. 4s. 11d. being carried forward. The total route mileage operated during the year (18·64 miles) has remained unaltered, while the passengers carried have increased by 1,743,342. The number of cars in service at the end of the year was 55, compared with 47. An agreement has been entered into to construct an extension of the company's system (about 3 miles).

BANBURY & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The gross revenue for 1905 was £1,520. 17s. 7d., expenditure £1,270. 5s. 3d. The installations connected to the mains at Dec. 31 represented the equivalent of 8,558 8 c.p. lamps, an increase of 49 per cent. on the year.

BATH ELECTRIC TRAMWAYS (LTD.)—At the meeting on Friday Sir Vincent Caillard said the revenue figures for 1905 were good. The reconstruction of the Midland bridge had been completed, but they had not yet been able to lay their track across the bridge. They could have proposed a larger dividend, and they could even have made some distribution on the deferred ordinary shares, but they considered it better policy to strengthen the financial position of the company by commencing to build up a reserve and by carrying forward a substantial sum. They had purchased six motor omnibuses at a cost of £7,300; they paid to Bath Corporation for the reconstruction of the Midland bridge £8,400; the Newton extension, which was opened for traffic from August, cost £11,300; and the purchase of the York Villa site for the extension of their power house and works and car sheds, and for a garage for the motor omnibuses, cost £2,200. The motor omnibus service had quite fulfilled expectations, and had rather more than paid its way, and it had acted as a very valuable feeder to the tramway system. They might take it that practically all the traffic brought by motor omnibuses to the cars was net profit to the cars, inasmuch as the costs of working did not increase. The units generated in 1904 were 1,227,200 and in 1905 1,411,900, an increase of 184,700. The cost per unit in 1904 was 0·635d. and in 1095 0·511d., a decrease of 0·124d. The single track miles in use in 1904 were 16 and in 1905 19. The car-mileage in 1904 was 900,200 and in 1905 967,600, an increase of 67,400. The passengers carried in 1904 were 6,648,100, and in 1905 6,746,300, an increase of 98,200. The cost per car-mile in 1904 was 5·268d. and in 1905 4·791d., a decrease of 0·477d. The receipts per car-mile were 8·831d. in 1904 and 8·654d. in 1905, a decrease of 0·177d. The percentage of costs to receipts was in 1904 59·65 and in 1905 55·36, a decrease of 4·29. The average miles per car per day were in 1904 89 and in 1905 99. Parcels receipts in 1904 amounted to £346 and in 1905 to £660.

CALCUTTA TRAMWAYS CO. (LTD.)—At the meeting on Friday Mr. E. C. Morgan said the capital had been increased by the issue of 35,000 new £5 shares and £117,000 had been expended on additions to plant and machinery during the year. It was largely due to that outlay that they had been able to handle so effectively the very much increased traffic, and to run an additional 500,000 miles during the year. Although there was a considerable increase in annual expenditure, it was satisfactory that the receipts had enabled them to meet the interest charge on the new capital and to add £10,000 to depreciation whilst maintaining a dividend at the same rate.

COVENTRY ELECTRIC TRAMWAYS CO.—The net earnings for 1905 amounted to £6,597. 11s. 5d., an increase on the previous year of £3,187. 8s. 3d. The gross earnings were £20,684. 14s. 3d., against £15,981. 10s. 4d., the cost of operation being £14,087. 2s. 10d. and £12,571. 7s. 2d. respectively. The directors recommend a final dividend of ½ per cent. (making 3 per cent. for the year) and that £1,850 be placed to reserve.

DEUTSCH-ATLANTISCHE TELEGRAPHENGESELLSCHAFT, COLOGNE.—The report for 1905 states that the company acquired the Emden–Vigo cable of the Deutsche See-Telegraphengesellshaft on Jan. 1, 1905. The company own half the share capital of the Norddeutsche Seekabelwerke Aktiengesellschaft, which amounts to 3,000,000m., and the dividend (15 per cent.) on those shares will be included in the accounts for the current year. The amount brought forward from 1904 was 417,382m., interest received amounted to 172,877m., traffic receipts were 3,487,355m., and the Government subsidy was 309,530m., total 4,387,146m. (about £219,357). After meeting expenses (including working costs of 623,193m., cable repairs 162,645m., and contributions to cable amortisation and renewal funds 595,955m.) and writing 127,526m. off cable in stock, apparatus, buildings, &c., the profit is 2,648,940m. (£132,447). A dividend of 6½ per cent. is recommended, against 6 per cent. for 1904 and 5½ per cent. for 1903.

MARKET DRAYTON ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting on Wednesday Mr. R. C. Donaldson-Hudson moved the adoption of the report, which stated that the profit for the past year was £515. 2s. 5d. During the year over 1,000 additional 8 c.p. lamps were connected, the total number now being equivalent to 8,226 8 c.p. lamps.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The directors' report for the year to Dec. 31 last states that there is (after allowing for interim dividends on preference and ordinary shares, interest, and providing for a sinking fund for the redemption of the share capital, calculated over a period of 50 years) £16,335. 2s. 11d. available for distribution. After providing for balance preference dividend, the directors recommend a final dividend of 4 per cent. on the ordinary shares (making 7 per cent. for the year). The telephone exchanges worked by the company continue to expand, and this has been particularly noticeable at Rangoon and Singapore. Underground cabling operations are steadily proceeding in Bombay and Singapore, and work is now going on in Calcutta, Rangoon and Madras. The Indian local companies have paid the same dividends as for 1904 (the Bengal Co. 5 per cent., and the Bombay Co. 6 per cent.) and the Telephone Co. of Egypt has declared dividends of 7½ per cent. That company continues to receive further contracts from the Government of H.H. the Khedive for the installation of additional provincial telephone lines. The China & Japan Telephone & Electric Co.'s exchange at Hong Kong has made considerable progress during the year. The underground and overhead cabling is now almost completed.

RAWORTH'S TRACTION PATENTS (LTD.)—The report for the 14 months ended Dec. 31 states that the gross profit was £4,428, and the expenditure (including £636 written off preliminary expenses, furniture and experiments and development accounts) £3,159, leaving £1,269. The directors propose dividends at rate of 6 per cent. on amounts paid up on 10,224 preferred ordinary and 4 per cent. on 15,000 deferred ordinary shares. There are now 89 cars in operation with Raworth's regenerative control. Mr. Raworth has accepted the office of managing director and has appointed the company sole agents for the sale of his foreign and colonial patents.

READING ELECTRIC SUPPLY CO. (LTD.)—Capital expenditure on Dec. 31 amounted to £144,312. 2s. 11d. The total revenue for the year was £17,001. 5s. 3d. and expenditure (including generation and distribution costs, management expenses and £2,100 written off to depreciation) was £9,716. 11s. 5d., leaving a profit of £7,284. 13s. 10d. £7,315. 17s. 3d. is available for dividend, and the directors recommend a dividend of 5 per cent. (tax free) on the ordinary shares for the year. The new gas-producer plant and engines have not yet been formally handed over by the contractors. During the year there was a net increase of lamp connections of the equivalent of 12,531 8 c.p. lamps. Since Dec. 31 the total number of lamps added and applied for is 2,248, making total connections and applications to date equivalent to 93,594 8 c.p. lamps, in which is included the equivalent of 1,026 H.P. of electric motors.

SOUTHPORT TRAMWAYS CO. (LTD.)—At the meeting to-day (Friday) the directors reported that after paying rental of lines and interest charges (£7,170. 2s. 11d.) the loss for the year was £709. 8s. 4d. Since the commencement of the present lease an annual payment of £1,053. 9s. 8d. has been made to Southport Corporation towards maintenance, repair and renewal of the permanent way and electrical equipment within the borough. £1,199. 19s. 11d. is payable to the British Electric Traction Co. as interest on money advanced to the company in 1902 and 1903 for the purchase of shares in the Birkdale District Electric Supply Co. The Birkdale Co. is now working at a profit, and the loss accrued since the commencement of working has been liquidated. The tramways, apart from the company's investment in the lighting company, show a profit of £490. 11s. 7d.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

HELIS CELL & ACCUMULATOR CO. (LTD.) (88,437.)—Reg. April 18, capital £1,000 in £1 shares (666 preference), to carry on the business of electrical engineers, manufacturers of and dealers in electrical and mechanical apparatus and goods, &c. First directors, J. T. Szek and H. Hunt. Reg. office, 12, New Oxford-street, London, W.C.

KEELER & CO. (LTD.) (88,465).—Reg. April 20, capital £5,000 in £1 shares, to acquire the business carried on at 12, New Chesterfield-street, Marylebone, as Keeler & Co., to adopt an agreement with E. M. Collins, and to manufacture and fix telephones, telegraph, electric bells, phonographs, electric light and other apparatus, &c. Reg. office, 12, New Chesterfield-street, Marylebone, London.

RHONDDA TRAMWAYS CO. (LTD.) (88,415.) Reg. April 13, capital £200,000 in 200,000 ordinary shares of 5s. each and 150,000 $5\frac{1}{2}$ per cent. cumulative preference shares of £1 each, to adopt an agreement between the District Council of Rhondda and the Tramways Development Co., to enter into agreements with the Rhondda Tramways Construction Co., to construct, equip, work and maintain the tramways authorised by Rhondda District Council (Tramways, &c.) Act, 1902, or any part thereof, &c. The subscribers are, L. B. Schlesinger, J. C. Saunders, W. B. Cownie, B. Bernheim, J. T. Jervis, E. A. Mitchell and R. Watson. First directors, L. B. Schlesinger, J. C. Saunders, W. B. Cownie, B. Bernheim and J. T. Jervis. Reg. office, Queen Anne's-chambers, Westminster, S.W.

W. W SCOTT & CO. (LTD) (6,169)—Reg. in Edinburgh April 20, capital £5,000 in £1 shares, to carry on the business of opticians, electricians, &c. First directors, W. W. Scott and W. Cousin, A. Cousin and R. Scott. Reg. office, 180, Sauchiehall-street, Glasgow.

VULCAN DYNAMO & MOTOR CO. (LTD.) (88,445.)—Reg. April 18, capital £6,500 in £1 shares, to adopt arrangements with Mr. W. R. Saltrick and with Messrs. W. Geipel and F. M. T. Lange, and to carry on the business of mechanical and electrical engineers and contractors, manufacturers of and dealers in dynamos, lamps, cables, insulating materials and accumulators, &c. The subscribers are H. Chitty, electrical engineer, W. Geipel, engineer, F. M. T. Lange, engineer, D. J. Edmonds, W. R. Saltrick, W. H. E. Godolphin, and A. J. Edmonds. Permanent directors, H. Chitty, W. Geipel, F. M. T. Lange and D. J. Edmonds. Reg. office, 72A, St. Thomas-street, London, S.E.

STATUTORY RETURNS.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—According to return to April 12 capital is £100,000 in 99,900 ordinary and 100 founders' shares of £1 each, of which 59,400 ordinary and 100 founders' have been taken up. £1 per share has been called up and £59,500 has been received. Mortgages and charges, £40,880.

LONDON ELECTRIC SUPPLY CORPN. (LTD.)—In return to March 8 capital is £950,000 in 200,000 ordinary shares of £3 each and 70,000 preference shares of £5 each, of which 110,000 ordinary and 59,840 preference have been taken up. £3 per share has been called up on the ordinary and £5 per share on the preference and £632,360 has been received, including £160 paid on 160 forfeited shares. Mortgages and charges, £374,395.

LONDONDERRY-MOVILLE ELECTRIC RAILWAY SYND. (LTD.)—Return to Jan. 14 gives capital as £10,000 in £1 shares, of which 6,507 have been taken up. £1 per share has been called up on 1,507 and £1,425. 5s. has been received, leaving £81. 15s. in arrears. £5,000 is considered as paid on the remaining shares. Mortgages and charges, nil.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—Return to March 29, capital is £1,000,000 in 100,000 preference and 100,000 ordinary shares of £5 each, of which 75,000 preference and 75,000 ordinary have been taken up. £5 per share bas been called up on 64,241 preference and 67,029 ordinary and £656,350 has been received. £93,650 is considered as paid on 10,759 preference and 7,971 ordinary. Mortgages and charges, £250,000.

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—The capital in return to March 14 is £10,000 in 5,000 ordinary and 5,000 preference shares of £1 each, of which 4,561 ordinary and 1,151 preference have been taken up £1 per share has been called up and £5,712 has been received. Mortgages and charges, £5,140.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—Return to March 6 gives capital as £100,000 in shares of £1 each, of which 61,094 have been taken up. £61,094 has been received. Mortgages and charges, £42,100.

SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.)—Return to March 17 gives capital as £100,000 in 10,000 shares of £10 each, all of which have been taken up. £10 per share has been called up on 9,000 and £7 per share on 1,000 and £97,000 has been received. Mortgages and charges, nil.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)—In return to March 2 capital is £100,000 in 20,000 shares of £5 eacb, of which 12,000 have been taken up. £60,000 has been received. Mortgages and charges, £58,000.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—Return to March 14 gives capital as £2,000,000 in 200,000 ordinary and 200,000 preference shares of £5 each, of which 110,000 ordinary and 81,279 preference have been taken up. £5 per share has been called up on 110,000 ordinary and 31,379 preference and £1 per share on 50,000 preference. Mortgages and charges, £250,000.

MORTGAGES AND CHARGES.

BASTIAN & PARTNERS (LTD.)—Issue on March 24 of £2,700 10 per cent. debentures, part of series created July 1, 1905, to secure £4,000, charged on company's undertaking and property, present and future. No trustees. No previous issue of same series.

GENERAL INTERNATIONAL WIRELESS TELEGRAPH AND TELEPHONE CO. (LTD.)—A charge, dated April 18, 1906, to secure £150 and further advances up to £450, charged on the company's patents, has been registered. Holder, F. W. Derby.

PREMIER ELECTRIC LAMP CO. (LTD.)—Particulars of £3,000 debentures, created by resolutions of March 29, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been filed. No trustees.

CITY NOTES.

MEMORANDA (April 26).—Bank rate $3\frac{1}{2}$ per cent. (since April 5, 1906). Price of silver $29\frac{7}{16}$d. per oz. Consols $90\frac{5}{16}$—$90\frac{7}{16}$ for money, $90\frac{9}{16}$—$90\frac{11}{16}$ for account; $2\frac{1}{2}$ per cent. annuities $89\frac{1}{8}$—$89\frac{5}{8}$. Consols Pay Day, May 4, Stocks and Shares Continuation Day, May 9; Ticket Day, May 10; Pay Day, May 11; Mining Share Carry-over Day, May 8.

CIA. TELEGRAFICO-TELEFONICA DEL PLATA (BUENOS AYRES).—This company has declared a dividend of 12 per cent. for 1905.

LONDON ELECTROBUS CO. (LTD.)—This company (which has a capital of £305,000) has issued this week a prospectus inviting applications for 300,000 ordinary shares of £1 each. The subject is commented upon in our editorial columns.

MONTE VIDEO TELEPHONE CO. (LTD.)—The directors have resolved to pay an interim dividend for the six months ended Jan. 31, at the rate of 4 per cent. per annum on the ordinary shares, besides the first instalment of the 5 per cent. preference dividend, payable May 1.

MONTREAL LIGHT, HEAT & POWER CO.—A dividend has been declared for the three months to April 30 at rate of 4 per cent. per annum, payable May 15.

SIMPLEX CONDUITS (LTD.)—The success attained by the Simplex Steel Conduit Co. (Ltd.) in placing upon the market during the past eight years their special makes of tubing for electric wiring for all purposes, has, as our readers are aware, been very complete, and has led to a great and constantly increasing demand for the company's manufactures. This success has, in the nature of things, necessitated the employment of considerable capital, and, as will be seen from our advertisement pages, the prospectus is now issued of Simplex Conduits (Ltd.), which has been formed to take over the old-established Simplex Steel Conduit Co., and to provide capital for greatly extending the use of "Simplex" specialities. Subscriptions are now invited for an issue of 8,000 6 per cent. cumulative preference shares of £5 each. The company has an authorised share capital of £100,000, divided into 10,000 6 per cent. cumulative preference shares of £5 each and 50,000 ordinary shares of £1 each. £40,000 of these ordinary shares will be issued as fully paid to the vendor company (the Simplex Steel Conduit Co., Ltd.), in part payment of the purchase money, and when the present issue is taken up there will remain 2,000 of the preference shares and 10,000 of the ordinary shares to be issued as occasion requires. The operations of the vendor company have, as we have said, extended over a period of eight years, and the profits during the past six years, as set out in the prospectus, average £12,231. 12s. 5d. per annum, while the net sales for 1906 show a satisfactory increase over those for the corresponding period of last year, with slightly better prices. These profits provide ample funds for meeting the dividends on the present issue of cumulative preference shares, and leave a large margin for all possible contingencies. Owing to the development of the business it has been found necessary to build and equip a large new up-to-date factory at Birmingham, with foundry attached. with a view to meeting the increased demand for the company's manufactures and reducing the works cost to the lowest possible figure. The prospectus gives investors very full particulars of the undertaking acquired by the new company, and the fact that the entire prospectus is published will put intending investors in possession of all the main facts. The valuation of the company's assets, as made by Mr. Alexander Smith, M.Inst.C.E., are set out in the prospectus, and it will be seen that Mr. L. M. Waterhouse, A.M.Inst.C.E., M.I.E.E., whose name is so closely identified with the Simplex Co. and the "Simplex" specialities, is a member of the board of directors of the new company. The list of subscriptions opened yesterday (Thursday) and will close on Monday next for both town and country.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of £100,000 deferred ordinary stock of the *British Columbia Electric Railway Co. (Ltd.)*, and also to grant quotations to a further issue of £37,100 5 per cent. first debentures of the *Costa Rica Electric Light & Traction Co. (Ltd.)*, and £400,000 4 per cent. debentures of the *India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.)*

TORONTO RAILWAY CO.—The gross earnings for 1905 were $2,747,324.58; operating expenses, $1,560,437.42. After paying interest on bonds, &c., and four quarterly dividends of $1\frac{1}{4}$ per cent. each, there is a surplus of $292,583.70. The capital expended during the year was $507,493.79. Extensions of the system, aggregating about 7 miles, were completed during 1905, and a further extension (about $24\frac{1}{2}$ miles) is under construction.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 21	1,815	+ 142	47	62,875	− 305
Airdrie	,, 18	229	+ 82	15	8,909	+ 348
Anglo-Argentine	,, 22	15,144	+ 1,883	16	239,689	+ 24,862
Ashton-under-Lyne Corpn.	,, 14	524	+ 247	3	1,219	+ 336
Ayr Corporation	,, 14	265	+ 22	49	13,891	+ 11
	,, 21	320	+ 69			
Baker St. & Waterloo Ry.	,, 21	1,523	...	6	9,071	...
Barnsley	,, 13	176	+ 22	15	2,298	+ 32
Barrow	,, 18	310	+ 91	15	3,117	+ 300
Bath Electric Trams, Ltd.	,, 18	1,272	+ 669	16	10,933	+ 2,053
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 21	699	...	3	1,474	...
*Birmingham & Mid.	,, 15	1,454	− 372	15	20,813	− 5,342
Blackburn Corporation	,, 18	1,867	+ 999	¶3	4,052	+ 1,140
Blackpool Corporation	,, 19	2,273	+ 1,811	2	3,189	+ 1,936
Blackpool and Fleetwood	,, 21	9·2	+ 385	6	4,320	+ 773
Blackp'l St. Anne's & Lytham	,, 19	1,053	+ 866	§24	4,697	+ 1,197
Bolton Corporation	,, 22	2,071	− 283	3	7,136	+ 430
Bournemouth Corporation	,, 18	2,605	+ 1,611	†3	4,764	+ 2,100
Bradford Corporation	,, 14	4,539	+ 575	3	14,664	+ 2,801
	,, 21	5,870	+ 1,904			
Brighton Corporation	,, 22	1,090	+ 97	3	3,115	+ 315
Bristol Trams & Carriage	,, 20	6,539	+ 1,341	10	49,553	+ 4,210
Buenos Ayres & Belgrano	,, 22	3,697	+ 198	16	56,822	+ 4,456
Buenos Ayres Elec. Trms.	Mar. 24	1,452	+ 227	12	17,020	+ 3,789
Burnley Corporation	April 21	1,091	− 276	3	3,969	+ 281
Burton Corporation	,, 22	333	+ 13	§3	957	+ 1
Bury Corporation	,, 15	1,281	...	2	2,332	...
Calcutta Tramways Co.	,, 21	R41,181	+ R5,438	16	R702,314	+ R69,728
Camborne-Redruth	,, 21	121	...	25	2,695	+ 69
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 13	93	+ 48	15	746	+ 163
Central London Railway	,, 21	6,359	+ 143	16	109,330	− 4,012
Chatham & Dist. Lt. Rys.	,, 19	887	+ 259	†16	9,418	+ 80
*City of Birm'gh'm Tram Co.	,, 13	5,879	− 331	15	76,679	− 3,555
City & South London Rly.	,, 22	2,715	+ 190	16	46,659	+ 194
Colchester Corporation	,, 19	295	+ 105	36	6,295	− 1,293
Cork Electric Trams Co.	,, 19	508	+ 60	16	6,658	+ 83
Derby Corporation	,, 21	931	+ 231	3	2,506	+ 382
Devonport & Dist. Trams.	,, 13	581	+ 102	15	6,149	− 278
Dover Corporation	,, 21	291	+ 75	3	769	+ 152
Dublin & Lucan Railway	,, 20	166	+ 32	‡16	1,545	− 30
Dublin United	,, 20	5,886	+ 1,292	‡16	72,616	+ 2,479
Dudley—Stourbridge	,, 13	832	+ 51	15	11,121	+ 260
Dundee Corporation	,, 18	1,042	+ 278	§48	45,563	+ 4,745
East Ham Council	,, 21	1,132	+ 331	3	3,072	+ 773
Exeter Corporation	,, 20	386	+ 151	3	883	+ 215
Gateshead & Dist. Trams.	,, 13	1,029	+ 140	15	13,587	+ 748
Glasgow Corporation	,, 21	16,576	+ 1,860	47	720,157	+ 49,594
Glossop	,, 14	143	+ 22	16	1,989	+ 218
	,, 21	135	+ 8			
Gloucester Corporation	,, 18	410	+ 129	†3	791	+ 66
Gravesend—Northfleet	,, 13	252	+ 37	15	2,959	+ 135
Gt. Northern & City Rly.	,, 21	1,7 9	+ 125	16	23,903	+ 1,073
*Greenock & Port Glasgow	,, 13	817	+ 121	15	8,704	+ 708
Halifax Corporation	,, 18	2,627	+ 1,329	3	4,992	+ 1,204
Hartlepool Tramways	,, 13	322	+ 90	15	3,787	+ 230
Hastings Elec. Trams Co.	,, 19	1,237	...	16	6,868	...
Huddersfield	,, 21	1,958	+ 693	3	4,872	+ 1,130
Hull Corporation	,, 21	2,388	+ 193	3	6,923	+ 80
Ilford Dist. Coun.	,, 21	636	+ 190	3	1,668	+ 312
Ilkeston Dist. Council	,, 18	156	+ 46	3	379	+ 45
Ipswich Corporation	,, 21	499	+ 71	3	1,343	+ 106
Isle of Thanet Co.	,, 21	644	+ 154	28	8,096	− 349
Keighley Corporation	,, 19	214	+ 86	42	5,838	...
Kidderminster & District	,, 13	108	+ 10	15	1,348	− 13
Kilmarnock Corporation	,, 21	160	+ 13	49	7,551	...
Kirkcaldy Corporation	,, 18	213	+ 11	7	1,422	− 4
Lanarkshire Trams Co.	,, 19	918	+ 287	†16	13,178	+ 3,039
Leamington	,, 13	167	+ 122	15	1,997	+ 837
Leeds Corporation	,, 21	7,409	+ 1,995	3	19,500	+ 8,262
Leicester Corporation	,, 21	2,634	+ 672	15	32,984	+ 4,116
Leith Corporation	,, 21	468	+ 199	48	18,414	+ 12,751
Liverpool Overhead Rly.	,, 22	1,551	+ 79	16	22,834	− 1,325
Liverpool Corporation	,, 14	10,969	+ 508	15	154,089	+ 5,061
*London County Council	,, 14	16,547	+ 1,957	2	30,506	+ 8,510
London United	,, 20	9,223	+ 3,717	†16	83,337	+ 7,379
Lowestoft	,, 21	164	+ 16	30	3,881	+ 86
Maidstone Corporation	,, 19	144	+ 87	3	316	+ 23
Manchester Corporation	,, 21	18,929	+ 1,289	3	40,817	+ 4,467
Mersey Railway	...	...	...	...	...	...
Merthyr	,, 13	228	+ 21	15	2,643	− 1
Metropolitan Dist. Railway	,, 22	7,401	+ 857	16	127,369	+ 6,793
*Metropolitan Elec. Trams	,, 13	4,311	+ 2,291	15	42,822	+ 14,017
Middleton	,, 13	408	+ 115	15	4,593	+ 822
Nelson Corporation	,, 21	136	− 17	..	...	...
Newcastle-on-Tyne Corp.	,, 21	4,601	+ 795	3	12,450	+ 1,323
Newport (Mon.)	,, 21	720	+ 151	3	1,978	+ 300
Northampton Corporation	,, 20	583	+ 195	3	1,279	+ 246
Oldham, Ashton & Hyde	,, 13	657	+ 131	15	7,659	+ 374
Oldham Corporation	,, 22	1,891	+ 263	4	7,274	+ 557
Perth (N.B.) Corporation	,, 11	153	...	23	3,409	...
	,, 18	163	...			
Perth (W. A.) Elec. Trams	,, 20	1,548	+ 112	†16	24,492	+ 1,808
Peterborough	,, 13	156	+ 42	15	1,485	− 64
Pontypridd District Coun.	,, 21	265	+ 1	3	616	+ 79
Portsmouth Corporation	,, 21	2,133	+ 708	3	6,237	+ 889
Potteries	,, 13	1,797	+ 148	15	25,701	+ 1,480
Preston Corporation	,, 18	912	+ 378	...	...	...
Reading Corporation	,, 12	618	+ 17	3	1,954	+ 195
	,, 19	171	+ 170			
Rochdale Corporation	,, 21	1,170	+ 554	3	3,485	+ 1,658
Rotherham Corporation	,, 19	688	+ 301	3	1,447	+ 283
Rothesay	,, 13	201	+ 120	15	910	+ 188
Salford Corporation	,, 23	4,024	− 779	3	14,825	+ 246
Sheerness	,, 11	51	− 12	15	693	− 131
Sheffield Corporation	,, 22	5,664	+ 1,041	4	20,895	+ 1,977
Southampton Corporation	,, 18	1,157	+ 305	†3	2,526	+ 361
Southend Corporation	,, 11	285	+ 81	3	973	+ 251
	,, 18	553	+ 231			

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ‖ Plus 4 days. ¶ Plus 8 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	April 13	822	+ 69	15	3,543	+ 63
S. Staffordshire Trams.	,, 13	816	+ 135	15	11,403	+ 1,753
Stalyb'dge, Hyde &c., Jt Bd.	,, 21	806	+ 100	3	2,456	+ 900
Stockport Corporation	,, 20	1,890	+ 610	3	3,020	+ 1,174
Sunderland & District	,, 11	688	...	2	1,049	...
Swansea Trams	,, 13	925	+ 439	15	10,770	+ 3,879
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 13	44	− 6	15	608	− 10
Tynemouth and District	,, 13	281	+ 103	15	2,520	− 45
Tyneside Trams Co.	,, 4	392	+ 7	16	6,079	+ 703
	,, 11	413	+ 74			
	,, 18	927	+ 589			
Wallasey District Council	,, 21	913	+ 210	3	2,384	+ 828
Walsall Corporation	,, 21	692	+ 242	14	7,863	+ 732
Warrington Corporation	,, 19	426	+ 112	3	1,127	+ 187
West Ham Corporation	,, 19	2,916	+ 1,739	3	7,388	+ 3,880
Weston-super-Mare	,, 11	59	+ 11	15	451	− 13
Wolverhampton Corpn.	,, 18	1,118	...	3	2,596	...
* Wolverhampton District	,, 13	392	+ 39	15	5,531	+ 456
* Worcester	,, 13	2·0	− 4	15	3,487	− 331
Wrexham	,, 13	121	− 1	15	1,408	− 3
Yorkshire W.R. Trams	,, 22	1,301	+ 524	16	11,767	...
Yorkshire Woollen District	,, 13	895	+ 305	15	12,073	+ 3,81

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., April 25.	Rate per Cent. Yielded. £	s.	d.	Dividend Due.	Business, Week to April 25. Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.							
5	5/0	†Anglo-Argentine Ord. Shares	8¼—8¾	4	10	6	Ap, Oct	8⅛	8
5	2/9	Do. 5½% Cum. Pref.	5⅞—6⅛	4	10	0	—	6	6
St.	6%	Do. Permanent 6% Deb. Stock	140 —145	4	3	9	—	—	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4	14	3	—	105	..
5	..	Brisbane Electric Trams. Invest Ord.	⅞—1⅛		..		..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅛	6	1	4	—	.	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	13 —16	4	13	9	—	.	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	120 —123	4	17	6	—		..
St.	5%	Do. Pref. Ord. Stk	110 —113	4	8	4	—	11	110½
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4	11	0	—	10	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	101%—103%	4	7	8	—	.	—
100	4½%	Do. Vancouver Power Debs.	102 —105	4	5	0	—	..	..
5	8/0	† Buenos Ayres and Belgrano Ord.	5⅜—5⅝	5	7	6	—	3	..
5	8/0	† Do. 6 per Cent. "A" Cm. Pref	5⅝—5⅞	5	2	6	—	..	..
5	8/0	† Do. "B"	5 —5½	5	7	0	—	5¼	5⅛
St.	5%	Do. 5 per Cent. Debs.	106 —108	4	12	6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4	15	0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	101 —103	4	17	0	..		..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	102 —106	5	4	3	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	100 —105	5	14	0	..	.	—
5	4/6	†Calcutta Tramways (Nos. 1 to 105)	8¾—9¼	4	6	6	—	9	9
5	2/6	Do. Nos. 105,001 to 137,610	8½—9	4	9	0	..	8⅞	8¾
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4	3	8	—	..	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5	14	0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	102 —104	4	16	0	—	.	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 —97%	5	2	6	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 —93		..		..	91½	91
St.	..	Do. "B" Ditto	83 – 88		..		..	85½	8¼
1	..	Lisbon Elec. Trams Ord.	1½—1⅝		..		..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4	7	4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4	17	0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	103 - 106	4	14	8	Ja, Jul	.	..
100	5%	Montreal St. Ry. St'g 5% Mort. Debs. (1908)	101 —103	4	17	0	—	..	..
100	4½%	Do. Sterling 4½% Debs. (1922)	102 —104	4	6	6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —108	4	12	6	..	—	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	145 – 148		..		..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5	0	0	..	99¾	99⅞
		ELECTRICITY SUPPLY.							
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5	11	6	..	.	—
1	7/5	Calcutta Elec. (1-50,000)	9⅛ 9⅝	4	5	4	—	9¼	..
100	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4	16	0	..	.	..
.	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5	4	0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3		..		..	..	—
St.	5%	Do. 5% Debs.	88 —92	5	9	4	—	..	..
10	..	Havana Electricity Co. Shares	8½—9½		.		—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	95 —97	5	2	6	..	..	..
St.	£6/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	111 —114	5	5	0	—	..	..
1	5·38d	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞ -1	6	0	0	—	29/32	..
1	1/0	Rand Electric	1¼—1⅜		..		—	.	..
1	..	River Plate Electricity Co. Ord.	1⅛ – 1⅜		..		..		1 7/16
1	1/2⅞	Do. 6% Non. Cum. Pref.	15/16 – 1 1/16		..		..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4	17	0	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅜—5⅝	5	8	6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4	8	0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 —103	4	17	0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., April 25.	Rate % Yielded.	Dividend Due.	Business, Week to April 25.	
				£ s. d		Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10½—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 8 3	..	..	..
5	3/6	†Bromley (Kent) El. Lt. & Power Shares	5⅛—5⅝	4 18 0	..	..	—
St	4½%	Do. Do. 1st Debs	103 —106	4 5 0	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord	8½—9½	5 8 6	—	..	..
5	3/6	Do. 7 per Cent. Pref.	8½—9½	3 15 6	Mar, Sept	..	..
St	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 —105	3 16 3	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	4½	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	101¾	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 —4½	5 0 0	—	..	..
5	2/3	Do. Do. (1903)	4 —4½	5 0 0	—	.	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	5⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —109	4 2 6	Jn, Dec ..	..	.
10	7/0	City of London Electric Lighting Ord.	10½—11	5 9 0	Feb, Aug	10 15/16	10⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 6	Jan, July	13 1/16	13
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	101½	..
5	4	County of Durham Elec. P. D. Ord. £3 pd.	2 31/32—3 1/16	3 19 1	April, Oct	3 1/16	2 31/32
5	5%	† Do. Do. 5% non cum. pref.	5⅛—5⅜	4 15 3	April, Oct	5¼	..
10	6/0	County of London Elec. Supply Ord.	8 —9	5 11 0	—	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Mar, Sept	12 1/16	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 6	..	102½	..
5	3/6	†Folkestone Electricity Supply Co. Ord.	3⅛—3⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	—	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	—	..
5	5/0	†Hove Electric Lighting Ord.	8¼—8¾	5 5 0	..	8 9/32	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	100 —103	4 7 5	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾—10¼	4 18 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4½	London Electric Supply Ord.	2 —2½	4 0 0	—	4⅜	4¼
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	5⅛	5 1/16
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	3 19 2	Mr, Jn, S, D	100	..
5	10%	Metropolitan Electric Sup. Ord.	8¼—8½	5 5 0	April, Oct	8 13/16	8⅝
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 2 0	Jan. July	5 15/32	5⅜
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Ju, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 3	—	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	101 —103%	4 7 4	—	102	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞—11⅛	5 14 9	Feb, Aug	..	..
100	..	Do. 4½% Deb.	101½—102½	4 6 6	Jan, July	102	..
5	8%	Newcastle Elec. Supply Ord.	7⅜—7⅝	5 6 8	Feb, Aug	7 7/16	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6 —6⅛	4 2 5	Feb, Aug	6	5⅞
100	4%	Do. 4% Mort. Deb. red. 1907	99½—100½	4 0 0	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	⅞—29/32	3 6 8	Mar, Aug	..	..
100	..	Do. 4½% Deb.	101 —102	..	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	—
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	—
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	9 —10	6 5 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	3¼	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	..	—
1	0/8¾	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	4¼ 4¾	5 5 0	—	—	—
5	2/6	Do. 5% Cum. Pref.	4 15/16—5 1/16	4 14 0	—	—	..
St.	4½%	Do. 4½% 1 Mort. Deb.	102 —104	4 6 6	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	9½—10½	6 4 0	Mar, Sept	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16—5 9/16	4 10 0	..	5 15/32	5⅜
5	..	Do. Issued at 7/6 premium all paid	5 5/16—5 9/16	..	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4 Perp. Db. St.	97 —99	4 1 0	..	..	..
1	—	Bath Elec. Trams Pref. Ord.	15/16—1 1/16	..	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16—1 1/16	4 12 3	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 —103	4 7 3	—	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	102	101½
10	9½%	Bristol Tramways and Carriage Ord.	15½—15¾	5 15 2	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10¼	3 18 0	..	—	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	6 —7	4 5 8	—	6¾	6¼
10	6/0	Do. 6 per Cent. Cum. Pref.	8⅞—9⅜	6 8 0	Feb, Aug	9¼	9
St.	5%	Do. 5 per Cent. Perpetual Debs	111 —114	4 8 11	..	113	111¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	96½—98½	4 11 10	..	96½	..
St.	4%	Central London Ordinary Stock	90 —92	4 7 0	June, Dec	91¾	90¼
St.	4%	Do. 4 per Cent. Pref. Stock	100 —102	3 18 6	..	101½	100¼
St.	4%	Do. Deferred Stock	81 —84	4 15 0	..	82⅜	81
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	95 —97	4 2 6	..	96	95
5	2/6	† City of Birmingham Trams. 5% Cm. Prf.	5 —5¼	4 15 0	..	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	41 —43	4 7 0	Feb, Aug	43	42
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	115 —118	4 4 8	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	106 —109	3 13 4	May, Nov	107¾	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	4 —4½	9 8 2	..	4 7/32	4⅛
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8 —9	4 8 11	—	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	—	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	106½—107½	4 8 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2¼—2¾	9 8 6	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3 11/16—3 15/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9½—10	5 0 0	—	9¾	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 —99	4 1 0	—	98	97½
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	..	⅛
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	29/32	⅞
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	103½	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½—1½	..	May	..	..
10	8/0	†Potteries Electric Traction Ord.	8 —9	5 15 0	..	—	..
10	5/0	Do. 5 per Cent. Cum. Pref.	9 —9½	5 5 0	Feb, Aug	—	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 0	—	—	—
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	..	..
..	5%	Underground Elec. Rys. Co. of London	97 —99	5 1 0	..	97⅝	..
St.	3½%	Waterloo and City Ord.	100 —103	3 3 0	June, Dec	102	..
St.	4½%	Yorkshire W.R. El. Trs. Co. 4½% 1st Debs.	95 —97	4 13 0	—	..	—

Shre.	Last Dividend	Name.	Price Wed., April 25.	Rate % Yielded.	Dividend Due.	Business Week to April 25.	
				£ s. d.		Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	6d.	Alliance Elec. Co. 5% Cum. Pref.	⅝—⅞	5 6 6	—	—	..
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	1/7½	Babcock & Wilcox Ord.	3⅞—4⅛	4 17 9	..	4 1/16	4 1/32
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6½—7	5 14 0	July, Feb	6 11/16	6½
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	5⅞	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	103 —106	4 4 11	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞—2⅜	..	..	2¼	2⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 —85	4 14 0	..	81	..
2	1/0	†Brush Electrical Engineering	¾—1	..	March ..	¾	..
2	2/4½	† Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	1 11/16	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	98⅛	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10½—11½	4 7 0	Jan, July	11 1/16	11
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6	4 8 4	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	109	..
1	4½d.	Castner-Kellner Alkali Co.	1 1/16—1 3/16	5 1 6	..	1 3/32	1 3/32
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 —100	4 10 0	—	..	..
1	9¾d.	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	—	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2¼	3 9 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%—98%	5 2 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	9¾—9⅞	5 8 0	Sept	—	..
5	3/0	Do. 6% Cum. Pref.	1 5/16—1 7/16	4 6 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	—	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅝—1⅞	—	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½—3	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5 —5½	5 9 0	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	102½	..
2	1/7½	Electric Construction Co.	1 9/16—1 13/16	9 6 0	July	..	..
2	2/9¾	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅜—9⅞	5 3 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 —98	4 1 6	—	..	—
5	10/0	Henley's Telegraph Works Ord.	12½—13½	5 11 0	Feb, Aug	12⅞	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	—	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 —111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½—59½	..	..	..	—
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17½—18½	2 14 6	Feb, Aug	17⅝	17½
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	15/16	..
1	7½d.	Do. 6% Cum. Pref.	15/16—1 1/16	5 15 0	..	1	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 10 0	..	99½	..
12	24/0	Telegraph Construction & Mainten'ce.	33 —35	5 2 6	Mar, July	33¾	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2½—2⅝	5 14 3	..	2 9/16	2½
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1½	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	116 —119	4 4 0	—	116½	..
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	105 —107	3 14 8	..	106½	105¾
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 —108	4 3 8	..	108	..
5	—	Willans and Robinson Ord.	1¾—2¼	—	Apr, Oct	—	—
5	—	Do. 6 per Cent. Cum. Pref.	3½—4	—	Apr, Oct	..	—
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 —85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	3¾—4¼	..	Ju, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	..	..
St.	15/0	†Anglo-American	66 —68	4 15 6	F, My, Ag, N	..	..
St.	30/0	† Do. Preferred	113½—114½	5 5 0	F, My, Ag, N	114	112
St.	10/0	Do. Deferred	22 —22½	..	F, My Ag, N	22¾	20⅝
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	96 —98	4 1 6	Ju Ap, Jy, O	97½	96¾
10	5/0	Cuba Submarine Ord.	8¾—9¼	5 8 0	Feb, Aug	9⅛	9
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅝—3⅞	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
60	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 8	Jan, July	101½	..
20	4/0	Direct United States Cable.	15¾—16¾	4 5 0	Ja, Ap, Jy, O	15 15/16	15 15/16
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	25/0	†Eastern Ordinary	144 —147	4 16 0	Ja, Ap, Jy, O	146½	145⅞
St.	17/6	† Do. 3½ per Cent. Pref. Stock	89 —91	3 17 6	Ja, Ap, Jy, O	90½	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107½—109½	3 13 0	May, Nov	108½	..
10	2/6	Eastern Extension	14½—15	4 13 6	Ja, Ap, Jy, O	14 13/16	14¾
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 3	Feb, Aug	..	—
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 18 8	May, Nov	101¼	..
10	5/0	G. N. (of Copenhagen) with coupon 66	40 —42	5 15 0	Jan, July	40⅞	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 —103	4 7 3	June, Dec	..	..
25	12/6	Indo-European	58½—60½	5 7 6	May, Nov	59⅝	60¼
100	$1	Mackay Companies Common	66 1/16	3 0 6	Jan, July	—	..
100	4%	Do. Preference	75 3/16	5 6 8	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	1 3/32	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 —103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾—10¼	4 17 6	..	10 3/16	—
2½	—	West Coast of America	⅝—¾	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100 —102	3 18 3	Jan, July	100½	..
10	—	West India and Panama	⅝—¾	..	May, Nov	¾	9/16
10	6/0	Do. 6% 1st Pref.	8½—8¾	6 6 8	May, Nov	8¾	..
10	—	Do. 6 per Cent. 2nd Pref.	6½—7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	103	..
10	3/0	Western Telegraph	14 —14½	4 17 6	Mr, Jn, O, D	14⅜	14¼
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	100 —103	3 18 6	..	103	102½
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	8 —8½	4 17 0	August ..	—	..
1	0/9¾	Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	1/0	Do. 5% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	108 —110	5 9 0	—	109½	108
St.	5%	Do. Def. Stock	109½—111½	4 9 8	—	110¾	110
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	..	—
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—12½	4 16 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5½	4 11 0	Feb, Aug	—	—
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—101½	3 9 0	June, Dec	99½	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 3	—	104½	103
1	0/7½	Oriental	1⅛—1¼	4 0 0	April, Oct	1 7/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	1 5/16	..
St.	24/7½	Do. 4% Red. Deb. Stock	98 —100	4 0 0	..	100	—
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	..	—
5	3/0	United River Plate	7 —7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 7 0	June, Dec	5 11/16	5 21/32
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —112	4 9 3	June, Dec	110⅜	110½
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	..	..	..
10	2/0	Globe Telegraph and Trust	10⅞—11⅛	4 16 6	Ja, Ap, Jy, O	11⅛	10⅞
10	3/0	Do. 6 per Cent. Pref	14¾—15	4 0 0	Ja, Ap, Jy, O	14 13/16	14⅞
10	6%	†Submarine Cables Trust (Cert.)	126 —129	4 18 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE consideration of the London County Council's Electric Power Bill has been commenced in earnest, and Mr. JOHN H. RIDER, electrical engineer to the Council's Tramways department, to whose efforts the preparation of the technical details of the scheme was largely due, occupied the witness chair for the greater part of yesterday. The estimates he submitted will be read with interest by all power-station engineers, and we look forward to an instructive analysis of these figures, not only by Mr. RIDER himself and others who support the Bill, but also by its opponents and their witnesses. Mr. MERZ's estimates last year have done much to promote the extension of cheap electric power supply, and it is to be hoped that Mr. RIDER's will help us to fix our ideas as to the cost of generating and distributing electricity on a large scale. We also await with interest the policy that will be adopted by the powerful joint opposition with regard to these figures. The counsel and experts opposing the Administrative County of London Electric Power Bill last year endeavoured to show, in the first place, that it was impossible to generate at the low costs put forward by Mr. MERZ; and, secondly, that they could sell power as cheaply as he could in accordance with his estimates. To prove either one of these propositions would have been a reasonable course to adopt, but by taking the illogical attitude of trying to prove both of them at once they naturally spoilt their case. We also await with interest a statement as to the selling price that the London County Council propose to charge. No prices at all are included in the Bill, and yet specific statements were published some months ago as to the prices that were to be charged, and presumably their publication was authorised by the London County Council's officials. It may be noted, moreover, that, since the County Council proposes to bind itself by a clause similar to the famous "Northumberland" and "Bermondsey" clauses, by which the price of supply is to undergo revision in accordance with the profit and loss account of the undertaking, it can hardly have a maximum price fixed in the Bill; but on the other hand, the Council would be able to evade the provisions of the "Northumberland" clause by entering into long contracts for supply at a particular price, as such contracts are to be excluded from the operation of this clause. It is probable that the Committee will take exception to such an inconsistency. A full report of the proceedings before the Committee appears in our Parliamentary columns.

◆

ONE of the great problems that has confronted from the beginning the pioneers of electric wave telegraphy is that of despatching their message-bearing waves in a chosen direction. The solution of the problem carries two obvious benefits: some measure of privacy is thereby afforded, and energy is economised if all that is emitted can be poured in the proper direction. Mr. MARCONI's recent Royal Society Paper, reprinted on another page, describes his first steps towards this goal. The method he puts forward is simplicity itself, and consists merely in stretching the great part of an ordinary direct-excited air wire horizontally towards the receiving station. The degree of success attending this simple expedient is excellently expressed by the measurements and diagrams given in the Paper. From the curves it will be seen that the strength of signals received by stations on lines at an angle with the horizontal air wire is approximately proportional to the square of the cosine of the half angle. This is not a high degree of concentration along the desired line, but it constitutes, nevertheless, a great advance on the old equable distribution of energy. It is noteworthy, though, that over long distances, where, unfortunately, no precise measurements could be made, experiments point to a higher degree of concentration forward than is shown in the short range experiments quantitatively chronicled.

◆

THE converse problem of receiving signals only from selected directions is tackled by Mr. MARCONI in a precisely similar manner. Two advantages again follow upon the complete power of discriminating in azimuth. First, the source of the waves received can be located, and, second, undesired or obnoxious signals or disturbances, if not on the line of communication, can be shut out from the receiver. The first advantage would be extremely precious to the mariner, and the second would be welcome in every application of wave telegraphy. Mr. MARCONI'S curves show again that his device is a good step towards the solution of the problem of receiving with discrimination, and, also, that the device has the same limitations as afflict it at the transmitting station. Perhaps the most curious items of information offered concerning the receiving end are the success attained with wires placed on the ground, and the fact that signals were received best when the horizontal air wire was directed away from the sending station. Though these small points bear no immediately obvious explanation, the general principle of the proposed mode of directing the signals is clear. For when the horizontal air wire is charged, the lines of electric force are most concentrated in the plane of the air wire, and therefore a large proportion of the lines of force are despatched moving in that plane.

◆

AT the May-Day demonstration in Hyde Park, a member of the Electrical Trades Union delivered himself of a speech of a revolutionary character, and expressed opinions which, if avowed by other members of the Union, will do much to discredit it in the eyes of the electrical industry and employers of skilled labour generally. We quote the following report of his speech from the *Daily Telegraph* :—

> Mr. G. Pegg (Electrical Workers Union), who spoke from No. 2 platform, commented in sarcastic terms on the apathy and pacific ways of the English workers. In France, he proudly said, the May-Day demonstration had caused a panic among the rich, who fled in thousands to England, because they knew the easy-going methods of the English workers. He hoped the time would come when the rich in London would also have uneasy feelings on May Day, and instead of standing ogling the labour demonstration from their club windows in Piccadilly they would have to "scoot" somewhere for safety like their wealthy French friends. These observations were cheered wildly. It is but fair to add that only a small minority of Mr. Pegg's auditors were British-born.

On reading this, we wrote to the Secretary of the Electrical Trades Union—whose motto, by the way, is "Defence not Defiance"—asking whether Mr. PEGG is a member of the Union, if he was authorised to address the meeting as its delegate, and also whether the Union associates itself with the opinions expressed by him. We received the following remarkable reply :—

> THE EDITOR, "THE ELECTRICIAN,"
> 1, 2 & 3, Salisbury-court, Fleet-street, E.C.
>
> DEAR SIR : In reply to yours received this morning re May-Day Labour Demonstration, the Mr. G. PEGG referred to is a member of our trade union, but I cannot express any opinion on the *Daily Telegraph* report of the speech, not having been present at the meeting, but my knowledge of the member leads me to believe that he would only advocate true principles.—Yours faithfully, A. EWER.
>
> London, May 2nd.

Mr. EWER is general secretary of the Union, and we must express our surprise that he has not made use of the opportunity we have afforded him of dissociating himself and the Association which he represents from the truly violent principles and incitement to riot conveyed in Mr. PEGG'S harangue.

◆

THE prospectus will shortly be issued of a company, to be known as "The Gearless Motor Omnibus Company," to run petrol-electric omnibuses in London. The system to be employed is the Pieper "auto-mixte" system, which was fully described in *The Electrician*, Vol. LVI., p. 807. As will be remembered, the petrol engine drives a machine which acts either as dynamo or motor, according to circumstances, and is used in conjunction with a small battery of accumulators. When the car is standing, or when the full power of the engine is not needed for propulsion, the dynamo can charge the cells, but when extra torque is required for starting or hill-climbing, the battery drives the machine as a motor to assist the engine. Thus not only is the necessity for mechanical change-speed gears avoided, but a smaller engine is required than would be needed otherwise, as it has only to be capable of the average instead of the maximum horse-power. The combined electromagnetic clutch and brake has already been described and illustrated in the article referred to.

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THE system has been very favourably reported on by Mr. W. WORBY BEAUMONT, who made a practical trial of several of the cars last February in Belgium. The battery is, of course, quite small in size, and thus its upkeep does not form the preponderating item as it does in a vehicle entirely propelled by accumulators. In the particular omnibus which is to run on the London streets, it consists of 25 Tudor cells of 60 ampere-hours capacity at the one-hour rate, but capable, it is said, of giving about 400 amperes for short periods without undue strain. Each cell will contain nine plates, all $5\frac{1}{2}$ in. by 8 in., and the weight of the complete battery will be about $3\frac{1}{2}$ cwt. The conditions under which the battery works are favourable in-so-far as it will be very frequently receiving short charges, but, especially in careless hands, the discharge rate when starting on hills may be excessive. Also in the case of a route of which the average gradient is uphill there is some risk of the battery, if too small, becoming seriously discharged. Experience alone will tell whether the very small battery proposed will be equal to the work without greatly exceeding the figure of cost of maintenance (0·1d. per mile) set down in the prospectus.

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The weight of the complete vehicle will not greatly exceed that of a petrol 'bus, as the added weight of the electrical equipment is to some extent compensated by the absence of the gear box and the reduced size of the engine. Apart from the battery, the maintenance should compare favourably with that of a petrol 'bus, the cost of fuel should be slightly lower, and it is claimed that a saving will be effected on tyre maintenance, as the starting is smoother than with the ordinary petrol system. The directors of the new undertaking include Mr. E. Manville, Mr. Philip Dawson, and other well-known men, and we are pleased to see that the sum to be paid the vendors (the Cerol Syndicate, Ltd.) is of more reasonable proportions than in the case of a recent electric omnibus flotation commented on in these columns. A contract has been entered into with the London and Parisian Motor Co. for the supply of 150 chassis, and we understand that these will be constructed by Messrs. Turgan, of Paris, and the electrical equipment by Messrs. Pieper of Liège. We look forward with interest to a prolonged trial under practical working conditions, and would suggest that the omnibus should be entered for one of the long-distance reliability trials under the official supervision of the Automobile Club.

The article which we publish this week on the tests carried out on the Vienna–Innsbruck telephone line, which is "loaded" inductively according to the Pupin prescription, is of considerable value, and the Austrian Post Office deserves the thanks of telephone engineers for allowing a clear account of its experiments to be published. It is to be regretted that more information is not available with regard to the work that has been done by the Bell Company in the United States in this direction, for there it is not merely the case of a single experimental line, but several.

One of the most interesting conclusions of Herr Nowotny experiments is that it is not so necessary as was originally thought to space the inductance coils at exactly equi-distant intervals. Naturally, too great an irregularity is not permissible, for, as we all know, the extreme case of adding inductances at the ends of the line only impairs the distinctness of speech transmission instead of improving it. Some more tests as to the spacing of the coils will be useful, for if the distance between the inductances can be much greater and more irregular than was hitherto suspected, the solution of the problem of submarine telephony will be accelerated. Perhaps Mr. Oliver Heaviside would condescend to bring his theoretical investigations to bear on this practical point.

The observation that the "loading" of the line increases its sensibility to outside disturbances is interesting, but probably with a metallic circuit this action is not sufficient to have a marked prejudicial effect. It is a point that should be watched, however, owing to the parallel case of a submarine telegraph cable. If attempts are made to increase the speed of signalling through a telegraph cable by adding inductances, the disturbing inductive effects at the shore end—such as those which gave great trouble at Cape Town a few years ago—will also be increased.

Attention has again been drawn to the subject of smoke abatement by a Memorandum, mentioned more fully in another column, issued by the Commissioners of Works. In view of the number of electric power bills before Parliament, the opportunity is taken of repeating all the customary objections to the burning of coal in towns, especially as regards the deleterious effect on vegetation in the parks and gardens of which the Commissioners are the guardians, and the electric light station is, as usual, chiefly blamed. That the sulphurous acid and other products issuing from London chimneys do great damage to the plant life in our much-prized open spaces is only too true, but we cannot help agreeing with Sir Alexander Kennedy that it is the ordinary house chimney and not the chimney of the modern electricity works which is the chief sinner. With regard to coal, the Memorandum recommends the addition of a small quantity of lime to retain the sulphur as calcium sulphate. No precautions, however, are sufficient for the dust destructor station, which the Commissioners condemn to entire extinction.

Personal.—We are glad to inform our readers that Prof. Perry is progressing favourably towards recovery from the accident which he met with on Good Friday, but he is not yet allowed to see visitors. Col. Crompton was driving Prof. Perry in his motor car, when the car came into collision with a tramcar at Acton, and Prof. Perry was thrown out, severely injuring the upper part of his arm and bruising his face. The shock was so great that it was more than a week before an operation could be performed, when it was found necessary to remove a portion of the humerus and several small fragments of bone. Although Prof. Perry may not fully recover the use of the upper part of his arm, he is expected to be able to use his arm from the elbow downwards. We are glad to say that Col. Crompton escaped injury.

Birmingham Local Section of the Institution.—The report of the committee of the Birmingham Local Section of the Institution of Electrical Engineers has just been published. The committee for 1906-7 is as follows:—

Chairman: R. A. Chattock. *Past Chairmen:* J. C. Vaudrey (1903-4), W. E. Sumpner, D.Sc, (1904-5), R. Threlfall, F.R.S. (1905-6). *Vice-Chairman:* G. Kapp. *Members of Committee:* A. H. Bate, W. E. Groves, C. W. Hill, F. Hird, S. H. Holden, R. C. Jackson, Henry Lea, R. K. Morcum, D. K. Morris, Ph.D., R. Orsettich. *Hon Secretary:* H. B. Matthews.

During the past session the membership has increased by nine. The annual general meeting will be held on Wednesday next, May 9th, and a visit will also be paid on that day to the new power station which the Birmingham Corporation is erecting, under the supervision of Mr. R. A. Chattock, the Corporation's electrical engineer and the chairman-elect of the Birmingham Local Section.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Jamaica—Colon	Jan. 10, 1905	—
Cadiz—Teneriffe	July 20, 1905	*April 26, 1906
Tangier—Cadiz	Feb. 17, 1906	—
Paramaribo—Cayenne	April 20, 1906	—
Sydney—Nelson	April 26, 1906	—

* Restored provisionally.

The American Institute of Electrical Engineers.—The twenty-third annual convention of the American Institute of Electrical Engineers will be held at Milwaukee from May 28th to June 1st. The following Papers are included in the programme:—

"The Repulsion Induction Motor," by Mr. M. Milch; "Direct-Current Motor Design as Influenced by the Interpole," by Mr. C. H. Bedell; "Experiences with Lightning and Static Strains on 33,000 volt Transmission Systems," by Mr. F. Osgood; "Cell Type Lightning Arrester," by Prof. E. E. F. Creighton; "Protective Apparatus for Lightning and Static Strains," by Mr. H. C. Wirt; "Short-Circuit and Ground Currents in Alternating-Current Systems," by Dr. C. P. Steinmetz; "Magnetic Properties of Electrolytic Iron," by Prof. C. F. Burgess; "Measurement of Temperature by Electrical Means," by Mr. E. F. Northrup; "The Educational Value of an Electric Test Car," by Prof. T. F. Morgan; "The Art of Inventing," by Mr. E. J. Prindle; "Shunt and Compound-Wound Converters," by Mr. W. L. Waters; "Economics Derivable from the Use of Relatively Small Water Powers of Low Head in the Middle West," by Prof. D. C. Jackson: "Oscillations and Surges Against Ground in Alternating-Current Systems," by Dr. C. P. Steinmetz; "Relative Merits of Various Types of Booster Control," by Mr. J. Bijur; "Safety Devices for Steam Engines, Turbines and Motors," by Mr. C. M. Heminway.

Royal Society.—At the meeting of the Royal Society yesterday, the following were among the new Fellows elected: Mr. James Swinburne, who is well known to our readers; Mr. J. H. Jeans, the author of Papers, and a book of exceptional merit, on the dynamical theory of gases; Dr. C. H. Lees, Professor of Physics at the East London Technical College and formerly Principal Assistant to Prof. A. Schuster at the Manchester University; Prof. H. A. Wilson, Professor of Physics at King's College, London, who has carried out good work in radioactivity at the Cavendish Laboratory, and Mr. G. T. Beilby, who has also carried out useful radio-active research work and was President of the Chemical Section of the British Association at Cambridge in 1904.

Society of Power Company Officials.—The first convention of the Society of Power Company Officials was held on Friday and Saturday last week, in Glasgow, under the auspices of the Clyde Valley Electric Power Supply Co. The Society has been founded for the purpose of facilitating the interchange of information and discussion on problems relative to power company work. Representatives of the following companies attended: South Wales, Cleveland & Durham, Yorkshire, Lancashire, Fife, Scottish Central, Clyde Valley, Kent, North Metropolitan. On Friday visits were made to the two power stations at Yoker and Motherwell, and to the various substations, and some of the consumers' premises, where some of the most up-to-date and novel methods of driving have been adopted. The directors of the Clyde Valley Co. entertained the Society at the Grosvenor Restaurant in the evening under the presidency of Sir David Richmond. The Society met at 10:30 on Saturday morning (Mr. R. L. Gamlen, the President of the Society, being in the chair, supported by Mr. D. A. Starr, the Vice-President, and Mr. W. B. Woodhouse, the Secretary) for the reading and discussion of problems connected with the business.

The Working of the District Railway.—Sir George Gibb has written a long letter to *The Times* protesting against the many and often entirely unfounded criticisms which are being continually made in some sections of the press and pleading for some patience until the transition from the old steam conditions has been completed and things have settled down to normal working. Amongst other things the broken axle trouble has been greatly exaggerated. He writes "All the axles are good, sound, and of adequate strength, and have not shown the slightest tendency to weakness, except those which were in the trailing bogies of the motor cars. These were not designed of sufficiently large section for the weight they had to bear (it was no question of English or foreign steel), and, as soon as we recognised this fact, orders were placed with the Monkbridge Iron Company of Leeds for new axles of larger section, and practically all the weak axles have already been removed, the total cost involved being only about £1,700." He points out that the other troubles, of which so much is being made, mainly arose from quite minor defects, such as might be expected to occur in bringing into use, all at once, so many new electric cars and a complete system of automatic signalling, and which had occurred, though less public attention had been called to them, on other railways under corresponding conditions.

Opening of the Milan Exhibition.—The International Exhibition at Milan consists of two separate enclosures, one in the Parco and a larger section in the Piazza d'Armi, the two halves being connected by a special single-phase electric railway. The Parco division was formally inaugurated by the King and Queen of Italy on Saturday last in the presence of a distinguished gathering. According to *The Times*, the Royal party was received first at the chief entrance in the Via Venti Settembre, where a brief address was delivered by Senator Mangili, the President of the Exhibition. The Sovereigns and other guests then proceeded on foot through the gallery of the Simplon Tunnel to the great reception hall, where the chief ceremony took place. Speeches were delivered by the Marchese Ponti, Syndic of Milan, and Signor Pantano, Minister of Agriculture, both of whom recounted the story of the inception and completion of the Simplon Tunnel and of the consequent undertaking and aims of the Exhibition at Milan, a great feature of which is the working model of the Simplon Tunnel. At the close of the speeches Queen Elena performed the actual ceremony of opening that portion of the exhibition. The Piazza d'Armi section was opened on Monday last. Their Majesties were conveyed thither by the electric railway which connects the two sections, and they visited the pavilions of the different countries in the order in which they came, beginning with that of France and ending up with the British marine exhibit, where Mr. Des Graz and the commissioners were present.

Glasgow Section of the Institution.—The sixth annual report of the Committee of the Glasgow Local Section of the Institution of Electrical Engineers shows that the membership has increased by 19 members during the past session. These figures, the report states, although showing a decided improvement on the past two years, fail to indicate the progress expected, for, although there have been 31 members added during the year there have been 12 resignations for various reasons, which leaves the section only 19 stronger numerically than it was this time last year, and out of this number 16 of the new members are students. With reference to the visit of Foreign Societies to this country this summer, their visit to Glasgow and Edinburgh will fall on July 2, 3 and 4. The Local Committee have formed a very strong Reception Committee to look after the arrangements in connection with this visit, and a circular will be issued shortly to all members of the Local Section giving particulars of the arrangements that have been made. The following have been elected as the Council for the following session:—

Chairman: Lord Kelvin. *Past Chairmen:* Robert Robertson, John M. M. Munro. *Vice-Chairman:* W. W. Lackie. *Chairman of Student Section:* Prof. Magnus MacLean. *Hon. Sec. and Treasurer:* E. George Tidd. *Members:* Charles Day (The Mirrlees Watson Co., Ltd.,) James Lowson (W. C. Martin & Co.), John Macfee (chief engineer, Glasgow Corporation Telephone Department), Sam. Mavor (Mavor & Coulson, Ltd.), T. Blackwood Murray (Albion Motor Car Co.), Frank A. Newington (chief engineer, Edinburgh Corporation Electric Department), John S. Nicholson (Glasgow University), W. Stevenson (Caledonian Railway), A. W. Stewart (consulting engineer).

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, May 4th.**

ROYAL INSTITUTION.

9 p.m. Evening Discourse on: "The Steam Turbine on Land and at Sea," by the Hon. C. A. Parsons, F.R.S.

MONDAY, May 7th.

ENGINEERING AND SCIENTIFIC ASSOCIATION OF IRELAND.

7:45 p.m. Meeting at the Royal College of Science, Stephen's Green, Dublin. Paper to be read: "Internal Corrosion of Steam Boilers," by L. J. Le Clair.

TUESDAY, May 8th.

INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW LOCAL SECTION.

8 p.m. Annual General Meeting. The following Paper will also be read: "Observations on the Mercury Arc and Some Resultant Problems on Photometry," by C. Orme Bastian.

WEDNESDAY, May 9th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

3:30 p.m. Visit to the new power station of the Birmingham Corporation.

5 p.m. Annual General Meeting at the Grand Hotel, Birmingham.

THURSDAY, May 10th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting at the Society of Arts, John-street, Adelphi, when the adjourned discussion on the following Paper will be taken: "Long Flame Arc Lamps," by L. Andrews.

INSTITUTION OF ELECTRICAL ENGINEERS: DUBLIN LOCAL SECTION.

8 p.m. Annual General Meeting at Royal College of Science, Dublin. The following Paper will also be read: "In how Small a Town is it Possible to Successfully Operate an Electric Lighting Plant," by R. B. Forster.

FRIDAY, May 11th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington, S.W. Agenda: (1) "The Effect of a Rapid Discharge on the Throw of a Galvanometer," by A. Russell; (2) Exhibition of Lippmann Capillary Dynamo and Electrometer, by Prof. H. A. Wilson; (3) Exhibition of an Apparatus for Demonstrating the Movements of the Diaphragms of Telephonic Transmitters and Receivers and the Current Flowing into and out of the Cable during Speech, by W. Duddell.

THE FERRANTI WORKS.

(Concluded from page 46.)

The meter department contains a large number of special machines, and the whole process of manufacture is so interesting that an instructive day might be spent watching the work that is going on in the shops and observing the methods employed. An important part of the shop is devoted to cutting the trains. The machines for this purpose, which are of American design, are automatic. The stampings into which the teeth are to be cut are strung several together on a rod, 30 in the case of the smaller wheels and 23 of the larger ones. One tooth is milled out, and at the end of the travel of the tool, the work is rotated one tooth and the next one is cut. There are two worm-cutting machines which were made at the works. The spindle on which the worm is to be cut revolves in the lathe and moves slowly forward, and a milling cutter inclined at an angle corresponding to the pitch cuts the thread. Capstan lathes are employed for the caps which carry the jewels, and the pillars used for distance pieces, which are drilled, tapped and cut on one machine. Burnishing the pivots and mounting the pivots and pinions is another of the series of operations. Cutting the jewels is only carried out to a limited extent at the works. Some of the sapphires used for the lower bearings of the spindles are "made" here, but the majority are imported, as are also the garnets for the upper bearings. The meter assembling shop is illustrated in Fig. 7.

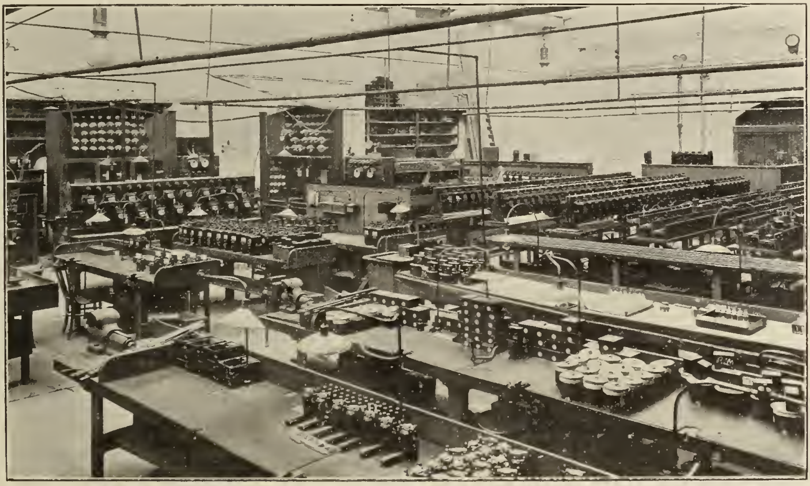


Fig. 7.—Meter Assembling Shop

The method of magnetising the permanent magnets is ingenious. This is done by means of an electric current. The magnet is placed on a base containing a number of mercury cups arranged on either side of the bent bar, and a wooden frame with projecting copper rods is placed over the magnet in such a way that the ends of the copper rods dip into the mercury. The rods and the mercury cups are so connected as to form a continuous winding, and thus a strong current passed through the device momentarily is sufficient to magnetise the bar. In order that a very strong current may be used, there is a cut-out in series with the switch, so that the current is automatically cut off about a second after it is applied. Subsequently, when the meter is assembled, a short-circuit current is passed through it to "age" the magnets.

As mercury is used in the continuous-current meter, and the mercury of commerce is far from pure, a mercury-cleaning apparatus is employed. A spray of mercury is passed through dilute nitric acid and then through caustic soda and distilled water, and it is finally dried and allowed to drop through a sugar filter.

The latest product of Messrs. Ferranti's meter department is the new continuous-current meter illustrated in Fig. 8.

Referring to Fig. 8, MB is the mercury bath formed by the two nickel-plated brass plates BP separated by the vulcanised fibre ring FR. The plates BP are suitably insulated from the mercury on their internal surfaces by the presspahn insulation PI, and are bolted together, with the ring intervening, by the nine bolts B. The bath is filled with mercury by means of the hole MH. After filling, this hole is closed with a screw plug. Inside the bath, the platinum-plated and enamelled copper disc CD is placed. The edge and centre are left unplated, and are amalgamated so as to ensure that the current passes through the disc in its passage between the the copper contacts C_1 and C_2. This platinum plating and enamelling are to preserve the copper from the action of the mercury. The disc is mounted on the spindle S, which is suitably supported by a cup jewel J, which is removable for repairs. The bouyancy of the armature is adjusted by the weight W so that the disc just sinks, thus ensuring the least possible pressure and friction between the spindle and jewel. Further, the three nuts N are provided by means of which the balance of the disc is adjusted so that it will remain in any position when no current passes and the meter is placed in the usual position. There are two pairs of poles. The pair SD, forming the driving system, drive the disc when the current passes and also retard the motion of the disc. The pair SB retard the motion of the disc. The top poles are united by the iron bar I_2B_2 and the bottom poles by the iron bar I_1B_1. The poles are magnetised by the two C-shaped magnets PM.

The current to be measured passes from the terminal to the contact C_1 in the side of the mercury bath, through the armature, passing between the driving pair of poles and away from the bath by the contact C_2. The flux from the poles SD, acting on the current, causes the disc to rotate, the driving force being proportional to the current. The motion of the disc between both pairs of poles sets up eddy currents in the disc, which, acting on the flux from the poles, gives a retarding force on the disc proportional to the speed. If there were no fluid and other friction this would be the only retarding force on the disc. When the disc settles to a uniform speed the driving and retarding forces are equal, and as the former is proportional to the current and the latter to the speed, the speed is, of course, proportional to the current. As its speed increases, the disc meets with another retarding force set up by mercury fluid friction. This would cause the meter to be slow at the higher loads. To overcome this, the current after passing through the bath, is passed round the coil CC placed round the iron bar I_1B_1. The coil is connected so that when the current passes the magnetic flux produced flows in the direction shown by the lines CF, which it will be seen increases the flux in the driving poles and decreases the flux in the retarding poles, the flux due to the permanent magnets PM is shown by the lines MF. Since both pairs of poles retard the motion of the disc, and since the flux in one is increased and decreased in the other by the same amount, it follows that this magnetic brake force is the same with or without the coil in action. But the driving force is increased at top loads, thus rectifying the effect of fluid friction.

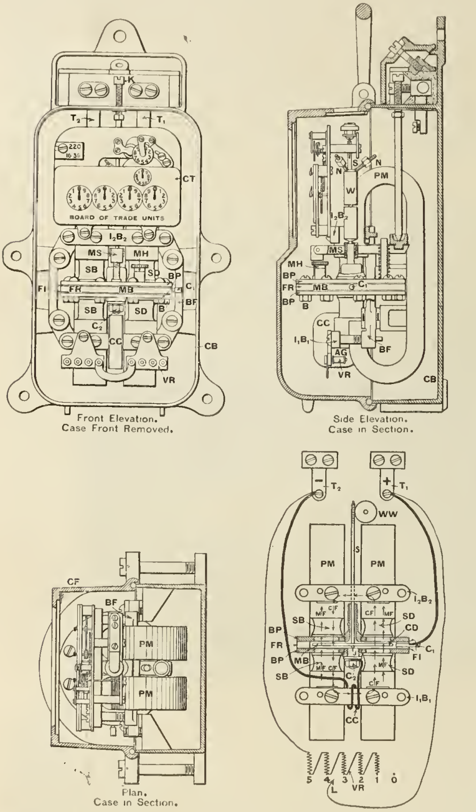


Fig. 8.—Front Elevation, Side Elevation, Plan and Back Elevation (with Connections) of New Ferranti Continuous-current Meter.

The spindle of the meter gears with a worm wheel, WW, the axle of which drives through a variable wheel gear, the train work actuating the index hands on the dial. The number of teeth in the gear wheels depends on the constant of the meter—*i.e.*, the ampere-seconds per revolution, and also on the voltage. Although it is possible by having a large range of wheels to find ratio wheels to suit any constant at any voltage, it is convenient to have a means of regulating the constant slightly. The variable resistance VR is connected as a shunt to the meter. It has six terminals. By connecting the lead L to different terminals, from 0 to 5 per cent. of the current is shunted from the bath, thus reducing the speed by a corresponding amount. The meter is first tested in the usual way and the nearest ratio wheel on the slow side fitted. The speed of the meter is then reduced by using the resistance VR until it has the value corresponding to the ratio wheels fitted. The resistance should also be convenient for the use of customers, as it allows of simple adjustment of the meter to a few per cent., without the trouble of removing the existing wheels and the fitting of others.

We are informed that the voltage drop of a 10-ampere meter is only 0 06 volts; there is no shunt across the mains and therefore no shunt loss, and the starting current for a meter of this size is stated to be 0·5 ampere.

The screw knob K in the terminal box is for sealing the mercury chamber when the meter is carried about or sent by rail. The bath and magnets are fixed to the brass frame BF which is fixed to the cast-iron case back CB. The cast-iron front CF is fixed to the back of the case by the seal screws. Rubber cord is fitted between the front and back cases to ensure a water and dust-proof case. The case is insulated from the working parts by the ebonite washers I.

Messrs. Ferranti are taking up the question of a prepayment meter, and interesting work in this direction is proceeding in the experimental department.

The instruments manufactured in the instrument deparment are principally switchboard instruments of a high class. For continuous-current measurements the moving-coil type has been adopted as most useful for modern switchboards. In these the current is led to the moving coil by two springs, and particular attention is given to the method of magnetising and ageing permanent magnets. For ammeters up to 1,000 amperes the drop on the shunt is only 0·08 volts, and in larger sizes this is further diminished.

The induction type has been adopted for the A.C. instruments, which are constructed on the same fundamental principle as the Ferranti A.C. meter. There are two iron castings, one of which is wound with a coil energised by a current proportional to the current in the main circuit. The voltage of the circuit is applied to the terminals of the coil surrounding the shunt casting. To obtain the necessary 90 deg. of retardation of shunt flux phase a solid core is used, in the same manner as in the meter, and the two coils act inductively on a round pivoted aluminium disc. The movement of the latter is damped by means of a permanent magnet, between the poles of which it moves, and it is controlled by means of a spiral spring. If the instrument is an ammeter, the disc is caused to rotate by means of an electromagnet wound with a few turns of thick wire, and if a voltmeter by many turns of fine wire. The voltmeter is compensated for frequency and temperature errors by means of a series resistance in some cases, in other cases by means of a choke coil, according as the frequency is high or low. The divisions of the scales of the ammeters and voltmeters are nearly equal throughout the entire length of the scales.

In addition to ammeters and voltmeters, wattmeters (with centre zero showing when a generator motors), idle-current ammeters and phase-indicating wattmeters are also made in this department, and some of these have been described in *The Electrician* at comparatively recent dates. The relays for working the tripping coils of switches (maximum with or without time limit and reverse with time limit) are also made here. At the present time, a further series of instruments arranged with flush cases are going through the shop; there is a large demand for these on the Continent, and the firm hopes to do a good export trade with them. They are also suitable for the bench-control boards of the remote-control switchboards. A view of the instrument shop is given in Fig. 11.

In order to make the instruments applicable to all voltages and currents, three lines of current transformers and three lines of potential transformers have been got out, rated respectively 10 watt, 50 watt and 150 watt sizes. Standard patterns are employed for voltages up to 20,000 volts and currents up to 5,000 amperes. A vacuum drying tank is employed, which is now being extended to deal with large coils and larger quantities of material.

Single-phase and three-phase transformers are also manufactured. At the time of our visit the following were some of the transformers going through the shop.

120 kw. 3,000 volt three-phase. Seven 47 kw. 10,000 volt. Two 60 kw. 7,500 volt. A number of small 15,000 volt for an ozone process. Some 75 kw. 3,000 volt three-phase transformers for Japan. Several static balancers for use with three-wire C.C. system for leading the out-of-balance current back to the armature of the generator. A number of 2,000 volt transformers for South Africa. A considerable number of 50 kw. and 30 kw. for various corporations and companies in England. A number of 40,000 volt testing transformers. Patent street tanks, and a considerable number of small transformers for sundry purposes.

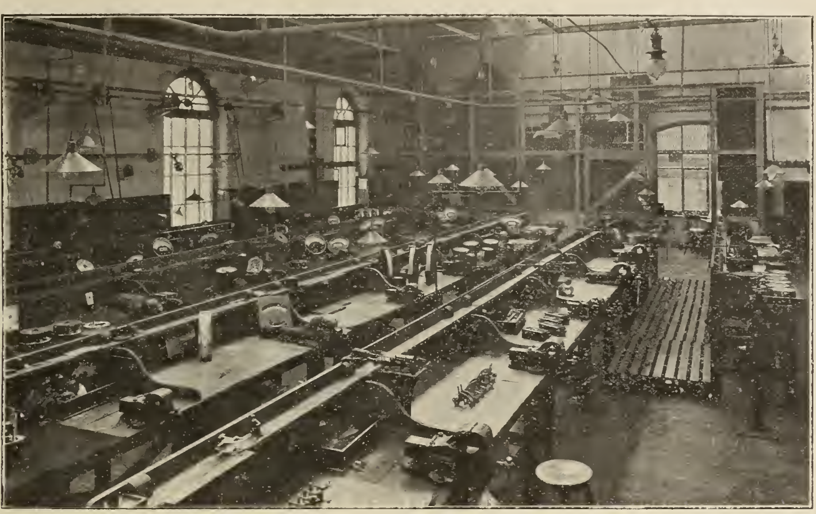


Fig. 9.—Instrument Shop.

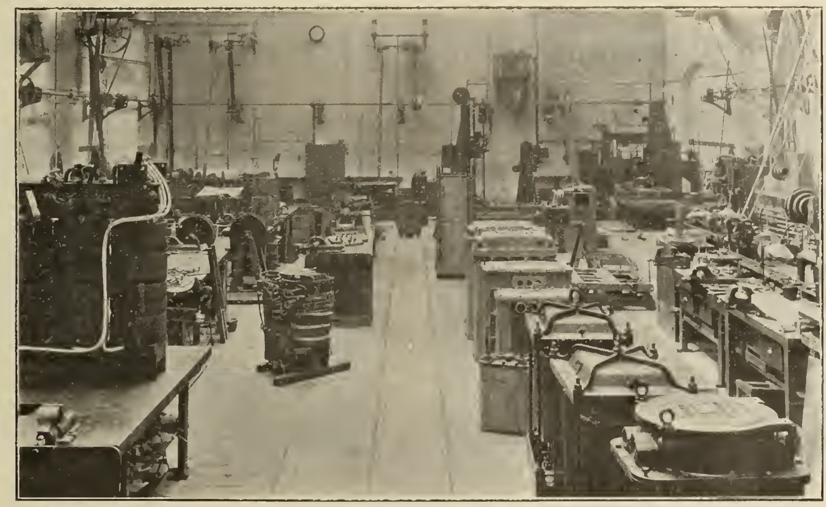


Fig. 10.—Transformer Shop.

Fig. 10 is from a photograph of this shop.

The test room contains four testing alternators, giving three-phase, single-phase and two-phase current of various wave forms, a large battery capable of giving 5,000 amperes for ammeter calibrations, a double motor-generator set for giving 700 volts and 500 amperes continuous-current, and a 700 volt battery of Leclanché cells. The test room is arranged so that every sub-standard can be verified in position against a standard potentiometer and standard Kelvin watt and ampere balances. For testing the ratios of transformers, a number of non-inductive, non-capacity resistances are employed accurately subdivided, these going up to a voltage of 15,000 volts.

We owe our thanks to Mr. A. B. Anderson, the general manager, for according us full permission to visit every part of the works, and to Mr. M. B. Field, Mr. Hamilton and Dr. C. C. Garrard, who acted as our guides over the switchboard, meter and instrument departments respectively. Mr. Field especially has given us much assistance in the preparation of this article and devoted considerable time to showing us over the switchboard section of the works and to explaining to us the various new points in the patterns we have illustrated.

ELECTRIC POWER AT ST. MICHAELS, AZORES.

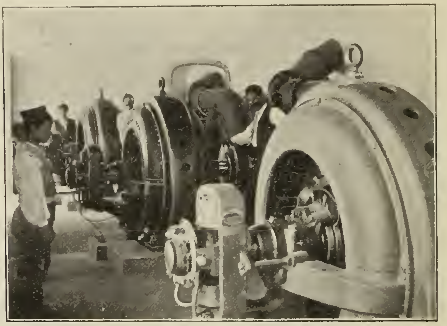
The employment of electricity in the island of St. Michaels Azores, has been gradually developed, and there are now no less than 12 places in the island lighted by electricity, and 11 private industrial establishments in which electric power is utilised. The energy is supplied from three water-power stations, the first of which was erected in 1899, the second in 1901, and the third in 1903, and all three stations are run from mountain torrents from the lake Fogo. This lake, the name of which implies the lake of fire, is situated nearly at the top of the mountains, at an altitude of about 2,300 ft. The two streams which are utilised flow from the lake, one 4·3 miles long on the south slope of the mountains, and the other on the north side 6·2 miles long. The first supplies 17·6 cubic ft. of water per second, except in autumn, when the flow of water falls to about 10 cubic ft. per second. The second supplies 21 cubic ft. per second generally, and 12·3 cubic ft. per second in autumn.

Generating Station and Workmen's Dwellings at Ponta Delgada.

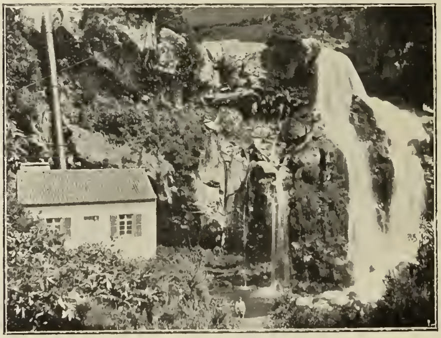
The first generating station for the lighting of Villa Franca was built on the southern watercourse near a natural fall of 79 ft. The water is led by means of a sheet steel conduit 26 in. in diameter to a Francis turbine, rated at 100 H.P. with a speed of 300 revs. per min. This machine is directly coupled by an insulating coupling to a three-phase alternator with revolving field magnets capable of developing 60 k.v.a. at 3,000 volts, and 50 cycles per second. After passing the switchboard and lightning arresters, the current is taken to the town, which is 2½ miles distant, where it passes to three transforming stations, each capable of dealing with 50 k.v.a. Three transformers reduce the pressure to 120 volts, and there is also a one 10 k.v.a. transformer station at Ribeira das Tainhas, and one of 7 k.v.a. at Ribeira Secca. The length of the high-tension mains is about 4·3 miles. On the low-tension network 110 volt lamps are used, in accordance with the usual continental practice.

Another View of the Generating Station and Workmen's Dwellings at Ponta Delgada.

The second generating station is for lighting Ribeira Grande, and is situated on the northern mountain torrent by a natural fall of 82 ft. By means of a canal 650 ft. long, half of which had to be cut in the solid rock, the available fall is increased to 125 ft. In this case the steel conduit leading to the works has a diameter of 26 in., as in the previous station, but the turbine is of the Escargot type. The machine develops 110 H.P. at 500 revs. per min., and is coupled directly to a three-phase alternator with moving field magnets supplying 80 k.v.a. at 4,000 volts and 50 cycles per second. There are eight transforming stations at Ribeira Grande, one at Ribeira Secca, one at Ribeirinha and one at Lameiro, all near the northern coast of the island. The high-tension mains are about 6·8 miles long, and 120-volt lamps are used on the low-tension network. The transformer stations reduce the voltage from 4,000 to 125.


Three Generating Sets at Ponta Delgada.

Finally, there is a third station for lighting Ponta Delgada, and this one is the most recent and most complete. A natural fall of 99 ft. is increased to 190 ft. by means of a canal 650 ft. long. In the station are three generating sets, each consisting of a 170 H.P. Escargot turbine running at 500 revs. per min., and coupled directly to a revolving field alternator rated at 130 k.v.a. with a frequency of 50 cycles per second, and a voltage of 3,000, as at Villa Franca. The current from the switchboard is led to three single-phase transformers connected in delta,


The Villa Franca Generating Station.

which step up the voltages to 11,000 for the transmission lines. Ponta Delgada is 14·3 miles from the generating station, and a number of transformers have been erected there which reduce the pressure to 125 volts. Two of these are rated at 50 k.v.a., three at 30 k.v.a., and two at 20 k.v.a. In addition to these, there is a 7 k.v.a. transformer at Santa Clara, one 10 k.v.a. at Faja, both of which places are near to the town, and the line also extends to the towns of Agua de Pau (3·1 miles, 15 kw.), Lagoa (8·1 miles, 15 k.w.) and Atalhada (9·4 miles, 5 kw.). Nearly all these transformers are air cooled, but some are oil cooled. Low-tension current is distributed in almost all cases by a three-wire three-phase network at 120 volts between phases, with two-wire service wires to the consumer. As the amount of water conveyed by the mountain torrent diminishes in autumn, as already explained, and all the power of the southern torrent is fully taken up, a large reservoir of 140,000 cubic ft. capacity has been constructed in reinforced concrete near the starting point of the head race, which receives the surplus water from the stream after 10 o'clock in the evening, and in this way the power of the station can be increased to 150 H.P. during the four hours of peak load. Under these conditions the three generators can be run in parallel.

Moreover, as the Villa Franca works are only about 220 yds. distant, the turbine there has been recently replaced by a 180 H.P. machine in order that this station also may benefit by the existence of the reservoir. The new turbine works the old generator at one end of its shaft, and at the other side a second machine of the same type and power has been added.

Finally, these two stations are already connected electrically and run in parallel at 3,000 volts, and the Ribeira Grande station is shortly to be connected up with the other two at a point near the town of Lagoa. This will increase the total capacity available to 1,000 H.P.

During the day time the Ponta Delgada works are the only ones running, and supply hardly 90 H.P., which is used for motors, and is sufficient for all the small industrial works already referred to. Three-phase motors are used, connected to the low-voltage network, and their sizes vary from 1 H.P. to 20 H P.

In nearly all the places mentioned above the price of current is the same—*i.e.*, either £1 per 10 c.p. lamp per annum, or £1. 6s. per 16 c p. lamp per annum, or by meter at 6·7d. per kilowatt-hour. To encourage the use of electricity on the contract rates, two or three way change-over switches may be used, so that the payment per lamp-year permits the consumer to turn the current to any one of two or three lamps at a time. For motors there is a contract price of £6. 12s. per horse-power year from sunrise to sunset.

All the works have been designed and erected by Mr. J. Cordeiro, of St. Michaels, who is the owner of them, and we are indebted to him for the information contained in this article and for the photographs from which our illustrations have been made. To Mr. H. H. Wilkinson, of the Europe and Azores Telegraph Co., Ponta Delgada, we are also indebted for his good offices. The alternators and transformers were supplied by the Alioth Co., of Münchenstein, near Bâle; the hydraulic plant by Messrs. Theodore Bell, of Kriens, Switzerland; and all the cables, wires, lamps and small material by Paris firms.

LONG FLAME ARC LAMPS.*

BY LEONARD ANDREWS.

(Continued from page 53.)

Fig 5 is reproduced from a photograph of a 10 ampere 85 volt "Carbone" arc, the incandescent tips of the carbons being just visible below the edge of the economiser. The dense portion of the flame is the violet mist, which is very similar in appearance and colour to the mist seen between the carbons of every arc lamp. This mist is surrounded by a sheath or envelope of burning gases. Unlike the ordinary arc lamp, the length of the arc mist to be traversed by the crater light is not appreciably increased by lengthening the arc. It would appear, therefore, that by ascertaining the area of the crater visible in a given direction for voltages ranging from 45 to 100 volts, it should be possible to ascertain to what extent the high efficiency of the "Carbone" arc is directly due to the fact that the higher voltages cause the crater to form more at the tips of the carbons.

Figs. 6 to 11 show the area of the crater visible when observed from an angle of 45 deg. below the horizontal, with voltages varying from 56 to 96, and Figs. 12 to 15 give corresponding observations taken directly below the arc. With voltages of less than 60, it will be seen that the crater forms between the carbons, and whilst the actual area is approximately the same as that of a similar current 90 volt arc, the area visible is only a fraction of the total area. In Figs. 6 and 12 the arc is formed between the hard surfaces of the carbons only. In Figs. 7 and 13 there are obviously two arcs in parallel, one about 3·5 mm. in length across the hard portions of the carbons, and the second about 7 mm. in length between the soft core of the positive carbon and the negative carbon. This is an interesting illustration of the fact that a given voltage will maintain a considerably longer arc between a soft core positive carbon and the negative than between a hard carbon and the negative. The effect of gradually increasing the pressure up to 94 volts is clearly shown by the respective Figs. 6 to 15. It will be seen that to form the craters at the tips of the carbons, a pressure of from 80 to 90 volts is required. A comparison of Figs. 10 and 11 shows that no useful improvement in the position of the craters is obtained by increasing the pressure of a 9 or 10 ampere arc above 90 volts.

Fig. 5.—Carbone Flame.

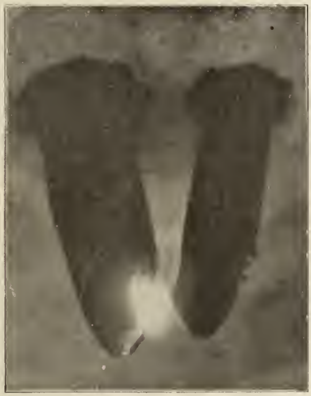


Fig. 6.—Pure Carbon Arc. L 1·15 mm.
Volts, 56. Amperes, 10·2. Area of craters visible, 3 sq. mm.
Watts per sq. mm. of crater, 190.

In Fig. 16, the areas of the craters visible directly below the arc with different voltages are plotted with rectangular co-ordinates, and a curve is added showing the efficiency in candle-power per watt, assuming that the candle power is directly proportional to the area of the crater. It will be noted that this curve has a very different characteristic to the corresponding curve given by Mrs. Ayrton* for coaxially arranged carbons, which latter is reproduced in Fig. 17. This reaches a maximum at about 42 volts and then steadily falls, whereas the "Carbone" efficiency curve continues to show a marked improvement up to 80 volts.

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* Paper read before the Institution of Electrical Engineers, April 26th. (Slightly abstracted.)

* "The Electric Arc," p. 382.

It has so far been assumed that the candle-power emitted by the positive crater is proportional to the area of such crater, and that no appreciable proportion of the light emitted is intercepted by the arc mist.

To ascertain how far this assumption is justified, we may compare with the polar curve constructed by Dr. Wedding showing the candle-power measured at a number of different angles, the polar curve constructed by multiplying the area of the craters in square millimetres by the intrinsic brilliancy in candle-power and by the cosine of the angle.

The positive crater area of a 9·3 ampere 89 volt "Carbone" arc was found to be 17·1 sq. mm., of which 3 sq. mm. was of soft-cored crater. The candle-power emitted by the positive crater, plus that emitted by the negative or white spot, should therefore be :—

Hard carbon positive crater	14·1 sq. mm.	× 158	=	2,227·8
Soft-cored ,, ,,	3·0 ,,	× 100	=	300·0
Negative crater ..	1·5 ,,	× 158	=	237·0
				2,764 8

As, however, Dr. Wedding's results are given in Hefner units, it will be necessary to divide the total maximum candle-power as calculated above by 0·88, the result being a maximum candle-power in Hefner units of 3,142.

The polar curve A, B, C, Fig. 18, can now be constructed, the maximum radius vector being made proportional to the candle-power derived as stated above. It will be seen that this curve is considerably smaller than Dr. Wedding's curve plotted from the mean of actual candle-power measurements taken at a number of different angles and in different vertical planes. We have, however, to add to the candle-power derived from the area of the craters the candle-power of the flame and of the red-hot portions of the carbons. The candle-power from these sources in the "Carbone" arc is very considerable. Dr. Wedding found the mean candle-power measured in the same horizontal plane as that occupied by the craters to be approximately 900, and as practically none of this could have come from the craters, the bulk of it must have emanated from the flame and red-hot portions of the carbons.

It may be assumed that the candle-power from these sources is practically constant in all directions. We may, therefore, add to the radii of the polar curve representing the light from the craters a length proportional to the light from the flame and red-hot portions of the carbons. A third curve, A_1, B_1, C_1, may now be constructed, representing the total light emitted from all sources. It would appear then that the light intercepted by the arc mist is represented by the difference between the radius vectors of curves A_1, B_1, C_1, and Dr. Wedding's curve of actual results, always assuming, however, that the figure of 158 c.p. per square millimetre which has been taken represents the true intrinsic brilliancy of the craters. This figure is, however, probably sufficiently accurate to show that with a "Carbone" shaped flame only a small proportion of the total light is intercepted, and consequently that the high efficiency of this lamp is in a great measure chiefly due to none of the crater light being intercepted by the negative carbon.

Turning now to the second improvement effected in arc lighting, namely, that due to the impregnation of the carbons by metallic salts, even greater radical departures from hitherto accepted principles are found. Whilst by far the chief source of light in a pure carbon arc is the positive crater, we see from Fig. 19, which is reproduced from a 10 ampere chemical carbon arc, that the area of the crater is only about 65 per cent. of the area of a 10 ampere pure carbon arc, the intrinsic brilliancy being also probably less even than that of the soft core of a pure carbon crater. It would appear, therefore, that of the total candle-power of 2,750 hemispherical candle-power emitted by a 10 ampere chemical carbon arc, less than 700 candle-power is emitted by the positive crater. Whilst, therefore, the high efficiency of this type of arc is in a measure due to the formation of the craters in such a position that none of the light from the positive crater is intercepted by the negative carbon, it is evident that it is only partially due to this cause.

The crater area of a chemical carbon arc is in a great measure dependent upon the portion of the carbon that is being consumed at the time. For instance, in Fig. 19 it will be seen that the arc is burning almost entirely from the chemically impregnated core; whereas at the moment when Fig. 20 was taken the chemical core had become hollowed out and the crater appears to be formed on the edge of the hard carbon shell. In this position the crater area is extremely small. When the shell on the side of the positive carbon nearest to the negative carbon

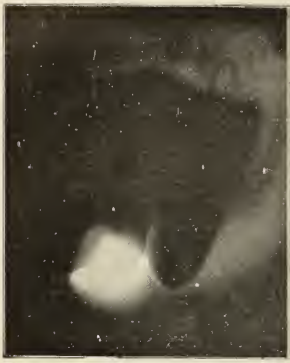

Fig. 7.—Pure Carbon Arc. L 3·5 mm. L_1 7 mm.
Volts, 61. Amperes, 10. Area of craters visible, 6 sq. mm. Watts per sq. mm., 98.;

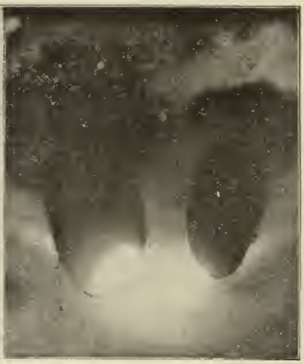

Fig. 8.—Pure Carbon Arc. L 9 mm.
Volts, 72. Amperes, 10. Area of craters visible, 9·75 sq. mm. Watts per sq. mm. of crater, 74.

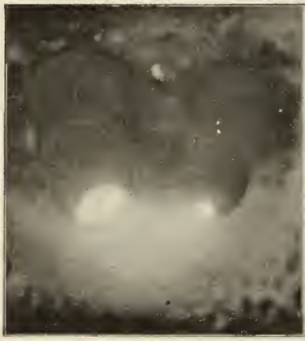

Fig. 9.—Pure Carbon Arc. L 10 mm.
Volts, 78. Amperes, 9·7. Area of craters visible, 10 sq. mm. Watts per sq. mm. of crater, 76.

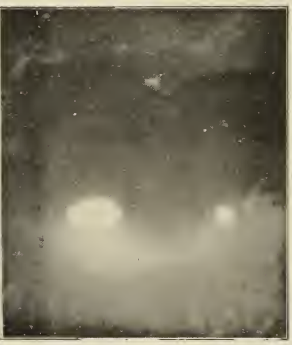

Fig. 10.—Pure Carbon Arc. L 12·5 mm.
Volts, 90. Amperes, 9·6. Area of craters visible, 10·6 sq. mm. Watts per sq. mm. of crater, 82.

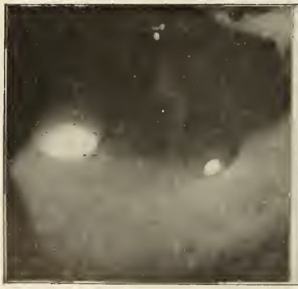

Fig. 11.—Pure Carbon Arc. L 13·5 mm.
Volts, 94. Amperes, 9·5. Area of craters visible, 10 6 sq. mm. Watts per sq. mm. of crater, 84.

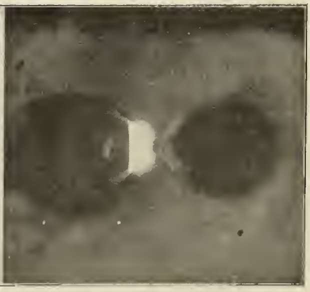

Fig. 12.—Pure Carbon Arc. L 0·5 mm.
Volts, 53. Amperes, 10·5. Area of craters visible, 3 75 sq. mm. Watts per sq. mm. of crater, 148.

Table III.

Volts between.	Ordinary 3 mm. arc lamp.	"Carbone" high-voltage arc lamp.	Chemical carbon arc lamp.
A and B	34 volts	36 volts	17 volts
A and C	..	78 ,,	36 ,,
A and D	49 ,,	88 ,,	46 ,,
B and D	..	44 ,,	28 ,,
C and D	9 ,,	10 ,,	10 ,,

has burnt away, the crater gradually travels round to the opposite side of the carbon. This causes considerable difference in the pressure across the arc, the total variation sometimes amounting to as much as 15 per cent.; that is to say, the voltage will increase from 40 volts, when the crater is on the near side of the positive carbon, to 46 volts when it is on the far side. It is interesting to note that, owing apparently to the lower resistance of a chemical carbon arc, the craters can be retained at the tips of the carbons with a very much lower voltage than is required for a pure carbon arc. Another noticeable difference between chemical carbon arcs and pure carbon arcs is to be found in the drop of potential across the positive crater.

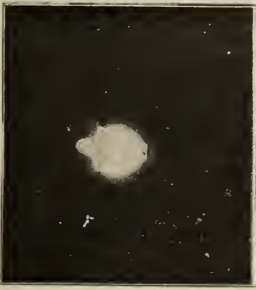

Fig. 13.—Pure Carbon Arc. L 3·5 mm. L 7 mm.
Volts, 63. Amperes, 9·8. Area of craters visible, 5·5 sq. mm. Watts per sq. mm., 89.

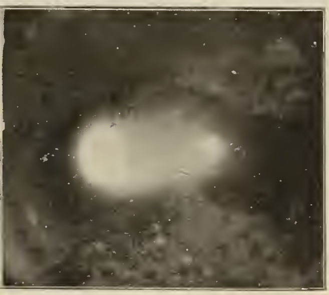

Fig. 14.—Pure Carbon Arc. L 9·5 mm.
Volts, 74. Amperes, 9·8. Area of craters visible, 15·5 sq. mm. Watts per sq. mm., 46·8.

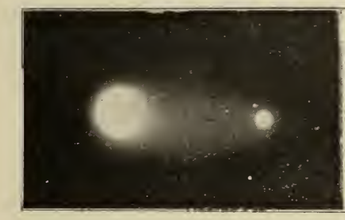

Fig. 15.—Pure Carbon Arc. L 13 mm.
Volts, 92. Amperes 9·2. Area of craters visible, 18·6 sq. mm. Watts per sq. mm. of crater, 45·4.

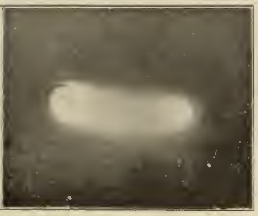

Fig. 19.—Chemical Carbon Arc. L 11 mm.
Volts, 38. Amperes, 10.
Area of craters visible, 13 sq. mm.

Table III shows the drop of voltage in different 10 ampere arcs measured between the respective points indicated by letters in Fig. 21.

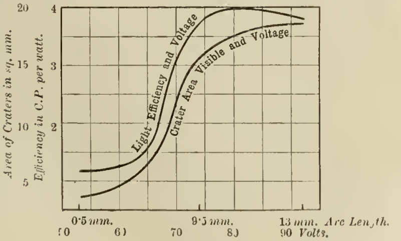

Fig. 16.—Visible Area of Crater and Efficiency of Carbone Arc.

The bulk of the light from a chemical carbon arc emanates from the flame, and is apparently due to minute burning particles in the flame which are raised to a very high state of incandescence. It has been found that the relative intrinsic brilliancy of the flame of a chemical carbon lamp is about one-third that of the positive and negative craters.* It must be remembered, however, that the area of the flame visible at any angle is many times that of the crater, and the total light emitted by the flame is consequently many times that emitted by the craters.

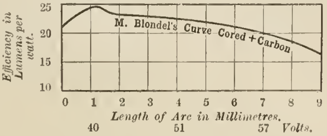

Fig. 17.—Efficiency Curve of Arc with Co-axial Carbon.

Whilst the commercial use of chemically impregnated carbons has only come to the fore within the past two or three years, the idea is by no means new. Mr. Trotter, in his Paper before this Institution in 1892, made the following reference to the suggestion: "Several attempts have been made to improve the arc by adding volatile substances, or by introducing gas through a hollow carbon. The only good effect that can be expected is the production of a long arc, which will reduce the shadow of the lower carbon; and it is likely that the temperature of the crater will be reduced by the presence of any substance less volatile than the best carbon." It would appear from the above that the chief gain in efficiency due to the high luminosity of the flame was not then appreciated. The efficiency of a chemical carbon lamp is so very much higher than it has yet been possible to attain with any type of pure carbon arc that it might appear at first sight that the use of pure carbons would very soon cease. Unfortunately, however, the advantage from the point of view of efficiency is discounted by certain defects which render this type of lamp unsatisfactory for many purposes.

The flickering noticeable in all chemical carbon lamps cannot a present be entirely overcome, though it has been greatly reduced in recent lamps. Considerable improvement has been effected during the last year or two in the composition of the carbons used for chemical carbon flame arc lamps. The large amount of calcium salts first proposed by Bremer and the non-conductive scoria caused a great irregularity in burning. The carbons are now usually of the composite type, consisting of three zones. The outer zone or envelope is composed of pure carbon, giving mechanical strength. The next contains carbon mixed with various salts, such as those of calcium and magnesium, and the inner soft centring core is made of the same materials less strongly compressed.

The poisonous fumes given off by the burning chemicals make the lamp unsuitable for use in a room not very efficiently ventilated, besides which these fumes are very apt to injure the mechanism of

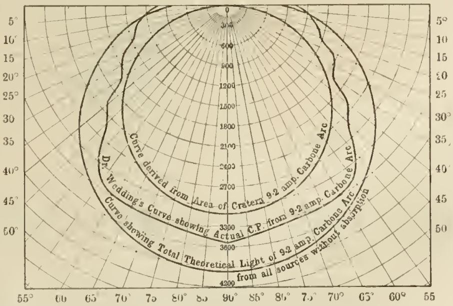

Fig. 18.—Candle-power Curves of Carbone Arc.

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* *Science Abstracts*, No. 662, 1905.

the lamp. The ash or residue from a chemical carbon arc is very much greater than from a pure high-voltage flame arc lamp. The author has obtained photographs of the ash from a 10 ampere chemical carbon arc and from a 10 ampere "Carbone" pure carbon arc after two hours' burning by placing plates of clear glass in the respective globes, these being carefully removed without disturbing the ash and used as negatives. The ash from the chemical carbon lamp was many times greater than that from the pure carbon arc. The carbons are at present considerably more costly than pure carbons, and as the globes cannot be entirely enclosed the life of the carbons is very short. The light is useless in positions where discrimination of colours is required.

Colour.—The colour of an artificial light is for many purposes of even greater importance than its efficiency. Considerable difference of opinion exists as to what is the best colour, and this difference will probably remain so long as it is attempted to define any one particular colour as the best for all purposes For the illumination of the outsides of public buildings, theatres, &c. (especially where these are built of stone), there is nothing more effective and more pleasing than the yellow colour given by the chemical carbon arc lamp. It is also the best light for penetrating a thick yellow fog. For many other purposes, however, a pure white light is generally to be preferred. What is the exact definition of the term "white light" is somewhat difficult to express. It is certainly not the violet-tinted light of the ordinary arc lamp, nor is it the distinctly green light of the incandescent gas lamp. Possibly the best definition is: "A light which makes all colours appear to be exactly the same, whether illuminated by daylight or the artificial light in question." The yellow light given by the majority of chemical carbon lamps is sometimes claimed to be similar to that of sunlight. One of the best tests of this is to examine colours, or, say, a crowd of faces illuminated by one of these lamps. It will be at once apparent that the resemblance in the effect of the two lights is extremely remote.

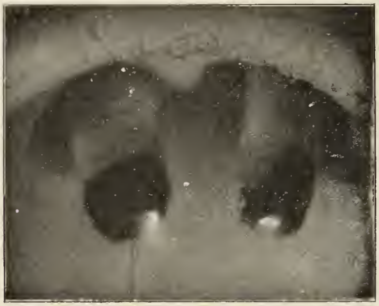
Fig. 20.—Chemical Carbon Arc. L 11 mm.
Volts, 40. Amperes, 10.

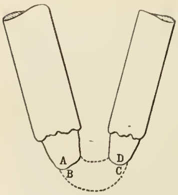

Fig. 21.—10 ampere Arc.

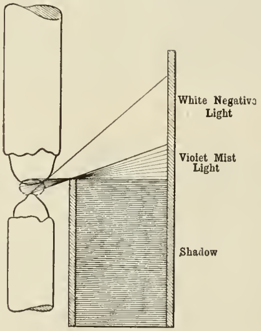

Fig. 22.—Coloured Shadow Effect of Arc.

The nearest approach to a pure white light that has yet been attained by artificial means appears to be that of the high-pressure pure carbon arc with downward-feeding inclined carbons. That it is so, however, is somewhat surprising, as it would be expected that the very long flame of the high-voltage arc would give a very violet light. The extreme whiteness of this light is referred to by Dr. Wedding in his report on the "Carbone" arc. In discussing the cause of this he says: "The spectroscope analysis shows a very wide spreading out in the violet parts of the spectrum alongside of a strong line in the yellow green. Numerous lines stand out in the violet, through which no doubt the tone of the colour is called forth."

Sir W. Abney has shown that the light emitted by the positive crater of a pure carbon arc lamp is very like sunlight, but has a slight excess of orange and green rays, and a slight deficiency of blue. Notwithstanding this generally accepted fact, it is well known that the light from an ordinary arc lamp tends to make objects appear to be blue or purple, particularly when the arc is long. Mrs. Ayrton[*] attributes this blueness to the fact that a portion of the light from the crater in passing through the flame of the arc is reflected and refracted by minute particles of incandescent carbon, and as these carbon particles absorb the red and green rays, and allow the violet rays to pass, the light emitted by the flame or carbon mist is of a deep violet colour. It would appear, therefore, that if just the correct quantity of this violet light could be mixed with the direct light from the crater, which, as has been shown, is deficient in violet rays, the result would be an exact reproduction of sunlight. In the ordinary direct current arc, a large percentage of the crater light is intercepted by the negative carbon, whereas, owing to the very much larger area of the flame, comparatively little of the light from it is so intercepted. The resultant mixture, therefore, contains far more violet rays than are required to produce a pure white light.

The colour effect of intercepting a portion of the light emitted by the positive crater may be shown by a simple experiment suggested by Mrs. Ayrton. If a plate of metal is interposed between the arc and a screen, as shown in Fig. 22, the shadow of the metal will be edged with a broad band of violet light, this being the portion of the screen illuminated by the refracted light from the carbon particles constituting the arc mist.

Now it appears reasonable to argue that the interception of some of the direct rays from the positive crater by the negative carbon of an ordinary arc lamp must have the same effect upon the total colour of the light as the metal screen referred to above. The fact, therefore, that none of the crater light of the "Carbone" arc is intercepted may, at any rate partially, account for the pure whiteness of this light. It is also noticeable that the light from the flame itself is by no means so violet as that of an ordinary arc lamp. This appears to be due to the large area of the sheath of burning gases. Is it not possible that this sheath is the cause of the numerous dark lines which Dr. Wedding observed in the violet portion of the spectrum, and to which he attributes the tone of the colour? Certainly the portion of the arc mist which is not sheathed by burning gases (namely, the upper portion of the hemispherically shaped flame) does emit a light which is intensely violet. This very violet light is thrown up into the mechanism between the carbons and the insulating carbon guides.

(*To be concluded.*)

DUNDEE, BROUGHTY FERRY AND DISTRICT TRAMWAYS.

This system of tramways, which was recently inaugurated, connects Dundee with Broughty Ferry and Monifieth. Formerly an old fishing village, Broughty Ferry has now developed into a residential town, extending 3½ miles along the seashore and back into the hills.

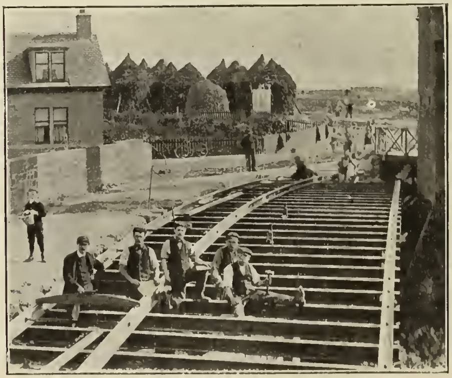
Fig. 1.—Special Construction for Widening of Bridge.

An attempt at joining up the above-mentioned places by means of tramways was first made in 1872, when the Dundee Tramways

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[*] "The Electric Arc," p. 357.

Act was passed. This act incorporated the Dundee Tramways Co., and sec. 6 of that act authorised, inter alia, the construction of a tramway from Craigie-terrace in Dundee to Broughty Ferry. This line was part of a general scheme of tramways for Dundee, but the powers conferred by the act were allowed to lapse. The existing tramways in Dundee were first commenced as horse tramways in 1878, and were worked by a company, but by the Dundee Corporation Tramays Act of 1898 the lines were taken over by the Corporation and electrified. In 1899 Messrs. Greenwood & Batley (Ltd.), of Leeds, obtained an order under the Light Railways Act to construct an electric light railway from Dundee through Broughty Ferry to Barnhill, which lies between Broughty Ferry and Monifieth. The Board of Trade, however, refused to confirm the order, stating that they were convinced that a great deal of good would accrue from the building of a light railway, but they could not confirm the order on account of the material effect it would have on the existing railway companies which were then serving the district in question. Another attempt to obtain a bill for the incorporation of the Dundee & East Forfar Tramways Co. was made in 1900 for the purpose of running a line from Dundee through Broughty Ferry and Monifieth to the eastern boundary of Carnoustie, but had to be abandoned. The existing bill was promoted in the spring of 1905, and was duly passed and sanctioned in the same year.

The total length of route of the present system is about 5½ miles, 4¼ of which are double track, giving 9¾ miles of single track. It starts with a physical junction with the Dundee Corporation Tramways at the extreme eastern boundary of Dundee. For the first 600 yds. it runs along a country road, and then, branching off to the left, runs for ¾ mile on a private road, especially constructed for the purpose, through parks on the Craigie and Home Estates, again joining the public road at the Broughty Ferry boundary. Continuing through the latter place the line terminates at Monifieth. By an arrangement with the Dundee Corporation, the cars run over the Corporation lines to the centre of the city.

The rails laid were 45 ft. lengths of No. 1 British standard section weighing 90 lb. to the yard with 96 lb. rails on curves of short radius. The sharpest curve has a radius of 30 ft. At the joints continuous rail joints were employed in lieu of the more usual fishplates; the rails are anchored every 22 ft. The bonding is double with concealed bonds of 4/0 section. The tie-bars are of Messrs. Bayliss, Jones & Bayliss weldless type. The points and crossings were supplied by Messrs. Edgar Allen & Co., Sheffield, the points being 11 ft. long of cast steel with a radius turnout of 100 ft. The crossings are iron-bound with an angle of 1 in 5, the legs being extended to permit of the use of continuous joints. The iron work rests on a 6 in. bed of 6 to 1 concrete, which was placed in position and well rammed after the rails had been surfaced and aligned. For the paving two classes of setts were used; 4 in. by 5 in. Aberdeen granite setts were laid, 7½ in. on each side of the rail, and the remainder of the track and margins were paved with 4 in. by 5 in. Whinstone setts. The private road above mentioned was made 50 ft. wide, and instead of Whinstone setts tar macadam was laid. This road is fenced on both sides, and the cars are allowed by the Board of Trade to run at a speed of 15 miles per hour. The bridge over the Dighty Water near Monifieth was widened by passing steel girders under the track as shown in Fig. 1. These girders are embedded in concrete and, acting as cantilevers, support the footpath on each side.

The overhead equipment is the standard side-running bracket-arm type, with double trolley wire and flexible suspension. The cables were supplied by Messrs. Henley's Telegraph Works Co., and are paper insulated, lead covered, laid solid in wooden troughs.

The power house is situated on the banks of the Dighty Water, from which, by means of a pipe 150 ft. long, the supply of condensing water is obtained. The feed water is taken from the Dundee water supply. The chimney, which was built by the Ferbeck Company, is 110 ft. high, with an interior diameter of 5 ft. There are three Lancashire boilers 28 ft. long and 7 ft. 6 in. in diameter, supplied by the Carmichael Ward Foundry of Dundee. The working pressure is 160 lb. per square inch, and each boiler is capable of evaporating 4,600 lb. of water per hour at normal rating. At the back of each boiler there is a Sugden superheater, provided with a bye-pass to allow of it being cut out if necessary. Each superheater has 190 sq. ft. of heating surface, and is capable of superheating 5,000 lb. of steam per hour 150°F. at the boiler pressure of 160 lb. There are two Worthington steam-driven feed pumps, each capable of delivering 1,400 gallons of water per hour to the boilers. The feed-water heater was supplied by the Wheeler Condenser Co.; it has 150 sq. ft. of heating surface, and, with the exhaust steam from the auxiliary plant, will heat 2,000 gallons per hour from 70°F. to 200°F. The water discharged from the condenser is purified by a Harris-Anderson purifier, handling 1,400 gallons per hour. The condenser is a surface condenser of the Worthington make, and is operated by a Blake-Knowles combined air and circulating pump. The condenser condenses 9,000 lb. of steam per hour and will maintain a vacuum of 26 in. with the barometer at 30 in. The pipework was supplied by Messrs. Babcock & Wilcox (Ltd.).

The generating plant comprises two Belliss-Bruce Peebles 200 kw. traction sets running at 400 revs. per min. The switchboard was supplied by Messrs. Ferranti, and consists of two generator, one feeder and one Board of Trade panel. The lighting can be taken from the switchboard or be supplied by a separate Willans unit. The engine room is fitted with a hand travelling crane with a 25 ft. span to lift 8 tons, supplied by Messrs James Carrick & Son. The Dundee & Arbroath Joint Railway are now putting in a siding to the station for the purpose of facilitating the delivery of coal.

The car shed is situated at Milton, about ½ mile from Monifieth and about 100 yards from the main road. The brickwork was carried out by S. Dick, of Broughty Ferry, and the steel roof by Pierson & Co., of London, as in the case of the power house. The length is 221 ft. and width 36 ft. One end of the shed is occupied by repair shop, paint shop, store-room and smithy. There are three pits, two of which are 135 ft. long and one 170 ft. in length; the three doors are fitted with Kinnear steel rolling shutters with their patent trolley wire attachment. The car-shed fan is made with Vignole rails running on sleepers with needle points and built-up crossings. The offices are in a separate building, and contain rooms for the manager, clerks and conductors

The cars, 12 in number, were supplied by the British Thomson-Houston Co., of Rugby. They are fitted with their electrical equipment, the two motors being each capable of giving 1,300 lb. draw-bar pull at a car speed of 10 miles per hour. The bodies and trucks are of the Brush Company's manufacture. All the cars are fitted with hand, electric and track slipper brakes. The lifeguards are of the Dundee pattern, which are of the drop-gate type, a special feature being that the guard is set at an angle with the track, an arrangement whereby obstacles are thrown clear of the car.

A LARGE TRANSFORMING AND DISTRIBUTING SUB-STATION IN MONTREAL.

The undertaking of the Montreal Light, Heat & Power Co., to one of the sub-stations of which reference is made in our correspondence columns, has rather unusual conditions to satisfy, as it receives power from four separate sources, as summarised below:—

Shawinigan Falls	85 miles	5,000 kw.
Chambley	15 ,,	15,000 ,,
Lachine	5 ,,	6,000 ,,
Soulanges	30 ,,	12,000 ,,
		38,000 kw.

According to the *Canadian Electrical News*, the Soulanges station is under construction, and, in addition to the above, there is a steam reserve of 6,000 H.P. The Mentana-street sub-station is one of several interlinked sub-stations supplied from the above sources, and may be fed from either of two directions.

As the voltage on the tie line may vary between considerable limits, owing to the effects of load at either receiving station, it is necessary to use an induction regulation so that voltage on the sub-station 'buses may be regulated at will. Put into other words, the tie line voltage may be dropping, and at the same time it may be necessary to raise the sub-station 'bus bar voltage in order to compensate for distributing feeder drop.

The building itself is 60 ft. square and 35 ft. from ground line to roof. A commodious basement with 9 ft. head room is provided, reached by an iron stairway. Wood was eliminated as much as possible, only the main sliding door and porch door being of this material. The sliding door is covered with sheet metal. Windows are of copper frames, and fitted with ¼ in. wire glass, as is also the large roof sky-light.

The walls contain 2¼ in. vitrified clay ducts from basement to point of exit, and each 2,400 volts feeder cable is thus isolated. This is a valuable feature in case of a cable breakdown.

A 15 ton hand crane is provided for handling transformers, blowers and regulator, and for lifting apparatus out of the basement. Two iron covered hatchways are provided under the crane area to give access to the basement, the heavy covers being themselves handled by the crane. The main floor is 5 in. thick, and contains a network of 1¼ in. wrought-iron cement lined conduit for control wires, something like 2,000 ft. being used for this purpose.

The station contains 17 1,000 kw., alternating current three-phase 2,400 volt feeder switching units, panels &c., and 20 50 light alternating current arc transformers and constant current regulators and 2,000/4,000 volt transformers.

The circuits, three incoming and three outgoing, come into the station through the lightning protection apparatus, thence to knife disconnecting switches, and thence to solenoid operated G.E. type form "F-K" oil switches, from these to knife disconnecting switches, and to a double set of concrete enclosed 11,000 volt 'bus bars. These bars are also sectionally divided, making it possible to operate different sections of station load from two distinct and separate sources of power.

From these 'bus bars, leads are carried to an automatic type H 3 G.E. oil switch, 300 amperes, 13,000 volts rating, thence through current transformers to an open wiring transformer delta connection. The lowering transformers consist of three banks of three each, 1,100 kw. air blast G.E. make. The primary windings are adapted for voltage of 9,700, 10,300, 11,000 and 12,100 volts, with taps to obtain either two-phase or three-phase on the secondary winding at 12,100 volt primary. The secondary winding is adapted for either 2,300 or 2,400 volts. The leads are brought up through the base and once in the air chamber, are brought to the clay ducts as quickly as possible. This is shown on Fig. 1.

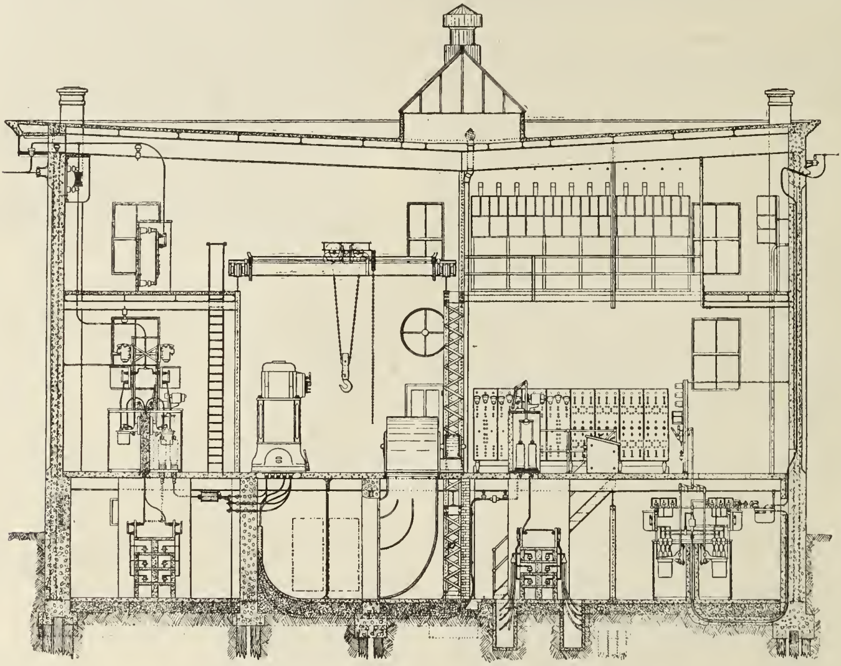
Owing to the standard spacing of transformers, bringing these large units into such close proximity, it has been found by practical experience that in the event of a transformer breakdown and resulting arcing, the flames are carried by the air blast into the neighbouring transformers, resulting in their destruction. To obviate this unsatisfactory result, a cast-iron sub-base or damper was devised. This stands 6 in. high, and coincides with the base outline of the transformer. A substantial grid, or valve, not unlike that used for steam, was devised, and with a horizontal movement of about 3 in. the air is instantly cut off. Balanced or butterfly valves have been experimented with, but found unreliable. With the valve above, as adopted, a quick pull on a lever completely isolates a defective air blast transformer. The working faces are, of course, machined and tested for air leads before acceptance. The transformer leads are carried through one side of this sub-base by means of closely fitting bushings. The upper part of the transformer is provided with pivot knife-blade switches to obtain the different primary winding combinations. These transformers have a floor space of 4 ft. 5 in. square and 8 ft. 9 in. in height, and are about 18,500 lb. in weight. The air required for cooling purposes is about 2,700 cubic ft. per minute at ¾ oz. pressure. Three motor-driven fan sets for cooling the transformers are provided, each driven by a 7½ H.P. 110 volt A.C. motor. The fans are 60 in. in diameter, and run at 600 revs. per min. Air is blown through the main floor into the air chamber 8 ft. 6 in. wide, 9 ft. high and 51 ft. long. An air screen is shown in the section and consists of a series of screens of ½ in. round iron frame covered with 10 in. wire mesh 3 in. centres. Over this is placed a layer of cheese cloth with edges stitched on the ½ in. iron frame. This is renewed periodically and accumulated dirt removed. The cheese cloth, to a certain extent, cuts down the air head or pressure. This is offset as much as possible by a large ratio of screen to fan opening area. In this case the screen area is approximately 460 ft., whereas the fan outlet area is 22¼ in. by 50½ in., giving 33·6 sq. ft. for the three fan sets.

Ordinarily two fan sets will furnish enough air for the nine lowering transformers and the induction regulator, which is also of the air-blast type, so that the ratio of screen area is 460 to 22 or over 20 to 1. The drop in air pressure under these conditions is negligible.

The use of these air screens is amply justified by the surprisingly large quantity of dirt removed from the pressure side of the screen. This dirt would otherwise be lodged in the numerous interstices of winding and laminations.

A no-air alarm is being devised so that in case a transformer damper is closed through error, a bell rings and notifies the station attendant that such is the case. This should prevent a slow burn out of a transformer due to lack of air, and will be an automatic check on the thermometer temperature readings. The air is conveyed from the blower set to the air chamber through a housing of steel plate. The air chamber is entered through two air-tight metal doors, one on each side of the air screen. The induction regulator, 350 kw. capacity, with 200 volts range up or down, is cooled by air drawn from the air chamber and conveyed to where the regulator is located, thence filtering up through the interior of regulator. The two 12 in. floor beams supporting the regulator are so spaced as to serve as sides of an air duct. A plate was put on top and bottom, thus making an air passage from the air chamber proper to the induction regulator. This regulator is automatic and is also compensated for unequal loads on individual legs of circuits. The capacity, 350 kw., is the nominal rating, but, in reality, the regulator can handle twelve times this amount of power, or 4,200 kw. of energy continuously. No duplicate regulator is provided, but it may be cut out at will by knife disconnecting switches located in the basement. This is shown on the general diagram of connections.

On leaving the 1,100 kw. lowering transformers, the leads are brought single-phase to an H-3 oil switch of 1,200 amperes capacity, the delta connection being made just where leads run through the series-current transformers. This arrangement eliminates as much as possible any joints, terminal boards, &c., in the air chamber. A double 2,400 volt receiving 'bus is then provided and connected so



Section of Mentana-street Sub-station, Montreal.

that one section or as many distributing feeders may be controlled as may be desired. The remaining feeders may be controlled through the induction regulator as may be desired. The remaining feeders or none at all, if desired, may be operated independently of the regulator. This is accomplished through the use of a double 2,400 volt 'bus bar arrangement situated immediately under the distributing switchboard panels.

The distributing switchboard consists of 14 1,000 kw. panels 2 ft. wide of blue Vermont marble, and three special panels, two being called totality and one auxiliary. The total station output is registered through the totality panels, which have three ammeters, one indicating and one polyphase recording wattmeter, as well as a voltmeter.

The auxiliary panel is intended to control a static 500 kw. one-to-one ratio transformer not yet located or shown on the floor plan. It has also an indicating wattmeter. An auxiliary three-phase 'bus is also provided and intended to work in connection with the above.

In case an overhead 2,400 volt feeder becomes grounded or defective, the one-to-one transformer is energised through an oil switch, and the defective feeder put on it through the medium of double-blade single-throw horizontal disconnecting switches in the basement. Double-blade switches are used so that the circuit need not be opened, but the transformer cut in before the feeder is taken off the main 'bus bars. A wattmeter reading may also be made of any feeder at will, by this combination. The auxiliary panel, as already stated, has an indicating and recording wattmeter mounted upon it.

A panel is provided to control the two 10 panel A.C. series arc switchboard equipments. Iron pipes are laid in the basement floor to carry the 2,400 volt cables, one to each 10 panel equipments.

The auxiliary services, all at 110 volts and comprising three 7½ H.P. A.C. blower motors, a 2 kw. motor-generator set for storage battery charging, induction regulator control motor 1 H.P., and the station lighting, are all controlled by a special panel and oil switches.

Each panel on this switchboard contains two hand-operating levers for the oil switches in the basement. These are interlocking, and signal lamps are also provided to show which switch is closed and which is open. These oil switches, which are quite heavy, are supported at the back by a heavy bracket bolted on to two 1¼ in. wrought-iron pipes, running from end to end through the cell-work barriers. This is a decided improvement on the usual method of setting bolts or studs through the centre wall, which as a rule is well occupied with ducts. The pipes may also be lined up more readily than bolts, as formerly used. These switches are automatically tripped by the usual bellows type time limit relay, set to predetermined time limits. The current transformers tripping these relays and controlling the various panel-measuring instruments are shown just above the division cell wall in the basement.

A benchboard is provided with hand-control switches. From this point all the K switches controlling incoming or outgoing tie lines are opened. This benchboard also opens the H-3 oil switches controlling primary and secondary of lowering banks of transformers.

Three 20 kw. 2,400 volt 110 volt transformers are installed in the basement and carefully isolated by concrete barriers and covers. These furnish the 110 volt current for above services. A panel with open knife switches and fuses is provided to start up or control any or all of the station services just mentioned.

The motor-generator set of 2 kw. capacity is used for charging a 55 cell, 20 ampere for three hours storage battery.

A special panel is installed with under-load and over-load circuit-breakers; also ammeter and voltmeter. This panel also controls throw-knife switches, the benchboard, oil switch, D.C. 'bus for opening and closing oil switches.

Attention is drawn to the method of bringing in the 11,000 volt tie-line conductors. These are of 2/0 B. and S. gauge and are 18 in number. The lines are terminated on a strain insulator of standard make. From there a wire is run through a standard bushing made for this voltage, thence through the station wall and in the building, all the wire being bare.

The roof proper is carried out 30 in. horizontally, as shown on Fig. 6, and a front, two ends, and bottom are bolted on. These consist of about 1½ in. thick concrete slabs, fairly weatherproof at the joints. This roof extension has some ornamental features, and the whole has a pleasing external effect from the street.

The lightning protection on the 2,400 volt feeders and arc circuits consist of the usual single pole lightning arresters and choke coils, all carefully sub-divided by soapstone barriers. Double pole arrester units have been found unreliable for this work. The barriers are at least 18 in. deep. Anything less than this has been found unsuitable to confine any arcing.

Birmingham and Midland Institute.—A party of members of the Birmingham and Midland Institute visited the works of the British Thomson-Houston Company, Rugby, on Tuesday and were much interested in the labour-saving appliances and modern machines, as well as the manufacture of the Curtis steam turbine, which they saw there.

THE MURRAY AUTOMATIC PRINTING TELEGRAPH SYSTEM.

Mr. Donald Murray informs us that his automatic page-printing telegraph system has now been installed between St. Petersburg and Moscow. He writes as follows: On February 23, 1906, a telegraphic loop line was made up as follows: St. Petersburg–Moscow–Smolensk–Vitebsk–St. Petersburg. The loop was triangular in shape, and the length of the line was 1,106 miles (1,770 km.). The wire was 5 mm. iron (about 600 lb., 8·88 ohms per mile) and there were two Wheatstone repeating stations, one at Moscow and one at Vitebsk. The Wheatstone automatic system (using the Morse alphabet) got 55 words per minute perfectly, but failed at 60 words per minute. The Murray system (using the Baudot alphabet), under exactly the same conditions, got 90 words per minute perfectly, but failed at 100 words per minute.

On February 24, 1906, the following loop was made up: St. Petersburg–Yaroslavl–Kazan–Moscow–St. Petersburg, a distance of 1,926 miles (3,082 km.), 5 mm. iron wire (600 lb. per mile), with repeating stations at Yaroslavl, Kazan and Moscow. The speeds obtained were indefinite, as one of the sections was not in good condition. The Wheatstone got about 35 to 40 words a minute, and at times a little higher. The Murray system got 56 words per minute, and 10 messages were transmitted and printed. They were found to contain two wrong letters—a remarkably good result considering the condition of part of the line. This is the first time on record that a printing telegraph has worked over such a distance as 1,900 miles, even of copper wire, and in this case the wire was iron.

On February 25, 1906, a trial was made of a loop without a repeater from St. Petersburg to Moscow and back, 800 miles (1,280 km.), 5 mm. iron wire, about 7,100 ohms in the line and 800 ohms in the receiving relay, battery 140 volts, and arriving current 13 milliamperes. The maximum speed of the Wheatstone (Morse alphabet) was 25 words per minute. The Murray system (Baudot alphabet) under exactly the same conditions got 63 words per minute easily and perfectly. Ten messages were transmitted and printed without an error.

On March 9, 1906, a trial of the Murray system was made from Berlin to St. Petersburg direct without a repeater. The length of this line is about 1,080 miles (1,728 km.). From St. Petersburg to Eydtkuhnen, on the German frontier, the line consists of 600 miles of 5 mm. iron wire, and from Eydtkuhnen to Berlin 480 miles of 3 mm. copper wire (4·37 ohms per mile). The total resistance of the line was 7,425 ohms. The trial was from 8:30 a.m. to 9:30 a.m., Berlin time. Berlin tested the wire, and reported that it was "not clean" (nicht rein), and wet snow was falling in St. Petersburg, where there was a thaw. After a few experiments a speed of 70 words per minute was reached perfectly with the Murray system on this line, the German typewriter sentence, containing all the letters of the alphabet, "Kaufen Sie jede Woche vier gute bequeme Pelze x y 1 2 3 4 5 6 7 8 9 0," being transmitted and received over and over again perfectly for about 10 minutes. Traffic requirements did not permit of further experiments, but it is probable that by the use of a shunted condenser and increased battery power the speed might have been raised up to 80 or 90 words per minute.

The highly favourable results obtained with the Murray system during these trials are explained by the inventor as being chiefly due to the employment of the Baudot alphabet, which is shorter than the Morse in the ratio of 5 to 8. It may also be mentioned that the inductive interference from neighbouring wires was very severe on these long lines and was an important factor in limiting the speeds obtained. The Wheatstone apparatus was well adjusted by skilful mechanics, and the results were as good as could be expected from it under the conditions. Special artifices, such as shunted condensers, were not employed.

Mr. Murray adds that whatever truth there may be in the newspaper reports about other departments of the Russian Government, the Russian telegraph service appears to be efficiently managed. Both in St. Petersburg and Moscow he found the head telegraph offices up to date and well equipped and arranged, and the officials hard-working, capable and well instructed. The volume of messages handled in Russia is far less than in Great Britain, about 20 millions as against 90 millions per annum; but, on the other hand, the territory served by the Russian telegraphs is vastly greater, and the enormous Russian distances and the Arctic winters have introduced special technical difficulties which have been surmounted in a way that would do credit even to American telegraphic enterprise. There is a general demand on the part of the public for an extension of postal and telegraphic facilities, and there are hopes that the newly-elected Gosudarstvennaia Duma, or Imperial Parliament, will recommend the appropriation of sufficient funds to enable these increased facilities to be provided. Meanwhile, the Russian post and telegraph department has made the best use of the means at its disposal, and succeeds in bringing in a very large annual profit to the State.

For working over moderate distances the Hughes is employed, and nearly all the long-distance circuits are equipped with the Wheatstone automatic, the received tape being handed to typewriter girls for transcription. A considerable number of typewriters are used for this purpose both in the St. Petersburg and Moscow telegraph offices. Nearly all the telegraph wires are 5 mm. iron (about 600 lb. per mile), and this fact, combined with the colossal distances, renders the use of an automatic system, such as the Wheatstone, inevitable. There are about 16 Wheatstone circuits in Russia: amongst others, Petersburg to Rostov 1,100 miles and two repeaters, Kazan to Omsk 1,000 miles and one repeater, Omsk to Irkutsk 1,200 miles and two repeaters, St. Petersburg to Odessa 1,000 miles and two repeaters. From Irkutsk to Vladivostok is roughly about 1,800 miles, and from St. Petersburg to Vladivostok about 5,000 miles. The longest Wheatstone circuit in Russia is the special wire from St. Petersburg to Irkutsk on Lake Baikal. This is 6 mm. iron wire (about 800 lb. per mile), and the length of the circuit is about 3,800 miles with six repeating stations. Pekin is roughly about 1,000 miles from Irkutsk, and on one occasion the experiment was made of working through direct from St. Petersburg to Pekin. A speed of 30 words a minute was reached quite clearly, a noteworthy achievement, considering that the line consists of over 4,500 miles of iron wire.

When Mr. Murray arrived in Russia the great postal and telegraph strike was over, and normal conditions had been re-established, but in Moscow the Telegraph Department was still hampered to some extent by the destruction of its city wires during the riots last year. The strikers tore down the telegraph lines in all directions, and in various quarters of the city telegraph poles could be seen with a tangle of wires still clinging to them. The inconvenience caused by the destruction of the Moscow wires was serious, because Moscow is a great telegraph centre from which wires radiate all over Russia. Temporary lines have been erected, but the Government is not going to be caught again in this way, and arrangements are being made for putting city wires underground in cables.

In conclusion, Mr. Murray states that his automatic printing telegraph system has now been working for about two years between Edinburgh and London, and a complete duplex installation is being constructed for London–Dublin. The system has also been working for more than a year between Hamburg and Berlin, and it is now working between St. Petersburg and Moscow. The Indian Telegraph Department has ordered a complete duplex equipment for use between Calcutta and Bombay, a distance of 1,200 miles, and the Austrian administration is having an experimental set constructed for trial between Vienna and Prague. When sets have been installed between London and Berlin and between Berlin and St. Petersburg it will be possible, he says (owing to the power of re-transmitting messages automatically from the received Murray tape), for any of the cities Edinburgh, Dublin, London, Berlin, Hamburg, St. Petersburg, and Moscow (and by-and-bye Vienna) to exchange telegrams with each other automatically without disturbing the local traffic between any two of these cities.

EXPERIMENTS ON THE INDUCTIVE VIENNA–INNSBRUCK TELEPHONE LINE.

An account of the technical features of the telephone trunk line between Vienna and Innsbruck, in which inductance coils had been inserted to improve the transmission of speech, was given in *The Electrician*, Vol. LV., p. 668. This account was a translation of an article by Herr R. Nowotny, which had appeared in our Austrian contemporary, *Zeitschrift für Elektrotechnik*. The same author has recently contributed another article, in which he describes a series of interesting tests carried out during the last year on this long-distance telephone line.

The following is a gist of his observations: As may be remembered, the distance between Vienna and Innsbruck is 354 miles, and the telephone wire consists for the greater part of 3 mm. (0·1181 in.) bronze wire. Inductance coils were inserted at intervals of 4 km. (2·48 miles). At the very outset it was observed that the transmission did not suffer appreciably if every second inductance coil was cut out. This result was confirmed by subsequent tests of long duration. In the autumn of 1905, the Innsbruck–Trient line (109 miles long, and of 3 mm. bronze wire) was connected up to the Vienna–Innsbruck line. This extension was also provided with inductance coils at intervals of 2·48 miles. When all the inductance coils between Vienna and Trient (463 miles) were short circuited, it was possible to maintain satisfactory communication between Vienna and Bozen (430 miles) but communication between Vienna and Trient was difficult and only possible by talking slowly and distinctly. But a satisfactory service between the subscribers at Vienna and Trient became possible at once when the inductance coils were inserted, and no appreciable difference was found whether the coils were 2·48 miles or 4·96 miles apart. The overhead telephone line Trient-Riva (33 miles long, 3 mm. bronze wire, no inductance coils) was then connected up also, and it was observed that with inductance coils 4·96 miles apart (between Vienna and Trient only) an indifferent communication could be carried on between Vienna and Rovereto (13·6 miles beyond Trient), but no further. It is noteworthy that no better result was obtained when all the inductance coils (at intervals of 2·48 miles) were inserted. After inductance coils had been inserted in the Trient-Riva line at intervals of 4·96 miles, it was possible to communicate satisfactorily between Vienna and Riva (496 miles). In view of these results the Austrian telephone authorities decided to remove half of the inductance coils between Vienna and Trient.

A further series of tests were carried out between Vienna and St. Pölten (37·2 miles) to determine whether the efficiency of transmission was impaired or not by placing the inductance coils at irregular distances. It was observed that the effect was the same whether the coils were at regular or irregular intervals. This was further confirmed by the fact that the transmission between Vienna and Innsbruck did not suffer appreciably if the inductance coils on the section between Salzburg and Bischofshofen (18·6 miles) were removed altogether.

It would appear that inductive telephone lines are more sensitive to extraneous electric influences than lines not provided with induction coils. The disturbances caused by strong telegraphic currents in telegraph lines parallel to the above telephone line were more pronounced, for instance, than if the telephone line had had no inductance coils. Insulation faults also led to greater disturbances in the case of inductive telephone lines, but a uniform leakage (as occasioned, for example, by wet weather or fog) had no marked influence on telephonic transmission. In the section between Vienna and St. Pölten the disturbances due to exterior sources (tramways, &c.) were appreciably increased by the presence of even a single inductance coil, and it was also observed that the disturbances were larger or smaller according to which coil was left in the circuit. Some of the coils, for instance, led to small disturbances, while others conduced in a remarkable manner to disturbing noises.

On investigation it was found that the self-induction of the coils had decreased from the original value of 0·08 henry to much smaller values. Most of the coils had a coefficient of self-induction between 0·05 and 0·06 henry, while in some it was as low as 0·03 henry. This effect is put down to the remanent magnetism produced by powerful temporary currents, such as may occur in testing by continuous current, or may arise from lightning effects. The self-induction could be increased in almost all cases to two-thirds its original value by demagnetising the coil with powerful alternating currents.

REPORT ON AN ACCIDENT AT A CENTRAL LONDON RAILWAY SUB-STATION.

Mr. A. P. Trotter, Electrical Adviser to the Board of Trade, has presented the following report on a fatal accident that recently occurred at the Notting Hill Gate sub-station of the Central London Railway on March 21st:—

The winding machinery for working the lifts at Notting Hill Gate station is situated in the well below the lifts, and below this again is a sub-station where an alternating current supply at a pressure of about 3,000 volts is converted into a direct-current supply at about 500 volts. The machinery and apparatus in this sub-station consists of a high-pressure switchboard, at which the supply is received from the generating works at Shepherd's Bush, transformers, rotatory converters, ventilating fans, and a low-pressure switchboard, from which current at a pressure of 500 volts is supplied to the railway. The machinery is placed on the floor and the switchboards are placed on an iron gallery. The main switches on the high-pressure board consist of a pair of levers hinged like tongs. The handle by which they can be opened or closed together is on the front of the switchboard, and is connected with levers by means of a vertical wooden bar 2 ft. long. This bar serves to insulate the handle from the levers, and is placed behind the switchboard. The distance from the bar to the iron walls of the well or vertical tube is about 3 ft. The top of the wooden bar is 6 ft. 3 in. from the iron floor of the gallery. The bar is attached by bolts to the metal switch levers. There are six such switches, in two sets of three, the supply being in duplicate. There is no high-pressure work at a less height than 6 ft. 3 in.

There is no necessity for doing any work on the high-pressure apparatus while it is "alive"; and no such work is done in these sub-stations. Since the supply is in duplicate either set of three switches can be opened, and they may then be handled with impunity. The permanent high-pressure work is about 9 ft. above the gallery.

Bone (the deceased) had just come on duty at half-past eight on the morning of March 21st, and Robert Prinn, who had been on the night shift, discussed the tightening of the bolts which connect the upper end of the wooden bar with the metal levers of one of the switches. Bone raised his right hand and touched the bolts. He received an electric shock, and his right hand gripped the metal work. Prinn seized him and pulled him off. Bone said "I'm all right," and collapsed. Artificial respiration was tried for an hour and a-half, but Bone did not recover consciousness. Medical evidence at the coroner's inquest showed that there was a burn on the index finger of the right hand, and a scar on the left knee. His knee probably touched the metal frame of the switchboard.

Robert Prinn, sub-station attendant, states: I was present on the date of the accident. I had been on the night shift. When Bone came we were discussing matters in general, and in conversation about our work he mentioned the need of tightening some of the bolts on the back of the high-tension board. The bolts occasionally want tightening up. The switches come out with a good force, as it is necessary to break hard. We never work on a "live" board. I take it he absent-mindedly wished to indicate to me which bolt wanted tightening. He raised his arm quite naturally; he did not slip in any way. He was thoroughly conversant of the danger. He was an old torpedoman and had worked in a magazine and on extracting fuses from torpedoes. He touched the bolt and got hung up. I got hold of him round the waist and pulled him off. When I pulled him off he said "I'm all right." Of course, I was surprised to hear him speak. He then staggered again and said "I'm all right." He then became unconscious and fell. I lifted him out and sent for a doctor and started artificial respiration.

Mr. E. P. Grove, chief mechanical engineer, states: The staff of the sub-stations are not all acquainted with artificial respiration. We propose to teach all assistants artificial respiration. I think oil switches are better, the men feel more satisfied when they are handling them, as there is no arc above their heads. We are putting some in other sub-stations, but I do not think oil switches would suit here; there is not enough room. The accident did not arise from any failure of the switches.

Conclusion.

This accident cannot be attributed to any defect in the switch gear or its position, nor to any rash attempt to tighten the bolts, nor to disobedience to the rules, nor to misjudgment by Bone of the distance between his finger and the switch, but merely to absent-mindedness. Bone had been engaged on such work for 10 months, and in this sub-station for six months. He was fully aware of the danger. He had been a leading torpedoman and was familiar with dangerous work in magazines.

Having regard to the economy of space necessary in this sub-station, which in several respects resembles an engine room on board ship, I do not consider the space behind the switchboard is too narrow. There is sufficient room for inspection while the apparatus is "alive," and for repair when it is shut down. The bare iron floor contributed, no doubt, to the fatal shock, and I understand that a teak grating is to be provided. This will reduce the risk of slipping. Wooden gratings or india-rubber mats are useful to prevent slipping, but they are a treacherous safeguard against high-pressure electric shocks. The kind of switch used here is open to the objection that sparks may fall on the man who opens it. Oil switches present some advantages, but they have to be provided with isolating switches, which would present more bare metal than those in use at this sub-station, and such isolating switches are not always placed in safe positions. These observations are of a general character and do not relate directly to the accident. Three sub-stations of this type have been at work for nearly six years without any accident from electric shock.

The accident was due to absent-mindedness or momentary aberration of a competent man.

ELECTRIC POWER SUPPLY AND SMOKE ABATEMENT.

A Memorandum has been issued by the Commissioners of Works, in which attention is called to the large number of bills introduced into Parliament this session for the grant of powers for the generation and supply of electrical energy in London—more particularly the following: The London County Council (Electric Supply) Bill, the Administrative County of London & District Electric Power Bill, the Additional Electric Power Supply (London) Bill (now rejected), the West London Electric Undertakers' Association Bill, the St. Pancras Electricity Bill, the Charing Cross, West End & City Electricity Supply Bill, the City of London Electric Lighting Bill, the London Electric Supply Corpn. Bill, the Metropolitan Electric Supply Co. Bill, the South Metropolitan Electric Light & Power Bill, the Kent Electric Power Bill, the Hackney Electricity Bill, the Shoreditch & Stepney Electricity Bill.

The introduction of all these schemes indicates an approaching great increase in the use of electrical energy, which will be generated chiefly within the London district; and this latter fact involves the development of existing generating works in the Metropolis and large additions to their number. The Commissioners of Works, as the public department in charge of the royal parks and gardens, have felt a growing apprehension as to possible injury from the products of combustion emitted by these extensive generating works to the life of the trees, plants and flowers which are the attraction and adornment of the parks, the public interest in the preservation and care of which must be duly considered along with that other public interest connected with the promotion of electrical industries. The Commissioners are not free from doubt whether the great national treasures in museums and pictures galleries are not exposed to danger from this same cause. They think it right, therefore, in view of the introduction of all these legislative schemes, to invite the attention of Parliament to the point, so that it may be fully taken account of in any inquiry upon those schemes.

The case is not entirely one of the emission or consumption of black smoke or sooty or tarry matters. The other products of combustion, such as sulphurous and sulphuric acid, with solid particles of mineral matter or ash, are very deleterious to vegetation, to buildings, and to pictures marbles, metals, and other museum exhibits.

It is no doubt true that in most cases the owners of generating stations are liable to the ordinary law against the negligent emission of smoke, and that they take measures more or less effective to prevent such emission, but the position is somewhat different as to other products mentioned above. In this connection it is to be observed that the Board of Trade, in provisional orders with regard to electric lighting in the provinces, incorporate the schedule to the Electric Lighting Clauses Act, 1899, sec. 81 of which runs as follows: "81. Nothing in the special order shall exonerate the undertakers from any indictment, action or other proceedings for nuisance in the event of any nuisance being caused or permitted by them."

Although the Act of 1899 does not apply to London, such a clause has hitherto been generally inserted, it is believed, in London orders; but it has not been introduced into acts when specific sanction has been given by Parliament for the acquisition of particular sites for generating stations, and a practice has now begun to be adopted of giving statutory exemption from nuisance proceedings.

A short summary then follows of some of the features of the principal bills now before Parliament.

The Commissioners of Works do not apprehend that the public interests in their charge are specially affected by some of the schemes, although they do consider that the cluster of generating stations which is growing up in the near neighbourhood of the Regent's Park, and other works indicated, may justifiably cause them peculiar uneasiness on account of their situation. There are several stations already in existence within a few hundred yards of the Regent's Park, owned or worked by the Central Electric Supply Company, the Marylebone and St. Pancras Corporations, or others: one of these is very close to the home of the Wallace collection. It may be admitted that many furnaces and chimneys are abolished by the institution of great electrical works; but undoubtedly the enormous amount of coal consumed by such works is equal to the consumption of tens of thousands of houses or small factories; and this is a very serious matter when many of these works chance to be gathered within a limited area. Apart from special cases such as these, the general condition of the atmosphere of London cannot be ignored.

It would appear that smoke with its sooty and tarry particles can be so well consumed by proper apparatus that no danger ought to arise in that respect. Effectual means should be taken to secure that apparatus of the most approved character shall be employed for the consumption of smoke. The use of dust-destructor refuse as fuel should be altogether prohibited. But the principal enemy to be combated is sulphuric acid, the production of which can be much diminished, if not entirely prevented, by pouring lime-water on the coal before it goes into the furnaces; and the Commissioners think that this condition, the fulfilment of which would involve small expense and not much labour, might reasonably be insisted upon.

Appended to the memorandum is a letter from Sir A. B. W. Kennedy relating to the working of the Central Electric Company's station at Grove-road. It is pointed out that the damage to plant life is almost entirely from the sulphurous acid and other deleterious matter products of imperfect combustion such as are emitted from ordinary house chimneys. It is, however, remarked that the working of such a chimney as that at Grove-road is essentially different, as not only is the Welsh steam coal used free from sulphur, but the combustion is complete, the main constituent of the products being carbonic acid, which is not only harmless but beneficial to plant life. Also the chimney, which is of great height, is so worked that it does not emit dense smoke. He also calls attention to experiments of horticulturists, who recommend the use of some 30 per cent. of chalk in the soil to counteract the effect of sulphurous acid. A reply to this from Prof. T. E. Thorpe expresses the opinion that no coal is absolutely free from sulphur, and denies that the minute excess of carbonic acid referred to can have any beneficial effect on vegetation.

A further appendix contains some answers to a series of general questions addressed to Prof. T. E. Thorpe, who states that the products of combustion emitted from electric generating stations under ordinary conditions are: Carbonic acid, water vapour, nitrogen, minute quantities of carbonic oxide, ammonia, and more or less sulphurous acid, depending upon the amount of sulphur in the fuel, together with more or less suspended carbonaceous matter (soot) and mineral matter derived from the ash. Of these, the most deleterious to vegetation, works of art and museum exhibits is the sulphurous acid, which, by oxidation, is converted into sulphuric acid, and so exerts a corrosive action. Sulphurous acid as such, even in small quantities, is injurious to vegetation. The formation of sulphurous acid and consequent production of sulphuric acid cannot be prevented by any rearrangement of the furnaces, or by the use of exhausts or modern appliances. Its evolution may be minimised by careful choice of coal, or by ensuring that the coal is burnt with small quantities of lime (if the amount of lime already in the mineral constituents of the ash of the coal is not sufficient to retain the sulphur as calcium sulphate).

With reference to future stations which may not be brought before Parliament for sanction, the Board are now accustomed to request the insertion in private bills of the following clause, which would enable them to exercise some control in extreme cases.

The . . . shall not, except with the approval of the Commissioners of Works, erect any generating station or take a supply of energy from any generating station unless the site for such generating station is specified in an Act of Parliament or in an order confirmed by or having the effect of an Act of Parliament. Provided always that this section shall not apply to any sub-station for the transformation and distribution of electrical power. Provided also that this section shall not apply to any station which may be in existence and which shall not be extended beyond the limits of the site occupied by the buildings of such station at the time of the passing of this act.

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While there has been a considerable improvement this session in the quality of the Papers read at the Institution of Electrical Engineers, the recent action of the Council in nominating as President a gentleman who has been member of the Institution for a comparatively short time, and has only served two years on the Council, has given rise to much adverse comment on all sides. As we stated in our last issue, when discussing this nomination, we do not wish to detract in the slightest degree from Dr. R. T. GLAZEBROOK'S high standing as a physicist. He has occupied the position of President of the Physical Society, he is an F.R.S., and has served on the Council of the Royal Society. His research work in optics has been of considerable value, and all old students owe him a debt of gratitude for his text book on "Physical Optics." In electrical work he devoted himself particularly to the perfection of standards of measurement while at the Cavendish Laboratory, and it was doubtless his experience in these matters that decided the Royal Society to call him from University College, Liverpool, where he was Principal, to take up the position of Director of the National Physical Laboratory. As a physicist, therefore, he is in the front rank, but it would be difficult to point to any definite advance in electrical engineering that has been directly due to his influence. If, contrary to all precedent, a new-comer is to be elected to the highest rank at the Institution of Electrical Engineers, his supporters should show some good cause why an exception should be made in his case. Let us look back to Past-Presidents. For twenty years the President of the Institution has been, with one exception, either a leading electrical engineer or a physicist who has contributed much to the practical advancement of the electrical engineering industry. The one exception was Sir WILLIAM

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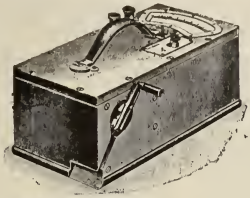

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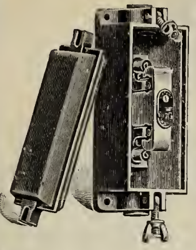

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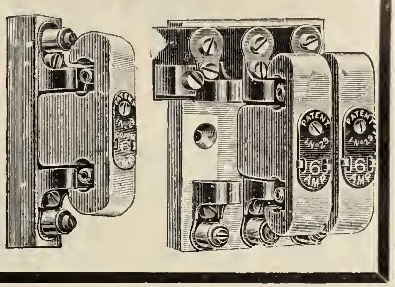

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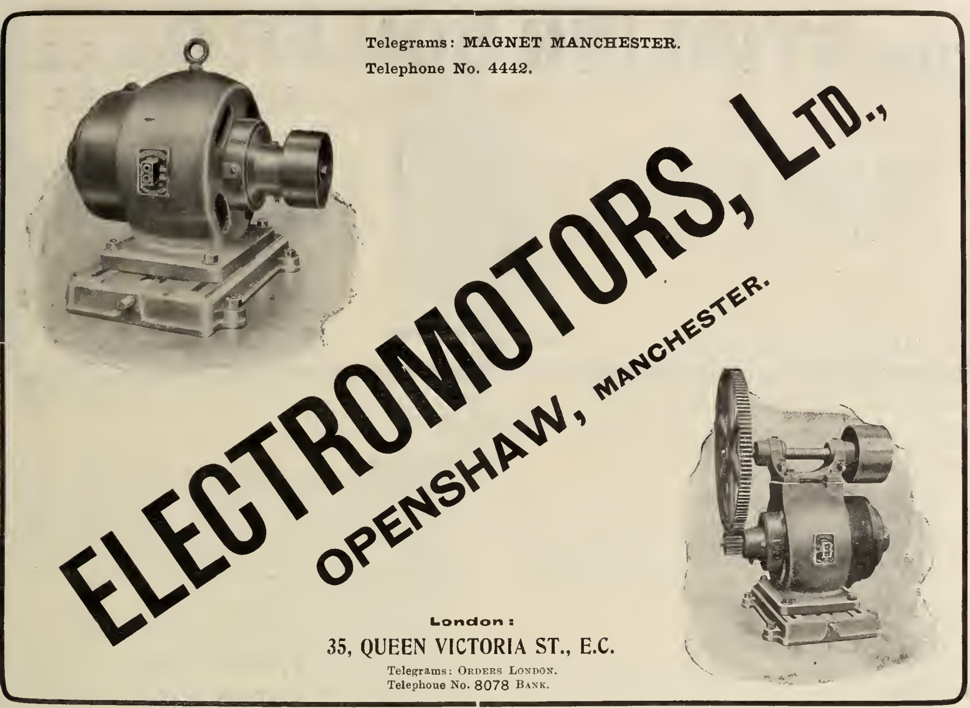
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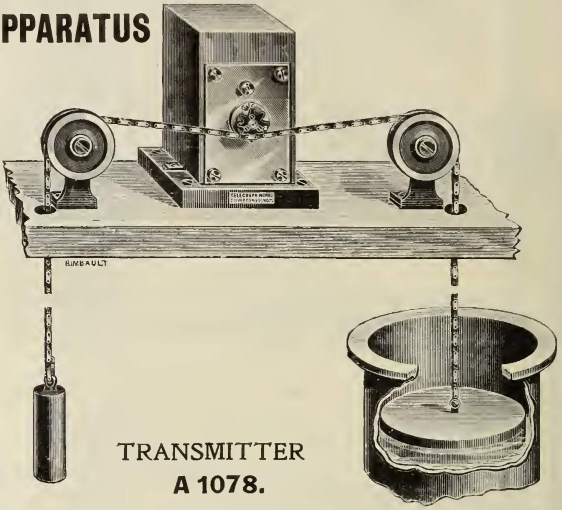

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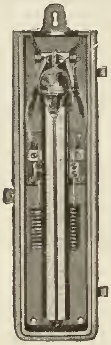

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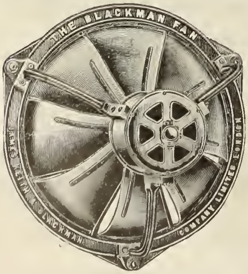

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CROOKES, whose distinguished services to electrical science are on a plane far above the estimation of units and standards in which Dr. GLAZEBROOK has so ably assisted. Moreover, Dr. GLAZEBROOK'S personality is hardly known to members at the Institution. He has never read a Paper there, and has probably not spoken a dozen times. We have reason to know that the membership generally would have preferred an electrical engineer of long standing as President, and several men have been suggested, all of whom have served longer on the Council than Dr. GLAZEBROOK. Mr. MORDEY and Mr. FERRANTI, for instance, have been on the Council ten and nine years respectively, and have each acted as Vice-President twice. Major CARDEW has been elected to the Council seven times, twice as Vice-President. Mr. PATCHELL has also been twice Vice-President, and has served three years as ordinary member of Council. Finally, Prof. GEORGE FORBES, although he has not been on the Council since 1895, has likewise served his two years as Vice-President and has been ten times on the Council.

Although two of these gentlemen have been asked to contest the Presidency, against the Council's nominee, and the request has been profferred and supported by several influential members, there will be no election. One week only is allowed for the nomination of alternative candidates, and before a man will undertake to stand, he naturally desires some time to satisfy himself as to the support he is likely to obtain and the reasons that have induced the Council to propose their own candidate. The difficulty of obtaining the consent of candidates and ten supporters to their nomination within the week allowed under the Articles of Association makes the article providing for alternative nominations, whether for President, Vice-President, or other members of Council, almost inoperative. It has frequently happened that dissatisfaction has been expressed as to the nominations, especially for Vice-Presidents, and also for associate members of Council, who are not now selected, as formerly, from the ranks of the younger electrical engineers, but no effective protest could be made. Again, although nominally a week is given for alternative nominations, the time is really shorter, for copies of the Council's list are not sent to every member of the Institution. The list is read out at eight o'clock on a Thursday evening, and only those members who happen to take an interest in the particular Paper discussed that night are in attendance to hear it. No official announcement is made at all to the members not in the metropolis; we believe that they do not even receive postcards to remind them that the nominations will be made. At eight o'clock on Thursday night the technical journals have already gone to press, and we are only able to publish the list on the following Friday morning each year by putting back the time of going to press at the risk of making our issue late. In fact, this year the only publication of the list was made in *The Electrician*, and no other publication of it will be made until it is too late to send in alternative nominations. As every member of the Institution does not read his *Electrician* on Friday morning, it is evident that this does not allow seven full days for the selection and proposal of new candidates. In this short period the written consent of the candidate has first to be obtained, and then the signatures of two proposers and eight other supporters.

In view of these circumstances, we urge the desirability of a suitable modification in the Articles of Association. Every member who has the right to vote should receive an announcement at least a month before the date for nomination, saying that the Council are ready to receive nominations, and at the end of this period the full list of nominations, including those of the retiring Council, should be posted to each member. Moreover, more candidates should be nominated for the Council than are actually required, so that there should be a ballot in any case, and this would give the Council valuable information as to the class of councillors which is most popular with the membership; and, lastly, a full fortnight, or even more, should be allowed between the issue of the nominations and the ballot. Such an alteration in the rules would at once dispose of the illusory idea that a ballot for the new Council implies a vote of censure upon the retiring one, and, if the new members to take the place of the members retiring by rotation were balloted for each year, there would no longer be any chance of the constitution of the Council being challenged by the membership.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

Wireless Telegraphy and Telephony. By Prof. DOMENICO MAZZOTTO. Translated by S. R. BOTTONE. (Whittaker & Co.) 6s.

This addition to the already large mass of introductory literature on wireless telegraphy possesses no special features, but will merely compete with its rivals on fairly equal terms. Like many other writers on this subject the author has kept two incompatible objects in view: he has endeavoured to treat the subject in a popular manner, that is, a manner understandable by the untrained, and he has tried to give simultaneously a pretty complete survey of the technology of the subject. We are more convinced than ever that the populace and the expert cannot be provided for in one volume. The reaching after completeness gives rise to a common defect among writers on this subject—namely, the aimless cataloguing of hosts of slightly differing "systems"—numbers of which have never been worked and never will be; and, further, leads to a complete neglect of the duty every author should keep in mind of trying to give his readers some notion of the efficiency of various types of competing apparatus.

La Telegraphie sans Fil. By I. VAN DAM. (Amsterdam: Scheltema & Holkema.) 5s.

The author of this well-designed work of 180 pages is to be congratulated on having adopted the attitude that the ideal introductory treatise on wireless telegraphy should deal chiefly with the scientific principles of the subject and with the types of apparatus of well-admitted value, instead of being a chronological inventory of all the devices that have ever been imagined for signalling without wires. To act upon this view involves, of course, the omission of much matter historically interesting and of several recently proposed methods of communication, but this is greatly to the advantage of the reader desirous of learning what is worth knowing of electric wave telegraphy. Thus telegraphic methods based on the sensibility of selenium to light, and on the action of ultra-violet light on spark-gaps, are omitted altogether from the book under notice, and in contrast to most other recent volumes the development of the subject is here unhampered by superfluous catalogue-like detail.

But although the book is so praiseworthy in plan, it is not faultless in execution. The mathematical part is of date 1853, and leaves untouched the important matter of the periods of compound transmitters. What is called Fleming's theory of wave propagation arises from confusion with an illustration which Prof. Fleming gave in his Cantor lectures, and which used the notion of vibrating electrons to explain the action of Hertz's oscillator. The accepted theory of the nature of the waves is attributed to Blondel, wrongly, we think. It is noticeable that from among the wave measurers described, Prof. Fleming's cymometer is omitted. Again the explanation offered by the author for the superiority of signals in wet weather, namely, that the S.I.C. of the air is then greater, leaves out of account the improved propagation that damp earth affords. Further, Marconi's "jigger" is classified with the miscellaneous apparatus such as signalling keys, though, surely, it should appear in the chapter on syntonisation. But such faults as these are separately small, and in the bulk do not diminish seriously our general appreciation of the volume.

Krane. By ANTON BÖTTCHER. (Munich and Berlin: R. Oldenbourg.) Two vols. 25m.

This elaborate treatise on cranes consists of two volumes. Vol. I. includes all the text as well as a large amount of crane illustrations, diagrammatic sketches of details, and theoretical diagrams, while Vol. II. contains (on 48 folded sheets) working drawings of many kinds of existing cranes and their details. In the opening chapters of Vol. I. the author deals concisely and lucidly with the general statical and dynamical problems which confront designers of cranes. Although these chapters are naturally of a theoretical nature, they are quite easy to follow, and are relieved by much practical data relating the design, efficiencies and so forth of the usual kinds of brakes and gearing. The chapter on strength of materials will also be found useful. In the next part of the book Herr Böttcher enumerates a large variety of hand, steam, hydraulic, electric and electro-hydraulic cranes in general use, giving a short description and an illustration of representative designs of each class, together with a reference, in most cases, as to where a fuller description can be found. The following chapters are devoted to the peculiarities of the various kinds of power used for operating cranes, and deal at length with the methods of transmitting, utilising and controlling steam, water under pressure, electricity and power from line shafting. In the 20 pages which are devoted to electric driving, a simple explanation of the nature, applications and control of continuous and alternating currents is attempted. The author has not been very successful, at all events in the theoretical passages, which are at times rather vague. Within a few lines, for instance, the symbol ϕ is used to denote both the angle between the current waves of a three-phase system and the phase angle between voltage and current, and the text reads as if both were one and the same thing. Then again, the author appears to confuse the mean voltage and current with the effective voltage and current. This chapter would need severe editing to render it useful.

In the next part of the book the author discusses the correct design of such crane details as gears, chains, hooks, pulleys, drums, bearings, &c., and then initiates the reader into the calculation and construction of lattice and girder work. In the last part of the book 11 cranes by reputed makers are calculated through. The examples include various electric cranes of different type. Not the least valuable part of the book is the appendix, which includes tables of standard girders, standard specifications for ordering and testing materials, an abstract of the regulations drawn up by the Verband Deutscher Elektrotechniker and relating to the installation and testing of electric transmission lines, machinery and apparatus, and a long list of references to recent publications on cranes which have appeared in the technical press of all countries. The working drawings in Vol. II. should be of great benefit to crane engineers, but the value of some of the drawings is impaired by the small scale to which they are drawn.

A SIMPLE METHOD OF MEASURING SPARKING VOLTAGES.

The following is an abstract of the discussion which took place on Mr. E. A. Watson's Paper on the above subject, read before the Birmingham Local Section of the Institution of Electrical Engineers, on April 25th. An abstract of the Paper itself was published in *The Electrician*, April 27th, p. 53.

Mr. M. J. E. TILNEY wrote that there were one or two points in Mr. Watson's Paper that did not quite agree with the results he had obtained in practical working with direct currents at pressures at or about 2,500 and 3,000 volts. They had at several of their stations transmissions of three miles or so at a normal working pressure of 2,500 volts, and had installed spark-gaps to deal with the surge rises that took place when short-circuits or big over-loads occurred either in the H.T. cables themselves or on the L.T. sides of the transformers. These spark-gaps were of the disc type, and had about 12 discs, giving 11 gaps, each of which was certainly not less than $\frac{1}{32}$ in.; this gave a total gap of about 0·344 in., or approximately 0·87 cm. In one or two cases this gap had actually sparked across without a surge at all, owing to the atmosphere being very damp, due to a leak of steam, and the arc had held. Mr. H. W. Fisher, in a Paper read before Section D of the St. Louis Congress, gave a sparking distance for 10,000 volts of 0·54 in., or rather over 1·25 cm., and though this was from a point to a disc he could hardly reconcile the results with those obtained by Mr. Watson. The question of the proper gap to use for H.T. direct-current transmission was so important if much progress was going to be made in its use that he hoped Mr. Watson might be enabled to continue his experiments, and he would like to suggest to him that it was possible that the results he was getting, and would get, from the use of a Wimshurst machine might be very widely different from what he would get either from a single direct-current generator wound for, say, 3,000 volts, or from a series of 500 volt machines connected in series.

Prof. KAPP said that Mr. Watson had made some admirable measurements on the dielectric strength of air. This was quite a different thing to the distance which would hold an arc that had been set up in a damp atmosphere, to which Mr. Tilney had referred. Neither were Mr. Watson's results to be compared with those obtained by the use of a number of small gaps in series, as the conditions were very different. The figures given in the Paper showed a fair agreement with those obtained by other experimenters, considering the different conditions under which the experiments must have been made as regarded barometric pressure, temperature, &c., and giving rather lower values of the sparking distance it would be safe to trust them. The results were important in connection with direct-current high-tension transmission, as they showed that the liability to brush discharge increased with a reduction in the size of the conductor.

Mr. E. A. WATSON said that the voltages with which Mr. Tilney dealt were rather below those he had used, which were of the order of 10,000 volts. He could quite understand that Mr. Tilney should get phenomenally long sparks in an atmosphere rendered damp by a leak of steam. Once a spark had passed, a different set of conditions held altogether, and the question of continuance or non-continuance of an arc had nothing to do with the breakdown voltage of the gap. Mr. Fisher's measurements were, he believed, made with alternating current, and of course an alternating E.M.F. of 10,000 corresponded to a steady E.M.F. of 14,000 volts. Moreover, it was a generally recognised fact that a point and disc was the easiest possible gap for a spark to jump. When one considered the great effect upon the sparking voltage produced by altering the diameter of the electrodes from 1·35 cm. to 3·2 cm., one might reasonably expect a greatly decreased voltage in the case of a point for the same length of spark. As to the use of a Wimshurst machine for the making of the tests, and the question as to whether the same results would be obtained as if using H.T. direct-current generators, he failed to see that any difference could result. Of course, once a spark had passed and an arc was set up, matters were entirely different; but the actual breaking down voltage of a spark-gap could only depend on the dielectric stress, which, in turn, depended on the voltage applied to the electrodes, and this voltage would surely be independent of the way in which it was to be produced—whether by electrostatic or by electromagnetic means. With regard to the problem of brush discharging, pointed out by Prof. Kapp, it would be a very serious difficulty in connection with H.T. work. The leakage in the cases noted in the Paper were of the value of about 18 micro-amps., that being the current given by the machine, and it would be found by calculation that this meant a loss of from one to two watts, depending on the voltage. In all probability the leakage was greater than would have been the case from a wire which was strung at a considerable distance from any other objects, as the potential gradient was much steeper. Also the leakage would probably not take place so easily off a cylinder as off a sphere of the same diameter, so that the trouble due to leakage might not really be so bad as it seemed.

THE TESTING OF TRANSFORMERS AND TRANSFORMER IRON.

The following is an abstract of the discussion which took place upon Messrs. D. K. Morris and G. A. Lister's Paper on the above subject, read before the Birmingham Local Section of the Institution of Electrical Engineers on April 25th. An abstract of the Paper itself was published in *The Electrician*, April 27th, p. 61:—

Dr. SUMPNER said that the Paper was particularly interesting to him, because 14 years ago he had developed the method of testing transformers which corresponded to the Hopkinson test on direct-current machines. When it was required to test machines for a long heat run, the method was very simple to carry out. But the transformer was really such a simple piece of apparatus, and its losses were so easily determined, that the Hopkinson test was not absolutely necessary. Two tests only were required, each of which could easily be made. These were a measurement of the iron losses by means of a wattmeter, and the short-circuit test to determine the copper losses. Usually the same wattmeter could be used for both tests. He thoroughly appreciated the author's modification of the method as one which had great advantages where a careful investigation had to be made, and it was required to make the test thoroughly satisfactory from a theoretical point of view. But in most cases the extra complication was not necessary. He much appreciated the method of testing transformer iron described in the Paper.

Prof. KAPP appreciated the objection made by Dr. Sumpner to the complication of using a special boosting transformer, especially in practical work, in order to boost up the voltage of one of the transformers under test, and lower that of the other. This necessitated a special transformer, with the middle point available. The same result could be easily obtained by a method which he had previously used, and in which he had not found any grave errors. The auxiliary testing transformer was connected in circuit, and a throw-over switch arranged so that one lead of the supply to the transformers under test could be connected first to one end of the auxiliary transformer and then to the other. If wattmeter readings of the iron loss in the transformers were taken, it would in one case be the sum of that due to normal flux in one transformer, and an increased flux in the other due to the boosting up of the voltage. In the other case it would be that due to normal flux in one transformer, and a decreased flux in the other, due to the boosting down of the voltage. The mean of the two wattmeter readings gave very nearly the loss in the two transformers at normal induction. It was not quite correct, since when boosting up the loss was greater in proportion than it was when boosting down by an equal amount. He mentioned this in order to take away the reproach which might otherwise be made against the method on account of the necessity of a special testing transformer.

Dr. ALFRED HAY suggested, in a written communication, the substitution of "watts per cycle per second" or "joules per cycle" for "watts per cycle," in the section headed "variable frequency test," as the latter phrase was clearly quite meaningless, and the former was obviously what the authors intended to express. In connection with the calculation of the core loss from the results of tests on small samples, attention might be drawn to the uncertainty which arose from the non-uniformity in the magnetic flux distribution due to the varying length of the lines inside the core. Any departure from uniformity resulted in an increase of the hysteresis loss, and a still greater relative increase in the eddy-current loss. It was curious to note, in this connection, the effect of a poor joint in the magnetic circuit. A core having butt joints will, for a given total flux, have its hysteresis and eddy current loss reduced by an increase in the reluctance of the joints, if we assumed that the small air-gaps at the joints are of uniform length. It was, therefore, quite conceivable that under certain conditions the presence of a slight amount of reluctance at the joints, although increasing the magnetising current, would, on the whole, be beneficial as tending to reduce the core loss, and increase the over-load capacity of the transformer.

Mr. J. T. MORRIS (written communication): In reference to the determination of hysteresis by slow cyclic change, he was in thorough agreement with the authors—from experiments he had made—that the method of *constant induced voltage* for the determination of hysteresis loops for large quantities of iron, without doubt, deserves to be brought much more generally into use. His attention was drawn to the method some five years ago, when determining the leakage co-efficient of certain dynamos. A suitable liquid rheostat being placed in series with the field coils of the machine, the current was gradually increased from zero to normal value at such a rate that the induced voltage developed in a single "search" turn on the limb of the machine was maintained constant. The duration of the period of growth was carefully noted. A single "search" turn on the armature was similarly treated, the same voltage being generated. Then the ratio of these times gave the "co-efficient of leakage." Further, if the voltage generated were known, the total flux could be at once determined. The method was then used for the determination of hysteresis loops of transformer cores, but great skill was required in the manipulation of the water resistance "chopper" switch, which was used for the control of the current. The authors had made a distinct step forward in devising the connections shown in Fig. 4, as this enabled one to pass from one end of the loop to the other without a break. He thought it would be of interest if the authors would furnish some idea of the degree of accuracy that they expected to obtain in the tests in duplicate experiments—as to agreement in time taken in passing from one of the loop to the other for the same limits of H, and also similar data with regard to area of loops. Unfortunately, all these tests, when they have to be compared with those made with all alternate currents, required a knowledge of the "form factor" of the current wave for the purposes of strict comparison. With reference to the author's remarks on the Steinmetz index, experimental results obtained in his own laboratories on actual transformer cores confirmed their results that over the normal range of transformer induction densities the index 1·5 is near the truth, although this index is considerably greater both for lower and higher induction densities. These results are also in accordance with Prof. Ewing's classic work on this subject, published in 1893, which was carried out on small ring stampings of sheet iron.

Dr. J. W. WAGHORN, in a written communication, pointed out that the method of measuring power factor which the authors had called the three-point wattmeter method, was described by Macalister some two or three years ago, and was the most convenient and accurate, not only for circuits of two or three-phase motors or transformers, but for any single-phase circuit where access can be had to a third circuit, in which the voltage differs in phase by a known amount. The difference between the expression he had recently quoted for a three-phase system,* and that which the authors used, obviously arose from the angle of lead or lag being measured from the phase of the E.M.F. in the line in which the current coil of the wattmeter is placed in his expression, and upon the resultant E.M.F. between the two line voltages in that of the authors. The latter was certainly better for the general case of the determination of the power factor of, say, a choking coil which is inserted between two live wires of a three-phase system, the third line being only used as a reference point for the wattmeter readings. In such a case 30 deg. must be added or subtracted to give the usual meaning to the value of ϕ determined from the expression he had used.

Mr. G. C. LAMB wrote that he was interested to see that the millivoltmeter method of measuring hysteresis loss had been found suitable for such small things as iron specimens. The experiment as regarded small transformers was one which had been regularly done in the Cambridge University Engineering Laboratories.

Mr. A. F. T. ATCHISON (communicated): The employment of the "characteristic triangle" of a transformer was very useful as it combined the resistances and leakage reactances of the primary and secondary into an equivalent resistance and reactance respectively, and thus enabled the regulation on different loads to be predetermined by a vectorial subtraction of the "equivalent" impedance drop from the constant primary applied voltage. It was especially satisfactory to know that the results so obtained were in close agreement with those obtained by other methods, as in the case of the regulation of alternators, for instance, the results obtained by this type of treatment could not always be relied upon owing to the large numbers of secondary effects which should be taken into account. The connections for the "standard test" suggested by the authors appeared to have been worked up into a wonderfully convenient form, enabling all the required adjustments to be made very easily. The use of a three-phase supply with the regulating contact for varying the phase angle was very ingenious, and the connections of the secondary of the auxiliary transformer for, as it were, averaging the disturbance of balance in the differential test, should give more accurate results for the losses, just as in the Hopkinson-Kapp differential test on D.C. machines, the field of one should be strengthened as the other was weakened, in order to average the iron loss. The "method of constant induced voltage" for determining magnetisation curves and hysteresis loops certainly did away with many inconveniences of the older ballistic methods, and was now, he believed, used to a considerable extent. For the determination of the hysteresis loop of transformer cores, however, he should strongly advocate the ingenious oscillograph method devised by Dr. Morris himself and Mr. Catterson-Smith when such an instrument was available, as the loop may be different when the core undergoes a slow cyclic change from that obtained with reversals of the normal frequency of the transformer. Perhaps Dr. Morris could say whether this difference was of appreciable importance.

Mr. LISTER, in reply, said that Dr. Sumpner had criticised their application of the Hopkinson or differential test to transformers on the ground of its complication, and had suggested that a simple measurement of the iron losses, and the short-circuit test would in the majority of cases be sufficient. These tests, however, required exactly the same instruments as those shown in Fig. 2, and unless the three-point wattmeter method of determining current were adopted, the short-circuit test would require an ammeter in addition. On the other hand, the combination of the two tests in the manner described, enabled the regulating properties, and also the heating of the transformers to be readily determined, and these latter qualities were probably more important in the case of transformers than the efficiency. Prof. Kapp's method which dispensed with the auxilary transformer was quite satisfactory for core losses, the mean of the wattmeter readings giving the iron loss for the standard flux density with great accuracy. The drawback was the necessity of taking two readings. But the method would not be so satisfactory in the heating test, since unless the connections were reversed periodically, one transformer would heat either considerably more or considerably less than the normal, and this would falsify the measurements of copper resistance. When making heating tests, it would be found that the difference in the readings of thermometers placed in the oil, or in proximity to the core, will clearly indicate which transformer is working at the higher voltage. The use of the middle point enabled a mean value of the heating closely approximating to normal conditions to be obtained. A testing transformer seemed to be necessary also on account of the variable voltages required.

Dr. D. K. MORRIS, in reply to Prof. Hay, said that the expression "watts per cycle" was certainly in error. "Watt-seconds per cycle" was meant. He was much interested in the remarks on the effect of non-uniform flux in samples on the hysteresis loss measured. In the test samples used by Mr. Lister and himself the radial depth of the ring was very small—sufficient iron being obtained by extending the sample axially in the form of a tube. The effect would be negligible in such samples. In reply to Mr. J. T. Morris, tests made by the new method were found to agree and bear repetition if properly taken, as well as those made ballistically. When comparing magnetic qualities by the slow method with those derived from alternating-current measurements, a knowledge of the form factor was only needed for the permeability. Hysteresis could be compared independently of the form factor, but depended probably on the higher harmonics of the E.M.F. wave. So many observers had found the hysteresis loss to vary almost exactly with the $\frac{1}{6}$th power of the induction in the region of maximum permeability that it almost suggested there might be some physical reason that the loss should be proportional to $\sqrt{(\text{flux density})^3}$.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Electrical Engineering in Theory and Practice." By G. D. Aspinall Parr. (London: Macmillan & Co.) 12s. net.

"Science Abstracts." April. Section A, Physics. Section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Transactions of the American Electrochemical Society." Vol. VIII. 1905. (Philadelphia: The American Electrochemical Society.) $3.

"Die Theorie, Berechnung und Konstruktion der Dampfturbinen." By Gabriel Zahikjanz. (Berlin: M. Krayn.) 6 m.

"Proceedings of the American Institute of Electrical Engineers." Vol. XXV. March, 1906. (New York: The Institute.) 50c.

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* *The Electrician*, March 30, 1906.

ON METHODS WHEREBY THE RADIATION OF ELECTRIC WAVES MAY BE MAINLY CONFINED TO CERTAIN DIRECTIONS, AND WHEREBY THE RECEPTIVITY OF A RECEIVER MAY BE RESTRICTED TO ELECTRIC WAVES EMANATING FROM CERTAIN DIRECTIONS.*

BY G. MARCONI, LL.D., D.SC.

This Note relates to results observed when for the usual vertical antenna employed as radiator or absorber in wireless telegraph stations there is substituted a straight horizontal conductor placed at a comparatively small distance above the surface of the ground or water.

When an insulated horizontal wire, AB, such as is shown in sketch 1, is connected at one end to a sphere of a spark gap, the other sphere of which is earthed, and sparks are caused to pass between the spheres, it will be noticed on investigating the space around such an oscillator that the radiations emitted reach a maximum in the vertical plane of the horizontal wire, AB, and proceed principally from the end, A, which is connected to the spark gap, whilst the radiation is nil, or reaches a minimum, in directions which are approximately 100 deg. from the direction in which the maximum effect occurs.

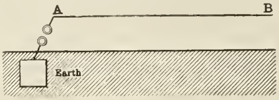

FIG. 1.

I have also noticed that any horizontal conductor of sufficient length placed upon or at a short distance above the surface of the ground, and connected at one end through a suitable detector to earth, will receive with maximum efficiency only when the transmitter is situated in the vertical plane of the said horizontal receiving conductor, and in such a direction that the end connected to the detector and to the ground is pointing towards the transmitting station.

If, therefore, such a horizontal conductor be swivelled about its earthed end in a horizontal plane, the bearing or direction of any transmitting station within range of the receiver can be ascertained.

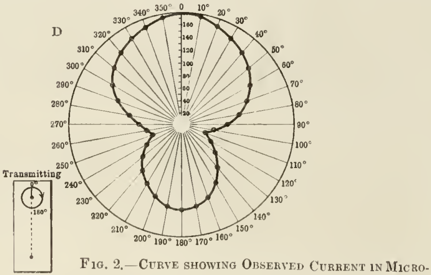

FIG. 2.—CURVE SHOWING OBSERVED CURRENT IN MICRO-AMPERES AT EARTHED END OF RECEIVING CONDUCTOR UNDER THE CONDITIONS OF DIRECTION SHOWN BELOW.

Transmitting Conductor · Horizontal, rotating from 0 deg. to 360 deg., 1·5 metres above ground. Receiving Conductor: Vertical, fixed; height, 18 metres. Length of Transmitting Conductor, 60 metres, Receiving Conductor, 18 metres. Distance of Transmission, 260 metres.

I have carried out a number of tests with transmitters and receivers having radiating or receiving antennæ or conductors arranged as follows:—

(1) Transmitting conductors consisting of horizontal wires, the radiations being received at a distance by means of the usual vertical wires suitably attuned.

(2) Both transmitting and receiving conductors consisting of horizontal wires.

(3) Transmitting conductors consisting of one or more vertical wires with or without capacity areas at top, such as have been generally employed in wireless telegraphy, the radiations being received by means of horizontal conductors.

At long distances I almost invariably used as a detector my magnetic receiver.† At shorter distances I utilised a Duddell thermo-galvanometer* by means of which it was possible to measure the root-mean-square values of the currents induced by the oscillations in receiving wires disposed in various positions relative to the transmitting conductors.

With arrangements such as are referred to in (1), the following tests have been carried out:—

1. *Transmitter.*—Horizontal wire 100 metres in length, direct excitation, spark length 2 cm., wave length, approximately 500 metres.

Receiver.—A vertical wire 8 metres in length, tuned to the period of the transmitter by means of a syntonsing coil, and connected to a magnetic detector and to earth in the usual manner.

Results.—Signals quite distinct at 16 km. in the vertical plane of the horizontal transmitting wire and in the direction of its earthed end; weak at 10 km. in the same vertical plane, but in the reverse direction; inaudible at 6 km. at right angles to the directions above mentioned.

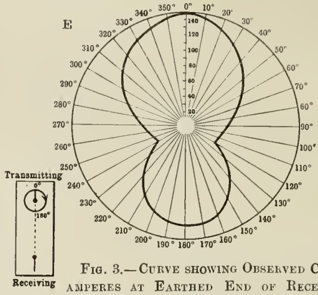

FIG. 3.—CURVE SHOWING OBSERVED CURRENT IN MICRO-AMPERES AT EARTHED END OF RECEIVING CONDUCTOR UNDER THE CONDITIONS OF DIRECTION SHOWN BELOW.

Transmitting Conductor: Horizontal, revolving from 0 deg. to 360 deg., 1·50 metres above ground. Receiving Conductor: Horizontal, fixed, 1·50 metres above ground. Length of Transmitting Conductor, 60 metres, Receiving Conductor, 60 metres. Distance of Transmission, 260 metres.

2. *Transmitter.*—(At Mullion, Cornwall); consisting of horizontal conductor 150 metres in length, composed of four parallel wires about 3 mm. in diameter, placed 1·50 metres apart. supported at a height of 20 metres, and all connected to earth through the spark gap of an induction coil placed in a building on the ground; spark length about 2 cm.

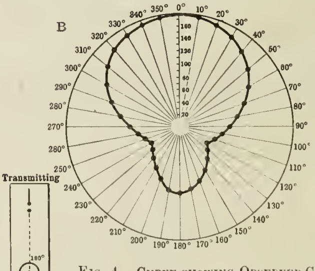

FIG. 4.—CURVE SHOWING OBSERVED CURRENT IN MICRO-AMPERES AT EARTHED END OF RECEIVING CONDUCTOR UNDER THE CONDITIONS OF DIRECTION SHOWN BELOW.

Transmitting Conductor: Horizontal, fixed, 1·50 metres from ground. Receiving Conductor: Horizontal, rotating from 0 deg. to 360 deg., 1·50 metres from ground. Length of Transmitting Conductor, 30 metres, Receiving Conductor, 30 metres. Distance of Transmission, 225 metres.

Receiver.—At the Haven, Poole (distance 240 km.); consisting of vertical wire 50 metres long, connected through a syntonising coil to a magnetic detector and to earth.

Results.—A movement of 15 deg. of the plane of the transmitting conductor out of the right direction was sufficient to cause signals to become indetectible at Poole.

Polar diagram D (Fig. 2) gives the values of the received current in micro-amperes, with conditions as marked under the diagram. The values of current in micro-amperes shown in each diagram are the mean of a considerable number of readings, the transmitted energy being kept as nearly as possible constant by means of a suitable interrupter applied to the sending induction coil,

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* Paper read before the Royal Society, March 22nd. Communicated by Dr. J. A. Fleming, F.R.S.

† See *Proc.* Roy. Soc., London, 1902, Vol. lxx, p. 341.

* *Phil. Mag.* 1904, Vol. viii, p. 91.

With the arrangement mentioned at (2)—*i.e.*, both transmitting and receiving conductors horizontal, the following results, among others, were obtained:—

1. *Transmitter.*—Conductor 200 metres in length, supported at a height of 15 metres above ground; spark length about 2 cm.

Receiver.—Similar conductor supported 1 metre above ground connected at one end to a detector and to earth as usual.

Results.—In the direction for maximum effect (as already explained) readable signals at 25 km. At about 90 deg. from said direction at 12 km., nothing; in the same direction at 5 km., weak signals.

2. *Transmitter.*—Consisting of four wires each 330 meters in length, separated from one another by a distance of 1·4 metres, supported at a height of 20 metres above ground and connected by means of a nearly vertical conductor to a spark producer; spark length, 3 cm.

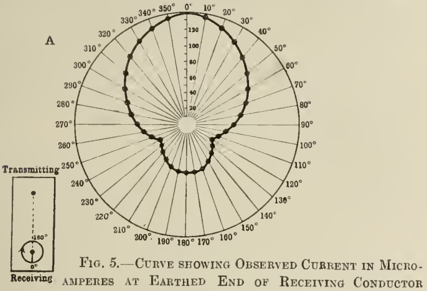

Fig. 5.—Curve showing Observed Current in Micro-amperes at Earthed End of Receiving Conductor under the Conditions of Direction shown below.

Transmitting Conductor: Vertical, fixed; height 44 metres. Receiving Conductor: Horizontal, rotating from 0 deg. to 360 deg., 1·50 metres above ground. Length of Transmitting Conductor, 45 metres, Receiving Conductor, 30 metres. Distance of Transmission, 680 metres.

Receiver.—Consisting of one wire 220 metres in length, covered with insulating material, placed on the ground and connected to the end nearest the sending station through a syntonising coil to a magnetic receiver and to earth.

Results.—When in the vertical plane of the transmitting antennæ, and in the best direction, weak but distinct signals were received at a distance of 160 km.; at 45 deg. from said direction and at 150 km. distance nothing was received; at 25 deg. from the best direction, and at 160 km. distance, very weak signals were received.

The results over shorter distances are given by the readings obtained on the thermo-galvanometer, and are shown in the polar diagrams E and B.

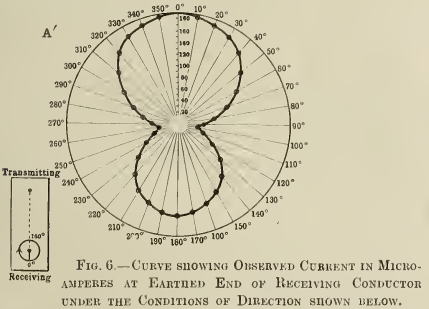

Fig. 6.—Curve showing Observed Current in Micro-amperes at Earthed End of Receiving Conductor under the Conditions of Direction shown below.

Transmitting Conductor: Vertical, fixed; height, 44 metres. Receiving Conductor: Horizontal, rotating from 0 deg. to 360 deg. on ground. Length of Transmitting Conductor, 45 metres, Receiving Conductor, 30 metres. Distance of ransmission, 680 metres.

With arrangements such as are mentioned at (3)—*i e.*, the transmitting conductor consisting of the usual vertical type and the receiving conductor horizontal, the following results among others merit attention:—

At Clifden, Connemara, Ireland, by means of a horizontal conductor 230 metres in length, laid on the ground and connected at one end to a magnetic receiver and to earth, it is possible to receive with clearness and distinctness all the signals transmitted from the Poldhu station (situated 500 km. distant) provided that the free end of the said conductor points directly away from the direction of Poldhu. No signals can be received if the horizontal wire at Clifden makes an angle of more than 35 deg. with the line of direction of Poldhu.

The signals from the Admiralty station at Scilly can be received at Mullion, Cornwall (distance about 85 km.) by means of a horizontal wire 50 metres in length, 2 metres above ground, provided said wire is placed in a radial position with respect to the sending station and with its free end pointing away from it. But it is unreceptive if placed so as to make an angle of more than 20 deg. with the line of direction of the station at Scilly.

Some tests have also been carried out for the Admiralty in the vicinity of Poldhu in conjunction with H.M.S. "Furious." For this purpose eight horizontal wires 60 metres in length, supported at a height of about 2 metres, were arranged radially and made to converge in a small building situated in a field near Poldhu. These radial wires were so arranged as to divide the circle into eight equal sectors. By means of a suitable switch any one of the ends of these wires at the position where they converge together could be connected to earth through a magnetic receiver.

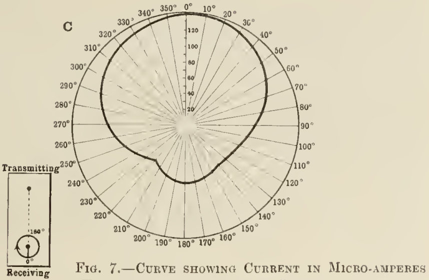

Fig. 7.—Curve showing Current in Micro-amperes at Earthed End of Receiving Conductor under the Conditions of Direction shown below.

Transmitting Conductor: Poldhu Station Aerial, consisting of multiple vertical Conductors with large capacity at the top. Receiving Conductor: Horizontal, rotating from 0 deg. to 360 deg., 1·50 metres above ground. Length of Receiving Conductor, 30 metres. Distance of Transmission, 650 metres.

The wireless telegraph station on H.M.S. "Furious" consisted of an ordinary vertical wire aerial about 50 metres in length, connected to a suitable spark-gap. The station on the ship transmitted at intervals, and the ship followed a course describing an arc of about 180 deg. round Poldhu, keeping at distances varying up to 16 miles. By means of the horizontal wire arrangement, the bearing of the ship from Poldhu could be determined at any time by noting on which particular wire or wires the reception of signals was strongest, and also by observing which wires were non-receptive.

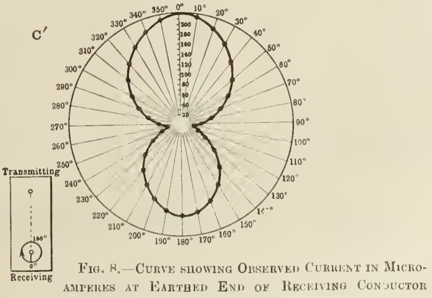

Fig. 8.—Curve showing Observed Current in Micro-amperes at Earthed End of Receiving Conductor under the Conditions of Direction shown below.

Transmitting Conductor: Poldhu Station Aerial, consisting of multiple vertical Conductors, with large capacity at the top. Receiving Conductor: Horizontal, rotating from 0 deg. to 360 deg. on ground. Length of Receiving Conductor, 30 metres. Distance of Transmission, 650 metres.

It was also found possible to receive simultaneously and without mutual interference different signals sent by means of oscillations of the same wave-length coming from the ship and from the Lizard wireless station (10 km. away) whenever the ship was in such a position that its bearing from Poldhu made an angle of at least 50 deg. with the bearing of the Lizard station.

For further values and curves of received current in receivers I refer to Diagrams A, A′, C, C′.

Referring generally to the results mentioned in this note, I have observed that, in order that the effects should be well marked, it is necessary that the length of the horizontal conductors should be great in proportion to their height above the ground, and that the wave-lengths employed should be considerable—a condition which renders it difficult to carry out such experiments within the walls of a laboratory.

I have found the results to be well marked for wave-lengths of 150 metres and over, but have not been able to obtain as well-defined results when employing much shorter waves—the effects following some law which I have not yet had time to investigate. There also appears to be a decided advantage in so far as effects at long distances are concerned in utilising a directly excited radiating conductor—that is, an insulated conductor in which the high frequency oscillations are started by means of a suitable spark discharging it to earth or to another body, as was usual in my early forms of Hertzian-wave wireless telegraph transmitters.

If inductive excitation is employed, that is, if the oscillations are induced in the radiating conductor from another oscillating circuit, the comparative results in various directions appear to be in the same proportions as those noticed when using the method of simple excitation, but the distances over which the effects can be detected are much smaller at parity of the power employed at the transmitter.

I have noticed that the most advantageous length of the receiving horizontal wires, in order to obtain results at maximum distances, is about one-fifth of the length of the transmitted wave, if said wires are placed at a distance above the ground; but the receiving wires should be shorter if placed on the ground. It would be instructive to investigate more thoroughly the difference of the results and curves obtained by means of horizontal wires placed at different heights above ground, and also the effect of varying the length of said wires.

When using horizontal receiving wires arranged as described in this note, I have often noticed that the natural electrical perturbations of the atmosphere or stray electric waves, which are generally prevalent during the summer, appear to proceed from certain definite directions, which vary from time to time. Thus, on certain days the receiving instruments, when connected to wires which are oriented in such a way as to possess a maximum receptivity for electric waves coming from the south, will give strong indications of the presence of these natural electric waves, whilst on differently oriented wires the effects are at the same time weaker or imperceptible. On other days these natural electric waves may apparently come from other directions.

It would be exceedingly interesting to investigate whether there exists any relation between the direction of origin of these waves and the known bearing or direction of distant terrestrial or celestial storms, from whence these stray electric waves most probably originate. A considerable number of observations would be necessary to determine whether there exists any relation between the bearing of storm centres and the direction of origin of these natural electric waves. I propose to carry out some further investigations on the subject.

I ought to explain that the experiments described in this note were carried out during a period of many months, and that as other results achieved over greater distances coincide generally with those here described, I have not thought it necessary to make special reference to them.

I should also mention that the tests over short distances were carried out over practically flat country, whilst those over considerable distances took place over hilly country, such as the West of England, and in some cases partly across sea and partly across land.

ELECTRIC v. STEAM WINDING IN COLLIERIES.

We have received the following communication from Mr. Gerald Hooghwinkel :—

Will you permit me to briefly review Mr. Mountain's latest, and let me hope final, corrections and remarks in connection with his Paper on electric winding and the discussion thereon in London and Newcastle. This request may be the more pardonable as the complete discussions will not appear in print for some time. As far as I am concerned, I shall consider the discussion closed and await patiently the installation and results of electric winders in this country, which are now being ordered and under construction.

My position has been from the beginning not to question the correctness of Mr. Mountain's figures as far as they were actual figures. Others have done so and with remarkable results, especially as regards the only actual figures of electric winding given—namely, those at the Grand Hornu Colliery. I am not in agreement with the makers as regards the economy of this winding engine, even, as in this case, where two or three engines are running from the same power station. It may or may not be possible to compensate for the enormous starting losses and resulting unequal load on the generating plant to a certain extent, by the judicious running of the three winders. The figure of 1·46 units (varying between 1·78 and 1·4) per horse-power-hour given by the makers seems to me too favourable, in comparison with figures of 1·44 and 1·50 obtained with balanced winders. This certainly is the case when only one winder is considered, and at the present discussion this was done.

Leaving alone for the present the question of capital expenditure, a balanced system must be, and in all cases has been proved to be, far more economical than a pure three-phase winder, or to make the comparison more general, for all such intermittent work as rolling mills, winding and traction. Everybody who has followed the current and voltage variations of the Preussen winding engine will readily agree. Besides, the batteries in traction stations and the balancers and flywheels (fixed on the mill shafts) in the first rolling-mill installations all point in this direction. Moreover, the makers of the Grand Hornu and Preussen engines are now almost entirely making the Ilgner balancer system, as may be seen from their latest printed matter.

Although I do not consider the Ilgner balancer as a finality in winding, it is at present, if intelligently adapted to each individual plant and local requirements, the only economical system of electric winding. There are, however, many variations and simplifications which will reduce the first costs considerably. I am looking forward, however, in not too long a time, to a simple and purely three-phase system of balancing.

Mr. Mountain's estimates for heavy electric winding, based on the experience acquired on a trip to Germany and on steam winding based on figures supplied by the makers as test figures, have too little value for a profitable discussion, and I have always refrained from mentioning them, although several inaccuracies, as a 5·5 ton cage for winding electrically (against 3 ton with steam) 3·6 ton of coal have been pointed out by other gentlemen.

The actual figures obtained from the Zollern Colliery are at present the only reliable source of information, and I am therefore quite willing to accept Mr. Mountain's so-called revised figures given in Table VI., remarking, however:

(1) That the wages are British wages taken from Mr. Mountain's Table III. (original Paper) for an identical case with steam, while maintaining at the same time that wages can be reduced by having stokers, ashmen, &c., combined in one power station.

(2) That the depreciation and interest throughout my Paper are calculated as in his own, on a basis of 10 per cent. over 250 days.

(3) That he has made another slide-rule slip in giving the Zollern Colliery figures, winding single shifts, as 10s. 9¾d., which must be 9s. 9¾d.

This table should then read as follows, after substituting the figures for steam consumption during actual winding:—

—	Coal wound pr. day	Depth in yards.	Hours winding.	Cost per 100 ton.	Cost with int. and dep.	Value of coal.	Steam per H.P. hr.
Mr. Mountain's estimate (electric)	1,500	500	16 8	2s. 7d.	6s. 11¾d. 11s. 3d.	3s. 6d.	37½
Average for 12 steam collieries	1,700	430	11	5s. 10d.	9s. 8¾d.	4s. 3d.	90
Mr. Hooghwinkel's actual cost at Zollern (electric).	1,350	330 550	16 8	1s. 5¾d.	6s. 1¾d. 9s. 9¾d.	3s. 6d.	26

This table, giving Mr. Mountain's own figures and mine as corrected by him, shows the remarkable saving in winding only, mainly due to the last column, while the resulting saving when taking capital cost into account largely depends on the hours of winding. The actual figures obtained at the Zollern Colliery, without interest and depreciation, are nearly half those estimated by Mr. Mountain, and are much less than with steam.

The average figure obtained for steam winding from Mr. Mountain's list is merely shown up as an illustration of what is done at present with steam, and showing what can be done with electricity; but it is clear that every case has to be considered on its own merits. The principal points at issue between Mr. Mountain and myself are: (1) That I maintain the only safe basis of comparison is the amount of steam and coal consumed per useful H.P.-hour. (2) That the cost of electric winding should be calculated from the cost per unit in the common generating station, and no allowance made for special seperate generating plant or part of it for winding purposes. (3) The same as far as interest and depreciation are concerned. (4) The steam consumptions obtained with electric winding are below those estimated by Mr. Mountain, and the savings therefore greater. (5) The maximum speed with electricity may be much less than at present usual with steam winding, while at the same time the average speed of getting out the coal remains the same.

I do not think that Mr. Mountain has succeeded in proving these points to be incorrect.

We have also received the following letter from Dr. R. Herzfeld, of the Electrical Co.:—

In your last issue you published a letter from Mr. W. C. Mountain dealing with some of the objections that had been put forward in the discussion of his Paper on electrical winding engines at the Institution of Electrical Engineers.

In this letter Mr. Mountain also touches on the remarks which I made with regard to his statement as to the cost of winding at the Grand Hornu mines, and he tries to explain the big mistake which he made in stating that the words, "these figures apply to the working of No. 7 shaft winder only," led him to believe that the communication of the Electrical Co. was a statement of costs incurred from the operation of one winding engine.

To enable you to arrive at an independent judgment as to whether the communication was of such a misleading nature as Mr. Mountain would make you believe, I have pleasure in sending you enclosed a copy of the pamphlet of which this calculation is an appendix, and I would refer you to the heading of this appendix: "Working Costs per K.W. Hour at the Power Station," and to the footnote following this, which reads: "These figures apply to the working of No. 7 shaft winder only, and the daily output of the station will ultimately be raised to 24,000 kw.-hours when the second ventilator and the winders at shafts No. 12 and 9 are running normally, &c."

Mr. Mountain would further make you believe that this communication, which is really a calculation of the working costs at the power station, and which he takes as a calculation of the working costs of winding engines, is utterly wrong, as it does not take into account the interest and depreciation on the cost of the electric winder. This, of course, is the result of the same mistake explained above.

Mr. Mountain is under a misapprehension if he thinks that I was attempting to put another figure against the figure which he put forward in his Paper, namely, 19s. 7¼d. as the cost of 100 tons of coal wound. I merely maintained that, on the same basis as used by Mr. Mountain, which I know to be wrong, his figure of 19s. 7¼d. would work out at 6s. 6d. I would not have attempted to put forward a figure of my own, as I do not think that a statement of the cost of 100 tons of coal wound will throw much light on the question contested.

ANNUAL DINNER OF THE INSTITUTION OF MECHANICAL ENGINEERS.

The anniversary dinner of the Institution of Mechanical Engineers was held on Thursday, April 26th, at the Hotel Cecil. Mr. Edward P. Martin, the President, was in the chair, and about 250 persons were present. In addition to the speakers mentioned below, we noticed:

Sir William Christie (Astronomer Royal), Captain Sir G. B. Vyvyan (Deputy Master of the Trinity House), Colonel Sir C. M. Watson, Sir Melville Beachcroft (Chairman of the Metropolitan Water Board), the Hon. Sir Horace Tozer (Agent-General for Queensland), the Hon. A. Dobson (Agent-General for Tasmania), Sir Henry Tanner (H.M. Office of Works), Lt.-Col. P. G. Von Donop (Board of Trade), Prof. T. E. Thorpe (Director of Government Laboratories), Prof. W. C. Unwin, Dr. J. A. Ewing (Director of Naval Education), Dr. R. T. Glazebrook (Director National Physical Laboratory), Mr. J. Gavey, C.B. (President of the Institution of Electrical Engineers), and Col. H. C. L. Holden (Supt. Royal Gun Factory, Woolwich).

After the loyal toasts had been duly honoured, the toast of "Our National Defenders" was proposed by Sir James Kitson, who referred to the way in which both the Army and Navy depended on mechanical engineers, so much so that he thought the steel makers, who produced the guns and armour, ought to be included in the toast. He applauded the action which the Admiralty had taken in including in the education of naval officers much of the training of a mechanical engineer. The toast was acknowledged by Major-Gen. D. D. T. O'Callaghan (President of the Ordnance Committee), who said that no one had more respect for the mechanical engineer than the services which he had the honour to represent. The next toast, "Kindred Societies," was proposed by Sir Francis Mowatt, who mentioned, in the course of his speech, the reports of the two committees which have recently been dealing with questions of the education of engineers—the one under the chairmanship of Mr. Haldane, relating to the Royal College of Science and School of Mines, and the other Sir William White's committee, which had dealt with the broad principles of engineering training. The results of these two investigations represented two years' good solid work in the interest of the engineer of this country, which would go far towards providing the equipment necessary to meet the competition of other nations in the engineering industries. He coupled the toast with the name of Sir Alexander Binnie (President of the Institution of Civil Engineers), who, in his reply, said that it was the Royal Society to whom all the "kindred societies" looked to a great extent for the scientific facts upon which their work was based, and referred at some length to the far-reaching effects of the applications of science to the benefit of the human race made by the engineering profession. Mr. J. F. Aspinall proposed "The Guests," and pointed out how the many professions of which he saw representatives there as guests depended upon the mechanical engineer. Speakers had already mentioned the way in which the Army and Navy looked to him, and he ventured to suggest that even the legal profession, a prominent representative of which was present, owed some debt of gratitude to the engineer, if only for the amount of work he gave him in the way of patent cases. Sir William White responded, and, in referring to the education committees which have been mentioned, reminded his hearers that much of the work of the earlier stages of the Royal College of Science committee was due to Sir Francis Mowatt himself, who had been the chairman of that committee previously to Mr. Haldane. In dealing generally with the training of engineers, he emphasised the necessity for a due proportion of mechanical experience to be included in the seven years' training which he considered essential for the making of an engineer, for mechanical engineering was the foundation upon which all other branches of engineering were built. The toast of the Institution was proposed by Mr. Justice Darling in a witty speech and replied to by the President. The increase of membership of their body, he said, had in no way been checked since the qualification for admission had been raised, and was now upwards of 5,000. He also mentioned the activities in the direction of research which had taken place during the year.

CORRESPONDENCE.

"THE LARGEST SUB-STATION IN THE WORLD."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of to-day, under the above heading, you are, I think, rather unfair to the main sub-station of the Montreal Light, Heat & Power Co., in Montreal. This latter sub-station may fairly claim to be larger than that of Toronto, though whether it is actually the largest in the world I am not prepared to say. It contains at present ten 2,750 kw. air-blast transformers stepping down from about 25,000 to 2,200 volts—*i.e.*, a total of 27,500 kw. transformer capacity.

Inasmuch, however, as this sub-station is connected to several steam stations, from which it receives and distributes a 2,200 volt supply, and further obtains from the sub-station of the Shawinigan transmission surplus power at the same pressure, the total available from these sources being over 2,000 kw., the Toronto total of 28,800 kw. is exceeded. It is true, of course, that all of this energy is not transformed, as stated above, but the station is arranged to accommodate 16 2,750 kw. units—*i.e.*, 44,000 kw. total, and these additional units are likely to be installed in the near future.

The Toronto sub-station has an area of 61 ft. by 202 ft. = 12,322 sq. ft., or 0·43 sq. ft. per kw. The Montreal sub-station measures approximately 120 ft. by 125 ft. = 15,000 sq. ft., which, on the basis of 44,000 kw., works out at 0·34 sq. ft. per kw.—Yours, &c., JOHN M. DONALDSON.

Croydon, April 27.

[We thank our correspondent for calling our attention to relative sizes of these two sub-stations. A description of the Montreal sub-station will be found in another column of this issue.—*Ed. E.*]

SINGLE-PHASE MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your issue of April 27th, p. 66, what I take to be an abstract from a recently published patent. It is to me a matter of great surprise that the American patent office, which as a rule institutes a very thorough search, should grant a patent for a motor which has been well known for the last 13 years at least. To my knowledge this machine was described for the first time by Dr. Behn-Eschenburg on p. 300 of the "E.T.Z." for 1893. Mr. McAllister's application must either be prior to 1893, or his claims can only refer to minor details. I cannot judge as I have not seen the specification.

The theory of the motor, as suggested by the patentee, certainly carries one back to something like the year 1893, and the motor can certainly not be described as a "series induction motor." This machine, by the way, has also sometimes been described, and with not much more justification, as the converse of the so-called "repulsion motor."

This motor must, I think, be classed as a "neutralised, self-excited, series conduction motor." Its theory is of the simplest.

In Fig. 1 I give a two-pole diagrammatic representation which is somewhat easier to follow than the figure in McAllister's specification. Let the stator winding S and the rotor winding R be of the Gramme ring type, assume the brushes $a_1 a_2$ to rest directly on the rotor winding, then R is the primary of a transformer, the secondary S of which is short-circuited along an axis, y, displaced with regard to the axis x of the primary by α degrees. The current flowing through the primary under the influence of the E.M.F. (E) impressed on it will be reproduced or reflected in the short-circuited secondary, the difference between the ampere-turns in R and S being responsible for the necessary transformer field in that axis. The current in those conductors of the winding S, which are symmetrically situated with respect to x, will tend to neutralise the self-induction of the rotor or armature but without ever being able to annul it. The disposition of these conductors is indicated by heavy lines; it is seen that they are *not* symmetrically placed with regard to y. The same current, however, also flows through the remaining portions of S (conductors within the angle 2α). These are non-inductively situated with regard to R, present a very high self-induction, and are responsible for a field, F_0, in a direction perpendicular to x. This field will be of the same phase as the secondary current, therefore of nearly the same phase as the armature or primary current. The torque results from the interaction between the armature current and the field F_0, which, in fact, is the motor field. The back E.M.F. is generated by rotation in the motor field, and is only nearly opposed to the working E.M.F. (E). It is clear that the power factor can never be unity mainly owing to the great self-induction of S, but it is also clear that whatever the power factor, the torque per ampere will be high and independent of it although the weight efficiency will vary with the power factor. The energy required for the operation of this motor is conveyed to the armature by *conduction* as in the ordinary continuous-current machine; the field excitation is due to the neutralising current flowing through that part of the winding S which is non-inductively situated with regard to R and is not derived directly from the supply.

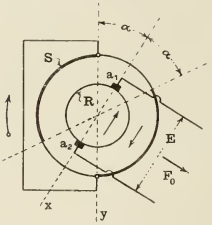

Fig. 1.

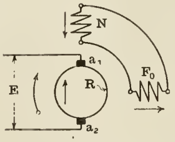

Fig. 2.

In Fig. 2 I show another well-known modification in which the winding S is divided into two distinct groups, N and F_0. The former only serves to neutralise the armature ampere-turns, and the latter only serves to produce the motor field F_0; the two groups are in series relation and the current induced in N by the transformer field along the armature brush axis is taken through F_0. The machine cannot lay claim to any compensation over and above that secured by partly neutralising the armature reaction.—Yours, &c., Val. A. Fynn.

Blackheath, S.E., May 1.

ECONOMIC CONSIDERATIONS IN THE EMPLOYMENT OF STORAGE BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I fear the expression, in the fourth paragraph of my letter appearing in your issue of last week, "having easy slopes to the peak," may prove a bit confusing and is, in fact, incorrect when applied to load factors less than, say, 10 per cent. It might be more correct to say "relatively easy"—*i.e.*, relatively in contrast to the peaks assumed for station "B."

I also note that I have given rather a superlatively good steam consumption for the size of engine considered. The argument is not, however, materially affected thereby; so, perhaps, it is sufficient to point it out.

The word "generating," in the ninth line of the third paragraph, should of course read "generalising." I fear the printers are to blame here.—Yours, &c., A. M. Taylor.

King's Heath, May 1.

PARLIAMENTARY INTELLIGENCE.

◆

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL

Tuesday, May 1.

The Select Committee of the House of Commons which has been appointed to consider the London County Council (Electric Supply) Bill commenced its work on Tuesday. It will be remembered that this is a Hybrid Committee, consisting of nine members, five of whom have been selected by the House of Commons, and four by the Committee of Selection. Mr. Luke White (Liberal) is chairman, and the remaining members are Sir Francis Lowe (Unionist), Mr. Henry Norman (Liberal), Mr. Richard Bell (Labour), Mr. J. H. Duncan (Liberal), Mr. Chance (Liberal), Mr. J. Nolan (Irish Nationalist), Mr. James Parker (Labour) and Mr. Watson Rutherford (Unionist). The full instruction to the Committee is as follows; "To consider, with special reference to the proposals of the bill, the best means for providing for the supply of electrical energy in bulk and for power and motive purposes and to report thereon." Mr. Freeman, K.C., Mr. Lewis Coward, K.C., Mr. Clode and Mr. Clease appeared for the bill.

Some 60 petitions have been deposited against the bill, including all the electricity supply companies in London, many borough councils, as well as municipal authorities in the part of the proposed area which is outside the County of London. The Administrative County of London & District Electric Power Co. have been granted a locus standi and are represented by counsel.

Mr. FREEMAN, K.C., in opening the case for the London County Council Bill, said that its main purpose was to enable the L.C.C. to supply electrical energy to authorised distributors—*i.e.*, persons who were either local authorities or companies authorised by act of Parliament or provisional order to supply electricity for lighting or power purposes. The bill did not propose that the L.C.C. should supply direct to any individual consumers in the areas of any authorised distributor except by consent. In the second place, the bill proposed to supply electricity in bulk to railways, canals, docks or public buildings which were situated partly in one area and partly in another, and which the existing distributors had no statutory authority to supply. The only competition would be between the Council and some bulk supply authorities outside the London County area, and for this he would show there were good reasons. But the important point in connection with this bill was that it was merely permissive in its character. Having gone into the history of electric supply in London from the passing of the Act of 1882, counsel pointed out that there were now 16 local authorities and 13 companies supplying electricity in London. The capital expenditure of the local authorities amounted to £6,500,000, and that of the companies was £12,000,000. The capacity of the generating plant of the municipalities was 58,000 kw., and that of the companies 122,450 kw. As a fact the maximum load upon the stations of the local authorities was only 31,800 kw. and of the companies 81,200 kw., leaving between 67,000 kw. and 68,000 kw. as the margin which had to be left for stand-by, repairs, &c. This arose from the multiplicity of stations, and a point in favour of the present bill was that the County Council could themselves act as this stand-by, and so release practically 50 per cent. of the existing generating plant which was now only used for the purposes of stand-by, &c. This was further emphasised, he thought, by the statement that whereas the capital expenditure per kilowatt of the local authorities was £42 and that of the companies £51 per kilowatt—excluding distribution plant—under the proposal of the L.C.C. the capital expenditure for generating plant would be £15, or including distribution £30 per kilowatt. Mr. Freeman then dealt at some length with the efforts that have been made in London for bulk supply, including the promotion of the Central Electric Supply Co., and the arrangements made by the Kensington & Knightsbridge & Notting Hill Companies, the Metropolitan Electric Supply Co., the Charing Cross, City & West End Co., &c. Mention was also made of the futile promotion in several years of the Supply of Electricity Bill by the Government. In view, therefore, of the want of uniformity in price of electric power in London, and the inadequate provision now made, the opinion of the L.C.C. was that the time had now arrived for a decision to be given by Parliament once and for all. A further reason for such a decision was that a large number of the local authority generating stations had just about reached the limit of their capacity, and that before further capital expenditure was incurred—the L.C.C. being the authority to lend the money—it should be considered whether a more economical method of procedure should not be pursued. The argument for municipal control, he said, was strengthened by the provision in the Electric Lighting Acts that all companies should be purchased eventually. Reference was next made to the East London and Lower Thames Electric Power bill of 1904, and the lengthy proceedings in connection with the Administrative County of London & District Electric Power bill last year. In pointing to the advantage which the County Council had, counsel emphasised the existence of the Greenwich power station, originally built for tramway purposes, and as diversity of load was an important factor in an electric supply undertaking, it would be seen that the existing tramway load was a valuable nucleus. The supply for tramways at the end of the next 12 months would be 37,000,000 units and by 1915, it was estimated at 89,000,000 units. Discussing the reports of the Finance committee against this bill, Mr. Freeman said the Council as a whole did not adopt the opinion expressed by the Finance committee, because the whole of the details were not then available to that Committee. Since then, however, several of the members of the Finance committee had voted for the resolution to proceed with the bill. Electrical engineering experts of the highest authority had been consulted and he ventured to think that the committee would be satisfied from the evidence of these gentlemen that there would be no loss to the rates by the adoption of the scheme. Coming next to the provisions of the bill, Mr. Freeman said that the conditions of supply were contained in clauses 11 and 35. Clause 11 differed from similar clauses in other power bills in that without the consent of the local authority, the Council could not supply in the area of any authorised distributor—*i.e.*, there was no appeal to the Board of Trade for competition as in the bill of the Administrative Co. last year, Under clause 35, the Council took authority to appeal to the Board of Trade at intervals of five years, if necessary, for a reduction of the prices charged by any authorised distributor. This was solely in the interests of the consumer, as otherwise the distributor might take the supply at a very cheap rate from the Council and not give any advantage to the consumer. The area, said counsel, substantially that of the Administrative Co. last year, had been selected as a desirable one for the reason that the large part to the east was land suitable for the building of factories, whilst on a considerable portion of the western area, residential estates were being erected. Clause 36 authorised the raising of 2½ millions of money, but only a very small portion would be raised initially, as the Council was bound to proceed by its annual money bill for the sums required for its immediate use.

In answer to the Committee Mr. FREEMAN said there was nothing in the bill to compel the Council to give a supply, and nothing to compel a consumer to take a supply. It was permissive.

Mr. W. RUTHERFORD : It is permissive for you.

Mr. FREEMAN : It is permissive for both.

Mr. BALFOUR BROWNE, K.C. (who represented 14 London electric supply companies) : That is where you differ from the companies.

Mr. FREEMAN : We deal with the matter for the general benefit of the community as a whole. We are in a totally different position from that of a company.

On the financial position, it was pointed out that the intention of the Council was to use the Greenwich generating station at first, then to build a new station at Battersea, and finally to use both stations for the supply of electrical energy, leaving the tramway supply solely to Greenwich. By 1908, it was estimated that the Greenwich station would have 10,000 kw. available, over and above the tramway supply, in 1909 from Greenwich and Battersea together 36,000 kw., in 1911 50,000 kw., and in 1913 the whole of the Battersea station would be complete with a capacity of 60,000 kw., leaving, if necessary, Greenwich to deal with the tramway supply alone. Adopting the rate of increase in consumption of electric power in London for the past five years and applying it to the future, it was calculated that by 1911 the supply would be 390,000,000 units, and a 6 hour user would be able to get it at 0·81d. per unit, whilst an 8 hour user would only be charged 0·67d. per unit.

Mr. BALFOUR BROWNE : There are no prices in the bill.

Mr. FREEMAN said he was going to give evidence on this.

Continuing, Mr. FREEMAN referred to the equipment of the Greenwich power station, and pointed to the advantage of being able to lay tramway and power cables at the same time, and so obviate much breaking up of the streets.

Mr. W. RUTHERFORD : Experience shows that, although both cables *may* be laid at the same time, no local authority ever does this.

Mr. FREEMAN : That is one of the millennium prospects that we hope to get under the bill. But I do seriously believe that we shall make a great saving in this respect.

Mr. RUTHERFORD : You are not bound as to price ?

Mr. FREEMAN : No. But our proposals as to price are as follows : We should charge £3. 12s. per kilowatt as a standing charge, plus 0·2d. per unit according to the length of user. This would work out that for a 3 hours' user the price would be 1d. per unit, 4½ hours ¾d., 8 hours ½d., 13½ hours ⅜d.

Mr. MACKINNON WOOD, M.P., chairman of the Parliamentary committee of the L.C.C., was the first witness, and, under examination by Mr. COWARD, K.C., went at length into the policy of the Council in promoting this bill, which was indicated in Mr. Freeman's opening speech. On the question of the area scheduled in the bill, he said that the Council already went far outside its area for other purposes. In addition, the London Traffic Commission had expressed the opinion that the tramway question should be considered in conjunction with outside areas. Manchester was authorised to supply outside its area, and there was precedent all round for the proposal. With regard to competition with existing power companies, witness said that very little had been done by these companies, and he saw no reason why the Council should not compete.

Mr. W. RUTHERFORD : Is there any provision for the Board of Trade to revise your prices ?

WITNESS : No.

Mr. RUTHERFORD : Then everybody is to be subject to revision except you ?—But we limit ourselves as to the amount of profit that we make.

Under further examination by Mr. Coward, WITNESS said that in most of the London electric lighting orders granted to companies the local authority was given the right to appeal to the Board of Trade for a revision of prices.

Mr. BALFOUR BROWNE pointed out that this latter related to maximum prices and not to actual prices as was the case here.

Mr. MACKINNON WOOD, continuing, said the revision of prices would not apply outside London.

The CHAIRMAN remarked that the memorandum issued by the Commissioners of Works re smoke from electric generating stations(given elsewhere in this issue) had been referred to the Committee, and would be taken into consideration in connection with this bill.

Wednesday, May 2.

Mr. McKINNON WOOD was further cross-examined by Mr. BALFOUR BROWNE. He stated that the total area scheduled in the bill was about 387 square miles, the larger part of which was outside the County of London. He admitted that outside London the Council would be in the same position as a statutory company, and in this respect would be precisely the same as the Administrative Co. He would not say, however, that the question of purchase by local authorities in the outside area would be prejudiced by the existence of the Council's scheme, although this point had been urged last year by the Council in opposition to the Administrative Co.

Counsel next put several questions as to details, but Mr. Coward, for the L.C.C., objected, as he was going to put in a witness on these points.

Mr. BALFOUR BROWNE said he wanted to show how much the Council as a body knew of the matter. He would show that the Council had never known anything about it and did not know anything now.

Counsel then read several extracts from the debate on the proposal in the Council tending to show considerable difference of opinion.

Witness disputed the accuracy of the report.

Mr. BALFOUR BROWNE : Was not this bill promoted as a counterstroke to the Administrative Co.'s bill ?—No.

The CHAIRMAN : I do not think we need hear all the individual speeches for and against the proposal. We have the conclusions of the Council as a body.

Mr. BALFOUR BROWNE said he wished to discover whether the Council was bona fide on this scheme, or whether they merely wished to get the bill and then to drop it if it did not promise success. Several of the speeches indicated this.

Mr. McKINNON WOOD said it was not the intention to spend a large amount of capital at once, but to develop the undertaking as the demand grew.

Further cross-examination : The foundation of the bill was that the Council could supply cheaper than the existing authorities.

If you cannot, then your bill goes ?—Nobody would take a supply.

If, say, the Administrative Co. can prove that they can supply your tramways at a cheaper price than you can generate it for yourselves, then, in the interest of the London ratepayer, you ought to take it ?—That would depend upon other circumstances.

Continued cross-examination : The Controller had advised the Finance committee, which had reported against the scheme. If there was a loss it would fall on the rates in London, and not on the rates outside. On the clause giving the Council power to go to the Board of Trade to reduce the price charged by any authorised distributor, this was inserted for the benefit of the consumer, and was not intended to force any distributor to take energy from the Council. He admitted that under the bill there would be two profits, but he thought a combination of existing local authorities and companies in order to supply direct with only one profit was impossible. He did not know that the rateable value of the borough councils who voted against the bill was greater than that of those who were in favour, but he did not think such a calculation had any value. There was no undertaking from any borough council to take a supply, as no one had been asked.

Cross-examined by Mr. J. D. FITZGERALD, K.C., for the promoters of the Administrative County of London & District Electric Power Co., witness said he did not know of a power company which had started as a permissive undertaking. Mr. Fitzgerald put to the witness the case of the Lancashire Electric Power Co., which in 1900 had been given permissive powers, but so unsuccessful had been the result that this year they were applying to Parliament for an alteration in their powers. In answer to further questions, witness said that similar undertakings in Glasgow and elsewhere existed.

Mr. FITZGERALD pointed out that this was hardly correct, as in Glasgow the whole of the business was in the hands of the Corporation, lighting, tramways and power. In London the Council could not supply the ordinary consumer.

In answer to further questions, witness considered clause 35 (the right of the L.C.C. to ask for a revision of prices charged by authorised distributors) safeguarded the consumer, and gave him as many rights as did the clause in last year's bill, under which he could directly apply for a supply from the power company. It was not the intention of the Council to hire out machinery to manufacturers, as proposed last year, and in this respect the bill did not assist the manufacturer. The reason why there was no schedule of prices in the bill was because it was a permissive bill.

Mr. FITZGERALD : But the Lancashire Act was a permissive one, and yet there was a maximum price in it.

Continuing : It was true that there was no limit to the tenure of the bill should the Council do nothing, but although he did not believe any such clause would do much harm, he did not think that the ordinary conditions applied to a County Council.

In answer to further questions on behalf of other petitioners, Mr. WOOD admitted that the provisions of the bill as to breaking up streets were more stringent than usual, but the protection was less. This would be best discussed in clauses, however. He could not agree to cut out any of the areas of the local authorities included in the bill, but was willing to discuss the question of supply to railways, so that this should not enable the Council to supply to railway stations alone. He repudiated the suggestion made on behalf of the Middlesex County Council that the ultimate object of the Council was to make the area scheduled in the bill the London county area.

Thursday, May 3.

Mr. McKINNON WOOD'S cross-examination was again continued. One interesting point was raised by Dr. Mansfield Robinson (for Shoreditch Borough Council) on the question of the possibility of the Council restricting loans to the borough councils for electric lighting purposes. Witness replied that there was an appeal to the Local Government Board if the Council felt they had a grievance.

Dr. ROBINSON : But the President of the Local Government Board is a member of the London County Council and a supporter of this power bill.

Re-examination did not bring out any new points.

In answer to Mr. Watson Rutherford, Mr. WOOD said that if the suggestion of the hon. member that the other County Councils in the area should have the right to ask the Board of Trade to revise the prices of the bill every five years were carried out it would be very inconvenient, as the Councils in question had no financial responsibility. He admitted that probably the bill had taken in the best paying portions of Middlesex, Surrey and Kent.

He did not think it likely that the County Council would refuse to supply any authorised distributor, if the Board of Trade decided that the Council's application for a revision was unnecessary. Under the bill, of course, the Council would not be compelled to supply, but it would be a bad business policy to refuse to continue to supply under such circumstances. The question of a clause requiring the Council to give a supply was a matter for the Committee. He believed the business would pay without any railway custom. He should not be surprised if a scheme for London alone would pay better, at any rate at first, but the interests of the surrounding districts were so much bound up with the centre that he thought eventually, as a scheme, the area proposed would be the best. He did not think it was a riskily speculative business.

Sir FRANCIS LOWE: If you were a trustee of money would you feel justified in investing in such a scheme as this if it were promoted by a company? I should observe the Trustees Act most rigidly.

At the conclusion of the witness's evidence,

The CHAIRMAN said that the Committee were unanimously of the opinion that the remark made by Dr. Mansfield Robinson with reference to the President of the Local Government Board was a very improper one, and ought to be withdrawn.

Dr. ROBINSON said he did not wish to imply any improper motive to the President of the Local Government Board, and he withdrew it.

Mr. J. H. RIDER, electrical engineer to the London County Council, said he had been considering the needs of London in the matter of electric supply for the past five years. Under examination by Mr. Clode, he detailed the essentials of a good generating station as to site, and also as to equipment, preferring turbo-generators to reciprocating engines on the score of price and space occupied. He then explained the meaning of load factor and the advantages of diversity of load. In this connection, the larger the area, in reason, the greater the chance of a diversified load. Sir William Preece, Mr. Robert Hammond and Mr. J. F. C. Snell had been engaged in elaborating the details of the scheme. The basis of the scheme was the Greenwich power station (see *The Electrician*, Vol. LVI., pp. 743, 789, 833, 877, 930), which now had a capacity of 14,000 kw., and when completed it would have a capacity of 34,000 kw. The new station at Battersea would have a capacity of 80,000 kw., and it would be worked in parallel with Greenwich. At present there were nine sub-stations at work, but ultimately there would be 19 inside London, and of these a certain number would be used for bulk supply. Outside London there would be 10 sub-stations. The method to be adopted was to treat the tramways department as an ordinary consumer. The laying of mains for power supply and for tramways would take place at the same time, and this would apply particularly to the northern tramways, for it was well known that many of the cables for the southern tramways were laid, and the roads might have to be opened again for power supply purposes. Coming to the scheme in detail, he first dealt with the capital outlay on Battersea, the capital outlay on Greenwich having been provided for in the tramway estimates already. The Battersea station would be constructed in quarters, and the details are shown in the following table:—

Estimated Cost of Battersea Generating Station (Expenditure included in Bill). Normal Capacity 80,000 kw. Overload Capacity 120,000 kw.

Station built in three stages as demand requires.

—	First two quarters. 40,000 kw. normal.	Third quarter. 20,000 kw. normal.	Fourth quarter. 20,000 kw. normal.	Complete station.	
				Total cost.	80,000 kw. per kw.
Land	£60,000	..	..	£60,000	£0·75
Buildings	200,000	£92,000	£92,000	384,000	4·80
River work & pier	64,000	..	..	64,000	0·80
Turbo-generators, with condensers	180,000	90,000	90,000	360,000	4·50
Boil'rs ec'n'misers, &c.	100,000	50,000	50,000	200,000	2·50
Switchgear & sundries	35,000	8,500	8,500	52,000	0·65
Piping and pumps	40,000	10,000	10,000	60,000	0·75
Coal & ash handling plant	15,000	2,500	2,500	20,000	0·25
Totals	£694,000	£253,000	£253,000	£1,200,000	£15·00

The total expenditure under the bill, however, was £2,370,187, which, it was expected, would be spent in the following proportions: 1907-8, £325,600; 1908-9, £530,321; 1909-10, £451,202; 1910-11, £296,855; 1911-12, £362,173; 1912-13, £205,280; 1913-14, £199,756. The station would have a steel framework and four chimneys. The units would have a normal capacity of 10,000 kw., and 15,000 kw. was their overload capacity. There would be 32 boilers in eight rows of eight each, each boiler evaporating 42,000 lb. of water per hour under normal conditions.

The cost of the whole Greenwich generating station when completed would be £26·40 per kilowatt, as against £15 at Battersea. This was accounted for by the fact that the sets were much smaller at Greenwich, and that reciprocating engines instead of turbines had been adopted. In the second half of the Greenwich station he intended to instal four 5,000 kw. turbo-generators. This was practically the whole explanation of the difference. There would be eight sets in each power house, and this was the most economical number. Six of these would be working, the other two acting as stand-by. Water-tube boilers would be used at Battersea. With regard to the estimated power required for tramway service and the amount available for bulk supply, a table was handed in showing that by 1915-16, by a gradual process from 1908-9, there would be 114,000 kw. installed in both stations. Similarly the tramway requirements would increase from 10,500 kw. at the present time up to 25,500 kw. in 1915-16. As the actual amount of machinery at work then would be 85,500 kw., in order to leave some sets for repairs, the total power available in 1915-16 for bulk supply would be 60,000 kw. All his estimates had been based upon the experience in connection with the tramways undertaking, and where he had had any doubt he had secured estimates from reliable firms. With regard to the transmission system, the estimates included two cables from the generating station to each of the sub-stations and two cables from there to a certain number of customers. The estimates of the transmission system are as follows:—

Ducts to 29 centres	£137,593
Ducts to customers	89,393
Ducts from Greenwich to Battersea................	10,515
Trunk cables to 29 centres	528,400
Cables to customers	140,287
Cables from Battersea to Greenwich	54,000
10 supply centres at £2,000 each..................	20,000
Switch gear, &c., in 29 centres..................	43,500
Fixed and loose tools, meters and sundries	41,500
Total	£1,065,187

The following figures were also given of the estimated cost of generation when the whole of the Greenwich generating plant is in use and working alone—viz., 34,000 kw. The assumption is made that the load factor is 35 per cent., the output for this being 78,183,000 units per annum. Generating costs are 0·2484, capital charges 0·1505, management and office 0 0092, rates and taxes 0·0368. Total generating costs 0·4449d. Of this output only 21,900,000 units are estimated for bulk supply, the remainder being required for tramways. The load factor of the bulk supply is put at 25 per cent., and the total works costs, including transmission, are put at 0·6012d. per unit. These figures, it should be noted, are for the undertaking before the Battersea station is at work. The revenue account under these circumstances was given as follows:—

21,900,000 units generated..................	£50,865	
Sale of 20,805,000 units at 25 per cent. load factor or 9,500 kw. at £4. 10s.		42,750
Plus 20,805,000 units at 0·2d........................		17,337
		£60,087

leaving a gross surplus of £9,222, from which is deducted £4,000 for interest on transmission system (interest on the generating costs being already included), and thus there was a balance to be carried to reserve of £5,222. A series of some 20 tables were then handed in showing the results with the power houses in their various stages of completion. The net result is that with both Greenwich and Battersea working fully and generating 183,960,000 units at Battersea at 0·1972d. per unit, and 78,183,000 units from Greenwich at 0·2484d. per unit, and selling 249,035,850 units, or 81,225 kw. at £4. 10s. per kilowatt plus 0·2d., after allowing for all charges, including interest and sinking fund, there would be a net profit of £68,494. This is on the basis of a 35 per cent. load factor —*i.e.*, 42 per cent. for the tramways and 17·8 per cent. for the bulk supply. Detailed estimates were also handed in for the labour, repairs, management and office expenses, and interest and sinking fund charges. In the course of his evidence, Mr. Rider pointed out that the tramway department, when the system is working properly, would be treated as an ordinary customer of the supply department. The charges given were for the energy in its untransformed state, the cost of transformation having to be borne by the consumer. A table was also put in confirming the figures given by Mr. Freeman in the opening that the actual cost per unit to the consumer will decrease with the load factor.

The Committee adjourned until Tuesday.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

Sir Lewis McIver's Committee of the House of Commons further considered the proposal of the London County Council to run tramways over Westminster and Blackfriars Bridges and along Victoria Embankment on Friday. In our last issue we briefly gave the evidence of the officials of the L.C.C., and the case for the promoters of the bill was closed with general evidence from the mayors of St. Pancras and Lambeth.

The case for the opposition was then taken.

Mr. LEWIS COWARD, K.C., on behalf of the omnibus owners of London, discussed the various details of the proposal, and pointed to the disadvantage, from the point of view of the general traffic, of the system, proposed by Mr. Fell, of "bunching" several cars together on the south side of Westminster Bridge, and then, whilst holding up the general traffic, allowing them to proceed over the bridge all together. He further pointed out that although it was proposed to lay tramlines close to the kerb on one side of the bridge this would only allow a width for the ordinary traffic of 36 ft. 10 in., whereas from the police evidence it was clear that they considered 38 ft. a minimum. He argued that the proposed extension of the tramways would give no better facilities than were now given by the motor omnibuses, and in view of the state of transition of means of locomotion at present the omnibus owners felt very strongly the injustice of giving the L.C.C. the monopoly of a considerable width of the roadway over the bridges. The scheme was financially unsound, and only an authority having the rates to fall back upon would have proposed it.

Mr. R. TILLING, managing director of Thomas Tilling (Ltd.), gave evidence to the effect that the omnibus proprietors of London intended to increase the number of motor omnibuses crossing Westminster Bridge to double their present number, within the next nine months. He contended that the L.C.C. tramways in the South of London only showed a profit because of the rent paid to them by the company which leased the lines in the north. The flexibility of omnibus traffic obviated that very congestion which, from the evidence of the Council's officers, would be created at the bridges.

Mr. A. A. CAMPBELL SWINTON, who is chairman of the "Arrow" line of 'buses, said that with the improvements now being made in motor omnibuses the expenditure in money in laying tramlines should not be incurred without the very fullest consideration.

Other evidence of this character was also given.

Supt. BEARD, who was called by the Committee, said that 36 ft. 10 in., which would be the width of Westminster Bridge available for other traffic if the tramlines were laid as proposed, would hardly be sufficient for four lines of traffic. However, he thought the police would be able to regulate the traffic provided that the cars did not stop within 200 yds. of the bridge, and if on special occasions the Chief Commissioner of Police had authority to suspend the tramway traffic over the bridge during certain hours.

Mr. C. C. HUTCHINSON having addressed the Committee on behalf of a number of frontagers,

Mr. E. POLLOCK, K C., replied for the L.C.C., and said that they were quite agreeable to fall in with the suggestion made by Supt. Beard that the Chief Commissioner of Police should have authority to suspend the tramway service over the bridges on special occasions.

The Committee gave no decision, but will consider the City of London Corporation proposal as to widening Blackfriars Bridge first.

Blackfriars Bridge Widening.

On Monday the Committee considered the proposal of the City of London Corporation to widen Blackfriars Bridge in order to facilitate the laying of the tramways proposed under the London County Council (Tramways and Improvements) Bill.

Sir RALPH LITTLER, K.C., said it was proposed to widen the bridge from 75 ft. to 105 ft., and the cost would be borne by the Bridge House Estates. Sir Benjamin Baker had prepared the plans. The estimated cost of the widening was £230,000.

Sir BENJAMIN BAKER said that the proposed widening would allow of six lines of ordinary traffic if the tramlines were laid to one side as proposed.

After consultation, the CHAIRMAN said the Committee would not give a decision until a full financial statement in relation to the tramway accounts of the London County had been presented to them.

The Committee then proceeded to consider some additional tramways proposed by the London County Council relating to other parts of London. The first line was an extension from the existing terminus in the East India Dock-road to join up the tramways of the West Ham Corporation. The estimated cost was put at £30,000, the length of the line being 4 furlongs 5½ chains, and the cost of some short lines for connections with with car sheds was put at £3,000.

On Tuesday the only opposition to this tramway—viz., that of the London & East India Dock Co.—was withdrawn, as an agreement had been come to with them on the question of a road widening. The tramway, therefore, was unopposed, and was passed in due course.

Mr. POLLOCK then dealt with the tramway running from Kilburn, via Edgware-road, to the Marble Arch. Originally, he said, there had been two competing applications for this line, one by the L.C.C. and the other by the Middlesex County Council. An arrangement had, however, been come to between the parties, by which the portion of the line between Kilburn Priory and Cricklewood would be constructed and worked by the Middlesex County Council and the remainder would be constructed and worked by the L.C.C. The cost of road widenings along the whole route was estimated at £95,000, and, under the agreement above referred to, one-third of this would be borne by the L.C.C. and two-thirds by the Middlesex County Council. This, however, did not do away with all the opposition to this tramway, but merely that of the Middlesex County Council. The line within the County of London would be worked on the conduit system and the Middlesex portion would be constructed on the overhead system, but the same cars would run through, and the passengers would not have to change. The Paddington Borough Council and the Willesden Urban District Council still opposed the tramway.

The opposition of the omnibus companies was then dealt with.

On Wednesday evidence was given by the statistical department of the London County Council as to the traffic along the Marble Arch-Cricklewood route, and the general opinion of the County Council was that there is a lack of tramway communication, although there is a good motor omnibus service. On the other hand, it was intended to run a two minute service from Marble Arch to Cricklewood for 2d. as against 3d. now charged by the 'buses.

Mr. A. L. C. FELL said that no decision had yet been come to with regard to the system of electric traction to be adopted, although the overhead system was to be used on the portion to be worked by the Middlesex County Council. The County Council could, under the bill, adopt the overhead system with the consent of the Board of Trade, and it was in order to prevent this that the borough Councils were opposing. As a matter of fact, the local authorities had a veto, and if they refused to agree to the overhead system the conduit system would, of necessity, have to be adopted.

The CHAIRMAN said he did not believe the Committee would sanction the use of overhead wires in the heart of London. So far as they were concerned that was settled.

The Committee adjourned.

POST OFFICE EXPERIMENTS ON ELECTRICAL CONDENSERS.

In the House of Commons on Monday, Mr. Steadman asked the Postmaster General, whether he would explain why, in view of the amount of money expended at the General Factory, Mount Pleasant, in experimenting on electrical condensers and other work, and of the fact that the whole of the work was done at the factory and by the staff generally, some seven patents had been taken out by an officer of the factory on the results of the experiments done, and was he aware that the patents had been let on royalty to a foreign firm who were now manufacturing condensers on the results obtained at Mount Pleasant. Mr. Sidney Buxton, in a printed reply, stated that the officer in question had been allowed to take out patents on conditions which amply protected the interests of the Post Office and other Government departments. He thought it was to the public advantage that the inventive faculty of public servants should be encouraged.

MISCELLANEOUS.

Lancashire Electric Power Bill.—Eight members have given notice of their intention to move the rejection of this bill in the House of Commons on the motion for second reading.

The Macclesfield & District Tramways Bill was read a third time in the House of Commons on Friday last week.

The Preston, Chorley & Horwich Tramways Bill, and the South Lancashire Tramways (Extension of Time) Bill were read a third time in the House of Lords on Monday.

LEGAL INTELLIGENCE.

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D. Firth & Son v. the Cardiff Corporation

An Arbitration.

The above case has occupied the attention of the arbitrator (Mr. W. H. Patchell, M.Inst.C.E., M.I.E.E.), sitting at the Law Courts, London, for six days. The concluding hearing took place on Monday.

Mr. Maurice N. Drucquer, instructed by Mr. R. Tweedy Smith, appeared for plaintiffs, and Mr. J. Sankey, instructed by the town clerk, appeared for defendants.

The claim was for £1,605. 9s. 5d. for work done in installing the electric light at Whitchurch Asylum, near Cardiff. Messrs. Firth, by a contract dated Oct. 3, 1905, engaged to do the wiring work for £6,421. After making several applications to the engineer for certificates, and being unable to obtain one, the contractors withdrew their men on Nov. 21, 1905, and, in consequence, the Corporation took possession of the materials on the works and counterclaimed for £5,169. The main point left for the decision of the arbitrator is whether the Corporation, without paying anything on certificates, can, notwithstanding, claim the benefit of the work done and also counterclaim in addition.

Mr. H. D. FIRTH gave evidence as to the work done, and produced invoices and time sheets to support his statement. He also gave evidence as to the reading of the specification, which did not fix the the size of all the cables. He read it one way and the engineer another way on very many points. Evidence was given that the applications for certificates, with particulars of the work done, were sent in on Oct. 18 and Nov. 3, 8, 13, and 15. The engineer contended that in applying for a certificate a correct statement of the work done should be supplied by the contractor. The contractor, however, gave evidence that he had given the engineer "approximate statements," and thus complied with the contract and the general custom.

Mr. POTTER (W. T. Henley's Telegraph Works Co.) gave evidence in support of plaintiffs' claim.

Mr. E. M. LACEY, M.Inst.C.E., gave technical evidence as to the ambiguity of the specification.

Members of the Electrical Contractors' Association also attended to give evidence as to the many meanings which could be placed upon the specification, but after Mr. Sankey had objected to the admissibility of the evidence, and the arbitrator having ruled against his contention, defendant's counsel applied for special case to the High Court. Plaintiffs' counsel, however, decided for the time being not to proceed with such evidence.

Mr. ARTHUR ELLIS, M.I.E.E., M.I.M.E., gave evidence on behalf of the Corporation, occuping the witness chair for two days. He gave his reasons in support of his reading of the specification being the right one, and in support of the allegation as to the thickness of cable, delay and the desire of the contractor to be relieved of the job.

Mr. H. J. Veale (chairman of Cardiff Asylums committee), Mr. Cecil George Brown (deputy town clerk) and Mr. Thomas (clerk of the works) also gave evidence.

The arbitrator reserved his decision.

Berghtheil, Young & Co. v. R. N. Cunningham & Co.

At the Lord Mayor's Court (London) last week, before Sir F. Fulton, K.C., and a jury, plaintiffs sought to recover from defendants £11. 10s., the price of electrical fittings.

It appeared that plaintiffs in January held a sale of show-room stock, and defendants selected certain fittings, taking away a bronze figure with other goods. Afterwards plaintiffs' manager had a conversation with Mr. Cunningham on the telephone, saying that the figure had been taken in error. Defendant said that the figure was included, and plaintiffs remarked that the bargain had better be cancelled. Mr. Bergtheil, in the meantime, had discovered that the figure was included in the articles sold. Defendants returned the goods next day, and were then informed that a mistake had been made over the figure, but they refused to take the fittings, and payment of the cheque given was stopped.

The jury found for plaintiffs, but leave to appeal was given.

Lansard & Co. v. R. Adams.

At Clerkenwell (London) County Court on Monday plaintiffs sought to recover £7. 10s. for an electric motor. Plaintiffs said they supplied defendant with an electric motor for driving his machinery. A guarantee was given whereby they undertook to repair any defect in the motor during the year. Defects did arise, and it was examined by their elec trical expert, who found that the motor had been overloaded and had not been subjected to fair and proper treatment. Therefore, they declined to repair it free of charge. Defendant said it must be repaired, and, acting upon his instructions, they did the work. When the circuit-breaker was fixed it was quite in order. They found that the motor sparked, but that was mainly through the gear not being looked after or attended to. It was not only overloaded, but it was in a dirty condition.

DEFENDANT said from the first the motor was not satisfactory. It was always a source of trouble, and frequent complaints were made to plaintiffs. He never promised to pay plaintiffs for doing what was necessary to put the motor in order. The circuit-breaker did not act properly.

The JUDGE said there was a conflict of opinion as to how the defect had arisen, because electrical engineers, like doctors, disagreed. But the case had been gone into at considerable length, and he was satisfied that the circuit-breaker did not work properly. He would give judgment for defendant over and above the £2. 12s. 6d. paid into Court.

Metallic Seamless Tube Co. (Ltd.) v. Simplex Steel Conduit Co. (Ltd.)

This case came before the Master of the Rolls and Lords Justices Romer and Cozens-Hardy in the Court of Appeal yesterday on the appeal of the Simplex Steel Conduit Co. from a judgment of Mr. Justice Buckley (reported in *The Electrician* for Nov. 24 last).

Mr. A. J. WALTER opened the case for the appellants, and had not concluded his opening address when the hearing was adjourned.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A laboratory assistant is wanted in the department of electrical engineering of the Glasgow and West of Scotland Technical College. Applications to Prof. Magnus Maclean. See an advertisement.

The governing body of Battersea (London) Polytechnic invite applications for the position of head of the department of electrical engineering from September next. Particulars from the secretary. See an advertisement.

A commercial assistant is required for Birmingham electric supply department. Commencing salary £300, rising to £400 per annum. Applications to city electrical engineer and manager (Mr. R. A. Chattock, M.I.E.E.), 14, Dale End, Birmingham, by 14th inst. See also advertisement.

An assistant in the meter-testing department and a youth to assist same, and a clerk, are wanted at a London municipal electricity supply station. Further particulars in an advertisement.

An electrician, well up in electric lighting, telephones and bell-work is required for Middlesex Hospital, London, W. Commencing wages 35s. per week. Applications by May 9 to the secretary-supt. See an advertisement.

A designer, with experience in the design of direct-current motors, is required by the Brush Electrical Engineering Co., Loughborough. See an advertisement.

An electrical engineer is wanted to take charge of generating station and electrical machinery at Clydebank Dock. Applications to Secretary, Clyde Navigation Trust, 16, Robertson-street, Glasgow, by May 7.

London County Council have appointed Mr. Eustace Ridley as assistant to the chief officer of the fire brigade, in connection with the electric lighting and heating arrangements at theatres and places of amusement, at a salary of £400 per annum. Mr. Lea, who was recently appointed, withdrew his application.

Mr. W. H. Gowing, for some years with the General Electric Co and for the past two years works manager of the Morris-Hawkins Electrical Co., has become works manager of Kramos Limited.

Mr. T. Hunter, of the Westminster Electric Supply Corpn., has been appointed manager of the Musselburgh & District Electric Tramways Co., in succession to Mr. Wm. Bain, who recently received an appointment in the L.C.C. tramways department.

Mr. V. P. Martin has been appointed canvasser for the electricity department at Dover for another year.

Mr. J. R. W. St. John Brown, of Leytonstone, has been appointed canvasser to Hammersmith electricity department at £3 per week. There were 300 candidates.

Mr. J. J. F. Shoolbred, of Newcastle-under-Lyme, sails on May 11 to take up the position of manager of the Tucuman electricity works, Argentina.

Personal.—Mr. C. Ashmore Baker, of Dudley, has joined Mr. Reginald P. Wilson, consulting engineer, 68, Victoria-street, Westminster, S.W.; and Mr. C. E. Savage takes his place as resident electrical engineer at Dudley, with Mr. E. S. Hounam as chief assistant.

Acton.—For the year ended March the deficiency on the electricity department was £2,819, but the deficiency on the current year is not expected to exceed £1,800.

Argentina.—The "Review of the River Plate" says that La Plata and Ensenada Tramway Co.'s systems will shortly be converted to electric traction.

The municipality of Quilmes, a Buenos Ayres suburb in which electricity works are already in operation, have given the Cia Alemana Transatlantica de Electricidad permission to lay mains.

Chascomus Council have placed a contract with the Cia Obras Publicas del Rio de la Plata for public lighting for 10 years. 18 8 ampere and 64 4 ampere arcs will be issued at the outset.

Australasia.—In regard to the intended adoption by the Government of the toll system of charging for telephonic facilities (to which, as we stated in our last issue, strong exception has been taken), the acting postmaster-general (Mr. Ewing) has notified that if, under the toll system, matters are not found to be fairly adjusted, further consideration will be given to the subject; that instructions have been given for a return showing the cost of the telephone service; that there is no desire to unduly hasten finality with regard to the proposed alteration of charges; and that efforts will be made to bring the department into harmony with the public on the question.

The report of the engineer (Mr. G. H. Lofts) on the working of Devonport (Tasmania) municipal electricity department during 1905 shows that 39,289 units were sold for lighting, at an average price of 7·577d. per unit, and 1,612 units for power and heating at 2·929d. The accumulator battery supplied all demands between midnight and dusk. The charges on the maximum demand system for current for lighting are to be reduced to 7d. and 2½d., and for power and heating to 2½d. and 2d.

Kalgoorlie (W.A.) Council have received an offer from Noyes Bros. to prepare plans and erect a battery of accumulators at the electricity works at 15 per cent. on outlay. The offer has been accepted on condition that the cost involved does not exceed the Corporation's estimate of £5,000.

The report of Kalgoorlie municipal electricity department for 1905 shows revenue £17,245 and a credit balance of £1,913. There are 27½ miles of streets lighted by 45 arcs and 730 incandescents. Capital expenditure is £60,000, of which only £22,500 was borrowed, the remainder having been met out of profits. The charges for current are 7d. per unit for lighting and 4d. for power.

Zeehan (Tasmania) Town Board recommend the purchase by the municipality of the Zeehan Electric Light Co.'s undertaking at £3,500.

In reference to a proposal by Admiral Fanshawe, at a recent meeting of the Naval Board, that about a dozen wireless telegraph stations should be erected on the Australian coast for communicating with warships and with New Zealand for defence purposes, Senator Playford, Minister for Defence, is of opinion that the scheme would mean useless expense at the present juncture.

Barking.—The Council's electricity department has made good progress during the year. 992,320 units were generated, an increase of about 140,000 over the previous year. Extensions of the plant, which will increase the capacity of the generating station by 400 kw., are in hand.

Bath.—The Electric Lighting committee recommend the extension of the mains at a cost of £2,044 to supply current to Messrs. Stothert & Pitt's works for power. The firm agree to take 140,400 units per annum at 1d. per unit. The committee also recommend the Corporation to apply for sanction to a loan of £4,000 for mains extensions.

Belfast.—Application has been made for sanction to a loan of £10,000 for extensions of the electric lighting mains, house services, meters, &c.

Bermondsey (London).—Tenders are to be invited from 10 firms for wiring the Rotherhithe baths. A loan of £5,390 for electric lighting purposes was taken up by the Council on Tuesday.

Bingley (Yorks).—The Board of Trade have refused the application of the Mid-Yorkshire Tramways Co. for an extension of time for constructing the tramways through Bingley.

Bridlington.—At the meeting of the Council last week the chairman of the Electricity committee (Mr. J. V. Mainprize) stated that the committee had asked the L.G. Board to allow a longer period for the repayment of the loan of £5,580 recently sanctioned for electricity supply.

In regard to the inquiry into the Council's application for another loan for electricity works, Mr. Mainprize referred to the statement made by the inspector (Mr. Hooper) as to the value of incandescent gas for street lighting. The inspector's remarks, he wished it to be understood, applied to side streets, and he had made no observations on the quality of gas or of incandescent gas as an illuminant for private houses or for main thoroughfares. He was not aware even that the L.G. Board had sent down their inspector to air his opinions on that subject, and it certainly hardly came within the scope of the inquiry.

The gross revenue of the electricity department for the past 12 months was £3,255 and the expenses were £1,592. After meeting interest and sinking fund there was a small deficit (£31. 13s. 4d.). The department is making good progress, and has 200 consumers connected to the mains, against 96 last year. The gas company has had to reduce the price of gas by at least 20 per cent., saving the ratepayers from £2,000 to £3,000 per annum.

Colchester.—In the mothly report of the borough electrical engineer (Mr. A. R. Sillar), presented at the last meeting of the Council, a protest was made against the decision of the Electricity committee for incurring a large outlay for incandescent gas, while there were nearly 13 miles of electric lighting distributors, with additional cores, which were of no use to the committee except for public lighting.

The amount of additional copper, labour, &c., in those 13 miles of distributors represents £1,114. 3s., and it seemed (Mr. Sillar says) a great pity that such a large sum should have been sunk without, apparently, a chance of return. The price of 1¾d. per unit for all additional street lamps connected was extremely low. He had carefully examined the returns of 349 municipal and company undertakings, representing the whole of the provincial supply stations, and, omitting the towns which paid a lump sum per annum for arcs and incandescent lamps, and, of course, those which did not publish prices, he could only find 14 towns obtaining their supply at a lower rate than Colchester. Moreover, out of those 14 towns, 10 were situated in the centre of the coal fields. He found, also, that the usual price for public lighting ranged from 2¼d. to 4d. per unit.

County Councils and Electric Power Bills.—A deputation from the Council of the County Councils Association waited on the President of the Board of Trade on Wednesday to ask the Board to adopt, for insertion in all electric power and light bills and provisional orders, certain clauses for the protection of County Councils in respect of bridges and roads.

Mr. Lloyd George, in reply, said that, with regard to the question of bridges, he sympathised with the Councils, but he was advised that, as the law stood at present, he could not introduce into provisional orders words which would carry out the purposes of the desired clauses. Whether it could be done by a confirming bill was another matter. If it could be done without infringing the law he was in favour of doing it, and if not he would consider the possibility of introducing a bill for the purpose.

Coventry.—Sanction has been received by the Council to a loan of £5,000 for the purchase of electric motors to be let on hire.

Derby.—The Corporation adopted on Wednesday the Electric Light committee's estimates of capital expenditure for the current year, and it was decided to apply for sanction to borrow the amount (£8,130).

Devonport.—The electricity department made a gross profit during the year ended March of £10,300 (against £8,684 in the previous year) and a net profit of £4,000 (against £2,728), which it is proposed to place to depreciation and reserve.

Dudley.—The chairman of the Tramways committee (Ald. Dunn) announced at the Council meeting on Tuesday that the award in reference to the purchase of the tramways had been issued, but as they could not tell exactly what would be required the Council would be wise in applying for sanction to a loan of £90,000, and this was agreed to.

Some discussion took place upon the recommendation to appoint Mr. R. P. Wilson for two years further, from the 24th inst., as consulting engineer at a salary of £325 per annum, and a commission on capital outlay of 2½ per cent.

Durham.—The County Council have decided not to reconstitute the Electric Supply committee and to proceed no further with the County electricity supply scheme.

Edinburgh.—The Council have agreed, on receipt of a letter from Lord Kelvin, to entertain at lunch the American and Continental electrical engineers on the occasion of their visit to the city on July 4.

Elgin.—A disussion on the question of the erection of electricity works took place at the last meeting of the Town Council, but it was decided to defer consideration of the subject until the ratepayers have been consulted.

Elland.—For the year ended March 31 their was a deficit of £445 on the Electricity department.

Gloucester.—The City Council have compromised the claim of the late city electrical engineer (Mr. W. J. Bache) for remuneration for extra services rendered in connection with the electric tramway scheme by paying Mr. Bache £44. 12s. 6d.

Hammersmith (London).—Owing to the increased demand for current at Stamford Brook and London Bishopric estates, it has been decided to supplement the h.t. feeders between the Grove substation and the generating station at an estimated cost of £697.

Institute of Chemistry.—The pass list of the April examinations has been issued.

Of seven candidates who entered for the inter-examination, six passed—viz., C. T. Bennett, B.Sc., S. H. Groenewoud, B. R. James, G. R. W. Lawson, E. H. Merritt, B.Sc., and C. A. Wonham, B.Sc. In the final examination for the Associateship (A.I.C.), of four examined in mineral chemistry, three passed—viz., G. N. Bacon, A.R.C.Sc. (Lond.), B.Sc., F. M. G. Johnson, M.Sc., and E. J. Wilson, B.A.; of four in metallurgical chemistry, one passed—viz., H. J. Bailey. Two candidates presented themselves in organic chemistry, and both passed: L. H. Berry and O. W. Stickland, B.Sc.; and of seven who entered in the branch of the analysis of food and drugs and of water, including an examination in therapeutics, pharmacology and microscopy, the following five passed: B. J. Eaton, W. R. Mummery, F. L. Okell, R. P. Page and R. G. Pelly.

Liverpool.—The annual report of the traffic manager of the tramways department (Mr. C. W. Mallins) for 1905 has been issued.

At the outset reference is made to the services rendered by the late manager (Mr. C. Bellamy) and the various tramway routes are then fully dealt with. 119,123,644 passengers were carried, against 116,642,663 in 1904. The car-miles run were 12,067,033 against 12,166,419. Traffic receipts were £550,084 (against £540,850), the total receipts being £557,055. The electrical energy consumed was as follows: Haulage and lighting of cars, 20,871,002 units; lighting of car sheds, works and routes and power for works motors, 315,780 units; total 21,186,782 units (of which 1,047,918 units were supplied by Bootle Corporation), against 20,045,629 units in 1904. The total cost of electrical energy for hauling and lighting during 1905 was £96,596, compared with £94,937. 1·677 units were used per car-mile, against 1·566 in 1904. The cost of maintenance and renewal of overhead equipment amounted to £5,671, against £4,809 in 1904. The whole of the 351 cars authorised by the Tramways committee to be fitted with top covers have been completed and are in service. The total cost of working per car-mile (including interest and sinking fund) was 9·759d. (against 9·400d.) and the total earnings were 10·94d. (against 10·67d.). After paying all expenses, interest, sinking fund, &c., £25,320 has been applied in relief of rates and £50,639 has been carried to reserve. The total net capital expenditure is now £1,898,812. 10s. 10d.

The Corporation propose to supply electric motors on the hire-purchase system.

London County Council.—At Tuesday's meeting it was resolved to lend Marylebone £44,850 and £12,000, and Shoreditch £14,905 for electric lighting.

Municipal Telephony.—The accounts of the *Hull* Municipal telephone department for the past year show revenue of £7,235 and an expenditure of £4,372. £1,450 (less £273 interest on current account) has been applied in payment of interest on loan, £1,109 has been placed to suspense as an instalment towards repayment of loan, and £100 has been set aside as provision for bad and doubtful debts. A net balance is thus left of £476, which is reduced by the deficit of £73 on 1904-5 to £403. Whilst no amount has been expressly provided to cover depreciation, a full years' instalment has been taken into account towards repayment of capital loan. During the year the capital expended was £15,065, making a total of £45,435, and during the year £14,202 has been further advanced by the Hull Savings Bank, making with £29,000 previously advanced, a total of £43,202. This amount is repayable by 25 yearly instalments. The year's revenue was made up as follows:—Exchange rentals, £6,616. 4s. 4d.; private line rentals, £195. 5s.; toll services, £173. 5s.; public telephones, £124. 2s. 11d.; inland revenue, £74. 15s. 1d.; trunk fees and telegrams, £50. 17s. 5d.; and terminal fees, 7s. 3d.

The accounts of the *Swansea* Municipal telephone department show a profit of £534 for the past year, compared with £286 for the previous 17 months. Capital expenditure amounts to £27,172. The Telephone committee consider the year's working extremely satisfactory, as £382 was spent out of revenue for charges incurred over a lawsuit to establish intercommunication.

At *Swansea* on Tuesday Mr. H. R. Hooper held an inquiry into the application of the Corporation for sanction to a further loan of £7,000 for extensions to the municipal telephone system.

The town clerk (Mr. J. Thomas) explained that the area of the Corporation telephone licence was 104 square miles.

The manager of the telephone department (Mr. A. G. Mackie) said the original scheme provided for 750 complete lines—725 subscribers and 25 public telephones—also spare ducts and spare accommodation poles for another 750, but did not include spare cables, instruments and spare wiring. The cost was to be £20,000 (including £2,000 for land and buildings), but since that time sanction had been obtained for a further £2,500 for additional completed lines, &c. On March 31 1,419 lines were working, and the total capital expenditure was £27,172. For joining up new subscribers it was necessary to provide additional ducts and switchboards which would provide for another 350 subscribers at an estimated cost of £7,000. To enable the Corporation to meet the demands of the public and to extend and develop the telephone system that sum was necessary, and they could not possibly do without it. The original scheme provided for the opening of exchanges at Mumbles, Morriston, Clydach, Pontardawe, Loughor, Skewen, Manselton and Pontardulais. Only four of these had yet been opened, the further distant ones being left out altogether so far. The sanctioned expenditure had been exceeded by £4,000. During the last three months they had obtained 120 new subscribers' lines. They had been able to obtain the amount represented by the difference between £23,100, the amount sanctioned, and £27,172, the amount expended, by means of a bank overdraft, which they proposed to repay out of the £7,000 for which borrowing powers were now sought. With regard to the profit of £800 claimed to have been earned since the opening of the service in November, 1903, he admitted that there had been no allowance made for depreciation. The plant was kept in good repair and up to date out of revenue.

In reply to the Inspector, Mr. Mackie said that 14 miles of pole work and six sub-exchanges remained to be completed, whilst none of the underground work specified in the present application had been carried out. The proportion of the £7,000 now applied for which had already been expended was £4,066, upon which interest had been paid out of revenue.

The Inspector : That would make the cost at March 31 last £30. 2s. 6d. per direct line ?—Yes.

The Inspector : It was stated at the first inquiry that the cost would be £27 per direct line, and that that would decrease as the subscribers came on ?—That is so, on your calculation.

After a short adjournment, Mr. Mackie was under cross-examination by the Inspector, when it transpired that the estimate as sent in to the L.G. Board had been varied materially, overhead work having been substituted for underground work, and the Inspector protested against being allowed to come to that inquiry, thinking he had all information in regard to the subject, and then to find that the plan had been almost entirely withdrawn. It made it very hard for an inspector, and he did not consider the estimate a true one. Although nothing of the work had been done, more than half the money had been expended, and yet they had not advised the L.G. Board that the application for £7,000 no longer held good. It had only been by a searching cross-examination that he had discovered that the information before him was incomplete and incorrect.

The Town Clerk admitted the Inspector had serious cause for complaint, and, as far as he was concerned he wished to say he was equally surprised with the Inspector, as he had only just learnt of the alterations.

After discussion, the Inspector said he must go into each detail, and he did not see how the inquiry could be closed that day. He must know precisely for what the money was required, what money had been expended, in what way and when, and a plan should be submitted showing the work which had been carried out under former loans, the work already done and carried out under the present application, and the work which remained to be done.

The inquiry was then adjourned sine die.

Since the adjournment of the above inquiry, Councillor D. Jones, Chairman of the Swansea Telephones committee, has issued an explanation as to the circumstances connected with the application for a loan of £7,000 for telephone extensions. Mr. Jones points out that the application was originally made to the Local Government Board 12 months ago. It was, however, hung up by the Board in consequence of the Post Office proposal to buy up the Swansea service ; but Mr. Jones explains that even 12 months ago an extension of the service had become necessary, and in the meantime money has had to be spent or extensions to the service would have been impossible, One estimate was sent when the application was originally made, and this estimate has had to be amended to meet the altered circumstances.

Newark.—The Board of Trade have inquired of the Council as to the steps they propose to take to carry out the provisions of their Electric Lighting Order, 1900. The members of the Council are divided in opinion between a municipal scheme and the taking of electricity in bulk from the Derbyshire and Nottingham Electric Power Co. The Electric Lighting committee have the matter in hand.

Poplar (London).—The charge for current to the public libraries is to be reduced from 5d. for the first hour and 3d. after to a flat rate of 3d. per unit, less 5 per cent. The charge to the Princes Theatre is to be reduced to 3d. per unit, less 5 per cent., for a minimum consumption of 40,000 units per annum.

Presentation.—The Northern and London Sections of the Electrical Contractors' Association recently made a presentation of a silver tray, cigarette box and trinket box to Mr. W. Cross, who has been hon. sec. of the Northern section since its inauguration on the occasion of his marriage. Mr. Cross was married on April 26th at Wesley's Chapel, City-road, London, E.C., to Miss Edith Annie Pickering.

Rome.—In a consular report on the trade of Rome and district for 1895 Mr. Consul Morgan writes :—

The electric power which is used in Rome for traction, as well as for illumination, has hitherto been supplied by the plant erected at Tivoli. The plant chiefly belongs to a private company, but owing to the price which is charged for electricity it is only the well-to-do classes who can afford to have electric light in their houses, and very few of the streets of the capital are lighted by that means. A scheme, however, has been recently submitted to Rome Municipal Council, by which it is proposed to utilise the waters existing in the neighbourhood of Subiaco, distant about 44 miles from Rome, and to erect plant for the distribution of electric current to the capital. Under this proposed scheme electric power would be supplied at lower rates than at present, and the service would be under the direct control of the municipality. The system of transmission is to be similar to the existing one, energy being conveyed to Rome by means of overhead cables.

An electric tramway connecting Rome with the surrounding villages has been opened to traffic. The advantages accruing to the population of the capital will be considerable, inasmuch as it is proposed to build houses for the less-favoured classes in the districts near Rome served by the projected line, and thus enable them to live out of the city, where house rents have of late years increased very much.

Rotherham.—The Council were informed on Wednesday by Ald. Winter, chairman of the Electric Lighting and Tramways committee, that the results of the past year's working of the electricity department were as satisfactory from the standpoint of profit as in 1904-5.

One of the chief items which had led to the profit being less was that of rent, rates and taxes, which showed an increase of £500. Had these charges been on the same basis as last year the profits would have been substantially the same. The other working expenses appeared to be quite normal, and practically they only increased in the same ratio as the receipts. He thought it should be publicly known that the department had made a surplus apart from renewals and depreciation which amounted to £2,006.

The tramway results had exceeded expectations. The total receipts were £24,214, against £23,568. For the first six months of the year there was a continuous drop in receipts, owing to reduction of railway fares and the zone system adopted by the two railway companies between Rotherham and Sheffield. The fact that they had recovered the drop on the first six months (£866) was a complete justification of the decision to run through cars to Sheffield. Since the introduction of the through service the receipts had steadily gone up, until they had actually gained upon the receipts of the previous year by £140 odd. The gross profit showed an increase of £1,064, due to causes which were creditable to the management. The percentage of gross profit was 5·2 per cent.

St. Pancras (London).—The Electricity committee have appointed Councillor Johnson as chairman, in place of Ald. Purchese, resigned.

The Council have adopted, on the recommendation of the Electricity committee, a scale of minimum and maximum salaries and wages in connection with the generating stations and mains department of the Council so as to obviate repeated applications for increases. The principal recommendations are :—Generating stations : Chief assistant (King's-road), from £2. 10s. to £3. 10s. ; first electricians, £2 to £2. 10s. ; second electricians, £1. 5s. to £2 ; engine drivers, £1. 15s. to £2. Mains department : Assistant to distributing engineer, from £2. 15s. to £3. 5s. ; general foreman, £2 to £2. 10s. ; gangers, £1. 10s. to £1. 15s. ; arc lamp foreman, £1. 15s. to £2 ; arc lamp repairers, £1. 10s. to £1. 15s.

Salford.—In February the Council asked the Tramways committee to report upon the expediency of introducing ½d. fares on the tramways, and in a lengthy report presented to the Council on Wednesday the committee stated, after setting out the results of ½d. fares in other towns, that it was inadvisable to adopt these fares.

San Francisco.—In a report just issued by Mr. Consul-General Bennett on the trade of California and district the following notes regarding electrical matters appear :—

Los Angeles county early became a fruitful field for electric railroad enterprises, and during the last few years the southern metropolis has been brought, by means of many new electric roads, into close communication with nearly every community and pleasure resort within a radius of 30 miles. The inter-urban electric railways in the neighbourhood of San Francisco do not aggregate a large mileage, but Central and Northern California have recently entered upon a period of unusual activity in electric railway construction, giving promise of large results. A company is now engaged in building a road from Merced to the Yosemite Valley, and the Southern Pacific and Santa Fé Cos. have jointly formed a corporation and undertaken the work of making surveys and obtaining right of way with the idea of building a parallel line between the same points.

Los Angeles city and district are well supplied with electric tramways and railroads, there are about 400 miles of double-track electric road centring in Los Angeles and running to the suburban towns close by. Nine of these roads connect Los Angeles with seaside resorts distant from 16 to 30 miles. At present the speed of the cars averages 40 miles per hour, special cars, known as "flyers," making a higher rate. A new line to Santa Ana, distance 34 miles, was opened during the year, also a new line to Sierra Madre, a distance of 18 miles. A second line to San Pedro, a distance of 25 miles, was also opened during the year. There are two electric roads to Pasadena, a distance of 10 miles north of Los Angeles, and a third is just being completed. The Pacific Electric Railway Co. announce that several other lines are projected.

An electric railway is now being constructed from Los Angeles to Hueneme, a distance of 60 miles. This line is to be extended to San Francisco in competition with the Southern Pacific Co. As a result of the facilities for transportation, the population of the beach towns (the seaside resorts near Los Angeles) has increased in the past year from about 30,000 to 100,000.

The Ocean Shore Railroad is actively engaged in building a double track electric railway to connect San Francisco with Santa Cruz. The road will skirt the ocean shore for the greater part of the distance, and will open up a rich country heretofore deprived of much-needed transportation facilities. The Napa and Lakeport Railroad Co. is another big project. It has completed surveys and right of way for an electric road from Napa to Lakeport on the shores of Clear Lake, and, in connection with another company, intends to construct a road that will extend from Clear Lake to some point on the Bay of San Francisco, making a system with its branches of 120 miles. A number of short lines are projected and some are being built.

The extensions of street railways at San Diego during 1905 were also notable. The Navy Bureau of Equipment is establishing a wireless telegraph station at San Diego and at several other points on the Pacific coast.

South Africa.—The current issue of "The British and South African Export Gazette" contains an article which throws considerable light on the working of the preference accorded to British goods imported into South Africa under the terms of the Customs Union tariff. The preference consists chiefly of a rebate of 25 per cent. off the duty in three out of the five classes into which merchandise is divided. With the help of official statistics, our contemporary proves that the preference, which only amounts to 2½ per cent. net, has been utterly inadequate to stem the tide of foreign competition.

South Bank (Yorks.)—The Council have before them three schemes for the supply of electricity—viz., a municipal scheme, an offer by the Cleveland & Durham County Electric Power Co., and an offer by the Cargo Fleet Iron Co., and they have received a report from their consulting electrical engineer, which will be discussed at the next meeting.

Staines.—The promoters of the Sunningdale and District Electric Lighting Order have decided to exclude Staines from the area referred to in the application.

Stoke-on-Trent.—Application has been made for sanction to a further loan of £1,500 for electric lighting extensions.

The Board of Trade have sanctioned the increase of speed of electric tramcars on the light railway extension to Handford Bridge from 6 to 12 miles an hour.

Stourbridge.—On Monday the Council decided to transfar their Provisional Order (1899) to the Shropshire, Worcestershire & Staffordshire Electric Power Co for £500, the Council reserving the right to purchase the undertaking at the end of 15 years.

Swansea.—The chairman of the Electricity committee (Major Sinclair) announced on Wednesday that the revenue of the electric lighting and tramways department for the year just ended was £15,660, compared with £12,917 in the previous year.

Tantalum Lamp in America.—An agreement has been entered into between Siemens & Halske Aktiengesellschaft, Berlin, and two of the leading lamp manufacturers in the United States (the General Electric Co., of New York, and the National Electric Lamp Co, of Cleveland) for the exploitation of the tantalum lamp under licence.

Todmorden.—The Todmorden Co-operative Supply Society offer to take 40,000 units of electrical energy per annum for lighting and motive power from the Corporation mains, provided a reduction can be made on the usual rates of 3d. per unit for lighting and 2d. for power. The Council, it is stated, have decided that no reduction can be made.

Tunbridge Wells.—At the meeting of the Council on Wednesday the chairman of the Electric Lighting committee (Ald. E. Robb) stated that the electric light department had been very successful during the past year, and the net profit amounted to £1,948, a considerable increase on the previous year.

The undertaking was now on a sound financial basis with good prospects. This prosperity reflected the highest credit on Mr. H. Boot, their electrical engineer, and he (Ald. Robb) thought the time had come when they should consider the wisdom of making some reduction in the charges for current. The gross profits had been £6,600, an increase of £118; the net profit had been £1,948, an increase of £1,168.

West Hartlepool.—An inquiry was held on Wednesday into the Council's application for sanction to a loan of £7,070 for additional plant at the electricity works, extensions of the mains, &c., to meet the rapidly increasing demand for electric current for power and lighting.

Worcester.—An inquiry was held last week into the application of the Corporation for permission to borrow £5,850 for electricity supply.

The Mayor explained that the sum asked for had been expended in excess of amounts already sanctioned.

The inspector (Mr. H. R. Hooper) said he must be satisfied of the expenditure. There had been throughout a floating balance, and the accounts had been irregularly kept. He eliminated several items from the details of the loan as being improperly charged to capital, reducing the amount to £5,194, and agreed to add £2,600 for anticipatory work upon mains, house services and meters.

Workhouse Lighting.—Strood (Kent) Guardians have asked the Kent Electric Power Co. to submit terms for supplying electric current to the workhouse.

Wrexham.—An honorarium of £30 has been voted to the electrical engineer (Mr. Wm. Sillery) for special services in connection with the electric light extension scheme.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Bristol Electrical committee invite tenders for (*a*) one 3,000 kw. (6,000 volt) three-phase turbo-alternator, with condensing plant; (*b*) one 500 kw. and (*c*) two 300 kw. motor generators or rotary converters (6,000 volts a.c. to 500 volts d.c.); (*d*, *e* and *f*) extensions to e.h.t, h.t. and l.t. switch gear: (*g*) 30 ton electric travelling crane; (*h*) water-tube boilers, with economisers, mechanical stokers, superheaters, induced-draught plant, &c.; (*j*) boiler feed pumps; (*k*) extension to coal conveyor; (*l*) steam and water pipe work; (*m*) water tanks; (*n*) steel troughing and fixing for protection of cables in subway; (*p*) annual supply of joint and junction boxes. Tenders from manufacturers only. Intending tenderers should communicate with the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, who will furnish particulars as to the date on which specifications will be available. See also an advertisement.

Swansea Corporation invite tenders for the supply, delivery and erection of one 600 kw. c.c. steam generator, with condensing plant, exhaust pipes, valves, connections, &c. Specifications, &c., from the borough electrical engineer (Mr. C. A. L. Prusmann), Strand, Swansea. Tenders to the town clerk (Mr. Jno. Thomas), Town Hall, Swansea, by noon May 29. See also an advertisement.

Johannesburg Town Council is prepared to receive tenders for supply and delivery (after erection for inspection at makers' works) of three electric watering cars for the Council's tramway system, together with various spare parts. Tenders are to be f.o.b. at any port suitable for shipment for South Africa, and separate prices must also be given for (*a*) delivery of cars and spare parts at Johannesburg and (*b*) erection of cars complete at Johannesburg. Tenders to the town clerk (Mr. John Dove), Municipal Offices, Johannesburg, to reach him by June 16. Specifications, &c., may be seen on and after May 10 at the offices of the consulting engineers (Messrs. Mordey and Dawbarn), 92, Victoria-street, Westminster, London, S.W. Further particulars are given in an advertisement.

Edinburgh Corporation invite tenders for arc lamps for street lighting. Specifications, &c., from the city electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh. Tenders to the Town Clerk, City-chambers, Edinburgh, by May 14. See also an advertisement.

Leyton District Council invite tenders for radial axle trucks, bodies, electrical equipment and assembling. Specifications, &c., from the electrical engineer (Mr. F. Harman Lewis), electric light & power works, Cathall-road, Leytonstone, on and after 8th inst. Tenders must be delivered to the Council meeting to be held at the Town Hall, Leyton, on May 29 at 7 p.m. See also an advertisement.

Bedford Corporation invite tenders from cable makers for the supply of high and low tension cables for 12 months. Tenders to the borough electrical engineer (Mr. R. W. L. Phillips), Cauldwell-road, Bedford, by noon May 23.

Poplar (London) Borough Council want tenders by 10 a.m. May 8 for supply and erection of overhead bunker and coal-handling plant. Form of tender from the borough electrical engineer, Glaucus-street, Bromley-by-Bow, E.

Tenders are invited for supply and erection of two turbine water wheels, two c.c. dynamos, two pumps, &c., at *Belfast* District Lunatic Asylum, Purdysburn, near Belfast. Tenders to S. M. Macrory (Ltd.), Limavady, by May 10.

Birmingham Electric Supply committee invite tenders for supply and delivery of various sizes of electric motors. Tenders to the city electrical engineer (Mr. R. A. Chattock) by noon May 8.

Dublin Electric Lighting committee want tenders by 4 p.m. May 14 for the erection of a sub-station at Fairview.

Bermondsey (London) Council require tenders by 4 p.m. 18th inst. for condenser and cooling tower, &c., and arc lamp lowering gear.

Salford Electricity committee want tenders by 12th inst. for two tramway feeder boosters, &c.

Warrington Electricity and Tramways committee want tenders by noon May 8 for 12 months' supply of motors.

Bexley Council want tenders by 5th inst. for about 500 tons of granite setts.

Southampton Corporation want tenders by 2 p.m. May 10 for storage battery and chain grate mechanical stoker.

Bray (Ireland) Council invite tenders for a.-c. arc lamps, brackets and carriers. Tenders by 10 a.m. May 15.

Leith Parish Council want tenders by 8th inst. for wiring the new poorhouse. Particulars from the Clerk, 45, Charlotte-street, Leith.

Leek Council want tenders by noon May 14 for a gas dynamo.

The Municipality of *Plasencia* (Spain) invite tenders for installation of public electric lighting and the public buildings. Tenders by May 28 to Ayuntamiento Constitucional, Plasencia. The "Madrid Gazette" of April 23 gives further particulars.

Tenders are invited for a concession for the construction and working of an electric tramway from Sarria to Vallvidrera, Spain, for a period of 60 years. The Compagnia del Ferrocarril de Sarria à Barcelona have already applied for the concession and will have preference on equal terms. Tenders to Direccion General de Obras Publicas, *Madrid*, by June 28.

TENDERS RECEIVED AND ACCEPTED.

The following tenders were received by London County Council for an electric light and power installation at Long Grove Asylum:—

Lea & Warren (*accepted*)	£11,200	Dargue, Griffiths & Co.	£14,448
E. D. Triswell	25,117	S. S. Cozens	14,217
Wm. Mackie & Co.	19,127	J. E. Spagnoletti & Co.	14,000
Wm. Dibben	17,027	H. A. Jackson & Co.	13,995
G. Hartland, Bowden & Co.	16,814	Tamplin & Makovski	13,883
J. O. Grant & Taylor	16,586	Buchanan & Curwen	13,880
Edmundson's Electricity Corpn. ......17,048 and	16,550	Sweet Bros.	13,655
		T. Potter & Sons	12,995
Tyler & Freeman	16,542	Army & Navy Aux. Stores	12,880
F. A. Glover & Co.	16,500	W. J. Fryer & Co.	12,769
W. H. Arundell	16,300	W. J. Furse	12,700
W. G. Heath & Co.	16,000	Wm. Winn	12,675
Strode & Co.	15,973	Cox Walkers	12,582
Thomas Hiscock	15,936	Bevan & Sons	12,495
Baily, Grundy & Barrett	15,751	R. Cort & Sons	12,336
Strange & Son	15,654	Jackson Bros.	12,235
G. N. Haden & Son	15,427	Bromley, Batstone & Kirk.	11,600
Hooper, Neary & Co.	14,976		

Hammersmith (London) Council received the following tenders for annual supplies of carbons:—

Geipel & Lange £271, 8s. 11d., H. Mayer & Co. £309. 12s. 6d., Sloan Electrical Co. £330. 16s. 3d., General Electric Co. £333. 16s., Pestalozzi & Co., £359. 14s., C. R. Heap £360. 13s., Johnson & Phillips £376. 1s. 8d., Improved Electric Supplies £384. 1s. 6d., Electrical Co. £412. 7s. 10d., International Electric Co. £446. 17s., Siemens Bros. & Co. (T quality) £522. 8s. 9d. (A quality) £670. 14s. 3d., Brush Co. £603. 5s. 6d., International Electric Engineering Co. £756. 9s. 11d.

The electrical engineer reported that it would be advisable that one-half of the carbons shauld be obtained from the Sloan Electric Co. (the contractors for last year) and that he be instructed to test the samples received from other tenderers, with a view to a contract being entered into for the supply of carbons for three years. This suggestion has been agreed to.

Sydney (N.S.W.) Council have accepted the following tenders for d.c. and a.c. motors for the next 12 months:—

D.C. Motors.—Electromotors Limited, Openshaw, Manchester (through their Australian agent, Mr. T. K. Steanes, Sydney) (6 to 25 H.P. inclusive); Robbins & Myers Co. (U.S.A.) (½ to 5 H.P.).

A.C. Motors.—General Electric Co. (U.S.A.) (½ to 5 H.P.); Westinghouse Electric & Mfg. Co. (U.S.A.) (6 to 25 H.P.).

Islington Lighting committee has provisionally accepted the following tenders for annual supplies: Sloan Electrical Co., carbons; De Grelle, Houdret & Co, arc-lamp globes; Ferranti Limited, transformers; British Insulated & Helsby Cables, cables. Seven tenders were received by Islington Council for cables required for the extension of arc lighting, and the tender of the British Insulated & Helsby Cables has been provisionally accepted at £10,391. 12s.

Hull Telephone committee have accepted the tender of the Land und See Kabelwerke for telephone cable at £390. Tenders were received for extension of switchboard from the Ericsson Bell Telephone Co at £1,248 and from the International Electric Co. at £1,375, but it has now been decided to accept a tender by the former company for a modification of the work at £447.

Southampton Council have received the following tenders for the reconstruction of the tramway in the Avenue (recently advertised in *The Electrician*):—

John Douglas (*accepted*)	£1,380	Wm. Griffiths & Co.	£1,617
R. W. Blackwell & Co.	2,054	F. Grace	1,421
F. Osman	1,994	Johnson & Phillips	1,400
Geo. Trentham	1,900		

An order has been placed with Bruce Peebles & Co., Edinburgh and London, for the complete electrical equipment of the mines of the Esperanza Copper & Sulphur Co. at Thielva, Spain. The order, which was placed under the advice of the consulting engineers (Messrs. Addie & Pringle), includes a central station with three large gas-driven sets, switch gear, cables, transmission lines and motors.

Leeds Corporation have placed an order with the Romapac Tramway Construction Co. for replacing a considerable portion of their worn-out track with the Romapac renewable tramrail, and a length of not less than 1 mile is to be laid immediately. This contract has been given in consequence of the satisfactory working of a length laid at Headingley last year.

Middlesex County Council received the following tenders for the construction of Edgware-road light railway extension.

Dick, Kerr & Co. (*accepted*)	£7,843	8	8
Charles G. Wall (Ltd.)	10,151	13	5
Wimphey & Co.	9,098	14	7
John Mowlem & Co.	8,352	0	0

Leyton Council have accepted the following tenders:—Recorders Limited, for six automatic traffic recorders at £35 each, with 2s. per key extra; Edgar Allen & Co., for points and crossings for car depot at £620. 19s. 4d. (For the latter work Hadfield's Steel Foundry Co. tendered at £677. 10s.)

Wimbledon Council have accepted the tender (at £110) of Jukes, Coulson, Stokes & Co. for supply and erection of constructional steel and iron work for the gallery round the engine room at the electricity works.

The tender of the British Westinghouse Co. has been accepted by South Shields Corporation for supply and delivery of 15 new tram cars.

Amongst recent contracts secured by the Empire Roller Bearings Co. are the fitting of 60 additional heavy goods waggons with roller bearing axle boxes (making 140 waggons for one company) and 100 tramcar axle boxes for Peckham trucks for Brazil.

Hull Electric Lighting committee have accepted the tender of the Underfeed Stoker Co. for stokers and coal-handling plant at £2,518, and that of Körting Bros. for pipework at £3,127. 5s. 6d.

Swindon and District Joint Hospital Board have accepted the tender of W. J. Fryer & Co. for wiring the hospital at £121. There were six tenders, varying from £121 to £179. 19s. 2d.

Belfast Corporation have accepted the tender of Combe, Barbour (Ltd.) for a steam dynamo and that of Edgar Allen & Co. for coal-conveying plant.

Bolton Electricity committee have accepted the tender of the British Insulated & Helsby Cables for cables, and that of R. & J. R. Creighton for castings.

Shildon Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting.

Halifax Tramways committee have accepted the tender of Legross & Knowles for a 32 H.P. motor tower waggon at £675.

Ebbw Vale Council have accepted the tender of the British Insulated & Helsby Cables for overhead electric light wires at £6,915.

Dover Town Council have accepted the tender of the Haste Pump Co. for condensing plant at £487.

Chester Corporation have accepted the tender of R. W. Blackwell & Co. at £11,955 for the extension of the city tramways to Boughton.

BUSINESS NOTICES.

We have received from Mr. G. M. Boddy, 18, Newington, Liverpool, a circular from which we extract the following:—

"Having traded at the above address for a considerable time under the style of Goossens, Pope & Co. and Pope's Electric Lamp Co., I beg to inform you that, having ceased to produce any of the goods formerly sold when trading under the names mentioned, I have now made improved arrangements for the production of new series of lamps of a much higher class, yet at most favourable prices, and that in future I shall trade at the same address under the name of G. M. Boddy & Co. All debts due to and owing by me under the late trade names will be received and paid by me as G. M. Boddy & Co."

We are asked to state that E. Goossens, Pope & Co. have made new arrangements with regard to their Liverpool depot, and have opened at 21, Manesty's-lane, Liverpool. Mr. G. M. Boddy (whose announcement appears above) is no longer connected with the company.

Dr. Max Breslauer has severed his connection with the British Electric Plant Co., Alloa, N.B., in order to settle in Berlin (40 Uhlandstrasse) as lecturer at the Technical University and as consulting engineer.

Messrs. A. Reyrolle & Co. wish it to be generally known that they still retain a shop in London, where they keep a stock of starters, &c., and where they are able to continue the general engineering business such as is required for repairs and sundry engineering jobs. This shop is situate very centrally at 8, Howland-mews, West Fitzroy-square, London, W.

Mr. Frank F. Evans, having resigned his appointment with Erith's Engineering Co., has joined the staff of the Underfeed Stoker Co. (Ltd.).

The Electrical Stampings Co., of Stour Works, Cradley Heath, write to inform us that Mr. Baxter has left their service.

John Yetton and Harry Marriott Gibb, electrical fittings makers, &c , 4, Carr-street, Limehouse, London, E., have dissolved partnership. Debts by Mr. Yetton, who continues.

The British Thomson-Houston Co. state that the prices contained in their price list No. 98 on DA motors are cancelled, and that a new price list will shortly be issued. Until then new prices will be supplied on application.

BANKRUPTCIES, LIQUIDATIONS, &c.

Fredk. Geo. Waters, electrician, 39, Park Cross-street, Leeds, has been adjudicated bankrupt. First meeting of creditors May 10 at 22, Park-row, Leeds; public examination May 22 at the County Court House, Leeds.

Samuel Hargreaves, electrical engineer, 2, Victoria-arcade, Buxton, has been adjudicated bankrupt. The first meeting of creditors will take place on May 8 and the public examination on May 9, at Vernon-street, Stockport.

In the bankruptcy of Robt. Boyd, electrician, Plas-y-Glyn, Caroline-street, Llandudno, the first meeting of creditors will take place on May 7 at Crypt-chambers, Eastgate-row, Chester, and the public examination on June 14 at the Magistrates' Room, Bangor.

Jas. M. Vaughan, electrical engineer, 2, Queen's-lane, Bristol, was examined last week. Debts, £561; assets, £86. Debtor commenced business five years ago, and attributed his failure to loss on a Welsh contract. Examination adjourned to 25th inst.

Power & Industrial Undertakings (Ltd.) is being wound up voluntarily. Mr. J. C. Gordon, 46, Gresham street, London, E.C., is liquidator.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. have received instructions to sell by auction towards the end of May, on the premises, the modern freehold motor works at 157A, Manor-street, Clapham, London, S.W., occupying an area of about 2,100 sq. yds., and shop floor area of about 20,000 sq. ft. The buildings are all brick built in one and two storeys, and comprise erecting, machine and painting shops, smithy, stores, offices, &c. The premises will be offered in one lot, after which will follow piecemeal in lots the sale of stock of new motors and parts, machinery, utensils, &c. Some particulars are set out in an advertisement, and further particulars and catalogues (gratis) will be supplied by Messrs. P. B. Peat & Co., C.A., 11, Ironmonger-lane, London, E.C.; Mr. J. Bransbury, solicitor, 7 and 8, Ironmonger-lane, London, E.C.; or by the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Plant for Sale.—Messrs. Richard Sizer (Ltd.), engineers, Hull, advertise for sale two Willans-E.C.C. combined electric power and lighting sets.

Liverpool Corporation electric supply department have for sale two Lancashire boilers, Worthington feed pump and feed-water heater, two w.-i. tanks, two Browett-Lindley and two Willans engines, direct coupled to Siemens dynamos. The plant may be viewed on application to the resident engineer, Highfield-street, Liverpool. See also an advertisement.

Some shop-soiled arc lamps and brackets, telephone instruments, and incandescent lamps are advertised for sale in another column.

Electric lighting plant (consisting of 7 B.H.P. Crossley gas engine, Parker dynamo, E.P.S. storage battery of 53 cells, switchboard, &c.) is advertised for sale in another column.

Premises to Let.—Messrs. R. D. & J. B. Fraser, Princes-street, Ipswich, advertise a spacious factory to let.

Workshops with private house, suitable for electricians and motor engineers, are advertised to be let.

Basement premises at 7, Finsbury square, London, E.C., are advertised to let.

Messrs. Hillier & Parker, 99, Regent-street, London, W., advertises to let part of small show-room and offices in the best part of the West End.

Electrical Winding Engines.—The International Electrical Engineering Co., Clun House, Surrey-street, London, W.C., have published in quarto form (Bulletin No. 27) the Paper read by L. Creplet, engineer to the company, before the Association of Engineers, Past Students of Liège University, describing the application of electricity to winding engines. The Paper describes very fully the design and construction of the special type of winding engines manufactured by the company, and diagrams of dimensions, &c , are shown. Some good illustrations of complete machines accompany the Paper, as well as numerous sectional diagrams.

Catalogues.—The "Hanby" watt-hour meter for alternating-current circuits is the subject of a well-illustrated pamphlet issued by the Union Electric Co., 151, Queen Victoria-street, London, E.C., and the accompanying illustrations show the meter as designed for mono- and poly-phase currents. These meters are made in two different sizes, which work upon the same principle, and register upon a dial the sum of electrical energy which has passed through a given circuit, whether the circuit is inductive or non-inductive, and independent of any phase displacement between current and voltage. The fundamental principle embodied is that of a split-phase motor without commutator. A simple metallic disc is placed in a rotating field created by a series and a shunt winding, so arranged that the torque is proportionate to the energy passing through the meter. Fig. 1 shows the hollow cast-iron plate looked at from the rear of the meter, and Fig. 2 the front of the base-plate with the disc rotating between the jaws of a seasoned permanent magnet, the base-plate effectively isolating any possible effect of the current-carrying parts from the permanent magnets, so that even in the event of a short circuit it is not in any way affected. Fig. 3 shows the face of the meter as erected.

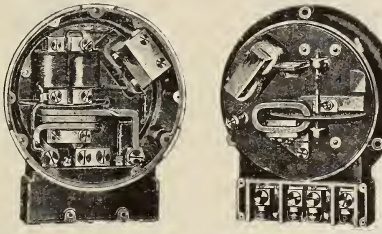


Fig. 1.—Back View, showing Electric and Magnetic Circuits.

Fig. 2.—Front View, with Counting Train removed.

The Union Co.'s "Hanby" Watt-Hour Meter.

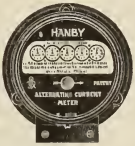
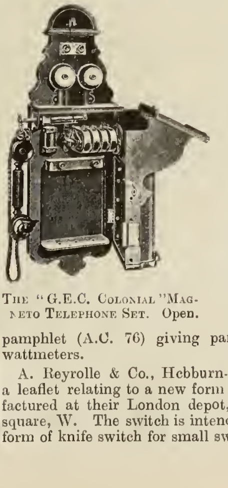


Fig. 3.—"Hanby" Meter, as Erected.

The April progress sheet of the General Electric Co. contains particulars of a number of items of interest to the trade. A new pattern of "Midget" wall plug (without cut-out) is shown, and improved patterns of the main cut-out for circuits up to 250 volts. The "Colonial" magneto telephone set for bridging work and long-distance lines, which has been specially designed for use in hot climates, is also illustrated, and we show in the accompanying figure this set, with it's interior fittings. It will be seen there is a four-magneto generator, and this is armature-wound to a resistance of 500 ohms. The automatic cut-out for short-circuiting the armature when in normal position is adjusted to ring through a resistance of 25,000 ohms. The set is fitted with an improved lightning arrester with mica insulation.



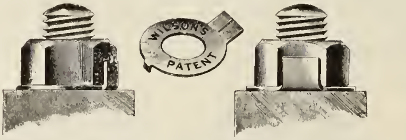
The "G.E.C. Colonial" Magneto Telephone Set. Open.

Elliott Bros., Century Works, Lewisham, S.E., have ready a pamphlet (A.C. 76) giving particulars and prices of type S.S. wattmeters.

A. Reyrolle & Co., Hebburn-on-Tyne and London, are issuing a leaflet relating to a new form of quick-break knife switch manufactured at their London depot, 8, Howland-mews, West Fitzroy-square, W. The switch is intended to meet the demand for a cheap form of knife switch for small switchboards.

Induction meters of the A.C.T. type for single and for polyphase alternating-current circuits are described and illustrated in pamphlet No. 194 just issued by the British Thomson-Houston Co. This meter has been designed for recording the energy of alternating-current circuits irrespective of the character of the loads, and great care has been taken in the design of the meter so that the calibration remains permanent even when the meter is subject to heavy momentary overloads or short-circuits.

The Positive Locking Washer Co. are issuing a sheet giving illustrated particulars and prices of a positive locking washer which is claimed to be the most efficient and economical method of positively securing bolt nuts and set screws where there is great vibration, and especially useful for motors, tramways, railways, &c. The device is shown in the accompanying figure.



Positive Locking Washer.

Messrs R. Easton & Son, Sumner-street, London, S.E., have forwarded a copy of their new catalogue of lifts and cranes, pavement flaps and lights, &c.

A new list of portable batteries, complete sets, and accessories for electric lighting for carriages, motor cars, motor omnibuses, &c., has been issued by Portable Accumulators (Ltd.). The list contains a number of illustrations from which we select the accompanying figures. There is also listed an electric telltale (for notifying electrically the extinction of the tail lamp), motor car inspection and hand lamps, &c. Special attention is called to the electric tell-tale device as shown in Fig. 3. This device, when used in conjunction with an accumulator and the electric tail-lamp shown in Fig. 2, instantaneously notifies the extinction of the latter by ringing an electric bell fixed to the dashboard. As the electric bell is actuated by a separate dry battery contained in the device itself and does not depend on the current supplied by the accumulator, the ringing of the alarm is assured, irrespective of the nature of the interruption of the circuit. The same company have a scheme for hiring out ignition batteries.

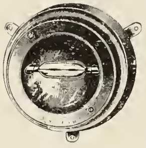


Fig. 1. — Interior Electric Lighting Lantern for Motor Vehicles.

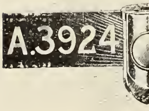


Fig. 2.—Electric Tail Lamp for Motor Vehicles.

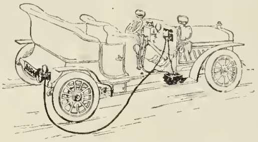


Fig. 3.—Electric Tell-tale for Indicating Extinction of Tail Lamp.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on April 25 to May 1, with the ports of destination :—

Africa—Alexandria, £220 (including £90 telegraph material); Axim, £47 (telegraph material); Cape Town, £143; Delagoa Bay, £515; Durban, £787 (including £189 telegraph material); East London, £27; Port Elizabeth, £261. *Argentina*—Buenos Ayres, £2,232 (including £826 telegraph material); Rosario, £430 (telegraph cable). *Australasia*—Brisbane, £45; Fremantle, £718; Hobart, £50; Melbourne, £548 (including £60 telegraph material); Otago, £21; Sydney, £1,053; Wellington, £293 (including £211 telegraph material). *Belgium*—Ostend, £2,249. *Borneo*—Labuan, £1,309; Sarawak, £19. *Burma*—Rangoon, £24. *Canada*—Montreal, £4,402; Toronto, £10. *Ceylon*—Colombo, £105. *Chili*—Autofagasta, £255 (telegraph material); Valparaiso, £231 (including £221 telegraph material). *China*—Shanghai, £1,177 (including £153 old telegraph wire); Tientsin, £28. *Holland*—Amsterdam, £186 (including £67 telegraph material). *Hong Kong*, £231. *India*—Bombay, £218 (including £87 telegraph material); Calcutta, £1,151 (including £95 telegraph material); Karachi, £51; Madras, £77. *Japan*—Yokohama, £1,973; Yokosuka, £148. *Madeira*, £17. *Malta*, £307 (including £245 telegraph material); *Mauritius*, £416 (including £16 telegraph material). *Mexico*—Coatzacoalcos, £6,945. *Philippines*—Manila £2,516 (telegraph material). *Portugal*—Lisbon, £13; Oporto, £87. *Russia*—Kurch, £1,653 (including £50 telegraph material); St. Petersburg, £20. *Spain*—Pasages, £17. *Straits Settlements*—Penang, £58; Singapore, £125. *U.S.A.*—New York, £786. *West Indies*—Trinidad, £76. Total £34,270, against £23,707 for 11 days last year (April 23 to May 3).

COMPANIES' MEETINGS AND REPORTS.

Great Northern Telegraph Co. (Ltd.)

At the meeting at Copenhagen on Saturday the chairman and managing director (Commodore E. Suenson, D.R.N.) said that the company's cables had not suffered so much from interruptions in 1905 as in the previous year. In Europe there had been 15 interruptions on nine cables, and in the Far East 13 interruptions on five cables, not counting the two cables between Wladiwostock and Nagasaki, which remained closed the whole year. After the ratification of the Portsmouth peace in October the company obtained permission to examine the condition of those cables and found both of them to be interrupted. Some of the breaks were repaired in December, but the year closed without their being able to repair some other breaks close to Wladiwostock. At last the "Pacific" succeeded on Jan. 14 in restoring one of the cables, and at the same time the Russian Government permitted them to re-open their station at Wladiwostock and to resume the direct service between Wladiwostock and Nagasaki, which had been suspended since Feb. 9, 1904. The repair of the other cable had, however, to be postponed till the spring, the approaches to Wladiwostock being ice-bound. In Europe their cable steamer "H. C. Orsted" has been 123 days on active service, 13 of which were for the account of others, whilst in the Far East the "Store Nordiske" and "Pacific" had been similarly occupied for 161 days, 62 of which were for the account of others. Owing to the interruption of the Wladiwostock cables, this route remained closed to all traffic between Europe and the Far East, but was, as in 1904, replaced by the Peking-Kiachta-Irkutsk route. This comparatively satisfactory state of affairs lasted till November, when the revolutionary movements in Russia, and the strike of the postal and telegraphic employés in Russia and Finland paralysed not only the service via Peking-Irkutsk and on the lines in Siberia, but also the working of the lines in European Russia, including the connections between the company's Libau and Nystad cable stations and the central station at St. Petersburg. The company's Danish staff had at all points taken no part in the mutiny of their Russian colleagues, but had stuck manfully to their posts.

During the war and the peace negotiations the traffic receipts remained at about the same figure as in the corresponding period of 1904, or even higher, but they naturally decreased considerably after the conclusion of peace and particularly during the revolutionary disturbances in Russia, which decrease is still manifest. The total receipts for the year had, nevertheless, not been affected, thanks to an increase in the proceeds from their participation in other telegraph undertakings, and also to a considerable increase under the headings "profit on exchange" and "sundries." The additional revenue had, however, been absorbed by an increase of expenditure and particularly by "salaries and wages," principally due to the continually increasing number of their staff and to the rise in the cost of living, especially in the Far East and in Russia on account of the abnormal conditions ruling in those countries for several years. The item "rates and taxes" had also risen considerably in consequence of the large recetpts in 1904 and of the new taxation laws in Denmark, which have imposed a heavy tax on limited liability companies. The financial result of the year had been about the same as that of the previous year. The board, therefore, proposed to pay a dividend for 1905 of 12½ per cent. (including 5 per cent. already paid), and the altogether exceptional bonus of 11½ per cent., or 24 per cent. in all, placing the same amounts as in 1904 to reserve and to dividend equalisation fund.

The contract for the cable to Iceland has been given to the Telegraph Construction & Maintenance Co., which company has laid several of the company's most important cables to their entire satisfaction. The cable will consist of two sections, one connecting Shetland Islands with Thorshavn, the principal place on the Faroe Islands, and the other from the latter point to Seydisfjord, a small town on the east coast of Iceland. The total length of these two cables will be about 600 nautical miles, including spare cable, and they will probably be laid in August. The station buildings and the necessary cable houses at the various landing places are under erection. The telegraph and telephone lines connecting Reykjavik, the capital of Iceland, on the west coast with Seydisfjord and intermediate towns, will be constructed by the Government of Iceland, and at their expense, the company contributing about £16,800 once and for all. This line has to be completed and opened by Oct. 1 next. During last year the directors continued the negotiations opened some years ago with various Governments for extending their concessions which are drawing more or less near expiry. The rupture of the union between Sweden and Norway, the political disturbances in the Far East, and the consequent changes in its political geography, together with the constant anxiety caused by the general situation in various directions—all these circumstances have not been favourable for such negotiations, and it is to be forseen that the consequences of the war will prove to be less beneficial to the company than the war itself. The company have obtained from the Swedish Government an extension of their concession similar to the one granted last year by the Danish Government. A German cable was laid and opened in 1905 from Shanghai (Woosung), connecting China with the island of Yap and with extensions to Guam and the Dutch Indies. These cables belong to the German-Dutch Telegraph Co., and quite lately (March and April of current year) the Commercial Pacific Cable Co. completed their system between America and Asia by laying a cable between Manila and Shanghai and another cable between Guam and Bonin Islands, which have at the same time been connected with the mainland of Japan by a cable belonging to the Japanese Government. The mouth of the Yangtze River and its narrow tributary, the Whangpoo, have now been crowded with submarine telegraph cables to such an extent that it will be extremely difficult to increase their number and still more difficult to repair those cables when breaks or faults occur. It is a proof of the great confidence which the owners of the numerous cables landing in China have in the Great Northern Company's cable steamers, their officers and electricians, that they have all made arrangements with them for the general repairing and maintenance of their cables.

AUCKLAND ELECTRIC TRAMWAYS (LTD.)—Mr. C. G. Tegetmeier stated at the meeting on Tuesday that the year's operations pointed to the continued progress and prosperity of the company. 1905 was the first year that they had had a full year's working of their system as at present constructed, and the traffic receipts were over £6,500 per route-mile. They had recently agreed to construct a further extension of about 3 miles, to be completed and opened for traffic within three years of obtaining powers. Capital expenditure now stood at £583,834, an increase during the year of £13,414. Their traffic receipts for the first three months of the present year were £1,310 in excess of those of the corresponding period of last year.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO. (LTD.)—At the meeting last week it was reported that the total revenue for 1905 was £8,709. 15s. and the expenditure £6,911. 14s. 6d. The profit was £1,798. Capital expended during the year was £1,399. 6s. 8d., making the total £66,780. 7s. 2d.

BRITISH ALUMINIUM CO. (LTD.)—At the meeting on Monday, Mr. J. D. Bonner said that, owing to the phenomenal drought in Scotland last summer the company's production was considerably reduced for four months, and during a third of that period their works were practically at a standstill. Fortunately they had a stock which carried them on for a time. In the autumn the demand increased and it became clear that in the interval before they could commence production at Loch Leven the maximum output they could hope to secure at Foyers would not suffice to satisfy their customers. They had lately been effecting sales at prices substantially higher than those ruling a year ago, but they had not been disposing of their production at anything like the high prices which were reported in the newspapers to have been recently paid for aluminium. However, they were doing very well, and before the next meeting they hoped to have a considerable increase in their production. To that end, and partially with a view to the requirements of Loch Leven later on, a large extension of their Larne works was well advanced. But the event to which they were now looking forward was the completion of their great power scheme at Loch Leven, which, he regretted to say, was still a long time off, as works of such a magnitude necessarily took a long time to carry out. The building of the dam was in itself a great task, for the structure was 80 ft. high, ½ mile long, and when completed the reservoir would contain more water than any other artificial lake in Europe. If they utilised the whole of that power in producing aluminium, they would be able to manufacture annually at Leven more than three times as much metal as they could produce at Foyers.

At a subsequent extraordinary meeting the capital was increased from £500,000 to £700,000.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units of electrical energy sold during 1905 was 3,548,229 compared with 2,760,457 for 1904. The gross revenue was £73,472, compared with £60,243. Working costs (including provision for renewals) were £38,871, compared with £30,744, and net revenue £33,720, compared with £29,499. The capital expenditure at Dec. 31 was £498,277, an increase of £73,774 on the year, including £31,614 on machinery and tools, £25,957 on mains, and £6,515 on meters. £5,477. 12s. has been expended in repairs and renewals, £628. 6s. 5d. has been written off, and the balance £31,590. 12s. 9d.) is carried forward as reserve for renewals. After deducting interim dividend, &c., there is an available balance of £24,983. 18s. 5d. The directors recommend a final dividend at the rate of 10½ per cent. for the half-year on the paid up share capital, making 8½ per cent. for the year. The new stations at Howrah and Ultadanga are approaching completion, and there is a prospect of satisfactory demands for current at both stations.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The directors report for 1905 states that the balance at credit of profit and loss is £79,095, added to the balance from 1904 (£23,406), making £102,501. Deducting interest (£13,500), preference dividend (£10,000), appropriation for depreciation of plant and machinery (£13,013) and for office furniture and wharf (£816), the available balance is £65,172. It is proposed to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum (10s. per share) and a bonus of 5s. per share, and carry forward £38,922. The profits during 1905 were £22,029 in excess of those of previous year, notwithstanding keen competition and unusual difficulties due to the exceptional position of the metal market. The state of trade throughout the country was (the report continues) on the whole, somewhat more satisfactory than during the previous year, and a larger business was done, especially in the closing months. The continued progress which was then looked for has not, however, been fully maintained, largely due to the high price of copper, and to the uncertainty in regard to legislation in Parliament affecting electricity supply. In spite of this, however, considerable contracts have already been secured. The company once again devoted much attention to developing its foreign trade, with the result that its operations in India have been further extended, and a large amount of important work has been carried out in that country. A new contract has been secured in Hong Kong, which is still in course of execution, and mains have been supplied for Dunedin, Fremantle and elsewhere in Australasia. Contracts have been secured for mains in Shanghai and in Rangoon. A contract for Bahia Blanca (Argentina) had been secured. Many important orders had been received from municipal undertakings, from private lighting and railway companies, and from power companies; and, generally speaking, the company's business has been consolidated and increased, and its position fully maintained during the year. The complete reorganisation of the Anchor Works has been carried out and the factory and business have been put into a satisfactory position, although, owing to the continued high price of rubber, and the consequent restricted state of the trade, the company has not yet reaped the benefit which it will eventually obtain from the investment. The control of the Anchor business, however, has already proved of the greatest service in many ways to the company.

CHELMSFORD ELECTRIC LIGHTING CO. (LTD.)—The net profit for 1905 was £3,817, compared with £3,869 in 1904. The connections to the mains at Dec. 31 were equivalent to 21,394 8 c.p. lamps, an increase of 1,832 lamps on the year. The directors propose to pay a dividend of 6 per cent.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—At the meeting on Friday Mr. Emile Garcke said the increase in capital expenditure shown in the report of £26,000 was due to the additional cars required on the electric lines and for additional plant at Yardley power house. Last year he told them they had nothing to fear from the competition of motor omnibuses on their electric and steam lines, but that motor omnibuses were capable of competing effectively with horse 'buses. That they had found to be the case, and after negotiations between the directors and the proprietors of the Motor Omnibus Co. an amalgamation was arranged, as the result of which a new company was formed to take over the motor omnibus undertaking, the horse omnibus undertaking of their own company, and the horse omnibus undertaking of the Birmingham & Midland Tramway Co. They were in negotiation with King's Norton Council for that portion of King's Norton and Moseley steam tramways within their district. The portion within the city would pass to the Corporation of Birmingham at the end of the year, and King's Norton Council had the right to purchase the remaining portion, and they were in negotiation with the view of facilitating the reconstruction of the line and equipping it for electric traction when the Corporation line would be ready for that system of traction. They were doing everything in their power to facilitate the electrical conversion, not only of the portion acquired by Birmingham Corporation, but of the portion within the area of the adjoining authorities. Municipalisation having been decided upon, there was no object in doing anything but to facilitate the conversion for the convenience of the public. He was sorry to say the working of the Aston lines had not been satisfactory, but there was no reason why it should not be a profitable undertaking. It was due almost entirely to delays caused by Aston Council in reconstruction and other matters. The company had entered into an agreement to work tramways to be constructed by Erdington Council, and also to carry out the electric lighting order. They were to pay interest and sinking fund charges upon capital expenditure incurred by Erdington Council, but when the plans were prepared they found that the Council proposed to do the work in a more costly manner than they thought necessary. The matter had been referred to arbitration, but the difficulty had not been disposed of. With regard to Handsworth, the arbitrator had fixed £11,700 as the purchase price to be paid by the Council for the lines within their area. The lease was not yet settled, and they were working the lines without.

COUNTY OF NORTHAMPTON ELECTRIC POWER & TRACTION CO. (LTD).—At the meeting on Monday the directors' report for 1905 stated that the capital expended during the year was £1,058. 9s. 10d., bringing the total to £20,872. 7s. 3d. The year's gross revenue was £1,845. 14s. 9d., and, after deducting expenses, the profit was £369. 7s. 2d. The installations connected to the mains at Dec. 31 represented the equivalent of 7,832 8 c.p. lamps, an addition of 2,279 during the year. During the year negotiations took place with the Council regarding the lighting of the streets after the present contract expires and also for taking over and working their dust destructor. The company submitted a tender, which was recommended for acceptance by the Electricity committee; but the gas company ultimately secured the street lighting, as they agreed to remove the dust destructor to the gas works.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—For the year ended March 31 the net profit was £4,945. 19s. 1d. The directors recommend a dividend of 4 per cent. on the ordinary shares. Business in the cable department continued satisfactory, and while prices of raw materials are still high, the directors are encouraged by the growing volume of their trade to anticipate a still more successful year for 1906.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.—The gross receipts for 1905 were £46,662. 12s. 10d., and expenditure was £34,330. 10s. 3d. The directors recommend that £2,100 be placed to reserve (sinking) fund, to pay a dividend of 5 per cent. on the ordinary shares (£5,000), to carry forward £506. 14s. 3d. Capital expenditure during the year was £8,619. 5s. 5d.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year to Dec. 31 last shows that the gross receipts amounted to £317,100. 1s. 3d., against £331,788. 0s. 8d. for the corresponding half-year of 1904. Working expenses, including £16,901. 1s. 5d. for maintenance of cables, absorb £135,597. 8s. 8d., against £150,034. 17s. 7d. for the corresponding period of 1904, leaving £181,502. 12s. 7d. From this is deducted £2,472. 0s. 6d. for income tax payable in England and donation to Queen's Unemployed Fund, and £15,048 for interest, leaving as net profit for the half-year £163,982. 12s. 1d. After adding £42,081. 5s. 10d. brought forward there is an available balance of £206,063. 17s. 11d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is proposed to distribute another of like amount on 10th inst (making a total dividend of 5 per cent). It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1905. £50,000 has been transferred to general reserve fund, and the balance of £21,063. 17s. 11d. is carried forward.

ELECTRIC TRACTION CO. OF HONG KONG (LTD.)—The profit for 1905 was £8,882, and after paying interest, the credit balance of £418 from ast year was reduced to £12. The ten new cars reached Hong Kong in August. Substantial progress has been made, and the directors anticipate greater progress in the current year. The report was adopted at the meeting on Wednesday.

GENERAL ELECTRIC POWER CO. (OF S. AFRICA).—At the last meeting the chairman (Mr. R. G. Fricker) said that the business of the company had increased considerably, and the directors had decided to enlarge the plant by ordering additional generators. Some of the plant had already been delivered and was being erected as quickly as possible, and the manager was sanguine that it would be in operation before the close of the year. The year's profit was £16,651, while £18,114 had been written off for depreciation.

JARROW & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The directors' report states that the capital expenditure to Dec. 31 last amounted to £15,853. 11s. 1d. The Board of Trade have granted a further extension of time for the completion of the light railways. Tenders have been let for the remainder of the permanent way construction and overhead equipment, and it is anticipated that the lines will be working by Midsummer. Advantageous terms have been arranged for supply of electric energy, and South Shields Corporation will consider the question of running powers as soon as the lines are working.

KALGOORLIE (W. AUSTRALIA) ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1905 were £53,512 and the total expenditure in London and Kalgoorlie £37,570, leaving a profit of £15,912. After lengthy negotiations, an arrangement has been arrived at with the Kalgoorlie Electric Lighting & Power Co. for a considerable reduction in the price of power. The rate formerly paid was 4d. per unit, and this has been reduced to 3½d. from June 1 to Dec. 31, 1905; to 3d. from Jan. 1 to March 31, 1906, and to 2¾d. per unit as from April 1, 1906, for five years, with an option to the company to continue at same rate for five years further. With power at 2¾d. per unit the profit at present rate of consumption of power will be increased by about £4,000 per annum. During the past year £10,655 has been expended on capital account, and the additions to equipment and construction have been of great value in facilitating the handling of traffic. The cars travelled 683,827 miles (against 609,389) and carried 3,301,989 passengers during the year (against 2,908,593 in 1904). Car bodies can now be built locally.

NORTH OF SCOTLAND ELECTRIC LIGHT & POWER CO. (LTD.)—The directors' report submitted to the meeting last week stated that the lamp connections in Montrose were equivalent to 17,542 8 c.p., in Brechin to 15,019, and in Inverness (where supply was commenced in May last) to 5,322, total 37,833 equivalent 8 c.p. lamps. The directors recommended a 2½ per cent. dividend. The report was adopted.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—At the meeting on Monday, Sir A. Colvin said the steady progress of the branches and subsidiary companies had been maintained. The work of reconstructing and cabling the company's system was well in hand.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—At the recent meeting the directors' report for 1905 stated that the total revenue for the year was £7,229. 10s. 8d., and the profit after deducting all expenses chargeable to revenue £835. 2s. 5d. Capital expenditure during the year was £300. 9s. 2d., bringing the total to £62,590. 17s. 7d. The parcels traffic has been successful in a small way, and steps were being taken to further develop this branch.

RIVER PLATE ELECTRICITY CO. (LTD.)—At the meeting on Monday it was reported that the net revenue for 1905, after providing for interest and writing off depreciations, was £11,878. 14s. 5d. The directors recommended that £4,000 be added to the contingency fund, that £867. 16s. 6d. be applied in liquidating expenses in connection with the acquisition of the Government's interest in the La Plata station, and that the balance, £4,276. 1s. 7d., be carried forward. The new station at La Plata is practically completed, and the improvements and extensions at Tucuman, referred to in last report, have been carried out. There has been a steady growth of business at La Plata, but the position and outlook at Tucuman are less satisfactory.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The profit for 1905 was £27,998, and, after deducting London expenses, there is a profit balance of £17,111. The amount required to meet the 5 per cent. guaranteed dividends on the issued capital is £24,702, and the required balance (£7,591) has been provided by Edmundsons' Electricity Corpn. under their contract.

WEST LONDON & PROVINCIAL ELECTRIC SUPPLY CO. (LTD.)—At an extraordinary meeting on Tuesday resolutions were confirmed by the shareholders that the arrears of dividend accumulated on the 6 per cent. preference shares should be capitalised by the issue of funding certificates of £5 or multiples thereof, carrying interest at 4½ per cent. to be cumulative as from July 1, 1906, such interest to be paid exclusively out of the surplus profits of the company after payment of the preference dividend of 6 per cent.

WESTON-SUPER-MARE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Capital expenditure during 1905 was £1,299. 12s. 8d., bringing the total to £109,023. 1s. 11d. The receipts of the electricity supply department were £3,169 and of the tramways £3,598. Deducting expenses (£1,319. 1s. 5d.) and adding £2,154. 18s 2d. from 1904, the total was £7,697. 5s. 10d. A dividend of 4 per cent. is declared on the ordinary shares. Electric supply connections during the year show an increase of 16 per cent. The directors hope to put in hand during the current year an important scheme of mains extensions and an addition to the station plant will also be necessary.

WOLVERHAMPTON & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The revenue for 1905 was £22,312. 12s. 1d. After deducting expenses the profit was £2,132. 19s. 6d. The available balance is £2,740. 1s. 11d. The directors recommend a dividend of 1¼ per cent. on the ordinary shares. The total capital expended amounts to £262,762. 4s 2d.

The arbitrator (Mr. H. Graham Harris) appointed to determine the price to be paid by Dudley Corporation for the tramways and light railways within the borough had fixed the price for the company's lines at £9,086. The Corporation are under agreement to grant a lease of those tramways to the company for 21 years from the date of purchase, on terms to be settled (failing agreement) by arbitration. The parcels and goods department inaugurated on Nov. 1 last has met with considerable success.

WREXHAM & DISTRICT ELECTRIC TRAMWAYS (LTD.)—The total revenue for 1905 amounted to £5,455 and expenditure to £4,123. Capital expenditure amounts to £57,235.

NEW COMPANIES.

MANCHESTER ELECTROBUS CO. (LTD.) (88,556.)—Reg. April 26, capital £100 in £1 shares, to adopt an agreement with the X Electric Accumulator Co. (Ltd.), and to carry on the business of motor omnibus and vehicle proprietors, jobmasters, contractors, carriers of passengers and goods, &c. The subscribers are G. W. Statham, G. H. Lloyd, M.E., E. L. Oppermann (electrical engineer), H. C. Lloyd, T. Jones, J. McCanna and C. N. Jolly.

BIRMINGHAM ELECTROBUS CO. (LTD.) (88,539.)—Reg. April 26, capital £100 in £1 shares, with objects and all other particulars as Manchester Electrobus Co. (Ltd.) (q.v.)

LANCASHIRE & YORKSHIRE ELECTROBUS CO. (LTD.) (88,547.)—Reg. April 26, capital £100 in £1 shares, with objects and all other particulars as Manchester Electrobus Co. (Ltd.) (q.v.)

LIVERPOOL ELECTROBUS CO. (LTD.) (88,548.)—Reg. April 20, capital £100 in £1 shares, with objects and all other particulars as Manchester Electrobus Co. (Ltd.) (q.v.)

LONDON ELECTROBUS CO. (LTD.)—This company, reg. April 11, with nominal capital of £100, increased its capital to £305,000 a few days later.

NOTTINGHAM ELECTROBUS CO. (LTD.) (88,549.)—Reg. April 26, capital £100 in £1 shares, with objects and all other particulars as Manchester Electrobus Co. (Ltd.) (q.v.)

PROVINCIAL ELECTROBUS CO. (LTD.) (88,552.)—Reg. April 26, capital £100 in £1 shares, with objects and all other particulars as Manchester Electrobus Co. (Ltd.) (q.v.)

TELEGRAPHONE CO. (LTD.) (88,531.)—Reg. April 25, capital £100,000 in £1 shares, to adopt an agreement with the Aktiesselskabet Telegraphonen Patent Poulsen, of Copenhagen, to acquire, prolong and renew certain patents and patent rights specified in such agreement, and to manufacture, or cause to be manufactured, sell, let on hire and deal in telegraphones and other instruments, mechanical appliances, &c. The subscribers are C. Hage (Copenhagen), Baron A. von Cramm, H. Snowdon (electrical engineer), G. W. Ollett, S. C. Lambert, R. F. Collinge and C. Hodges (electrical engineers). First directors to be appointed by subscribers. Reg. office, 28-9, St. Swithin's-lane, London, E.C.

CITY NOTES.

MEMORANDA (May 3).—Bank rate 4 per cent. (May 3, 1906). Price of silver 30$\frac{11}{16}$d. per oz. Consols 89¾—89⅞ for money, 90—90⅛ for account; 2½ per cent. annuities 88⅞—89⅛. Consols Pay Day, May 4, Stocks and Shares Continuation Days, May 9 and 29; Ticket Days, May 10 and 30; Pay Days, May 11 and 31; Mining Share Carry-over Day, May 8.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The numbers are given in an advertisement elsewhere of the fifteenth and final drawing of the 4 per cent. mortgage debenture bonds of this company, which have been drawn for payment at par on July 2 at Parr's Bank, Bartholomew-lane, London, E.C.

GLOBE TELEGRAPH & TRUST (LTD.)—The directors have declared a dividend of 5s. per share on the ordinary shares, making a total distribution of 5½ per cent. for the year, leaving £4,400 to be carried forward.

HUDSON & BOWRING (LTD.)—The directors have declared a dividend of 20 per cent. for 1905.

OSWESTRY ELECTRIC LIGHT CO. (LTD.).—A dividend of 4½ per cent. has been declared.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During April 972,000 units were generated, yielding £9,250 gross, against 871,000 units and £8,300 gross for the corresponding month of 1905.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—During the quarter ended Lady Day 2,682,815 units were sold, realising £21,000, against 2,457,880 units and £20,640 in the corresponding quarter of 1905.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted quotations to a further issue of 16,300 £1 fully-paid ordinary shares, 32,600 £1 fully-paid 7 per cent. cumulative preference shares and £51,708 first debenture stock of the *South Metropolitan Electric Light & Power Co. (Ltd.)*. The committee have been asked to appoint a special settling day in and grant quotations to 22,900 £5 fully paid 5½ per cent. cumulative preference shares and scrip (fully and partly paid) for £200,000 4½ per cent. first mortgage debenture stock of the *Manx Electric Railway Co. (Ltd.)*, and also to allow a further issue of 30,000 £5 fully paid ordinary and 20,000 £5 fully paid 5 per cent. cumulative preference shares of the *Urban Electric Supply Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate, No. of weeks.	Aggregate, Amount.	Aggregate, Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 28	1,235	+ 18	48	64,110	− 287
Airdrie	,, 20	225	+ 30	16	8,434	+ 578
Anglo-Argentine	,, 29	14,901	+ 1,368	17	254,590	+ 26,230
Ashton-under-Lyne Corp.	,, 21 ,, 29	983 14,901	+ 43 + 1,368	5	251,590	+ 26,230
Ayr Corporation	...	...	...	...	...	...
Baker St. & Waterloo Ry.	,, 29	1,404	...	7	10,475	...
Barnsley	,, 20	231	+ 70	16	2,529	+ 102
Barrow	,, 20	296	+ 29	16	8,413	+ 329
Bath Electric Trams, Ltd.	,, 25	634	− 144	17	11,617	+ 1,918
Birkenhead Corporation	,, 29	949	+ 101	17	17,317	+ 291
Birmingham Corporation	,, 28	570	+ 135	4	2,095	+ 483
***Birmingham & Mid.**	,, 20	1,853	− 7	16	22,146	− 5,849
Blackburn Corporation	,, 25	841	− 676	¶4	4,894	+ 499
Blackpool Corporation	,, 26	494	+ 1,432	3	3,638	+ 509
Blackpool and Fleetwood	,, 28	281	+ 5 3	17	4,601	+ 270
Blackp'l, St. Anne's & Lytham	,, 26	265	− 500	§25	4,964	+ 692
Bolton Corporation	,, 29	1,834	− 6	4	8,970	+ 424
Bournemouth Corporation	,, 25	1,563	− 14	†4	6,327	+ 2,086
Bradford Corporation	,, 28	3,952	− 1,577	4	18,618	+ 1,224
Brighton Corporation	,, 29	791	− 101	4	3,906	+ 14
Bristol Trams & Carriage	,, 27	4,533	+ 1,181	11	54,086	+ 3,070
Buenos Ayres & Belgrano	,, 29	3,571	+ 67	17	60,393	+ 4,563
Buenos Ayres Elec. Trms.	Mar. 31	1,420	+ 274	13	18,440	+ 4,063
Burnley Corporation	April 28	1,062	+ 35	4	5,031	+ 316
Burton Corporation	,, 29	272	− 84	§4	1,280	− 82
Bury Corporation	,, 22	953	...	3	3,286	...
Calcutta Tramways Co.	,, 28	R41,918	+ R6,980	17	R744,232	+ R76,708
Camborne-Redruth	,, 28	97	− 5	26	2,792	+ 64
Cardiff Corporation	,, 21	2,509	+ 352	3	6,302	+ 3
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 20	300	+ 253	16	1,045	+ 416
Central London Railway	,, 28	6,661	− 18	17	115,991	− 4,025
Chatham & Dist. Lt. Rys.	,, 26	559	− 242	†17	9,976	− 163
***City of Birm'gh'm Tram Co.**	,, 20	6,373	+ 722	16	83,052	− 2,833
City & South London Rly.	,, 29	2,749	− 59	17	49,408	+ 185
Colchester Corporation	,, 26	174	+ 83	37	7,099	− 1,376
Cork Electric Trams Co.	,, 26	432	− 77	17	7,090	+ 6
Derby Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 20	524	+ 37	16	6,678	− 241
Dover Corporation	,, 28	187	− 69	4	957	+ 84
Dublin & Lucan Railway	,, 27	97	− 68	§17	1,642	− 93
Dublin United	,, 27	4,818	+ 844	‡17	77,434	+ 1,806
Dudley—Stourbridge	,, 20	1,380	+ 599	16	12,501	+ 859
Dundee Corporation	,, 25	974	+ 148	§49	46,538	+ 4,898
East Ham Council	,, 28	804	− 126	4	3,876	+ 647
Exeter Corporation	,, 27	214	− 87	4	1,127	+ 128
Gateshead & Dist. Trams.	,, 20	1,071	+ 119	16	14,658	+ 867
Glasgow Corporation	,, 28	16,070	+ 280	48	786,227	+ 49,824
Glossop	,, 28	136	− 7	17	2,105	+ 211
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 20	346	+ 118	16	3,365	+ 263
Gt. Northern & City Rly.	,, 28	1,779	+ 67	17	80,682	+ 1,140
Greenock & Port Glasgow	,, 20	657	+ 85	16	9,362	+ 794
Halifax Corporation	,, 25	1,283	− 893	4	6,301	+ 330
Hartlepool Tramways	,, 20	358	+ 109	16	4,145	+ 339
Hastings Elec. Trams Co.	,, 26	643	...	17	7,516	...
Huddersfield	...	...	...	..	...	...
Hull Corporation	,, 28	2,036	− 218	4	8,960	− 138
Ilford Dist. Coun.	,, 28	425	− 121	4	2,094	+ 192
Ilkeston Dist. Council	,, 25	100	− 53	4	479	− 8
Ipswich Corporation	,, 28	318	− 171	4	1,670	+ 24
Isle of Thanet Co.	,, 28	379	− 240	29	8,475	− 689
Keighley Corporation	,, 26	122	− 74	43	6,010	...
Kidderminster & District	,, 20	208	+ 110	16	1,555	+ 97
Kilmarnock Corporation	,, 28	142	− 19	50	7,696	...
Kirkcaldy Corporation	,, 25	275	+ 2	8	1,697	− 2
Lanarkshire Trams Co.	,, 26	990	+ 138	†17	14,168	+ 3,237
Leamington	,, 20	264	+ 221	16	2, 61	+ 1,057
Leeds Corporation	,, 28	5,447	+ 1,517	4	24,947	+ 1,672
Leicester Corporation	,, 28	1,988	− 449	17	34,973	+ 3,599
Leith Corporation	..	..	..	..	..	..
Liverpool Overhead Rly.	,, 29	1,373	− 811	17	23,707	− 1,636
Liverpool Corporation	,, 21	11,365	+ 1,749	16	165,465	+ 6,211
***London County Council**	,, 21	28,998	+ 4,466	3	83,410	+ 7,535
London United	,, 27	5,553	+ 2,007	†17	88,890	+ 5,372
Lowestoft	,, 28	113	− 60	31	3,495	+ 144
Maidstone Corporation	,, 26	89	− 59	4	436	− 34
Manchester Corporation	,, 28	11,998	− 935	4	52,815	+ 2,963
Mersey Railway	,, 28	1,693	− 81	17	29,125	+ 1,565
Merthyr	,, 20	284	+ 73	16	2,927	+ 71
Metropolitan Dist. Railway	,, 29	7,746	+ 707	17	135,115	+ 7,500
***Metropolitan Elec. Trams**	,, 20	4,770	+ 2,380	16	47,591	+ 16,396
Middleton	,, 20	605	+ 263	16	4,898	+ 585
Nelson Corporation	,, 28	122	− 2	..	...	...
Newcastle-on-Tyne Corp.	,, 28	3,595	− 674	4	16,045	+ 619
Newport (Mon.)	,, 28	626	− 141	4	2,504	+ 159
Northampton Corporation	,, 27	368	− 202	4	1,647	+ 44
Oldham, Ashton & Hyde	,, 20	784	+ 172	16	8,443	+ 516
Oldham Corporation	,, 29	1,509	− 199	5	8,788	+ 858
Perth (N.B.) Corporation	,, 25	138	...	24	3,547	...
Perth (W.A.) Elec. Trams	,, 27	1,423	− 73	‡17	25,915	+ 1,235
Peterborough	,, 20	204	+ 71	16	1,688	+ 7
Pontypridd District Coun.	,, 28	142	− 15	4	758	− 48
Portsmouth Corporation	,, 28	1,545	− 811	4	7,782	+ 78
Potteries	,, 20	1,967	+ 283	16	27,667	+ 1,713
Preston Corporation	,, 25	639	− 84	...	...	...
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	,, 30	859	+ 277	4	4,298	+ 1,929
Rotherham Corporation	,, 26	405	− 172	4	1,852	+ 116
othesay	,, 20	332	+ 213	16	1,242	+ 401
Salford Corporation	,, 30	3,920	− 83	4	18,745	+ 163
Sheerness	,, 18	83	+ 23	16	781	− 108
Sheffield Corporation	,, 29	4,727	− 414	5	25,622	+ 1,563
Southampton Corporation	,, 25	825	− 166	†4	3,351	+ 174
Southend Corporation	,, 25	291	− 168	4	1,265	+ 84
Southport Tramways	,, 20	523	+ 254	16	4,066	+ 317
S. Staffordshire Trams.	,, 20	1,192	+ 5.9	16	12,595	+ 2,3 2

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days ¶ Plus 8 days. * Partly electrical

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Stalyb'dge, Hyde, &c., Jt. Bd.	..	...	...	...	...	...
Stockport Corporation	April 27	759	+ 72	4	3,778	+ 1,495
Sunderland Corpn.	,, 29	1,182	− 186	4	5,517	+ 424
Sunderland & District	,, 25	317	...	...	...	...
Swansea Trams	,, 20	1,054	+ 551	16	11,824	+ 4,430
Swindon Corporation	,, 18 ,, 25	273 163	+ 92 − 75	¶8	781	...
Taunton	,, 20	60	+ 13	16	664	+ 2
Tynemouth and District	,, 20	371	+ 173	16	2,891	+ 128
Tyneside Trams Co.	,, 25	352	− 367	17	6,432	+ 399
Wallasey District Council	,, 28	719	− 127	4	3,104	+ 196
Walsall Corporation	,, 30	445	− 121	15	8,307	+ 610
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 26	1,954	− 118	4	5,294	+ 3,998
Weston-super-Mare	,, 18	204	+ 141	16	658	+ 131
Wolverhampton Corpn.	,, 25	714	...	4	3,310	...
* **Wolverhampton District**	,, 20	684	+ 339	16	6,215	+ 795
* **Worcester**	,, 20	398	+ 100	16	3,875	− 231
Wrexham	,, 20	124	+ 2	16	1,532	− 1
Yorkshire W.R. Trams	,, 29	719	− 282	17	12,486	...
Yorkshire Woollen District	,, 20	1,266	+ 668	16	13,339	+ 4,5.7

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., May 2.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to May 2. Highest.	Business, Week to May 2. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shares	8¼–8¾	4 10 6	Ap, Oct	8⅝	9⅜
5	2/9	Do. 5½% Cum. Pref.	5⅞–6⅛	4 10 0	—	6 1/16	5 15/32
St.	6%	Do. Permanent 6% Deb. Stock	140 –143	4 3 9	—	—	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 –106	4 14 3	—	—	..
5	..	Brisbane Electric Trams. Invest Ord.	⅞–1⅛	..	..	1 1/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞–4⅛	6 1 4	—	4⅛	4 1/16
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts	93 –96	4 13 9	—	..	..
St.	6%	†British Columbia Elec. Rlwy. Def. Ord.	116 –119	5 2 2	—	117	..
St.	5%	Do. Pref. Ord. Stk	110 –113	4 8 4	—	110¼	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 –110	4 11 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	101%–103%	4 7 8	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 –106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3¼–3½	5 10 0	—	3 5/32	3⅜
5	3/0	Do. 6 per Cent. "A" Cm. Pref	5⅝–5⅞	5 2 6	—	5⅝	..
5	3/0	Do. "B"	5 –5½	5 7 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	106 –108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 –105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	101 –103	4 17 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	102 –106	5 4 3	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	103 –105	5 14 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	9 – 9½	4 4 0	—	9 3/32	..
5	2/6	Do. Nos. 105,001 to 137,610	8½–9	4 9 0	..	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 –108	4 3 8	—	..	..
1	0/6	Cape Electric Tram Shares	⅝–⅞	5 14 0	—	..	..
St.	5%	†Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 –102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 –97%	5 2 6	..	96½	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 –93	..	..	..	..
St.	..	Do. 6% "B" Ditto	83 – 88	..	..	86	..
1	..	Lisbon Elec. Trams Ord.	1½–1⅝	..	..	1 19/32	1 9/16
1	0/7½	Do. 6% Cum. Pref.	1⅛–1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 –103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	108 – 103	4 14 8	Ja, Jul	—	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 –104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 –108	4 12 6	..	—	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	145 – 148	..	..	145	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%–100%	5 0 0	..	99½	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾–5¼	5 14 6	..	.	.
5	8/4	Calcutta Elec. (1-80,000)	9⅛ 9⅝	4 5 4	—	9⅜	9¼
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 –52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 –96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½– 3	..	..	..	—
St.	5%	Do. 5% Debs.	88 –92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	8½–9½	..	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	95 –97	5 2 6	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	111 –114	5 5 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref. ex 7½d. on a/c of arrears	⅞ –1	6 0 0	—	15/16	..
1	1/0	Rand Electric	1¼–1⅜	—	—	—	..
1	..	River Plate Electricity Co. Ord.	⅜ ½	..	..	15/32	..
1	1/2¾	Do. 6% Non. Cum. Pref	15/16– 1 1/16	..	..	..	..
St.	5%	Do. 5% Deb. Stock	101 –103	4 17 0	..	.	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅜–5⅝	5 8 6	..	5½	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 –102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 –103	4 17 0	..	101⅜	101½

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 2.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to May 2. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 –12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	.	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 8 3	..	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	6⅛–6⅝	4 18 0	..	..	..
St.	4½%	† Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾–9¼	5 8 6	–	..	..
5	8/6	Do. 7 per Cent. Pref.	8¾–9¼	3 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 –105	3 16 3	–	4⅝	4¼
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 – 5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜– 4⅞	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –103	3 17 6	–	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 – 4½	5 0 0	–	..	..
5	2/3	Do. Do. (1903)	4 – 4½	5 0 0	–	–	..
5	3/9	Chelsea Electric Supply Ord.	5½– 5¾	5 6 0	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 –109	4 2 6	Jn, Dec	..	..
10	7/0	City of London Electric Lighting Ord.	10½–11	5 9 0	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 –14	4 5 6	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 8 0	..	..	..
5	4	County of Durham Elec. P.D. Ord. £3 pd.	8 1/32–8 1/16	3 19 1	April, Oct	..	..
5	5%	† Do. Do. 5% non cum. pref.	6⅛–6⅜	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8 –9	5 11 0	–	8 17/32	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–11¾	4 18 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 –112	4 0 4	..	109	..
St.	4½%	† Do. Second Deb. Stock Prov. Certs.	99 –101	4 9 0	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	6⅛–6⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	5 3/16	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 6	–	–	..
5	5/0	Hove Electric Lighting Ord.	8½–8¾	5 5 0	–	–	..
St.	4½%	† I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9½–10½	4 15 0	..	10 1/16	10
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
3	2/4½	London Electric Supply Ord.	2 –2½	4 0 0	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5 1/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 –101	3 19 2	Mr, Jn, S, D	..	..
5	10%	Metropolitan Electric Sup. Ord.	8½–9½	5 5 0	April, Oct	9¾	9 13/32
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 2 0	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –114	3 19 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 8	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 –103%	4 7 4	–	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞–11⅛	5 14 9	Feb, Aug	..	..
100	..	Do. 4½% Deb.	102 –103	4 7 10	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 3 11	Feb, Aug	7⅝	7 7/16
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6 –6⅛	4 2 5	Feb, Aug	6	..
100	4%	Do. 4% Mort. Deb. red. 1907	99½–100½	4 0 0	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	29/32–15/16	3 4 10	Mar, Aug	..	..
100	..	Do. 4½% Deb.	101 –102	..	Jan, July	–	–
10	9/0	Notting Hill Electric Ord.	13 –14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½–7	4 16 0	March	..	..
St.	4%	Do. 4% Deb. Stock	99 –101	3 19 0	–	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	9 –10	6 5 0	Feb, Aug	9⅝	..
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 –98	3 12 0	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼–2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 –80	5 0 0	–	..	..
5	4/0	South London Electric Supply Ord	3 – 3½	6 14 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾– ⅞	..	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1¼–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	4¼– 4¾	5 5 0	–	–	..
5	2/6	Do. 5% Cum. Pref.	4 15/16–5 1/16	4 14 0	–	5	..
St.	4½%	Do. 4½% 1 Mort. Deb.	102 –104	4 6 6	..	103	102
5	6/6	Westminster Elec. Sup. Ord.	9½–10½	6 4 0	Mar, Sept	9⅞	9⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16–5 9/16	4 10 0	..	5⅜	..
5	..	Do. Issued at 7/6 premium all paid	5 5/16–5 9/16	..	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	96 –98	4 2 0	..	96½	..
1	1/0	† Bath Elec. Trams Pref. Ord.	29/32–1 1/32	4 17 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 12 3	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 –103	4 7 3	..	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 –103	4 7 9	..	102¾	..
10	9½%	Bristol Tramways and Carriage Ord.	15½–15¾	5 15 2	Feb, Aug	..	–
10	4%	Do. Cum. Pref. (fully paid)	10 –10¼	3 18 0	..	..	–
St.	4%	Do. 4 per Cent. Debs.	103 –105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	6 –7	4 5 8	–	6¾	6 9/16
10	6/0	Do. 6 per Cent. Cum. Pref.	8⅞–9⅛	6 8 0	Feb, Aug	9 1/16	9
St.	5%	Do. 5 per Cent. Perpetual Debs	112 –115	4 10 0	..	113½	112½
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock	93 –95	4 14 9	..	96	94
St.	4%	Central London Ordinary Stock	91 –92	4 7 0	June, Dec	91¾	..
St.	4%	Do. 4 per Cent. Pref. Stock	100 –102	3 18 6	..	101½	..
St.	4%	Do. Deferred Stock	80 –83	4 16 6	..	82	–
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	94 –96	4 3 3	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	.	..
St.	1¾%	City and South London Rly. Con. Ord.	41 –43	4 7 0	Feb, Aug	41¾	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	115 –118	4 4 8	..	.	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	..	..
St.	4%	† Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	104¾	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	12¾–13¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½–15½	3 17 3	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾–4¼	9 8 4	..	4 1/32	–
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8 –9	4 8 11	–	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 –103	4 7 6	..	102¼	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 –12½	4 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	106½–107½	4 8 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2¼–2¾	9 8 6	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 –85	4 14 0	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16–8 13/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	.	..
10	5/0	London United Trams. 5% Cum. Pref.	9½–9¾	5 2 6	–	9⅝	9½
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 –99	4 1 0	–	97⅛	97
St.	..	Mersey Con. Ord. Stock	4 –6	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛– ¼	..	–	3/16	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	–	15/16	⅞
St.	4½%	Do. 4½% Deb. Stock	102 –104	4 6 6	–	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	8 –9	5 15 0	..	–	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8¾–9¼	9 7 6	Feb, Aug	–	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 –106	4 5 0	–	–	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 –96	5 4 0	–	..	..
..	5%	Underground Elec. Rys. Co. of London	97 – 99	5 1 0	..	97	..
St.	3½%	Waterloo and City Ord.	100 –103	3 3 0	June, Dec	100½	..
St.	4½%	Yorkshire W.R. El. Trs. Co. 4½% 1st Debs.	95 –97	4 13 0	..	98½	–

Shre.	Last Dividend	Name.	Price Wed., May 2.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 2. Highest	Lowest
	–	**ELECTRIC MANUFACTURING, &c.**					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½– ⅝	..	–	..	..
1	2/4½	Babcock & Wilcox Ord .. xd & bonus	3¾–4	5 0 0	..	3 31/32	3 27/32
1	7½d.	† Do. Pref	1½–1⅝	3 14 0	..	..	–
5	4/0	British Insulated & Helsby Cables Ord	6½–7	5 14 0	July, Feb	..	–
5	3/0	Do. 6 per Cent. Pref.	5¾–6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 –107	4 4 0	..	–	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞–2⅛	..	..	2 3/32	2
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 –85	4 14 0	..	81	..
2	1/0	Brush Electrical Engineering	⅝– ⅞	..	March	1¼	..
2	3/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	97½	97¼
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 –86	5 4 6	Jan, July	84½	..
5	5/0	Callender's Cable Con. Ord.	11 –12	4 3 4	Jan, July	11¼	10¾
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6	4 8 4	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½–110½	..	Nov, May	..	..
1	4½d.	Castner-Kellner Alkali Co.	1 1/16–1 3/16	5 1 6	..	1⅛	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	–	..	..
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	–	–	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 3 0	..	..	–
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 1/16–2 5/16	3 8 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%–99%	5 1 0	Jan, July	–	..
5	10/0	Dick, Kerr & Co. Ord	1¾–1⅞	5 8 0	Sept	–	..
5	3/0	Do. 6% Cum. Pref.	1 3/16–1 5/16	4 6 0	Sept	1 5/16	..
St.	4½%	Do. 4½% Deb. Stock	104 –107	4 5 0	..	–	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	–	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½–3	–	Feb, Aug	2 19/32	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 –88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	92	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾– 4¼	8 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5 – 5½	5 9 0	..	5⅝	5⅛
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 5 0	–	104	103
2	1/7½	Electric Construction Co.	1 9/16–1 13/16	9 6 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref	2 –2½	5 12 0	July	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 –92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅜– 9⅞	5 8 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 –98	4 1 6	–	..	–
5	10/0	Henley's Telegraph Works Ord.	12½–13½	5 11 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 1 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 –111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½–59½	..	..	59	58¾
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17 9/16	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	31/32	..
1	7½d.	† Do. 6% Cum. Pref.	⅞–1	6 0 0	–	31/32	15/16
St.	4½%	Do. 4½% Perp. Deb. Stock	98 –101	4 10 0	..	..	..
12	24/0	Telegraph Construction & Mainten'ce.	33 –35	5 2 6	Mar, July	34	–
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 –103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2½– 2⅝	5 14 3	..	2 9/16	2½
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1¼	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	116 – 119	4 4 0	–	116¼	..
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	105 –107	3 14 8	..	105½	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 –108	4 3 8	–	107¾	107
5	–	Willans and Robinson Ord.	1¾–2¼	–	Apr, Oct	–	–
5	–	Do. 6 per Cent. Cum. Pref.	3½– 4	–	Apr, Oct	..	–
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 –85	4 14 0	May Nov	80	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99 –102	3 18 0	Jan, July	..	..
10	–	Amazon Telegraph	3¾– 4¼	..	Jn, Dec	..	..
100	5%	Do. 5% Debs. (red.)	83 –88	..	..	84½	..
St.	15/0	Anglo-American	67 –69	4 15 1	F, My, Ag, N	68	67½
St.	30/0	Do. Preferred	114 –115	5 4 6	F, My, Ag, N	115⅜	114⅛
St.	10/0	Do. Deferred	22¾–23	..	F, My, Ag, N	23⅜	21 11/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	96½–97½	4 1 3	Jn, Ap, Jy, O	96⅝	96¼
10	5/0	† Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	9⅛	8¾
10	10/0	† Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent. Deb.	100%–103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable	15¼–15¾	4 5 0	Ja, Ap, Jy, O	15 9/16	15½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 –103	4 7 6	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	143 –146	4 16 10	Ja, Ap, Jy, O	145	143
St.	17/6	Do. 3½ per Cent. Pref. Stock	89 –91	3 17 6	Ja, Ap, Jy, O	90¾	89½
St.	4%	† Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 –108	3 14 0	May, Nov	107½	..
10	2/6	Eastern Extension	14½–15	4 13 6	Ja, Ap, Jy, O	14⅞	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 4	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 3	Feb, Aug	..	..
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	101	..
10	38 0	G. N. (of Copenhagen) Ex coupon 63	38 – 40	6 0 0	Jan, July	40	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 –103	4 7 3	June, Dec	..	..
25	52/6	Indo-European .... Ex all	56 –58	5 12 1	May, Nov	58¼	..
100	$1	Mackay Companies Common	63⅞–64⅜	3 2 0	Jan, July	–	..
100	4%	Do. Preference	72 13/16–73 11/16	5 9 0	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 –103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	–
[illegible]	–	West Coast of America	⅝– ¾	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100 –102	3 18 3	Jan, July	..	..
10	–	West India and Panama	⅝– ¾	..	May, Nov	23/32	–
10	6/0	Do. 6% 1st Pref.	8¼–8¾	6 6 8	May, Nov	8⅝	8½
10	–	Do. 6 per Cent. 2nd Pref.	6½–7½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14 –14½	4 17 6	Mr, Jn, O, D	14¼	14⅛
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –103	4 17 0	June, Dec	..	–
St.	4%	Do. 4% Deb. Stock (red.)	100 –103	3 18 6	..	102¾	..
		TELEPHONES					
–	..	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	96 –98	..	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 – 103	4 17 0	..	102½	..
5	8/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August	7 15/16	..
1	0/9⅜	‡ Monte Video Telephone Ord.	15/16–1 1/16	3 16 3	–	–	..
1	1/0	† Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	108 –110	5 9 0	–	110	108
St.	6%	Do. Def. Stock	108 –110	4 11 0	–	110½	108⅛
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	12 1/16	–
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–6½	4 11 0	Feb, Aug	6½	5 9/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	103¾	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 –105	3 16 3	–	104½	103½
1	0/7½	Oriental	1⅜–1½	4 0 0	April, Oct	1 5/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 7 0	–	–	..
St.	24/7⅔	Do. 4% Red. Deb. Stock	99 –101	3 19 0	..	100½	99¾
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 –106	4 4 9	..	..	–
5	3/0	United River Plate	7 –7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜–5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 –112	4 9 8	June, Dec	–	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾– 5¼	5 14 0	–	..	..
10	2/0	Globe Telegraph and Trust	11 –11½	4 16 0	Ja, Ap, Jy, O	11⅛	1
10	3/0	Do. 6 per Cent. Pref	14⅞–15⅛	3 19 0	Ja, Ap, Jy, O	14⅞	1
10	6%	† Submarine Cables Trust (Cert.)	126 –129	4 18 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE object aimed at in the method of preparing the electrodes of the X accumulator, described in another column, is a most laudable one. It becomes more and more generally recognised that the merits of a lead accumulator are determined not so much by obvious differences of design and mechanical construction as by variations, practically undetectable at sight, in the quality and structure of their active materials. Porosity is certainly one of the most vital of these properties, and any active materials which may offer a real and fundamental improvement in this respect must undoubtedly add correspondingly to the capabilities and value of the cell containing them. It would appear, however, that the method described in the specification of this battery in no way goes to the root of the difficulty. From the very earliest days the idea of mixing with the lead oxides other materials which enter into little or no combination with them, and are afterwards removed by solvent or electrolytic action, has been often exploited; indeed the very materials here employed, *i.e.*, hair and fibre, are amongst the oldest and best known. The only difference is that in this case a finer subdivision is considered essential. Experience has proved that porosity cannot really be very much increased by such means without unduly weakening the cohesion and conductivity of the active material, and a practically equivalent result is more easily obtained by making the plates thinner; but, apart from this, what is wanted is not to space further apart the grains of oxide from which the active material is prepared, but to open out and expand each of these individual particles so that there is a freer access of electrolyte to their component molecules, and this is a chemical problem which will never be solved by mechanical means. For these reasons we should not expect much improvement from the described process, but should rather ascribe such advances that the cells may be proved to embody as a measure of the skill and experience devoted to their manufacture in general.

MR. F. FERNIE contributes an interesting article this week on the causes of faults in cables on an ordinary three-wire continuous current network. The phenomenon of the osmotic effect on the negative wire has long been known, and was studied in connection with the famous explosions in St. Pancras and in Paris many years ago, when metallic sodium was found on the insulators of the negative main in the case of bare copper strip laid in conduit. The experiment which Mr. FERNIE describes to show the magnitude of the action is interesting, as is also his experience that it is preferable not even to remove the earth from the middle wire momentarily for testing purposes. On one point, however, we cannot agree with him. Although he gives good reasons for breaking the continuity of the lead of the cable at every joint, there are equally good reasons against it, and modern practice has shown that a continuity of lead sheath and armouring throughout the system are desirable. The only case in which this rule might be broken with impunity is when the lead-covering of the cable is insulated from earth at the services as well as elsewhere, but this introduces the possibility of additional faults occurring at places where this insulation has failed. With a well-bonded system there should be no faults due to electrolytic troubles; and a system that encourages localisation of faults on a network by feeling for a 220 volt shock is not to be encouraged, as there is a risk of pressing into service people who are not intent on localising the fault and object to 220 volt shocks.

DURING the cross-examination of witnesses for the London County Council Power Bill, it was suggested that it was a commercial impossibility to interconnect supply stations working at different frequencies so that an interchange of power could be made. A method of doing this, practised to some extent in America, forms the subject of an article on another page. This throws interesting light on the problem, and indicates the precautions to be taken for overcoming some of the difficulties which occur.

THE question of the tariff to be charged for electric lighting used directly for business or trade purposes in the daytime is a difficult one. The "process" engraver and photographer who uses arc lamps all day long has the same claim to be "put on the power rate" as any motor-user, and in some cases he is willingly supplied with current at the reduced charge. On the other hand, there may be cases in which this daylight load is very intermittent, and a consumer who switches arc lamps on to a lightly-loaded network for a few minutes at a time is not so welcome that a special low tariff would be charged for his benefit. We remember the disgust of the engineer in-chief of the Charing Cross, West End & City Electricity Supply Co. when he found that the motor load at the London Coliseum amounted to 150 kw. for 75 seconds twice a day. A correspondence on the subject has been carried on in the *Liverpool Post.* It appears that at Liverpool the process engravers and similar consumers are charged power rates on their undertaking to take a minimum number of units corresponding to 200 hours' supply at the recorded amperage of their lamps. Apparently, also, this modest load factor is not always attained, so that the grievance may not really be a serious one. Everything depends, however, on the sluggishness of the indicator employed to record the maximum demand.

◆

THE Bill of the St. Pancras Metropolitan Council which is now going through Parliament as an unopposed measure is of interest in that it relieves the Council of the obligation of sec. 71 of their Electric Lighting Order of 1883 (corresponding to sec. 81 of the Electric Lighting (Clauses) Act of 1899), in which it is specifically stated that the owner of an electrical generating station for public supply purposes is in no way exonerated from any proceedings for "nuisance." We believe this is the first instance in which an existing undertaking has asked to be absolved from this clause, although there are one or two other Bills in Parliament this year asking for the same relief. We certainly recommend others to follow this course, especially in view of the experience of St. Pancras, which has had to pay a large sum in order to purchase surrounding property, whose owners alleged nuisance and claimed compensation for vibration from the electricity works. The need for such Bills as that of the St. Pancras Borough Council this year would have been obviated had the Supply of Electricity Bill, introduced on so many occasions, been passed. As, however, there seems little hope of this or a similar measure being introduced, at any rate this Session, we can only recommend other electric lighting authorities working under Provisional Orders, where the circumstances point to the possibility of an action for nuisance or threat of an injunction in the future, to proceed independently.

◆

THE celebrated action, Attorney-General v. Melbourne Corporation, in which the former (at the instigation of the Metropolitan Gas Co., Ltd.) imputed the legality of the maximum demand tariff of the Melbourne Electric Light Department, has at last resulted in a verdict for the Corporation. It will be remembered that the finding of the Victorian Courts was that the differential charging under the Wright system was illegal, and an injunction was granted against the Melbourne Corporation. As a result of an appeal to the Federal High Court this decision has been reversed. In giving his decision, the Chief Justice said that though the wording of the Act allowed of two interpretations, he considered that the evident intention was that all customers should be placed on an equal footing and have equal privileges, without preference being shown to particular individuals, and not that absolutely the same charge must be made to every customer irrespective of the conditions under which he took a supply; and consequently the Corporation's differential tariff, offered equally to all customers, was in no way contrary to the Act. The same would probably be the result of a trial action in this country if a question as to the legality of the maximum demand system of charging were raised; but it is less certain that an endorsement would be given to the contention of many engineers to the effect that different tariffs and discounts may legally be applied to practically every consumer, as no two are being supplied "under similar circumstances." Although these words, occurring in the Electric Lighting Act of 1882 are certainly somewhat indefinite, we doubt whether the wide interpretation sometimes put upon them is justifiable.

◆

SINCE the electricity works of the Willesden Urban District Council were sold to the North Metropolitan Electric Power Supply Co. there has been no case of the transfer of municipal electricity works to a company. Agreements were arrived at in one or two cases last year in the event of the Administrative County of London Power Bill being passed, but of course they fell through when the measure failed to pass the House of Commons. This week, however, as will be seen in our Parliamentary columns, the Whitehaven Corporation have agreed to sell their electricity works to the Cumberland Electricity & Power Gas Co. In this connection, attention may be drawn to an announcement in our advertisement columns to the effect that the Tynemouth Corporation desire to sell a 600 kw. generating set, just built for them and not yet delivered, as they have made arrangements to take a supply in bulk from the Newcastle-on-Tyne Electricity Supply Co. Arrangements for this supply have not actually been concluded, but we believe that, at any rate for the present, it will not be for the whole of their load but only a portion of it.

◆

Dundee, Broughty Ferry, and District Tramways.—We omitted to state in the description in our last issue of the above tramways that the contractors for the whole of the construction and equipment were Messrs. J. G. White & Co., of London.

Students' Section of the Institution.—We are asked to announce that the visit of the Students of the Institution of Electrical Engineers to the Greenwich generating station of the London County Council which was arranged for Saturday the 19th inst., has been postponed.

The Birmingham Local Section of the Institution of Electrical Engineers.—At the annual general meeting of Birmingham Section of the Institution of Electrical Engineers on Wednesday, a presentation, consisting of a case of drawing instruments and a silver match-box, was made to Dr. D. K. Morris, who is retiring from the local secretaryship after seven years' service, and whose place is being taken by Mr. H. B. Matthews.

The South Kensington Colleges.—We have reason to believe that the Government have in preparation a scheme giving effect to the recommendations of Mr. Haldane's Committee with regard to the establishment of a college for higher technical education, in which the two existing colleges at South Kensington would be absorbed and extended.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	..	—
Jamaica—Colon	Jan. 10, 1905	..	May 5, 1906
Tangier—Cadiz	Feb. 17, 1906	..	—
Paramaribo—Cayenne	April 20, 1906	..	—
Sydney—Nelson	April 26, 1906	..	—

Société Internationale des Electriciens.—At the annual general meeting of this society last month in Paris M. Leblanc succeeded M. Bouty as president, and M. Becquerel was elected president for the year 1907-8. The April number of the Society's *Bulletin*, in which this is recorded, also contains Papers by M. de Marchena on "The Limiting Pressures for Armoured Cables," by M. Pillier on "Some New Thermo-electric Pyrometers," and by M. de Recklinghausen on "The Single-phase Cooper-Hewitt Lamp." It also contains a list of the new council elected at the meeting.

Top Covers.—The Tramways committee of Burton-on-Trent lately decided to extend the number of their cars fitted with top deck covers from three to six, and the Board of Trade were approached with a view to obtaining their approval of the installation, as the track gauge is 3 ft. 6 in. After some correspondence on the consideration of the curves and gradients on the route, the Board have intimated their approval of the use of covers, with the stipulation that the cars are withdrawn from service on any exposed section of the tramways on days when owing to high winds the risk of the cars being blown over may be anticipated.

Electric Power Rates in Canada.—According to the *Birmingham Daily Post*, the Ontario Provincial Government is about to appoint a Commission to deal with the electric light and power meters and to discuss the advisability of fixing the rates charged for light, heat and power by the private companies. The Commission will have power, if the circumstances warrant it, to expropriate the business of the companies or develop the electric industries with the companies and the municipalities working conjointly. The Commission has been made necessary by the public demand for cheaper and more efficient services on a comprehensive plan for the supply of the various municipalities of the province.

Wireless Telegraph Notes.—A telegram from the Italian Minister of Marine to Mr. Marconi last week announced that the Royal Naval Marconi station at the Milan Exhibition was opened in presence of the King and Queen of Italy, and that wireless telegraphic communication had been successfully established with Venice.

The Chinese Government have arranged to establish several stations throughout China for experiment with Marconi's system of wireless telegraphy and instruct Chinese operators in working it. The apparatus has been installed on four Chinese men-of-war at Shanghai and at the three north China cities of Tientsin, Peking and Paotingfu, the radius of action being about 230 km. and the cost about 25,000 taels.

The *Review of the River Plate* reports that five wireless stations, each with a radius about 1,000 km., are to be established in the far south at Cape Virgenes, States Island, Rio Grande, Ushuaia and Cape Pico.

Mr. Buxton, the Postmaster-General, is reported to have said at a dinner on Wednesday night that the forthcoming International Congress on Wireless Telegraphy would deal with the question of wireless Press messages.

Electric Winding.—Last week's *Elektrotechnische Zeitschrift* contains an abstract of a Paper recently read before the Hanover Electrotechniker Verein by Mr. Horn, the chief engineer of the Clausthal Iron Mines, in which the author gave an interesting account of the results from an electric winding engine installed at the Ottilia shaft. The depth of the shaft is about 630 yds.; weight of cage, &c., 22 cwt.; weight of ore per lift, 25 cwt.; speed of winding, 33 ft. per second; average load on generators, 150 kw.; gas-driven power station, shift per day, 9½ hours; number of winds per day, 121. The continuous-current winding motor of 450 H.P. normal rating is started by means of a starting motor generator on the Ward Leonard principle, but instead of the flywheel of the Ilgner system, electrical storage of energy is provided by a small battery and reversible booster. This battery has a capacity of 220 ampere-hours, and the booster voltage varies from 0 to 50 volts. The voltage on the winding motor is gradually raised from 0 to 500 volts. The usual tell-tale apparatus with automatic stops to throw in the brakes and to cut off the current is also provided. It was pointed out by the author that the advantage of a battery over an Ilgner flywheel are that the losses are much less during long stops, and that extra winds at night can be effected from the battery alone. In one day of 9½ hours 350 tons of ore were wound from 630 yds. The power required, measured at the power station 'bus bars, was 1,360 units, or 1·9 units per useful horse-power hour on the rope. Per unit generated, the gas engines and producers required 1·2 lb. of anthracite coal, or only 2·35 lb. per useful horse-power hour on the rope.

Leeds Local Section of the Institution.—The annual general meeting of the Leeds Local Section of the Institution of Electrical Engineers was held on April 19th, when the following Council were elected for the session 1906-7:

Chairman: George Wilkinson. *Past-Chairmen:* H. Dickinson, W. Emmott, A. B. Mountain. *Vice-Chairman:* G. D. A. Parr. *Committee:* Wilson Hartnell, W. M. Rogerson, P. Rosling, S. D. Schofield, W. B. Woodhouse, H. E. Yerbury, G. M. Carr, A. S. Blackman, T. H. Churton, J. M. Smyth, J. D. Bailie, H. H. Wright. *Hon. Secretary:* Mr. G. R. Blackburn.

The membership now stands at 240. On March 29th the third annual dinner was held, representatives from the parent Institution and from other Local Sections being present. A representative committee has been appointed and a strongly supported local fund has been started to provide for the entertainment of the foreign delegates who will visit Leeds on July 6th and 7th. The City Council is entertaining the delegates to luncheon on July 6th and a conversazione is to be held on that evening at the Leeds University. On Saturday, July 7th, the delegates will be taken to Fountains Abbey and Studley Royal.

Royal Institution.—The annual meeting of the members of the Royal Institution was held last week, the Duke of Northumberland, K.G., in the chair. The annual report of the committee of visitors for the year 1905, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the report on the Davy Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read.

Forty-five new members were elected in 1905. Sixty-three lectures and 19 evening discourses were delivered during the year. The books and pamphlets presented amounted to about 254 volumes, making, with 697 volumes (including periodicals bound) purchased by the managers, a total of 951 volumes added to the library in the year. Thanks were voted to the president, treasurer and the honorary secretary, to the committees of managers and visitors and to the professors for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year:—

President: The Duke of Northumberland. *Treasurer:* Sir James Crichton-Browne. *Secretary:* Sir William Crookes. *Managers:* Sir William de W. Abney, the Right Hon. Lord Alverstone, the Right Hon. Earl Cathcart, Dr. A. H. Church, Dr. F. Elgar, Dr. D. W. C. Hood, Mr. M. Horner, Sir William Huggins, the Right Hon. Lord Kelvin, Mr. H. F. Makins, Dr. Ludwig Mond, Sir R. Douglas Powell, Bart., the Right Hon. Lord Sanderson, Mr. Alexander Siemens, and the Right Hon. Sir James Stirling. *Visitors:* Dr. J. Mitchell Bruce, Mr. Dugald Clerk, Sir John George Craggs, Mr. H. Cunynghame, Mr. G. F. Deacon, Mr. E. Dent, Rev. J. H. Ellis, Mr. R. K. Gray, Mr. C. E. Groves, Mr. F. G. Henriques, Mr. A. C. Ionides, Mr. C. E. Melchers, Mr. E. R. Merton, Mr. H. Swithinbank and Mr. G. P. Willoughby.

At a general monthly meeting of the members of the Royal Institution on Monday it was announced that His Grace the Duke of Northumberland, K.G., the president, had nominated the following vice-presidents for the ensuing year: The Right Hon. Lord Alverstone, G.C.M.G., Sir William Huggins, O.M., K.C.B., the Right Hon. Lord Kelvin, O.M., G.C.V.O., Dr. Ludwig Mond, the Right Hon. Lord Sanderson, G.C.B., K.C.M.G., the Right Hon. Sir James Stirling, Sir James Crichton-Browne (treasurer), and Sir William Crookes (honorary secretary).

Royal Society Conversazione.—This annual gathering took place on Wednesday evening, and was well attended. There were as usual some 50 exhibits, but not many of the electrical ones were of outstanding importance or of striking novelty. Prof. S. P. Thompson gave an interesting lecturette on the electrical production of nitrates from the atmosphere, the subject of his recent Royal Institution lecture. The Lodge-Muirhead Syndicate showed a portable pack-transport set of wireless telegraphy apparatus for military field purposes, capable of working 50 miles over land or up to 150 miles over sea. The whole was very compact, leaving out of account the air-wire system, a quality largely due to the employment of Lodge's vacuum-tube valves to accumulate the impulses of a small coil and battery. Mr. L. H. Walter showed a new magnetic detector, in which the electrical oscillations to be detected are made to act on only one armature of a small differential dynamo. It was arranged so that alternating currents for telephonic reception and continuous currents for recording, could be used simultaneously. Mr. Duddell exhibited his apparatus for demonstrating the movements of telephone diaphragms when speech is being transmitted, and the effects on speech of line capacity and inductance. Mr. K. J. Tarrent displayed a series of photographs of electrical discharges at ordinary and at low pressures. Dr. P. E. Shaw demonstrated his application of electric touch to the examination of end standards of length. Mr. Rivers showed his new electric heater; its "elements" are made of silicated carbon on a terra-cotta base, and, as shown, it was taking 3·5 amperes at 200 volts, sufficient, it was said, to warm a room 12 ft. by 12 ft. by 10 ft. The National Physical Laboratory had on view a number of very interesting photomicrographs and a specimen of the Picou permeameter.

Franklin Bicentenary.–Benjamin Franklin, America's greatest man of science, was born on January 17, 1706, and died on April 17, 1790. Although the 200th anniversary of his birth was celebrated by a number of societies last January, other American societies postponed the celebrations till April 17th. Among the latter was the American Philosophical Society, which arranged and carried out celebrations on a large scale at Philadelphia, the city where Franklin lived and laboured. At New York the Magnetic Club gave a dinner in celebration of the occasion. The current issue of the *Journal* of the Franklin Institute contains the first part of an address on "Franklin as a Man of Science and an Inventor," delivered by Dr. Edwin J. Houston, Emeritus Professor of Physics, Franklin Institute, on February 21, 1906, on the occasion of the birth of Benjamin Franklin. Franklin was a many-sided and self-educated man, a utilitarian, and an apostle of thrift, and the enormous amount of work which he accomplished testified to his thorough appreciation of the value of time. Franklin's first interest in the subject of electricity appears to have been excited in 1746 during a lecture on electricity by a Dr. Spence in Boston. At that time Franklin had formed a literary club called the Junto, where simple experiments were occasionally performed for illustrating the subject under discussion. Consequently, when Franklin received, in the early part of 1747, from his friend, Peter Collinson, of London, an "electric tube" for the production of electricity by friction, not only were many experiments inaugurated before the Junto, but an extended series of investigations were made by Franklin that resulted in obtaining for him a world wide reputation as an experimental philosopher. In a series of letters to his London friend Franklin described many novel experiments and propounded his single-fluid theory. In 1749 he had already made up his mind that lightning was nothing else than an electric discharge on a large scale, and he proposed to verify this experimentally. But it was not until the summer of 1752 that the familiar kite experiments, which placed Franklin's supposition beyond doubt, were carried out at Philadelphia.

Removal of Manufacturing Works from London.—At a meeting of the London Chamber of Commerce on Friday, April 27, a lecture was given by Mr. Walter Hazell on "The Advantages and Disadvantages of the Removal of Works from London to the Country." Mr. Hazell is a partner in the firm of Hazell, Watson & Viney, printers, and his lecture was based mainly on the experience which he gained in connection with the removal, some years ago, of the main portion of their works to Aylesbury. The obvious advantage of cheaper land, lower rates, &c., from the employer's point of view, and the cheaper and better living conditions of the employés were detailed, and although wages were 20 per cent. lower he had found that the employés in a works removed to the country were better off than when in London. Such a removal from London usually entailed an increase of administration expenses through the necessity of maintaining a department in London, but in this connection the telephone was working a revolution, and the distance between the works and the London department would be but little felt in the future. Apart from this the whole of the lecture was devoted to the social side of the problem, the question of wages, housing accommodation, &c., being discussed in some detail. Mr. Hazell advocated a large extension of the methods adopted by Messrs Lever Bros. at Port Sunlight, and Messrs. Cadbury at Bournville, amongst the 200 villages and towns around London, where exceptional facilities for the removal of works were available. Reference was also made to the success which had been attained by such engineering firms as W. H. Allen, Son & Co., Siemens Bros. & Co., Ransomes, Sims & Jefferies, and Willans & Robinson on removing their factories from the London district. During the discussion which followed, the hope was expressed that the inquiry into canal traffic and that a continuation of the development of motor traction would cheapen existing methods of transport. A warning was also uttered against the acceptance of the principle that any class of works could be removed. It was pointed out that many businesses, by their nature, could not leave London.

The "National Telephone Journal."—The May number of the *National Telephone Journal* quite comes up to the standard set by the first issue and even surpasses it. It commences with the first part of a Paper on the "Study of Telephonic Speech Transmission," read by Mr. B. S. Cohen before the Liverpool Telephone Society. This Paper commences with a review of the theory of the speech transmission, and then proceeds to give an account of some of the work done in a laboratory equipped by the National Telephone Co. for making investigations on the subject of transmission. It will be a valuable contribution to the subject. An article in lighter vein on "Telephony in the Isle of Man," by Mr. G. Gillmore, follows, and Mr. H. J. Maclure writes in a business-like way on the method of canvassing private subscribers. The latter gentleman warns the canvasser against making the slightest deviation from the truth, and explains to him exactly how far he may go and what are the excusable sins of omission in putting the facts before his prospective subscriber. He concludes with an American anecdote of the man for whom "Mr. Brown" wanted a job:—

> The telephone manager expressed his willingness to oblige if possible, and asked Mr. Brown if his *protégé* had any technical knowledge of outside work. "No." "Of inside work?" "No." "Of telephone work at all?" Mr. Brown feared not; in fact, he did not think the man had ever seen a telephone instrument; but, he added, "he is a thorough liar." This at once aroused the interest of the manager, who said, "Ah! Is he one of those liars whom it is impossible to find out?" "Yes," said Brown. "Then," said the Bell representative, "we will make him a contract agent." "Oh," added Mr. Brown, "and if that is any sort of a recommendation, I never met a man who could shift so much beer." "Ah," said the manager, with a sigh, "then we must make him a wayleave officer."

Among other articles of interest we may mention the conclusion of Messrs. Anderson and Thyne's contribution on "Staff Organisation," "The Elements of a Good Service," by H. J. Corner, which contains a useful table of traffic observation tests in London, and a description of the method of carrying a telephone cable over the Widnes-Runcorn transporter bridge. Among the miscellaneous notes, we quote the following one on the derivation of the call "Hallo" reprinted from the *Morning Leader*:—

> L'appel téléphonique allô! n'est pas d'origine britannique, bien que nous l'ayons emprunté aux Anglais. Allô! est de source française et bien française. Il vient de l'exclamation "au loup!" qui épouvantait les enfants au temps où il y avait encore des loups dans nos forêts. Et comme il y en avait beaucoup au douzième siècle, lorsque Guillaume le Conquérant devint roi d'Angleterre, les Normands apprirent aux Anglais à crier au loup! cri qu'ils répétèrent en l'estropiant. De au loup! ils ont

fait d'abord alloup ! puis allô ! Ces déviations de prononciation ne sont pas pour surprendre dans une langue où le nom très français de Beauchamp que porte un comte anglais est prononcé Bitchamme ! Nous avons été plus galants : nous leur avons repris leur allô ! sans lui infliger aucune torture.

Electricity and Tank Experiments.—According to *Engineering*, a ship-model experimental tank with an electrically-driven towing carriage has been in use at the works of Messrs. John Brown & Co. (Ltd.) at Clydebank for some time. The waterway extends for 445 ft., of which 400 ft. is deep, varying from 9 ft. at the north end to 10 ft. at the south end. This fall of 1 ft. is gradual, and is for the purpose of drainage when emptying. The breadth is uniformly 20 ft. At the north end there are wet and dry docks ; of the wet docks, one is for storing models, and the other, placed between the dry docks, is used for loading and trimming purposes. The towing-truck can be run over the central dry dock, and the dynamometer and propeller gears examined from it ; the latter must be raised to clear the dock-sill. At the south end there is a sloping beach, 25 ft. long, to assist in breaking up the waves formed by the passage of a model through the water. A recess, however, is left up the middle, to prevent screws or models being run aground. The basin, which is rectangular in cross-section, is formed of concrete, with expanded metal and puddled clay backing. The towing-truck is built of light wood boxing, so as to secure the maximum stiffness for weight. This is, as yet, the only electrically-driven tank carriage in this country. Current is supplied from one of the yard power-stations, but as it would be too irregular if applied direct, it is passed through a motor-generator into accumulators, from which it is again discharged through the motor-generator at a suitable and regular voltage, and delivered to the tank. Two 6 B.H.P. motors drive the carriage, and from shafts connected to the wheel cord leads are taken to rotate the resistance record drums and trim cylinders on the main truck, and to drive the screw-propellers and rotate the record-drum on the screw-truck. Automatic cut-offs for the motive power are fitted on the top of the carriage, being operated by fixed strikers on the roof-beams, one near each end of the tank. When these strikers engage the triggers, the driving current is cut off and the electrical brakes are put on.

Agreement between the Marconi Company and the Post Office.—The agreement entered into between the Postmaster-General and the Marconi Wireless Telegraph Co. and the Marconi International Marine Communication Co., and dated August 11, 1904, has been issued as a Parliamentary paper this week. The first two clauses indicate the scope of the agreement, and we give them in full :—

1. During a period of 15 years from the date of these heads of agreement the Postmaster-General will grant, subject to the conditions hereinafter specified, facilities for the collection, transmission and delivery in the United Kingdom of messages to and from places in Newfoundland and North America exchanged between the United Kingdom and Newfoundland and North America by means of the Marconi wireless telegraph apparatus, such apparatus to be installed at Poldhu, Cornwall, and such other stations in the United Kingdom as shall be agreed upon between the companies and the Postmaster-General, and such facilities to be substantially the same as are granted to the submarine cable companies in relation to similar messages.

Corresponding facilities for messages exchanged between the United Kingdom and other countries or places will be granted during the same period in relation to such countries or places and in relation to such stations in the United Kingdom as may from time to time be agreed upon between the companies and the Postmaster-General.

Provided that (*a*) the Postmaster-General will not grant any such facilities as are mentioned in this sub-clause, unless he is satisfied that the companies are in a position to transmit and receive with reasonable certainty and reasonable speed the messages for which the facilities are required, and to secure the delivery of outward messages at their destination.

(*b*) The Postmaster-General will not, except in the case of Italy, which shall be open to consideration, grant such facilities in respect of messages to or from the Continent of Europe.

2. Subject to the conditions hereinafter specified, and subject and without prejudice to the operation of the agreements of September 26, 1901, between the companies and the committee of Lloyd's, the Postmaster-General will, during a period of eight years from the date of these heads of agreement, grant the like facilities for messages exchanged between ships and the several stations in the United Kingdom specified in the schedule hereto (subject to the conditions appearing in such schedule) and such other stations in the United Kingdom as shall from time to time be agreed upon between the companies and the Postmaster-General. Messages exchanged between ships and stations on shore are hereinafter referred to as "ship-and-shore messages."

The agreement further provides that all messages of the British Government shall have priority over all other messages and at half rates. The companies also undertake to work their stations as far as possible so as not to interfere with the working of other stations, and to employ only British operators at the companies' stations in the British dominions. The Government takes the right to prohibit or control the working or, if necessary, to take over the working, of any of the companies' stations in the event of any emergency, subject to the payment of reasonable compensation to the companies under the same conditions as those prescribed in the landing licences granted to cable companies. The companies undertake to observe in the United Kingdom and on British ships if required the stipulations contained in the protocol of the recent Berlin Conference on Wireless Telegraphy (except Article VI.), or a convention based upon these stipulations. The agreement consists of 15 clauses, and a schedule which gives a list of the stations to be used for ship and shore communication. These are at Lizard, Rosslare, Crookhaven (or Brow Head), Withernsea, Caister, Niton, Holyhead, North Foreland, and Haven. The last six stations are to be closed if the Admiralty find that working at such stations interferes with Admiralty stations, in which case arrangements will be made for substituted stations or for the transaction of sea telegraphy, and if Lloyd's so desire, maritime signalling by the Admiralty on behalf of the companies at their adjacent stations.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, May 11th.**

Physical Society.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington, S.W. Agenda : (1) "The Effect of a Rapid Discharge on the Throw of a Galvanometer," by A. Russell ; (2) Exhibition of Lippmann Capillary Dynamo and Electrometer, by Prof. H. A. Wilson ; (3) Exhibition of an Apparatus for Demonstrating the Movements of the Diaphragms of Telephonic Transmitters and Receivers and the Current Flowing into and out of the Cable during Speech, by W. Duddell.

SATURDAY, May 12th.

Institution of Electrical Engineers : Students' Section.

2:30 p.m. Visit to the Acton Electricity Works, Acton Vale.

Institution of Electrical Engineers : Leeds Local Section.

3 p.m. Visit to the Municipal Electricity and Tramway Power Stations.

MONDAY, May 14th.

Institution of Mechanical Engineers : Graduates' Section.

8 p.m. Meeting at Storey's Gate, when a Paper on "The Construction of the Blast Furnace" will be read by Mr. A. Tannett Walker.

Institution of Electrical Engineers : Newcastle Local Section.

8 p.m. Annual General Meeting at the Armstrong College of Science. A Paper will also be read by Messrs. E. T. Hollis and R. Alexander upon "The Regulation of Pressure of Discharge of Lighting Batteries."

TUESDAY, May 15th.

Faraday Society.

8 p.m. Meeting at the Library of the Institution of Electrical Engineers, 92, Victoria-street. Papers to be read : (1) "The Electrolysis of Fused Zinc Chloride in Cells Heated Externally," by Julius L. F. Vogel. (2) "Sensitiveness of the Platinum Electrode," by H. D. Law.

WEDNESDAY, May 16th.

Royal Meteorological Society.

4:30 p.m. Ordinary Meeting at 70, Victoria-street, Westminster, London. Among the Papers to be read is the following : "The Development and Progress of the Thunder Squall of February 8th, 1906," by R. G. K. Lempfert.

Institution of Electrical Engineers : Students' Section.

7:30 p.m. Annual Meeting at 92, Victoria-street, Westminster, London. The following Paper will also be read : "Sub-station Equipment," by J. W. Fraser.

THURSDAY, May 17th.

Institution of Electrical Engineers.

8 p.m. Extra Meeting at the Society of Arts, John-street, Adelphi, when a discussion will take place upon the following Paper, which was read before the Birmingham Local Section on Feb. 14th : "Notes on Overhead Equipment of Tramways," by R. N. Tweedy and H. Dudgeon.

FRIDAY, May 18th.

Royal Institution.

9 p.m. Evening Discourse by Prof. A. Schuster, F.R.S., on "International Science."

LIVERPOOL CORPORATION TRAMWAYS.

The annual report of the traffic manager of the Liverpool Corporation tramways for the year ending December 31, 1905, part of the accounts from which were briefly summarised in last issue, commences with a reference to the sudden death of Mr. C. R. Bellamy, late general manager of the Liverpool tramways system, which occurred in December last. The whole of the 351 cars, authorised to be fitted with top covers, have been completed and are in service. The Plough lifeguard has acted efficiently. In the course of the year 89 persons fell in front of the cars or were knocked down, all of whom were pushed clear of the metals without any serious injury resulting. Four fatal accidents occurred in connection with the tramways during 1905, as compared with 22 caused by other vehicles in Liverpool. The ratio of fatalities to passengers carried was one in 29,780,911. This is lower than in any previous year.

During the year the total number of cars in service has been 479. These have been sent into the works for various repairs on 5,072 occasions. The average number of miles run per car was 2,452. In addition, 142 cars have been sent in for the usual periodic examination, and have been thoroughly overhauled and refitted where necessary. During the year the total number of emergency calls in connection with the overhead equipment amounted to 366, a decrease of 192 as compared with the previous year. These calls are exclusive of 89 for the breakdown waggon, dealing with obstructions caused by vehicles of various descriptions having broken down on the tramway tracks in various parts of the city, and requiring to be removed to facilitate tramway traffic.

The total electrical energy used during the year 1905 for tramway purposes was 21,186,782 units (including 315,780 units for lighting of car sheds, works and routes, and power for works motors) as against 20,045,629 units for the year 1904, an increase of 5·69 per cent. Of the above quantity 1,047,918 units were supplied by the Bootle Corporation.

The average units used per car-mile has been as follows:—

Year.	Units used per car-mile.	Percentage increase over preceding year.
1903	1·448	6%
1904	1·566	8%
1905	1·677	6%

The average charge made by the Electric Power and Lighting committee for energy supplied during the year 1905 was 1·107d. per unit, as against 1·159d. during 1904, being a decrease of 4·4 per cent. The price charged for energy includes the total working and capital charges and delivery of the current at the section boxes. The increase of passengers carried in 1905 over 1904 was 2 per cent. and the increase of receipts 1·7 per cent. A comparative table of passenger mileage and receipts is given below for each year since 1897:—

The total cost of electrical energy for haulage and lighting of cars during 1905 was £96,596. 6s. 8d., as compared with £94,937. 0s. 11d. for the year 1904, an increase of 1·75 per cent.

On December 31, 1905, the total staff employed by the Tramway department numbered 2,409, as against 2,292 at the end of 1904.

The following table gives a few of the most interesting figures in connection with the revenue and expenditure during the years 1904 and 1905.

—	1904.		1905.	
	Total.	Per car-mile.	Total.	Per car-mile.
REVENUE.	£	d.	£	d.
From passenger traffic	540,850	10·66	550,084	10·98
Miscellaneous sources	6,875	0·14	6,971	0·14
Total	547,625	10·86	557,055	11·12
EXPENDITURE.				
Maintenance and renewal of cars and fittings	42,722	0·842	43,252	0 860
Maintenance of tools & machinery	1,322	0·026	987	0·020
Maintenance of sundry stock	721	0·014	767	0·016
Repairs to sheds, &c.	1,799	0·035	1,909	0 038
Elec. energy—haulage, lighting cars, &c.	94,937	1·872	96,596	1·921
Road and traffic expenses—				
Salaries—wages to drivers, conductors, inspectors, &c.	121,205	2·390	121,121	2·409
Gravelling, &c.	1,404	0·027	1,034	0·022
Cleaning, &c., of cars	9,223	0·131	10,932	0·217
Cleaning and lighting sheds, &c.	2,509	0·049	2,472	0·049
Lighting routes	150	0·002	147	0·003
Tickets and punches	2,030	0·040	2,042	0·041
Repairs, &c., of knee aprons ..	44	0·0008	..	..
Licenses	427	0·008	369	0·007
Adv'tising, printing & stationery	935	0·018	772	0·015
Uniform clothing, bags, &c.....	4,374	0·086	2,489	0·049
Sundry charges	2,349	0·046	2,718	0·054
Maintenance and renewal of lines.	25,119	0·495	32,338	0 643
„ „ elec. equipm't	4,809	0·094	5,671	0·113
Acknowledgments for privilege of affixing rosettes	158	0·003	155	0·003
Rental of lines in Bootle	5,858	0·115	5,858	0·117
General charges, including rates and taxes, management and office expenses, compensation and law charges, &c..................	45,751	0·902	49,749	0·989
Total	367,846	7·246	381,378	7·585
Car-mile earnings	..	10·67	..	10·94
		% to mean cap. exp.		% to mean cap. exp.
Working profit	179,780	9·38	175,677	9·25
Transferred to reserve, renewal and depreciation fund	54,218	2·83	50,639	2·67
Net interest & sinking fund charges	98,453	5·14	99,718	5·26
Contribution in aid of general rate	27,109	1·41	25,320	1·33

The percentage of operating costs to total revenue was 65·9 per cent. in 1904 and 67·3 per cent. in 1905, and the passengers carried per car-mile amounted to 9·88, as against 9·58 in 1904.

Passengers, Mileage and Receipts.

—	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
Passengers—Electrics	...	785,064	15,853,160	58,068,531	100,076,789	108,906,472	113,015,728	116,642,663	119,123,644
Horse cars ..	30,596,229	31,985,158	39,321,946	19,051,875	218,166	74,685	41,506	..	..
Omnibuses ..	7,812,855	9,001,812	8,596,344	5,247,552	813,825	354,428	..	..	..
Total	38,409,084	41,772,034	63,771,450	82,367,958	101,108,780	109,335,585	113,057,234	116,642,663	119,123,644
Mileage—Electrics	..	53,197	1,473,750	5,584,357	10,771,461	11,705,425	11,724,097	12,166,419	12,067,033
Horse cars	4,674,609	4,736,103	4,758,652	2,571,163	46,247	16,534	10,741	..	..
Omnibuses	1,338,573	1,490,458	1,368,144	945,346	152,355	68,856	..	..	..
Total	6,013,182	6,279,758	7,600,546	9,100,866	10,970,063	11,790,815	11,734,838	12,166,419	12,067,033
Receipts—Electrics	..	£4,087	£77,515	£244,759	£463,164	£504,304	£524,321	£540,850	£550,084
Horse cars	£239,899	250,975	234,756	105,212	717	278	147	..	..
Omnibuses	51,344	59,145	47,658	27,603	4,502	2,146	..	..	..
Total	£290,743	£314,207	£359,929	£417,574	£468,383	£506,728	£524,468	£540,850	£550,084

CAUSES AND PREVENTION OF FAULTS ON DIRECT-CURRENT NETWORKS.

BY F. FERNIE.

The following observations all refer to a direct-current three-wire network, with the neutral wire earthed at one place, and 460 volts between the outer wires.

A negative fault, in popular language, always "draws water"; this effect is commonly described as "electric osmosis." It is easily illustrated by sticking a bare negative wire into the ground, in apparently dry soil, when moisture at once appears round it. Electric endosmose is defined in Whetham's book, "Experimental Electricity," as follows:—

> If an electric current be passed through a vessel divided into two compartments by means of a porous partition and filled with some solution, we shall find that, in general, besides the changes in concentration at the electrode . . . there is a bodily transfer of the liquid usually in the direction of the current, through the porous plate.

Also the final hydrostatic pressure is stated to be directly proportional to the E.M.F. across the partition and hence to the current flowing. In what follows, the writer endeavours to show that this effect is largely instrumental in causing faults on buried cables. The decomposition of the insulation, due to the abnormal osmotic pressure of some of its constituents (O'Gorman, *Proc.* I.E.E., Vol. XXX., p. 618), the writer has not taken into account, although it would appear very likely to take place, especially in the case of indiarubber and high pressures.

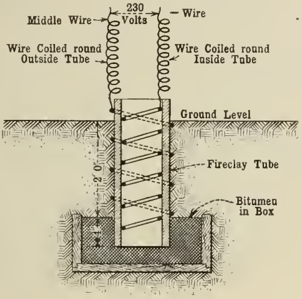

FIG. 1.

The origin of all faults on a three-wire network must be due to injuries to the insulation caused by—(1) *Mechanical* means (*a*) after the cable is laid, (*b*) whilst being laid, (2) *chemical* means, (3) *electrolytic* means, (4) variations in temperature, (5) careless workmanship (jointing), or (6) defects in manufacture. It is obvious that all the above causes may operate equally on either the positive, neutral or negative cable, assuming three single cables are laid, and yet in the writer's experience 90 per cent. of all faults occur on the negative main.

This is probably due to the electric endosmose effect, which, in a porous medium, bodily translates moisture from a region of high potential to one of low potential. No matter is absolutely non-porous; "porous" and "non-porous" are only relative terms, and substances one is accustomed to regard as non-porous, such as indiarubber, can be made to absorb water under a definite electric pressure, as well as under hydrostatic pressure. If a porous pot, such as is used in a Leclanché cell, be placed in a beaker of water, and if after the water has attained the same level inside and outside a difference of potential of 1 or 2 volts be applied between the outside and the inside, a considerable difference of level will be obtained, the higher level being on the negative pole side.

The writer buried vertically a highly glazed earthenware casing, used for a draw-in system of mains, the lower end was stuck into a very tenacious bitumen, and the upper end, projected 2 in. above the ground, a wire was wrapped spirally on the outside, while another made similar contact with the inside. The top was protected with a box (see Fig. 1). This was left for 14 days and buckets of water were daily poured into the ground round it. The inside remained perfectly dry. 230 volts were then applied to the two wires, the outside wire being positive to the inside one; in one hour beads of water appeared on the inside, in two days it was half full. The walls were about ½ in. thick.

On reversing the polarity of the wires, the casing was completely dried inside.

When the insulation of a cable becomes damaged from any of the causes mentioned above, if it be a positive main the probability is that no "earth" occurs, as the endosmotic effect acts in a helpful direction and drives away moisture, the great enemy to all insulation; thus, so long as the cable is "alive" it will remain to all intents and purposes quite sound. With a negative cable the reverse is the case, the earth being at a 230 volts higher potential; there is a constant strain on the insulation, tending to drive moisture through the insulation to the copper. Thus the slightest weak place breaks down, and water getting in, a bad fault is soon caused by the accompanying electrolytic action of the current. Of course, on the positive main, there is always the *disruptive strain* of the voltage, but with 230 volts this is insignificant, and a single thickness of oiled paper will easily withstand it. The writer has seen a rubber-insulated cable that has been connected to the negative pole saturated with water at a considerable pressure, so that, on slitting the insulation with a knife, the water spurted up some 2 ft. or 3 ft. into the air. This cable, of course, tested "dead earth." On changing it over to the positive, it dried itself out, and after some weeks gave quite a good test. On reconnecting it to the negative, however, it would speedily go wrong again.

If the third-wire earth connection be permanently made and *never* broken, faults practically *never* occur on the third-wire. For if the earth connection be broken, on the occurrence of a positive fault, the third-wire immediately becomes subject to the endosmotic effect, being somewhere about 230 volts *below* earth potential, and weak places break down. Of course, in the above case the unfortunate negative cables approximate to 460 volts below earth, and are worse off than ever. It would appear safer that the third-wire earth connection should *never* be broken, but that it should be permanently anchored down to earth potential.

As an illustration of this the writer was engaged in a station where the earth connection was broken every morning for the purpose of testing and the positive and negative mains in turn earthed, also the earth connection was automatically broken whenever an earth occurred on either outer. Now third-wire faults were common on this network. On another large network, where the earth connection is never broken, the result of over three years' experience was only one third-wire fault, which was located to the inside wiring of a theatre and was satisfactorily accounted for on other grounds.

The earth connection is often broken to make a test for the combined insulation resistance of the network, but this test can be made without breaking the earth connection, as described in Raphael's book on the "Localisation of Faults."

As an argument in favour of the above remarks, consider the almost entire immunity that alternating-current networks enjoy from faults. On two distinct networks of which the writer has had some experience, and both of which were partly supplied with direct current and partly with alternating current, the proportion of faults on the alternating network to those on the continuous-current net-work was about as 1 : 100.

In some experience of two 550 volt tramway systems, the writer does not remember a single earth occurring, and he would attribute their immunity to the fact that the "live" wire is 550 volts *above* earth potential. So it would appear that, within limits, the higher you raise the potential of a buried cable *above* earth potential the safer it will be.

On a three-wire network a negative fault probably raises the value of the insulation resistance of the positive mains, since it increases the endosmotic effect, which, in the case of the positive mains, is helpful. On the other hand, a positive fault lowers the value of the insulation resistance of the negative cables by increasing the endosmotic effect, which in their case acts in a harmful direction. This is why a bad positive fault generally produces a few negative faults, but a bad negative fault does not cause others.

From these considerations a triple-concentric cable would appear to be the safest to use, with the inner core the negative, the middle one the third-wire, and the outer the positive. It seems logical to make the outer positive in preference to neutral as the positive is the strongest and best able to protect itself; the negative is always trying to surrender, and should, therefore, be in the safest place. The third-wire is normally passive whilst the positive actively defends itself, and in doing so protects the other two. The more usual plan is to make the outer wire neutral, which has the disadvantage of putting 460 volts between two adjacent conductors. This, however, is not very important.

Regarding the actual electrolytic action that takes place, this is sure to vary with the soil in which the cable is laid; but the general action appears to be as follows :—

Taking a (single) negative lead-covered cable first, assume a weak place due to the lead having been made porous by too severe a strain in pulling it in, or by too sharp a bend. The endosmotic pressure gradually forces moisture through to the copper, and as soon as this gets through electrolysis begins. Now, all metals and hydrogen will travel with the current —that is, from the soil to the copper. The chief ions that reach the copper appear to be potassium and hydrogen, though doubtless there are traces of many other metals, including sodium. On electrolysing a solution of a potassium salt, potassium ions are deposited at the cathode, but immediately combine with water, forming KOH. In practically all negative faults a caustic solution is found in the cable, and, in the case of rubber-insulated cables, as stated above, often at a considerable hydrostatic pressure. Cables laid in chalk soil, as on the south coast, are, however, an exception to this. In high-resistance faults, where the moisture present is limited, large accumulations (sometimes as big as a cricket ball) of potassium salts are formed, and occasionally metallic potassium, which on being thrown into water disengages hydrogen which ignites. The cases where the salt or the metal are formed are generally those cases where the water has to be forced through a porous medium, such as an earthenware casing, or a brick wall. In such cases, the amount of water being limited, the solution would appear to become saturated and the water to slowly evaporate, assisted by the C^2R heat of the current passing, and thus to deposit a potassium salt; the current then passing through the moistened salt, deposits metallic potassium. The potassium apparently gets protected by a crust of salt, as it has been found in a ball of salt a couple of hours after it has been detached from the cable. One would expect potassium salts, being deliquescent, to have a high osmotic pressure in solution, and thus to tend to resist the evaporation of the solvent, and it seems probable that the effects described above are only the result of more complicated changes. In the case of a positive fault (apart from actual metallic contact with some earthed conductor) a persistent supply of water is necessary. If water is not supplied the fault soon dries up and practically no current passes. When there is a supply of water, oxygen ions, and probably many others (sulphions, &c.) travel through the electrolyte to the copper anode; the copper goes into solution and eventually the conductor is completely destroyed, and discontinuity in the cable results. Old rubber-insulated cables, drawn into earthenware ducts are frequently severed in this way, and if the supply of water ceases from some cause and the cable be fed from both ends, it may remain in this condition for months without being discovered. A positive leak always tends to grow less, whereas a negative leak tends to get larger.

The writer believes the system sketched below would be as free from trouble as any other system, and compare favourably in first cost with most others.

The cable should be paper insulated and lead covered, and over this, again, there should be a braiding suitably impregnated.

A draw-in system appears preferable to a solid system for a variety of reasons, for absolute immunity from direct mechanical injury (the chief enemy of any concentric) can be ensured. Also, an engineer who looks far enough ahead must, in making any extension of mains on the solid system, put in a far heavier section of copper than is at the time needed, which means borrowing money and paying interest on it for some years without getting any return. Provision has also to be made for possible street lighting by arc lamps. With a draw-in system one can always recover the whole of the copper at any time. Other advantages are ease in location of faults and the minimum of time and expense spent in repairs.

A system of compressed fibre pipes laid solid in concrete, with accessible boxes at each service (possibly one box may do two or three services), appears to be the best thing available. The service leads themselves, except for very short services, should be concentric, laid in earthenware troughs, and filled in with a good bitumen.

For short services (less than 10 ft.) galvanised iron pipes should be used.

With the class of cable and the draw-in system described, consider the possibilities of faults occurring :—

1. *Mechanical.*—(*a*) With good concrete, complete immunity. (*b*) The most fruitful cause of faults, especially with lead-covered cables. In this system it is very improbable that such injuries would ever develop into faults, as it can be made perfectly watertight.

2. *Chemical.*—Instances occur of the action of decomposing wood on lead due to the production of organic acids.

3. *Electrolytic.*—The lead should be broken at every service joint; the braiding and the fibre pipe will effectually prevent any stray earth currents (tramway or otherwise) from getting on to the lead, and, as the lead is broken at every joint, in the event of any current doing so it will only affect a short length.

With a network consisting of three single lead-covered cables, laid on the solid system, the following system of bonding would be found useful: At every service joint the lead on the two mains, off which the service is tapped, would be broken, and the lead of the service cables bonded to the lead of the mains on one side of the joint only, following some easy convention, say, always North or East; the lead, being laid in bitumen, would everywhere be insulated, and thus a simple separate test of every short piece of distributor could be made by merely feeling the lead at the fuses in every consumer's house. The meter reader could do this every time he read the meter. Fig. 2 shows the arrangement; the bonds are shown dotted. The third wire should also be bonded, and all the bonds must of course themselves be insulated in the bitumen. An experiment made on some short lengths of lead-covered cable with the lead intentionally made "alive" (230 volts below "earth") covered in with bitumen and buried, after some six months has shown no signs of electrolytic action on the lead.

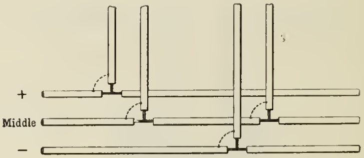

Fig. 2.

4. *Temperature.*—There is always enough slack in any draw-in system to render this negligible (bakers' ovens may be avoided).

5. *Careless Workmanship.*—Consequences less serious than in a solid system.

6. *Manufacturing Defects.*—Extremely rare and common to all systems.

A commonly urged objection to all draw-in systems is the possibility of explosions. These are due to accumulations of CH_4 ("fire damp"), or of coal gas in the ducts. Fibre pipes laid in concrete may be made quite gas tight, as also may brick boxes lined with cement, though these should have ventilated covers. One drawback is that in laying concrete in the winter the ground has to be left open an otherwise unnecessarily long time to allow the concrete to set hard enough for the earth to be rammed above it. This is rather serious when making short extensions. Also, being rather bulky, it may take some engineering to work it in amongst many other pipes (gas, water, &c.).

The phenomena described in a Paper read by Prof. F. T. Trouton to the Physical Society on March 23rd appear to be of the same order as the electric endosmotic effects above described.

SINGLE-PHASE RAILWAY FOR THE MILAN EXHIBITION, 1906.*

BY E. FUMERO.

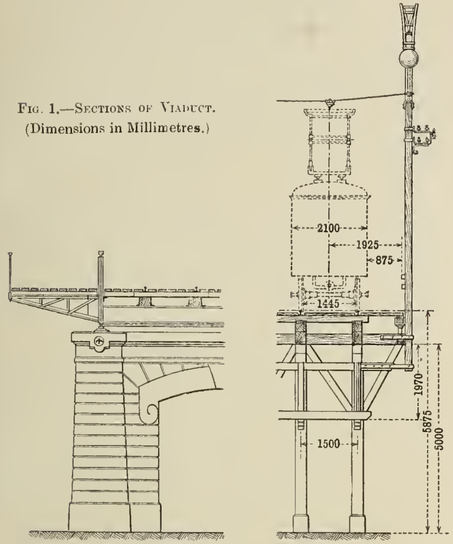

Fig. 1.—Sections of Viaduct. (Dimensions in Millimetres.)

The development of single-phase electric traction with commutator motors has steadily proceeded in recent years, and now there are about a dozen lines in operation in Europe and America. The advantages offered by its simplicity have always been apparent, and experience has gradually eliminated the difficulties which initial theoretical investigations had associated with the system.

The two great lines of progress have been, on the one hand, the utilisation of the ordinary series motor (exemplified in the work of Finzi in Italy and Lamme in America) and, on the other, the introduction of the Thomson and Latour-Eichberg repulsion motors.

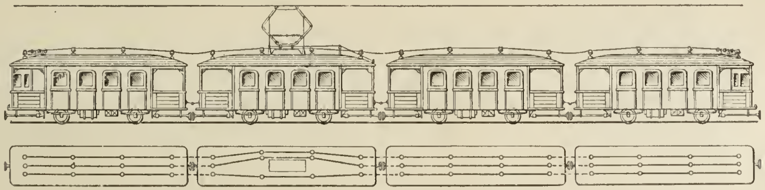

Fig. 3.—Complete Train, showing Arrangement of High Tension Wires on the Roof of the Carriages.

The series system proper seems to offer the simpler solution for large motors. In fact, the Westinghouse Company has already constructed machines up to 375 h.p. The essential feature of success is to choose a low enough frequency: 15 to 25 periods. The modifications introduced by Finzi consist chiefly in obtaining the complete neutralisation of the armature reaction by means of a subsidiary winding displaced 90 deg. with respect to the field magnet coils.

It is interesting to note that in the most recent Westinghouse motors Lamme has employed this same method of series compensation in place of saturated poles and short-circuited windings.

It will be remembered that the first practical experiments with single-phase electric traction were carried out on the Milan–Musocco route in 1903, by Dr. Finzi in conjunction with the Brioschi, Finzi Company and the Edison Company of Milan. The success there achieved did much to overcome the prejudices that had accumulated against the employment of commutator motors with alternating current.

The exhibition installation, of which we give a few of the chief features, was undertaken by the Unione Elettrotecnica Italiana and shows a distinct step in advance in the application of Finzi's system.

The Milan Exhibition is divided between two sites, one being in the park and the other in the Piazza d'Armi. It was necessary to have railway communication between them, and it seemed a good opportunity to utilize the latest method of electric traction as an additional feature of interest to visitors. As the line has to cross an existing railway station it had to be elevated throughout on a viaduct.

The whole of the project was worked out under Dr. Finzi by the Electric Traction Syndicate of Milan.

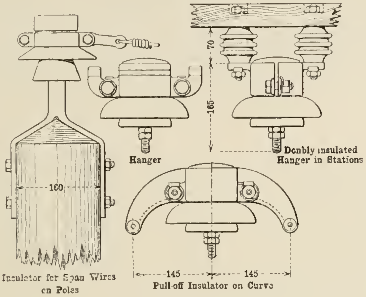
70
165
Hanger
Doubly insulated Hanger in Stations
160
Insulator for Span Wires on Poles
145
145
Pull-off Insulator on Curve

Fig. 2.—Insulators. (Dimensions in Millimetres.)

Track.—This is double throughout its length except at the stations. An auxiliary siding is, however, provided at both stations which can be made use of for emergency purposes. The length of the line is about 1,500 yds. The steepest gradient is 1 in 30, and the radius of the only curve is 300 ft.

The gradient leading to the station in the park was necessitated by the desire of the Exhibition authorities to avoid obstructing the view of the triumphal arch (Arco di Sempione), and the sharp curve was made to keep the line clear of the principal avenue of the park.

Viaduct.—The viaduct is constructed in one part of wood and in another of iron. The latter mode is employed for crossing the existing railway lines and the streets on the route.

In Fig. 1 the right-hand view shows the transverse section of the wooden viaduct, the poles carrying the trolley wires and the arc lamps for lighting the track. The other part of the figure gives an idea of the iron construction. The piers for this are made of reinforced concrete.

Rails.—The rails are of the standard Rete Adriatica type weighing 60 lb. per yard. They carry the return current, and are bonded with copper of 0·1 sq. in. section.

Generating Station.—The installation consists of a special single-phase alternator generating at the pressure of the trolley line (2,000 volts). It has four poles, and runs at 600 revs. per min. with a frequency of 15 cycles per second. This alternator is directly driven by a three-phase motor of standard type for 3,600 volts, giving

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* Abstract of an article in *L'Elettricita* of April 27th.

600 H.P. As spare plant there is a fly-wheel alternator of 2,000 volts 15 periods, coupled to a Langen & Wolf gas engine. A small three-phase asynchronous motor generator group is also provided for charging a battery to act as reserve for the excitation.

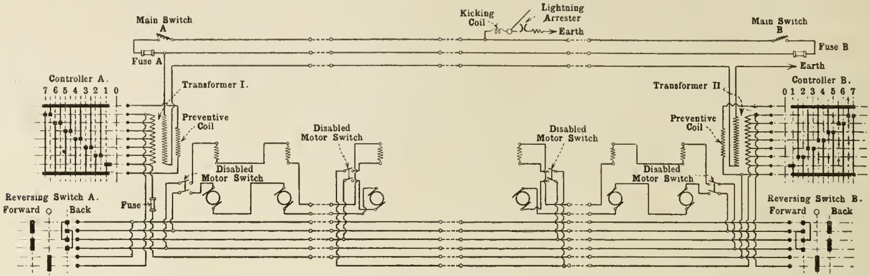

FIG. 4.—DIAGRAM OF TRAIN CIRCUITS.

Trolley Line.—In the figure illustrating the transverse section of the viaduct can be seen the ordinary trolley-wire suspension. The line itself consists of two wires of hard electrolytic copper 0·075 sq. in. in area, and works at a pressure of 2,000 volts. Its height from the ground is about 18 ft. It is hung from span wires on special metallic elastic suspensions, which enable the car to be fixed to the insulator without the use of cement. The construction is shown in detail in Fig. 2. In order to obtain double insulation of the trolley wire from earth the span wires are fixed to double-petticoat insulators on the top of the posts. Although these are of small dimensions they are very strong mechanically. At the stations it was thought necessary, on account of the nearness of the wires to the ground, to do away with the span wires altogether, and thus obviate any danger of touching them with a stick or umbrella. The type shown in Fig. 2, was therefore adopted. All the insulators, both for the trolley and span wires, were designed for an ultimate pressure of 10,000 volts, as it is proposed at the close of the Exhibition to carry out a series of experiments with voltages varying from 2,000 to 10,000 volts. Protection is given against lightning discharges by two horn-type arresters. As the line was designed for working with a roller or bow collector, it is set out in zigzag form in plan so as to give an equal wear on the collector.

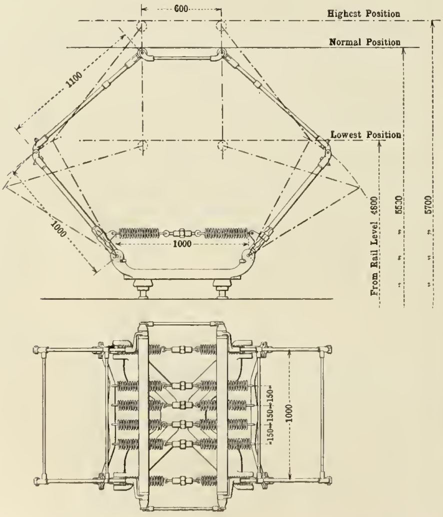

FIG. 5.—ELEVATION AND PLAN OF TROLLEY. (Dimensions in millimetres.)

Rolling Stock.—This consists of four regular trains, composed of four carriages with two more as reserve. The length of each carriage is 32 ft., the wheel base being 13 ft. Each train can accommodate 250 passengers, mostly on the end platforms, as there are only 96 seats. The maximum speed is 23 miles an hour. The carriages have radial trucks, which enable them easily to negotiate curves as sharp as 80 ft. radius. In addition to the ordinary brakes operated by hand there is an air brake on each carriage.

Fig. 4 shows clearly the arrangement of the high and low-tension circuits on the train. The most important characteristic of the system consists in the easy control from either end, which is obtained by the division of the transformer into two parts, one of which is in the front carriage and the other in the last. The high-tension 2,000 volt 15 ∼ current after first passing through the choking coil of the lightning arrester is led into the relay of the main switch, which can be operated either by hand or automatically. From the relay it passes through the switch, main fuse, and thence to the primary of the transformer in the first carriage. Then it goes through one of the three wires placed on the roofs of the carriages, to the primary of the second transformer in the last carriage and finally to earth.

The third high-tension line serves to put in parallel the primary of the first transformer with either of the main switches, and hence with the trolley. The end carriages are equipped each with two of Finzi's single-phase motors, type MF 25 of 30 H.P. each, while the intermediate carriages have each a single motor. The complete equipment of a train, therefore, consists of six motors, of which a group of three is coupled up in series with the secondary of the transformer. By means of the special device of dividing the transformer in two, the first position of the controller handle applies to the terminals of the motors a pressure corresponding to the secondary of the transformer placed in the last carriage, or the half of the whole available pressure. Experience has shown that this amount is the best adapted for starting the single-phase motors in series.

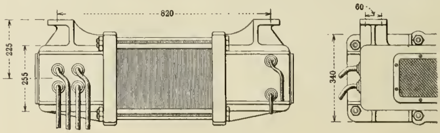

FIG 6—TRANSFORMER.

Passing from position 1 to 2, 3, 4, 5, 6, 7, the pressure is increased by steps of 30 volts each time, thus bringing it up from 180 to 360 volts.

As there are always three motors in series on the secondary side, each obtains an initial pressure of 60 volts, which is stepped up by 10 volts successively to a final value of 120 volts.

The arrangement is quite symmetrical for operating from either end of the train, and thus it is possible, by manipulating the controller, to obtain any secondary pressure that is required. To reverse the motors the action of the controller is the same as for continuous-current working.

Trolley.—The original idea was to use two ordinary Siemens bows, one for the outward and the other for the return journey; but, in view of the accidents that might happen if it were forgotten to lower one bow, it was thought wiser to use a new type of trolley designed by Messrs. Finzi & Tallers. This trolley, with double collector, has the advantage of minimising the sparking which would otherwise prove disastrous to the line with high-tension current. The rhomboidal arrangement of the links, Fig. 5, is very elastic, and ensures that, when one of the rollers momentarily leaves the wire as it passes a point of support, the other is making good contact. The rollers were carefully designed to revolve easily in their bearings. The provision of two rollers has the further advantage for high-tension lines that it renders it unnecessary for the driver to break the circuit when passing section insulators. The trolley is supported on strong insulators carried on the roof of the carriage.

Transformers.—These are of 40 kw. capacity each, illustrated in Fig. 6. The dimensions are carefully chosen to reduce the weight to a minimum, and this does not exceed 1,800 lbs. A gauze cover to prevent the entrance of dust into the windings is provided. With a primary pressure of 1,000 volts the secondary gives 180, and tappings are taken off so that intermediate values between zero and 180 can be obtained. As described above, the two primaries of the transformers on each train are put in series absorbing 2,000 volts.

Motors.—These have laminated poles and a compensating winding for the production of a flux at right angles to that of the field. This neutralises the effects of the armature self-induction, increases the power factor and maintains a high efficiency. The body of the machine is cylindrical, with openings to allow of the ventilation of the laminated poles. The brushes are the same in number as the poles and are carried on rigid rings. Although they are made very long they are as narrow as possible, so as to cover but little of the periphery of the commutators. The armature is built up of stampings on a steel spider and has 65 conductors in slots. The commutator segments are each composed of a large number of thin plates connected up *without resistances* to the conductors.

Preventive Coils.—In order to pass from one position of the controller to the next without breaking the circuit, and yet without causing a "short" on that part of the secondary winding comprised between the two stops, a choking coil comes into play during the change of contact.

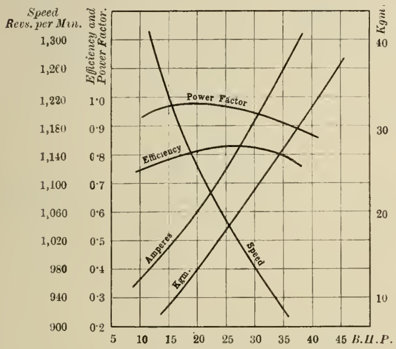

FIG. 7.—CHARACTERISTIC CURVES OF MOTOR.

Controller.—The dimensions of this are somewhat large, but it must be remembered it has to deal with currents up to 700 amperes. The working of the principal cylinder is done with a hand wheel, but for the reversing switches an ordinary handle is used. The design is such that the same controller can be employed for continuous currents by merely changing the principal cylinder, and a magnetic blow-out is provided in view of this change. This is not only unnecessary with alternating currents, but in some cases dangerous.

High-tension Connectors.—The high-tension joints between each carriage were designed to permit of easy disconnecting from the trolley main conductor In the event of any carriage being uncoupled the joint would be broken also, and would not then be under high-tension from the trolley.

Brakes.—Each train has a continuous air brake worked from two compressors, which serve also to operate the sand blast.

Train Service.—It was originally intended to have a three-minute service, but with the four trains all in use this will probably be much improved upon. The number of passengers expected to travel on the line during the whole period is about three millions. The fare is to be 10 centesimi (about 1d.) per journey, which is collected at turnstiles.

Although not an installation on a huge scale this line presents a complete model of a single-phase railway and its working results will yield useful information for larger projects. Much credit is due to Dr. Finzi and his colleagues for the thorough manner in which the details of his single-phase system have been carried out.

LONG FLAME ARC LAMPS.*

BY LEONARD ANDREWS.

(*Concluded from page 90.*)

General Effect and Distribution of Light.—It is interesting to note that arc lamp designers have during recent years paid very much more attention to these points. There is no doubt that for effective lighting the globe should have the appearance of being *full* of light. The popularity that has recently been attained by several types of enclosed arc lamps is undoubtedly in a great measure due to the use of small globes, and whilst the efficiency expressed in the "mean hemispherical candle-power per watt" is considerably lower than that of the large globe open-type arc, the efficiency expressed in the "satisfaction to the general public per watt" is considerably greater. The long flame arc is particularly well adapted for use with small globes, and all flame lamps, whether of the chemical carbon type or of the high-voltage pure carbon type, always appear to give a good globeful of light. This effect is also in a great measure due to the absence of shadows resulting from the use of inclined carbons.

It must be remembered that the general public do not judge of the efficiency of any system of lighting by taking photometric tests. It would probably be much better for the electrical industry if they did. Their usual method of judging a light is, first to look at the source of light, to satisfy themselves that there is a large area of light-giving surface, and secondly to examine the ground directly below the lamp they are judging. The engineer, however, recognises that it is of even greater importance to know what is the minimum illumination midway between lights than it is to know the maximum illumination directly below the arc.

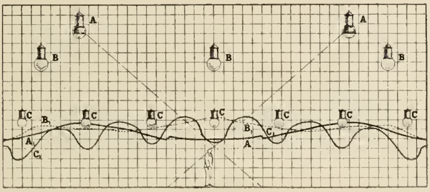

FIG. 23.

It is well known that at least 40 per cent. of the light emitted by an arc lamp is intercepted by the opalescent globe. This waste, with ordinary arc lamps, appears to be necessary, in the first place to prevent the dazzling effect which would result from an unscreened arc fixed at a position that comes within the natural angle of sight, and in the second place to give a diffused light, or the effect of a light emitted from a large surface. Dealing first with the screening effect necessary to prevent dazzling, this need not be considered if the source of light can be placed at such a height above the ground that it does not come within the natural angle of sight. It appears, in fact, that we might take a lesson from Nature. At midday, in midsummer, when the sun is directly above our heads, and consequently not within the natural angle of sight, the light emitted by it is comparatively unscreened, and is blinding to look at, even for a moment. When the sun is setting, however, and is consequently directly within the angle of sight, such a large percentage of its light is intercepted or screened by the atmosphere that we are able to distinguish objects clearly which are in a direct line between ourselves and the sun.

Owing to the fact that with an ordinary arc the bulk of the light is emitted at angles of less than 60 deg. below the horizontal, it is necessary to place such lamps comparatively near the ground to get efficient results from them. This objection does not, however, apply to long-flame arc lamps in which the maximum light is directly below the arc. It appears, therefore, that for many purposes, such, for instance, as for lighting large buildings, where the source of light can be placed 30 ft. or 40 ft. above the ground, it is unnecessary to use densely-obscured globes. It is suggested that for this purpose long-flame arc lamps should be used, fitted with globes of which the lower half is unobscured.

Curves A_1, B_1 and C_1, Fig. 23, show respectively the illumination per square foot on the floor space of a room illuminated by 800 watt high-voltage pure-carbon long-flame arc lamps, with globes half unobscured at A, A, 25 ft. above the ground, and with similar lamps fitted with globes, absorbing 40 per cent. of the light at B, B, B, 20 ft. above the ground, and with 460 watt ordinary enclosed arc lamps at C, C, C, &c., 10 ft. above the ground. It will be seen that the mean illumination is approximately the same in each case, but that a considerable saving of energy is effected by using unobscured flame lamps 25 ft. above the floor level. It is also noticeable that the distribution of light is much more even with the few lamps placed high up than with the larger number of lamps nearer the floor. Fig. 24 shows the arrangement of lamps required to produce a given mean illumination over a given floor space, the energy expended with the three systems being respectively as follows: —

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* Paper read before the Institution of Electrical Engineers, April 26th. (Slightly abstracted.)

	Watts.
Four 800 watt unobscured high-voltage flame lamps....	3,200
Eight 800 watt obscured ,, ,, ,, ...	6,400
Thirty-five 460 watt enclosed arcs....................	16,100

It is obvious that by doubling the height of all the lamps a floor space of four times the area would be illuminated to one-fourth the brilliancy, the relative illumination over the larger floor space being similar to that represented by the curves A_1, B_1 and C_1, Fig. 25.

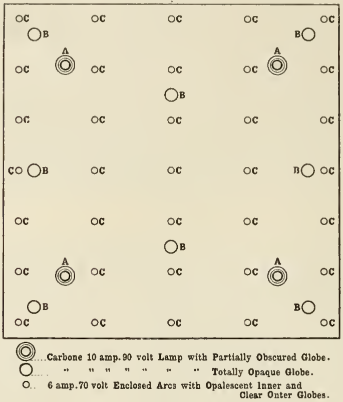

A
B
C
CO
Carbone 10 amp. 90 volt Lamp with Partially Obscured Globe.
" " " " " " " Totally Opaque Globe.
6 amp. 70 volt Enclosed Arcs with Opalescent Inner and Clear Onter Globes.

Fig. 24.

Alternating-current Arcs.—Alternating-current lamps are very unpopular in this country on account of their very low useful efficiency. This is in a great measure due to the fact that about 50 per cent. of the light is thrown up into the air, where for many purposes it is entirely wasted. This defect, however, disappears in long flame downward-feeding carbon arcs, as the whole of the light emitted by both craters is thrown down. Dr. Wedding has found that the efficiency of an alternating-current lamp of this type is practically similar to that of a direct-current arc of the same type.

The author has obtained a photograph showing the area of craters of a 10 ampere pure carbon high-voltage arc, the current being 10 amperes, voltage 67 and the area of the craters 15·3 sq. mm. The watts per square millimetre of crater area are therefore 44. They are consequently no greater for this alternating-current arc than for the 10 ampere direct-current arc illustrated in Fig. 15.

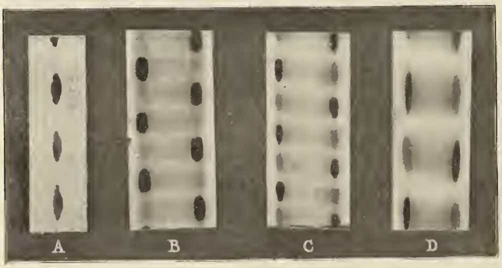


Fig. 25.

Another objection to alternating-current arcs is that, when connected across an alternating-current circuit of less than 50 cycles per second, the flickering is very objectionable. It appears that this difficulty may also be considerably lessened by using downward-feeding carbon arcs in which both craters are visible directly below the arc. As in the ordinary coaxially arranged carbon arc only one crater is visible from any position during one entire half of each cycle, there must of necessity be a dark period between each flash of light. This can be shown by focussing an image of the crater formed on the upper carbon of an ordinary arc on to a piece of bromide paper fixed to a drum which may be rapidly rotated. The record obtained will be similar to A (Fig. 25). B (Fig. 25) is a reproduction of a record obtained as described above from a downward feeding pure carbon arc, and C is taken from a downward feeding chemical carbon arc. As in both B and C the craters on both carbons are visible from one point, when the one is giving its maximum illumination the other will be at a minimum.

If a black disc with a white sector is rotated at 50 revs. per second below an ordinary alternating-current arc burning on a 50∽ circuit, the disc will appear as at A (Fig. 26), clearly showing that the white sector is illuminated once only during each revolution of the disc. If the disc is rotated at a speed of 25 revs. per second, it will appear as at B (Fig. 26), showing that it is illuminated twice during each revolution. Again, if the disc is rotated at 50 revs per second, and the arc is connected across a 100∽ circuit, it will have the same effect as reducing the speed of the disc to one half. If now the disc is illuminated by a downward-feeding carbon lamp connected across a circuit of a periodicity corresponding to the speed of the disc, it will appear as at B (Fig. 25). This experiment appears, therefore, to show that a downward-feeding carbon lamp on a 50∽ circuit gives the same effect as an ordinary lamp on a 100∽ circuit. Record D (Fig. 25), taken with a downward-feeding lamp on a 25∽ circuit, also shows, when compared with record A, that the maximum periodicity of illumination is the same with the downward-feeding arc on the 25∽ circuit as the ordinary arc on a 50∽ circuit.

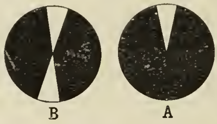


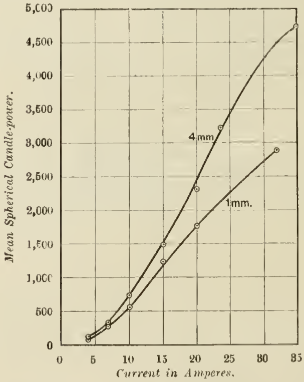
Fig. 26.

The thanks of the author are due to Mr. F. Bartholomew for much valuable assistance in carrying out the various experiments referred to in this Paper.

DISCUSSION.

Thursday, April 26th.

Mr. A. P. TROTTER said the author had touched upon a good many subjects, many of which had been discussed by Mrs. Ayrton at much greater length. The first table in the Paper was a little difficult to grasp, because the results were hardly comparable in the way in which they were stated; but, taking Table II., there was an attempt at giving the candle-power per ampere. If the four results were all taken on the same basis the comparison was a good one, but he did not think it was quite possible, and Mrs. Ayrton denied that it was possible to take "candles per ampere." On p. 366 in her book a diagram appeared (reproduced above) which had been confirmed by Blondel. The general result was that, taking 10 amperes, he got for the largest carbon (18 mm.) 90 hemispherical candles per ampere, and for the 10 mm carbon about 65. He thought that unless the three lamps were measured on the same basis this table was hardly a criterion to take. A watt measurement was an even more difficult thing to take, for there were



Curves (from Mrs. Ayrton's book) connecting Mean Spherical Candle-power with Current for Constant Lengths of Arc of 1 mm. and 4 mm. Carbons: Positive 13 mm. cored; negative, 11 mm. solid.

such a variety of volts that could be applied to arc lamps. This was also important from the economical point of view, for, given so many kilowatts to spend they had to consider the best way of applying these kilowatts to get so many candle-power. The intrinsic brilliancy had also been dealt with, but here again there was a great discrepancy between the different values. One of the lowest figures was made by M. Voit, at the Munich Exposition, who only got 48·4 candles—they might have been Hefner units—per square millimetre. In the experiment which he himself made in 1892 at Finsbury—or rather that were made entirely by Mr. C. F. Higgins, for he personally only looked on and made suggestions—he got 64 candles per square millimetre. This was also a very low figure, and they took in a large amount of the crater right up to the very fringe. Some time afterwards, during the discussion on his Paper, Prof. Thompson and Mr. Swinburne suggested that possibly a square millimetre of an arc would form a good unit of light, but on going into the matter fully he found that the results by no means represented the total brilliancy of the total crater. But in this connection again, if the various assumptions were made on the same basis it was all right. Fig. 18 in the Paper was interesting and the author certainly made out a very good case in the way he explained it. But he thought there were a good many things which might come in which were difficult to determine accurately, and this might account for the very good result. He was inclined to think that the inner curve in Fig. 18 could not be depended upon to within 20 or 30 per cent., possibly. With regard to the author's reproduction of his (Mr. Trotter's) curve (Fig. 1) it would be noticed that the polar curve of the arc came a good deal outside the semi-circle This meant that there was a certain amount of negative light and flame light above. With the arcs which Mr. Higgins used at Finsbury, which were 26 ampere, this point of intersection came out at 60 in one case and 70 in another. The point was that they must not credit the negative light and the flame light with quite as much as had been done in the author's curve. Fig. 2 of the Paper he thought was a very good lesson in showing the misleading character, sometimes, of polar curves. These were things to be dealt with carefully. The photographs shown by the author indicated that the expression of length of arc was used differently by the author than it was by Mrs. Ayrton and others. There the arc was a curve and not a straight line, but very probably much of Mrs. Ayrton's work could be made applicable to this case. Until these new chemical lamps came out the flame was very little good indeed, and did not play such an important part in the colour of the light as the author thought. It was as if for many years we had been accustomed to nothing but non-luminous flames such as Bunsen flames or water gas flames, and then someone discovered a carburetted flame like the ordinary gas light. The flame of the ordinary arc had been thought useless as a source of light until someone had succeeded in imparting a very horrible colour to it. But it was in its infancy and he hoped that someone would be able to cure this. He had been told that the colour of the mercury vapour lamp had been cured in this way lately, although there was still room for improvement. On the question of colour, he had nothing to withdraw from what he had said at the time of his Paper before this Institution in 1892. On that occasion he had quoted Capt. Abney and others that the way to judge of the colour of an arc lamp was not to look at it by night, where they had no standard of white, but on an ordinary grey day; not on a sunny day. If this were done with a tolerably good lamp and tolerably good carbons, the light shed would be found to be a pale straw colour, and the mere fact of night coming on could not alter the colour. Then the question was, why did the arc lamp look blue or violet at night, and it might be said philosophically that if to 999 persons out of a 1,000 it looked blue, it was blue. He maintained that if a lamp was straw colour by day it was also straw colour at night, and if it appeared to be different it was a delusion. There were two or there reasons why the standard of light became altered at night. Everyone was accustomed to seeing yellow lights at night. He dared say some of them knew what daylight looked like in the morning after a ball, for instance. It appeared a ghastly blue, because they were so accustomed to yellow at night. Another reason was that at night the blue-seeing nerves of the eye were resting, and the yellow and orange nerves got somewhat tired, and if they had a light with a little more blue than usual, it appeared to be blue. These were two reasons, and there were others. The author had stated that the lamp which he exhibited was whiter than an ordinary arc lamp, but probably comparison by daylight would show that it was yellower, and not whiter.

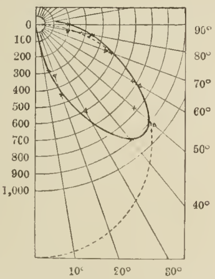


Fig. 4 of Mr. A. P. Trotter's Paper (*The Electrician*, Vol. XXVIII., p. 688). Curve of Areas of Crater and Candle-power of Short Arc. Δ = Area and x = candle-power. The scale of radii is arbitrary.

Mr. HAYDN T. HARRISON did not altogether agree with the opinions expressed in regard to the Carbone arc lamp. It was perfectly true that, by taking away the shadow of the lower carbon, the mean hemispherical candle-power had been increased, but the candle-power directly under the lamp had also been increased. It had been his own object in dealing with big areas to reduce the candle-power directly under the lamp and increase it near the horizontal in order to get even illumination. The curve in Fig. 23 had puzzled him exceptionally when he first saw it. It seemed curious that the illumination between the lamps should be higher than that exactly below them, and perhaps Mr. Andrews would explain just how that was feasible. To him it was only feasible because the author had crowded into a very small area apparently a very large number of lamps. The dimensions of the space in Fig. 24 were not given, but he concluded that it was intended to be 100 ft. by 100 ft., in which case the six ampere enclosed arc lamps, giving 400 c.p., were only 17 ft. apart and 10 ft. from the ground. Of course this was a condition which did not exist in practice. If the space taken for such a test had been 300 ft. by 300 ft., it would have been a more normal condition. Under these conditions, using the eight Carbone lamps, the maximum horizontal illumination at any point would be 5·6 candle-ft., and the minimum 0·29 candle-ft., a difference of 19 times. This was not anywhere near as even an illumination as with 35 lamps, because their maximum illumination would be 2·2 candle-ft. and their minimum 1·6, which was only 1·65 times. In calculating direct illumination, they should not, as many people did, add the illumination from the various sources, because it illuminated the various sides of the objects, and therefore only applied to certain points of view from which the object was looked at. He hoped Mr. Andrews would explain how he came to compile these curves, because he had spent a good deal of time trying to repeat them but had not succeeded. The question of the type of carbon used in that particular lamp for these tests was also important, because Mr. Andrews knew as well as anyone that this would affect the candle-power of an arc lamp probably as much as anything else. If a high-quality soft carbon were used on the Carbone arc lamp it would be utterly unfair to compare them with the tests described in the early part of the Paper, for many of these were with carbons which people could afford to use under practical conditions. The carbons would also affect to a large extent the colour of the light with an arc of that length. Mr. Andrews had invented a new factor which he did not remember having seen before. He spoke of "the satisfaction to the general public per watt," which was obtained by looking at the lamp and seeing if there was a large area of illuminated surface, and then seeing if there was a large bright splash of light below. He thought, however, that the public were getting a little more educated than that now. One would only have to use a very dense globe and leave a small hole in the bottom in order to get the necessary splash of light underneath the lamp. But Mr. Andrews had taken this very seriously, because he had actually done this. But this would look very curious if it were spread over a large area. Could they imagine walking down a street, for instance, with these beautiful circular brilliant holes at intervals all the way? This was just what they should try to avoid, although, curiously enough, it was what the Carbone lamp did. It gave the maximum rays beneath the lamp, and the horizontal rays were comparatively low. When he first heard of it, three years ago, the lamp was a great novelty. They were not used to lamps with inclined carbons, and he doubted whether we should ever have seen or heard very much of that type of lamp if it had not been for the introduction of the flame carbon, and Mr. Andrew himself gave the reason for this. These lamps were efficient simply because they were able to produce a flame which had a very big illuminating power and the light emanating from it was in the direction in which it was wanted to a very large extent. Their efficiency had nothing whatever to do with the crater of the light. If the satisfaction of the general public per watt were to be brought down to figures it would be best expressed as the inverse ratio of the cost per candle per hour. From that point of view he wished Mr. Andrews had given more figures as regards the actual cost with the Carbone lamp, such as the carbons that had to be burned, trimming, &c. He quite agreed with the author as to erecting this type of lamp as high as possible, and he only wished he could persuade people to do it. But there were lighting committees who objected to lamps being erected more than 20 ft. above the ground in the streets. Apparently the lesson which Mr. Andrews said they should learn from nature was that they should vary the height of the lamps for every hour of the day, so as to be able to please everybody.

OBSERVATIONS ON THE MERCURY ARC AND SOME RESULTANT PROBLEMS IN PHOTOMETRY.*

BY C. ORME BASTIAN.

Throughout this Paper a distinction is drawn between the mercury arc lamp, which is provided with mercury electrodes, and the mercury vapour lamp, which is provided with electrodes of some non-readily vaporisable material (such as iron or carbon) in an atmosphere of mere mercury vapour enclosed at a certain low specific density. In the latter type of lamp—more akin to a Geissler tube—the density of the mercury vapour within it must be the same when it is cold as when it is heated and in operation; whereas the vapour density within the mercury arc lamp varies as the temperature varies, owing to vaporisation or condensation of the mercury at the electrodes.

The author's serious attention was first directed to the mercury arc in the year 1902, whilst experimenting with a mercury switch in series with a 220 volt 100 c.p. carbon filament lamp. The mercury was enclosed within an exhausted glass tube about $\frac{1}{4}$ in. diameter, and it was observed that, on tilting the tube to cause the mercury to divide into two separate bodies, the effect was not to break the circuit, but on the contrary a 3 in. arc was formed between the two separate bodies of mercury, and at the same time it did not appear that there was any marked diminution in the light yielded by the carbon filament lamp in series. This brilliant 3 in. mercury arc was, therefore, apparently consuming a comparatively negligible quantity of energy, and the experiment furnished a sufficiently conclusive object lesson to encourage further trials, and particularly so when it was noticed that by enclosing the carbon filament lamp and the mercury "switch" under the same globe, a very pure white light was obtained from the combined spectra. It seemed as though something were being obtained for nothing, since the new combination certainly yielded much more illumination than the carbon filament lamp alone, and the consumption of energy was measurably less.

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* Paper read before the Glasgow Local Section of the Institution of Electrical Engineers, on Tuesday, May 8th.

Extended trials have forced the author to the conclusion that there is an altogether unexpected gain in luminosity obtainable by combining the characteristic green light of the mercury arc with the light yielded by a carbon filament lamp, in which, of course, red is the predominating colour; and it is thought that an explanation of this phenomenon may be found in a study of the physiological effect of light energy upon the optic nerve.

Every colour produces a certain degree of visual effect, and white light undoubtedly produces the greatest visual effect of all. It seems not unreasonable, therefore, to conclude that an actual gain is effected by combining two colours to produce white light, and this being so, then the addition of a carbon filament lamp to a mercury arc lamp results in a much more efficient light-producing combination than one would at first expect. It would be idle to claim any degree of gain in visual effect if, by the blending of red and green light, there were merely produced a *mixed* effect due to those colours, instead of the entirely different *compound* effect which actually is the result of their combination. The increased illumination can be optically demonstrated by causing two beams of light, red and green respectively, to impinge side by side upon a white surface, and, after taking note of the illumination yielded by the two separate coloured patches, deflecting the beams so that they are superposed, when a white light of greatly increased brilliancy will be the result.

It has been found impossible to first photometer a red light and then a green light, and then the white light resulting from the combination of the two, because the candle-power of a green light cannot possibly be determined or expressed any more than the intensity of one odour can be expressed in terms of a totally different odour.

The light from a candle bears no more relationship to the light from a mercury lamp than the smell of a violet bears to the smell of a rose, and any numerical comparison between them would be equally meaningless and impossible.

Several testing authorities have expressed the opinion that the impossibility of obtaining accurate and uniform results of the candle-power of a mercury lamp as compared with the usual carbon filament standard is to be ascribed to the Purkinje phenomenon, his law, according to Helmholtz, being as follows: "Intensity of sensation is a function of the luminous intensity, which differs with the kind of light;" and the author would amplify this law by stating that the optic nerves are proportionately more responsive to a white light than to any of the individual component colours, and that they respond to the component colours in varying degree. While the above law helps to explain the fact that a white light yields more visual effect than when it is resolved into its component colours, nevertheless it does not help towards an understanding of the further fact that a greenish-blue light gives better and better comparative photometric results as its distance from the carbon filament standard is gradually increased.

A mercury lamp tested at the Laboratoire Central d'Electricité (Paris) at 1·86 metres from the standard was returned as being of 14 c.p., but when tested against the same standard at the increased distance of 21·5 metres it was returned as being of 25 c.p., and the only explanation that was offered to account for the discrepancy was that it was due to the Purkinje phenomenon; but the author considers that this is no sufficient explanation at all, and that the varying results obtained are principally due to two additional causes: (1) The difference in the intrinsic light density of the two illuminants. (2) The different resistance offered by the atmosphere to the passage of different luminous wave lengths.

It must be remembered that the law of inverse squares is a law founded on purely geometrical considerations, based on the fact that light rays diverge in a definite manner, and on the assumption that the source of light is a point. In practice the latter assumption can, of course, never be correct, and the more diffused the light is at its source the greater will be the error due to this wrong assumption; and that this error is not of a negligible quantity will readily be appreciated when it is pointed out that the intrinsic light density of a carbon arc lamp, as compared with a mercury arc lamp, is in about the ratio of 40,000 to 10 as nearly as can be computed. Ganot points out that "it is important to observe that it is in consequence of the divergence of the luminous rays that light decreases as distance increases. This decrease does not obtain in the case of parallel rays; their lustre would be the same at all distances were it not for the absorption, which takes place even in the most diaphanous media."

By absorption of light, transformation of light into non luminous wave-lengths must be understood, and it is submitted here that such transformation of light, due to the resistance of the atmosphere, is not taken any account of in practical photometry to-day, whereas proper consideration of the losses due to this cause would go far towards accounting for the discrepancies which are referred to above, and which, by most practical men, are regarded as unexplainable phenomena. It is difficult to conceive why these losses are not generally appreciated as probable sources of grave error in photometric work, and are not allowed for accordingly.

The further the photometric screen is from the source of light, the more nearly will the rays impinging on it be parallel to one another, and the lower the intrinsic light density at its source, the lower will be the light density of the approximately parallel rays in the intervening medium between the source of light and the screen; and, bearing this in mind, it will be apparent that, in the case of a carbon arc lamp, the light density in this intervening medium is about 4,000 times greater than it would be in the case of a mercury arc lamp; and it is submitted that the transformation of light into obscure energy in that medium would take place in the same proportion; and if so, this would sufficiently account for the fact that illuminants of low-light density, such as mercury arc lamps, incandescent gas mantles, bat-wing gas burners, &c., yield light of much greater penetrative quality than that yielded by an open-type carbon arc.

That the atmosphere conducts or transmits light of one colour better than light of another colour is no new theory, but a thoroughly established fact pointed out by Tyndall and others; and it is because air is a better conductor of blue light than any other colour that distant objects appear blue, the light reflected from distant objects being all transformed into obscure wave-lengths except the blue light, which persists as such with less proportion of loss.

Tyndall also states that transparent bodies assume the colour which they best transmit; hence the blue colour of the sky and the green colour of water; and it follows that the atmosphere, composed as it is of air and water vapour, should be a better conductor of blue and green light than of any other colours; and this theory is exactly borne out by all photometric tests which have been made with the mercury arc lamp, in the spectrum of which, as is well known, in addition to yellow, green and blue are very abundant. The mercury arc light compares more and more favourably with a reddish-yellow standard as its distance from the standard is increased, and it is maintained that this increase of distance, resulting as it does in an increased length of resisting medium—especially when considered in conjunction with the intrinsic light density at the two lamps—will better explain the non-uniformity of the results obtained than a consideration of Purkinje's law alone.

The foregoing remarks may be summed up in the following conclusions:—

1. The penetrating quality of light is a function of the light conductivity of the atmosphere, the conductivity of which is different for each distinct wave-length.

2. The absorption of light in the atmosphere between any source of light and an illuminated body varies directly as the density of the light at its source, all other conditions being equal; and it also varies directly as the distances vary between the source of light and the illuminated body.

More useful results might be obtained if the luminosity of lamps were expressed in terms of a white standard, against which they should be tested—if the quantity of light permits—first at a distance of, say, 10 yds., and then of 100 yds., the luminosity being taken as the mean of the two results, although the size of the photometer room that would be necessary for such a test is certainly a practical difficulty in the way.

The question of light density continues to be of interest when the efficiency of reflecting surfaces and diffusing globes comes to be considered, as, on the same lines of argument, light density can again be proved an influencing factor. In order to obtain red light from the mercury arc many experiments have been made with rhodamine reflectors, which seem to transform the orange wave-lengths into red wave lengths. At first it was found that the rhodamine quickly lost its peculiar transforming property, fading into white, but increased permanence was obtained, and more efficient transformation of the light, by providing a large reflector at a greater distance from the burner. That the improved results were entirely due to lower light density, and not to temperature, seems to be shown by the fact that heating the reflector in the dark does not produce any fading. The rhodamine near the rim of a conical metal reflector will retain its colour much longer than that near the apex, although the distance from the burner to the rim may be less than the distance from the burner to the apex. In this connection it is interesting to note that the apex of such a reflector will remain hot long after the rim has cooled down, even though the apex is lowermost, and it may be, therefore, that the fading is due to the combined effect of heat and light.

One of the earliest difficulties encountered in the construction of a mercury arc lamp arose from the fact that the mercury apparently migrated from the positive electrode through the arc to the negative electrode, and consequently, sooner or later, the positive electrode became depleted of all its mercury; arcing then took place from the platinum leading-in wire, which, becoming hot, cracked the glass around it and spoilt the lamp. It did not seem possible that this migration of mercury was due to vaporisation from a hot positive electrode and condensation at a cooler negative, because all the observations seemed to indicate that the positive was the cooler of the two. It was exceedingly difficult to determine with certainty the difference, if any, between the temperature of the electrodes, because this migration of mercury resulted in constant variation of their respective heat-radiating surfaces; but two observations in particular may be mentioned in proof of the assumption that with equal heat-radiating surfaces the seat of highest temperature is at or near the negative electrode surface. When equal-sized electrodes are formed of a plastic alloy of cadmium and mercury, the alloy melts more quickly at the negative electrode than at the positive. Again, if a burner is overrun, the glass invariably melts at or near the negative electrode surface, and the absence of any evidence of heat at the positive electrode is very marked in contrast. It was concluded, therefore, that the migration was due to an attraction of mercury atoms from the positive to the negative electrode, through the arc. Certain peculiar markings that appear after a time at the bends of a burner formed out of a zigzag tube, seem to point rather to the fact that the atoms are attracted from one electrode to the other, and to disprove the general assumption that they are to be regarded as projectiles, the markings on the glass appearing just where a piece of elastic would bear, if stretched between the two electrodes. It should be mentioned, however, that these markings have only been observed in the case of burners made of lead glass, and have not so far been clearly traced in the case of burners made of Jena glass.

Taking it as proved, then, that mercury is transferred, during the operation of the lamp, from the positive to the negative electrode, due to some effect of the electric current other than heat, it was conceived that this could be compensated for by transference of mercury in the reverse direction, if the negative electrode could be maintained at a sufficiently higher temperature than the positive; and by constructing the burners so that the negative electrode surface is smaller than the positive, this compensating effect is actually obtained, with the result that constant quantities of mercury are retained at each electrode respectively throughout the operation of the burner.

If the theory is correct, there is a stream of vaporised mercury passing from the negative to the positive electrode, due to the difference in heat potential and a stream of ionised mercury passing from the positive to the negative electrode, due to the difference in electric potential; and whether the theory is correct or not, the result remains the same—namely, that the migration of the mercury from the positive to the negative electrode is compensated for or prevented. If either electrode is heated with a spirit lamp, an excess of mercury will be vaporised, which has the effect of choking the arc, and increasing its resistance until the lamp goes out; but heating the arc stream itself has not the same effect, and the arc is rendered more unstable by heating the negative than the positive electrode.

When an arc is struck by separating the column of mercury in the centre of a small, straight tube, the mercury forming the positive electrode steadily recedes as the formation of vapour in the arc increases the pressure; but the mercury forming the negative electrode does not recede steadily in the same way, but, on the contrary, commences a regular pumping motion, to and fro, and unless the burner is specially constructed to prevent it, this pumping motion continues indefinitely. No satisfactory explanation can be found, unless it be caused by the impact of mercury atoms attracted from the positive. It cannot be due to varying pressure in the arc, as that would surely cause the positive electrode to pump in the same way.

Another observation, that might be suggestive if it were not so inexplicable, is that two mercury arcs cannot be struck between one common negative and two positive electrodes. A burner has been constructed Y-shaped, with a negative electrode at the end of the leg of the Y and a positive electrode at the end of each of the forks. The leg of the Y was made out of tube twice the cross section of the tube forming each fork, and on tilting the burner, so as to strike an arc at the negative electrode, it was found that this arc could be drawn out down one or other of the forks of the Y, but it would never divide into two, so as to arc down both forks simultaneously. It occasionally jumps from one fork to the other, but under no condition yet discovered can the arc be divided into two.

When another metal, such as cadmium, is alloyed with the mercury and used as electrode material, spectroscopic examination of the arc shows that the cadmium is usually most evident in the negative half, the mercury spectrum alone being apparent in the positive half of the arc; but an addition of series resistance, which reduces the vapour density in the arc, causes the cadmium to manifest itself more evenly throughout.

On the other hand, if the burner is overrun the cadmium is crowded out of the arc entirely by mercury vapour, and is not spectroscopically visible at all; but it is probable that were cadmium vaporisable at a lower temperature and pressure than mercury, then the reverse would be the case, and the cadmium spectrum would alone be visible.

When a liquid alloy of sodium and potassium or zinc is used in the place of cadmium, the effects observed are the same as with the latter; and while it is possible to modify the colour of the mercury arc light almost as desired by alloying other metals with the mercury, it has not yet been found possible to do this, so far as the author is aware, except at great sacrifice of "life" and efficiency. It is highly improbable, however, that the last word has been said on the subject, and, in the meantime, an excellent alternative is found in the combination mercury arc and carbon filament lamp.

For some time past this combination has been tried with excellent results, and has given satisfaction to even such a critical class of customer as a London West End tailor. Another case may be mentioned where these combination lamps have replaced Welsbach gas lamps in the lighting of a public billiard room in London. One 60 watt mercury arc combined with one 60 watt carbon filament replaced two 5 ft. gas burners, and at 3d. per unit and 3s. per 1,000 ft. this works out at even cost for electricity and gas consumption respectively; but the electricity produces more light of better quality.

In addition to the question of current consumption, the amount of attention necessary must be considered; and here again electricity has the advantage, as, with careful manufacture out of Jena glass, the mercury arc has burnt continuously for over 10,500 hours without any appreciable diminution in efficiency; though the high voltage lamps have yielded much better results in this respect than the low voltage.

It is here submitted that for many purposes the mercury arc lamp will prove a useful weapon with which to combat the keen, but doubtless healthy, competition with which electric light is now threatened by other illuminants; and the necessity is urged for a reliable white standard of light, and larger photometer rooms than are now available.

UNSOLVED PROBLEMS IN METALLURGY.*

BY R. A. HADFIELD.

Heat Treatment.—As an illustration of the complex nature of the problems with which the metallurgist has to deal, I will specially refer to the effect of heat treatment upon the metal iron and its alloys. One example is found in the curious magnetic properties of high nickel-iron alloys and iron-manganese alloys. Whilst the alloys appear practically non-magnetic at atmospheric temperatures, upon cooling down in liquid air they become considerably magnetic, and remain in this state until again raised to about 500°C., when they become non-magnetic. This cycle can be carried out as often as desired with the same result.

These structural changes must be very great, for the special steel containing 20 per cent. of nickel, which is almost non-magnetic or only feebly so, has a tenacity of 44 tons per square inch, and elongation of 55 per cent., a reduction of area of 63 per cent., and can be readily machined at ordinary temperatures. Upon being immersed in liquid air, however, it becomes strongly magnetic, its tenacity increases to the extraordinary figure of 157 tons, whilst its ductility still remains fairly high—namely 15½ per cent., and it can now only be machined with difficulty. This steel after returning to atmospheric temperature retains a tenacity of no less than 115 tons per square inch, or more than 2½ times that of its original condition, and has an elongation of 4½ per cent.

The alloy of iron and manganese with which I have worked so many years is not, singular to say, affected by any change in temperature, whether the highest or that of liquid air; it always remains non-magnetic except when annealed for a long period.

Electro-Thermic Smelting of Iron and Steel.—There are many unsolved problems to be worked out in connection with the production of steel. The Bessemer and Siemens-Martin processes have been carried to a great refinement, and the material produced by them, as regards quality, holds a high place in engineering construction, whilst the rapidity of production and low cost they have made possible are economic advantages of a high order. Beyond improvements in detail, none the less important because they are small, these processes remain in principle much as they were originally. It will probably be a long time before they are supplanted.

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* Extracts from the fourteenth "James Forrest" Lecture, delivered at the Institution of Civil Engineers on May 1st.

There are those who look forward to an electrical method of producing iron and steel. If any practical system of this nature for converting iron ore into pig iron or steel could be introduced, using the stored-up powers of Nature instead of burning carbonaceous fuel, the revolution in practice would be great. Probably over 100 million tons of coal, equal to about one-seventh of the world's total output, are used annually in the smelting of iron, to say nothing of the further large quantities employed in the subsequent working of iron and steel into more finished form. Where water power and suitable iron ore can be found together, then, no doubt, satisfactory electrical smelting practice will be developed, but this can only come slowly.

Pioneer work is being done in Sweden, France and Canada in electrical smelting for the production of steel, but unless water-power can be obtained at economical rates it would seem that the application of this system must remain very limited; that other sources of power should be used at present appears out of the question from an economical point of view. Moreover, the electric furnace does not purify steel more than other furnaces not specially adapted to that purposes. Bad steel can be produced by it as easily as by the ordinary processes. Some of us know how often the old type of crucible steel melting, so largely practised in Sheffield, has been threatened with extermination, but more material is now produced in this way than ever before. The electrical system has in this older method, notwithstanding its extraordinary wastefulness, a competitor that will not soon be annihilated. There is no magic in the electrical method as it would almost seem some would have us believe. Steel made by it shows similar analysis, and has the same physical qualities as that produced in other ways.

Electric Furnaces.—An important question in connection with electric furnaces is, whether they can ensure uniformity of temperature. It is well known that they are apt to produce steel which is much colder at the top of the molten bath than underneath; this is, of course, objectionable. Of the many failures with electric furnaces we hear little; it would be interesting to know more about them. I say this in no disparagement of a "young" process, but to prevent the uninitiated being dazzled by the mere term "electric."

It is stated that the efficiency of the electric furnace is already comparatively high, say, 50 per cent., but under present conditions it would still be more expensive to develop heat at any temperature within the range of a coal-fired furnace by electricity than by coal; that is, if electricity has to be generated by steam power, even with plant of the highest efficiency.

The electric furnace has a range of temperature of about twice that of the ordinary steel furnace, so that it will extend up to about 3,000°C. Reactions which take place within certain limits of temperature as now practised may be reversed at the higher range made available by the electric furnace.

Whilst speaking of high temperatures it may be pointed out that no one knows the behaviour of the elements present in the sun, the temperature of which is estimated to be between 7,000°C. and 8,000°C., neither can we foresee what will be the behaviour of metals at temperatures above the limit of our present ordinary furnaces, that is, above about 1,500°C.

Alloys and their Special Properties.—In the brittle iron-manganese alloy containing 4½ per cent. manganese, the properties of iron seem quite reversed. Although the carbon present is comparatively low, yet this alloy is more brittle than cast iron. With an increase of manganese to about 12 per cent. the properties of this alloy again entirely change, and it becomes of more than ordinary interest. When forged and treated, this steel has a tenacity of about 60 tons per square inch, with a ductility of 40 to 50 per cent., or considerably more than that of pure iron. Yet the determining factor, manganese, is in itself an exceedingly brittle metal. It also becomes practically non-magnetic, and, unlike certain nickel-iron alloys which also appear to be non-magnetic, but are reversible, it cannot be rendered magnetic even by quenching in liquid air, nor does ordinary heating render it magnetic. When it is considered that the same metal, manganese, combined with copper and aluminium in the material known as the "Heusler" alloy, gives a magnetic product, although no iron is present, it will be recognised what a wonderfully wide field for research is offered by alloys of various kinds. The results to be expected are so curious that it is not possible to generalise from one to another; each alloy must be worked out.

Whilst speaking of magnetic properties, one of our profound thinkers in electrical problems, Dr. J. A. Fleming, F.R.S., in a joint Paper by him and myself to the Royal Society in June last, considers it is very probable that ferro-magnetism, *per se*, is not a property of the chemical atom, but of a certain kind of molecular grouping. The importance of this cannot easily be overstated. It shows that, in spite of the fact that ferro-magnetism has been hitherto regarded as the peculiar characteristic of certain metallic elements—iron, nickel and cobalt—this may depend eventually upon molecular grouping, composed of a comparatively large number of molecules; hence it may be possible to construct alloys which are as magnetic as, or even more magnetic than, iron itself. Attention may be drawn to the brilliant researches on alloys of iron with other elements by Mr. L. Guillet, of Paris, who has this year been awarded the Carnegie Gold Medal.

Another illustration of the peculiar nature of these iron alloys is that of "Resista" steel, already described before our Institution. This material contains 80 per cent. C., 6 per cent. Mn., about 15 per cent. Ni., and the rest iron. In the cast form it can be bent double when cold, as illustrated by the 2½ in. bar shown. When forged, its tenacity is 58 tons per square inch, with the extraordinary elongation of 60 to 70 per cent. This alloy is only feebly magnetic until cooled in liquid air, when its magnetic properties are considerably increased, but it is not embrittled by this treatment. Now a singular fact regarding this alloy is that if either the manganese or the nickel is omitted, an extremely brittle product is the result; but combined together they produce the most ductile iron alloy known. The curious electrical properties of this and many other iron alloys have been carefully studied by Prof. W. F. Barrett, F.R.S. They were illustrated by a number of experiments and researches in which he and I collaborated.

A number of alloys, also metals, have peculiar properties, including inert, pyrophoric alloy, magnetic copper alloy containing no iron, tantalum, manganese, chromium, 75 per cent. silicon alloy, hematite cast-iron containing only 33 per cent. silicon, yet at the same time no less than 2·03 per cent. graphite. The pyrophoric alloy contains 30 per cent. iron, also cerium and other rare metals. The pyrotechnic display on scratching with a file makes it of spectacular interest. "Inert" is a non-magnetic cast iron, containing about 13 per cent. manganese, yet at the same time it is machinable.

From this short summary it will be seen how extraordinary are the properties of different alloys, and that a knowledge of each of the metals of which they are composed may not necessarily be any guide as to the properties when alloyed together. The field is immense, and the future progress of the metallurgical world largely depends upon research which will enable us to correctly understand and interpret the laws at work in producing these curious results.

In a useful Paper on "Ferro Alloys" recently read before the Institution of Mining and Metallurgy, Mr. O. J. Steinhardt, Ph.D., F.C.S., points out the importance of this subject. With the many metals and alloys now at our disposal the number of useful alloy steels which may be produced has been greatly extended. The study of these affords a field of such magnitude that it requires the ceaseless investigation of master minds to select those combinations which give the desired results with the least expenditure.

Pyrometry.—Such immense strides have been made in this branch of science during the last decade that when we look back the advance appears marvellous considering the short time that has been occupied by the work.

It is but a few years ago that any correct determination of high temperatures became possible; chaos is the only word suitable to the conditions previously existing. Misleading data only increased the confusion. Now, by means of the modern pyrometer, temperatures up to 1,100°C. or 1,200°C. can be determined within a few degrees: in fact, Callendar claims that by his research instrument it is possible to indicate within one-tenth of 1°C. Modern advance in metallurgy largely depends upon working within extremely narrow ranges of temperature in heat treatment, and for this reason our debt is great to the scientific men in this and other countries who have helped to solve this important problem. Four names are specially prominent—Siemens, who originated the electric resistance pyrometer; H. le Chatelier, a Frenchman to whom we are all indebted, and Callendar and Roberts-Austen of this country.

SOME FEATURES AFFECTING THE PARALLEL OPERATION OF SYNCHRONOUS MOTOR-GENERATOR SETS.*

BY J. B. TAYLOR.

In this Paper the phrase "synchronous motor-generator" means an A.C. synchronous motor directly connected to an A.C. generator.

The most common use of motor-generator sets is to effect a change in frequency, so that standard lighting apparatus, A.C. arc lamps, &c., may be operated from a system of lower frequency designed primarily for railway or power purposes. Such sets are also used as a means of interchanging power between systems a ready established and operating at different frequencies.

Considerable difficulty was experienced with some of the first of these sets; for instance, a set on being started and connected in parallel with others already carrying a load would, on some occasions, refuse to take any of the load, and at other times it would take a great deal more than its proper share of the load. Those troubles were due mainly to lack of consideration of the possible combinations of phase relations of any given set depending on connections and loads.

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* Abstract of a Paper recently read before the American Institute of Electrical Engineers.

In addition to the phase displacement of the generator E.M.F., due to angular lag of the motor, there is a further displacement between the E.M.F. of the generator of the set under load and the set under no-load, due to the phase difference between the generator induced E.M.F. and the generator terminal E.M.F.; the amount of this displacement depending on the amount and power factor of the load, and also on the design of the generator.

Two sets of identical construction, connected in parallel on both motor and generator ends, will each take the same amount of load, provided field excitations are equal. If either set has a motor or a generator designed for closer regulation than the corresponding machine of the other set, the set having the closer regulating machines will take more than its share of the load.

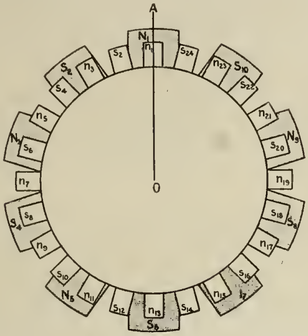

FIG. 1.—SYNCHRONOUS MOTOR, 10 POLES 25 ∽. GENERATOR, 24 POLES 60 ∽. 300 REVS. PER MIN.

In the previous discussion it has been assumed that the mechanical construction of the two sets is identical. Since identical mechanical construction involves perfect alignment when machining the keyways, milling slots for pole pieces, armature laminations, &c., it is difficult to construct two sets having an initial phase difference of less than two or three degrees. If slight differences in machining cause the generator of one set to have an E.M.F. wave in advance of the wave of the other sets, this machine will, at no load on the system, reverse the action of the other sets, causing the generators to act as motors, and the synchronous motors to act as generators. Such contingencies are provided for by constructing the sets so that one of the machines may be shifted slightly axially.

Consider a set working between 25 and 60 cycles. Tho smallest number of poles possible in this combination is 10 for the motor and 24 for the generator. Fig. 1 represents such a set. A study of this figure will show that there are only two poles on the motor which will give proper phase relations on the generator end. Therefore, with one of these sets in service, to connect in parallel a second set, it is necessary to bring one or the other of these two poles to the reference point, the reference point being already determined by the set in service. This means that it is not sufficient to phase the set for one end only, but it must be phased for both motor and generator ends simultaneously. This may be done by one of several methods.

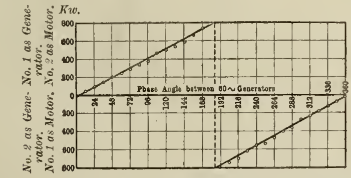

FIG. 2.-INTERCHANGE OF POWER. 500 KW. SYNCHRONOUS MOTOR-GENERATOR SET. 60 ∽ GENERATOR, 2,300 VOLTS. 25 ∽ MOTOR. 100 PER CENT. POWER FACTOR.

When the 25 cycle motors of the sets are in synchronism, the 60 cycle end of an incoming set has one chance in five of being correct for connecting in parallel with other sets already in service. The Chicago Edison Co. uses a special synchronism indicator with two hands appearing on the same dial. The position of the 60 cycle hand on the indicator shows whether or not the phase relation is correct. If incorrect, the switch in the circuit to the synchoronous motor is opened, and the set begins to slow down; the two hands of the synchoronism indicator begin to revolve at different speeds, the 60 cycle hand making 2·4 revolutions for each revolution of the 25 cycle hand. The operator closes the switch at the instant when both hands appear at the top of the dial simultaneously, indicating proper phase rolation for the two machines.

Obviously, in those cases where the sets are started by such means as direct-connected exciters or induction motors, we may use either a double synchronism indicator, connecting either motor or generator to the 'bus bars at the instant when the indicators show proper phase relations for both machines, or we may merely synchronise the motor by the ordinary methods, and then obtain proper phase position for the generator by suitable field reversing switches.

Fig. 2 shows the interchange of load between two similar 500 kw. sets working between 25 and 60 cycles. This curve gives the wattmeter readings, showing interchange of load between the two 60 cycle machines when connected in parallel with a given phase displacement. The 30 different phase positions were obtained by changing connections, as outlined previously. The wattmeter readings were obtained from polyphase instruments, and during the test the excitation of the synchronous motor was held so as to keep the power-factor indicator at 100 per cent.; the generator voltage was held at normal, 2,300 volts, by changing field excitation as required by the load. It will be seen that the curve does not cross the base line at zero degrees, these being machines which have been referred to in another part of the Paper as having an initial phase displacement, due to slight errors in machining, of approximately 4 deg.

It has been previously noted that the generator of a set, before connection to the 'bus bars, has a terminal E.M.F. in advance of the 'bus bars, or machines already under load. This means that with the usual method of procedure, at the instant of connecting the machine to the 'bus bars, it has a tendency to take momentarily more than its share of the load. In practice, however, this is not found to be a serious objection, although it might be obviated in various ways. For example, a reactive coil in the motor leads would allow sufficient phase difference between the motor 'bus bars and the motor itself to give the same phase relation at the generator terminals as at the generator 'bus bars. After connecting the generator to the 'bus bars the reactance can be gradually cut out; or, if left in, could be used to permit a change in division of load by adjusting the motor-field excitation. If the generator is connected to its 'bus bars before the motor is connected to its 'bus bars, the set will settle down to its proper division of load by the reverse process; that is, instead of first taking more than its share of the load and then settling down, the generator will, for a short interval of time, act as a motor and gradually assume its proper load as a generator. It should also be noted that there will be a given excitation for an incoming generator, which will give a minimum disturbance on the system, and this excitation having been found experimentally, there should be no appreciable flicker in the lights while connecting the new machine.

Some change in the division of load between sets may be effected by changes in excitation of generator, or motor, or both. Such means of securing division, however, is not to be recommended; it is done at the expense of leading or lagging currents, with consequent increased heating losses.

SUBMARINE SIGNALLING BY MEANS OF SOUND.*

BY J. B. MILLET.

I remember an old pilot telling me that his grandfather, who had been a pilot before him, was wont, in foggy weather, to go down into the hold, and, with his ear to the skin of the ship below the water line, would listen for the sound of the paddles of passing steamers. To-day the masters of our greatest steamships are listening with ears to the walls of their vessels, and it has been a triumph of modern science, not only to enable them to make their observations in the quiet seclusion of the chart house, but to demonstrate conclusively that, in the instinct of the old pilot, lay the fundamental principle of safety at sea.

The history of the Submarine Signal Company had its birth in 1895, when the United States were at war with Spain. Mr. A. J. Mundy, one of the chief inventors, while sailing from New Orleans up the Mississippi river, and sharing the general alarm created by the reported approach of Spanish torpedo boats, bethought himself of his youthful experience of hearing stones cracked together under water. With the principle of the telephone transmitter in his mind, he speculated whether the microphone could be utilised as a receiver of sounds under water. Not being himself an electrician, he wrote, on reaching St. Louis, to Prof. Elisha Gray, of Chicago, one of the pioneers in telephonic invention, and enlisted his assistance in devising a practical apparatus. Their investigations were carried on during the summer in the open sea near Boston, and the results obtained were such as to encourage the subscription of ample capital for continuing the work upon an extended scale. A scow large enough to be towed out to sea was built, and from it bells were suspended and rung for experimental purposes. A special shop was engaged and provided with a laboratory, and with all the machinery needed to make any apparatus that the inventors designed. The services of electricians, schooled in telephonic work, were engaged to devise a microphone adapted to use under water. This in itself was a most difficult undertaking, and was not successfully mastered for many years. As soon as the organisation of the working force was complete the inventors sought the assistance of leading professors of acoustics and experts in aerial signals for the sea. But to their dismay they discovered that students of sound had confined their researches to the air and had little knowledge of the various principles of sound in water. Nor were any references to the subject to be found in text books. The files of scientific publications were searched in vain for records of laboratory experiments with sounds submarine, so that the inventors were face to face with the necessity of depending upon their own unaided investigations. They reasoned quite naturally that whatever was true of sound in the air would be true of sound in water, but experience in time brought the conviction that it was most unsafe to trust to analogies between the two mediums. This made it imperative to construct and operate in the sea a large number of different forms of apparatus, in order to obtain results from which to lay down general lines of work. Everyone working on actual experiments had to be trained by experience in the sea before observations could be trusted. All this occupied several years, and was attended with great self-sacrifice and devotion to the cause, not to mention personal risk.

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* Paper read before the Society of Arts, May 2nd. Slightly abridged.

For my own part, I may say that to be suddenly called upon to turn from the peaceful trade of publishing to take charge of scientific research in an unknown and difficult field was somewhat terrifying. Death had overtaken Prof. Gray in the midst of his work, and not long after, continuous anxiety to succeed, combined with long hours of labour, undermined Mr. Mundy's strength, and he was obliged to abandon the work. For some time previously I had been associated with Mr. Mundy as vice-president of the company, and at this juncture the direction of affairs fell to me. I soon realised that only by making my home on the water, and, as it were, living with the problem, could I hope to acquire an intimate knowledge of submarine sound, and to apply along practical lines the somewhat unrelated strands of previous discovery. The nights and days of two summers on the water, innumerable winter voyages up and down the New England coast, in the open sea and in all weathers boarding and putting off from incoming ships—always listening and testing results—these experiences brought at length in their train a knowledge of sounds of sea and ships, which I now feel to be little less than instinctive. To this knowledge, and to this alone, I owe the inward confidence which has never deserted me in the face of difficulties and discouragements that have proved many times all but insurmountable to others. Neither criticisms from those who had a right to be regarded as experts in nautical matters, nor adverse reports from some whose lukewarm interest proved a hindrance rather than a help, nor yet the opposition of others who hoped to find a fallacy in the principles involved—none of these could shake a confidence founded upon such an extended experience.

The earliest attempts to invent apparatus which would enable ships to detect submarine signals contemplated the fastening of a microphone to the outer walls of the vessel or the lowering of it overboard. The latter seemed the more practical, and much time was lost in trying various kinds of so-called "fish receivers"; for it was believed that if the microphone were fastened inside the ship the noises of the engines and other machinery on a steamer would fill the receivers with a roar and drown the notes of the bell. A few rather hasty experiments in this direction seemed to confirm this belief; but when the towing apparatus turned out to be entirely impractical (for among other defects it could not locate the direction of the sound waves), the inventors were driven to solving the problem from the inside of the ship.

Many years previous to this, Prof. Lucien Blake, an American, who had been studying physics in Berlin, made the discovery in which lay the basis of practical submarine signalling. He found that bell sounds would pass readily from the water outside through the walls of floating structures. The old frigate "Constitution," with its 22 in. oaken walls, proved to be an excellent conductor of submarine sounds. In order to carry on extended observations, arrangements were made for the use of four steamers of 3,000 tons each plying between Boston and New York, and permission was obtained from the United States Lighthouse Department to place submarine bells on three lightships on the route. From this time, the operations of the company were conducted along the lines which led us successfully to a practical system.

The existing sound-producing apparatus used by the company is as follows: First, a bell weighing 160 lb. operated by compressed air and perfected for use on lightships. This is suspended over the side of the vessel and lowered about 25 ft. below the surface. The blows are controlled by a code-ringing device in the engine room, under the supervision of the officers, so that each lightship rings its own number. Second, a bell of similar weight, supported on a tripod placed on the floor of the ocean and operated by electricity sent along a cable from a power-house on shore. Third, a buoy supporting a submarine bell, some 25 ft. below the surface. Situated above the bell is a disc working on the principle of a sea anchor; the difference in movement between this and the buoy operates a mechanism known as the "accumulator," by which the bell is struck with uniform force. On a calm sea the blows will, of necessity, be less frequent than when the waves are larger, but a wave of only 6 in. in height will give sufficient energy to produce two blows per minute.

The tones of these bells have a range varying from six to twelve miles, according to the draught of the observing steamers. The pitch of the bells can be changed by altering the thickness of the rim, or by increasing the diameter. Those used in the earliest experiments weighed 1,000 lb., and were cast for church steeples. Practice showed that the higher overtones of these bells were weak, while those very notes possessed the most penetrating qualities. In order to strengthen these tones, bells less than one-half the diameter and weighing only 150 lbs. were cast with a peculiarly thick lip, and these were found to produce a very high clear note. This diminution in the size and decrease in the weight of the bell greatly simplified the problem of designing a practical bell buoy. It was even found that a bell 4 in. in diameter gave a high tenor note that penetrated the walls of a steamer at a distance of 3 miles. One of the puzzling results of experiments was that instruments which gave a poor musical tone in the air often proved singularly efficient in water.

Nothing in connection with this invention is more remarkable than the musical quality of the bell-note when passing through water and transmitted by a selective microphone. However attenuated by distance, I might say, however unexpected by the listener, the bell-sound when first heard is unmistakable. Amid the surge and hiss of the rushing water its high, clear tone is almost startingly isolated, and as the note becomes louder, with lessening distance, the sensation of a novice at the receiver is somewhat novel. And, again, distance in no way makes the apparatus less trustworthy; were the listening ship suddenly to be lifted and dropped, heading in the same way, in the ocean 5 miles farther off, the bell note, although fainter, would pass through the starboard and port transmitters with unaltered relative intensity.

The apparatus for receiving the sound consists, firstly, of two metal tanks, about 22 in. square, filled with sea water, fastened securely against the skin of the ship below the water line, and not less than a demonstrated distance from the fore-foot. Secondly, a specially-designed microphone suspended, wholly immersed, in each tank. Thirdly, wires connecting these microphones with an indicator box on the bridge. This box is of metal, circular in shape, and is fitted with two telephonic ear pieces or receivers, enabling two observers to listen simultaneously. By moving a switch the listener can hear instantly the sounds of port or starboard at will. As a provision against accident, a second set of microphones is placed in each tank, and by manipulating another switch on the indicator box, the operator is able to connect either set at will.*

The method of using the apparatus is remarkably simple. Let it be supposed that a ship equipped as above is coming within range of the sound of a submarine bell. The observer, with the receiver to his ear, listens to starboard and port alternately by quickly turning the requisite switch. Presently he hears the high musical note of the bell and, referring to the face of the indicator, can tell from which side the sound emanates. He then connects with the other side, and if the note of the bell can be distinguished there also, the observer knows that the ship is heading in the general direction of the signal. It then becomes his duty to compare, by turning the switch to and fro, the intensity of the bell notes on starboard and port sides. Experience has shown that by this method the bearing of the submarine bell can be rapidly determined to within less than a quarter of a point. Of course, if the bell is abeam or nearly so, the sound will be heard only on that side. These observations can be made when the vessel is proceeding at its full speed, and under such conditions, signals have been often accurately located at distances up to 10 nautical miles. In foggy or thick weather, when speed is reduced, the diminution in the ship's noises enables the observer to hear the bell at greater distances. These results are valuable, not only on account of the long range of the signal, but because the direction can be accurately determined under all weather conditions, whereas it is notorious that sound signals in the air are wholly untrustworthy. A remarkable illustration of this fact recently came under my notice. A party of observers set out to test the sound range of a siren on a lightship. The conditions were favourable—a calm sea and a clear, still air. The boat approached nearer and nearer the lightship, but not a sound reached the ears of the listening experts. At a distance of 600 yds., without the slightest warning, these gentlemen were all but deafened by an apparently sudden roar from the siren, which continued until they boarded the lightship. Inquiry amply proved that the instrument had been sounding at its full pitch at frequent intervals for over three hours.

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* Eighty-eight steamers and pilot boats on the Atlantic have already been equipped with the Submarine Signal Co.'s apparatus, including liners owned by the Cunard, White Star, Allan, Norddeutscher Lloyd, Hamburg American, Compagnie Transatlantique, as well as several warships of the United States Navy, amounting in all to a gross tonnage of 400,000 tons.

I do not suggest, however, that sound signals in the air should be superseded. Our invention is intended as an added aid to navigation. That it has accomplished more than its supporters could have anticipated is proved by the notable position it now occupies in the commercial navigation of the Atlantic.

DISCUSSION.*

The CHAIRMAN (Sir William White, K.C.B., F.R.S.) said it might be of some interest if he briefly recounted his own experiences on the subject. He had had the opportunity of testing the invention both at Kiel and in the English Channel. In the former case the German Admiralty made a series of tests. At Kiel the party had a lighthouse tender, which was a large tug full of machinery for dealing with buoys and all the the appliances required for lighthouse service along the coast. It was spoon-bowed, and had very shallow draught. The trial, therefore, was made under very adverse conditions, but up to 4 or 5 miles from the lightship one was able to place the source of sound within about half or quarter of a point. Though he had never tried before he experienced no difficulty. Of course, a person who was deaf was not likely to use the apparatus well, and one person on board could make nothing of it, but he (Sir William) noticed that he could scarcely hear what was said to him. There were some critical people aboard, who complained that they could not hear when the bell was abaft the beam; but as the ship was then going away from the point of danger, the issue was no longer a practical one. One strange phenomenon which he noticed particularly was the following: Many people had noticed when using the telephone that besides the sound they wanted to hear there was an undertone, and sometimes more than that, especially when people were chattering at the exchange. Such an undertone was present in this apparatus, due to the noises of the ship, the washing of the water outside as the bows rose and fell; but the bell sound could be heard quite clearly, and could be differentiated from all other sounds. He could substantiate all that the author had said, that as the distance increased the difference in intensity between the two sides remained; as long as the bell was heard one could tell which side of the ship the sound came from. The ship was slowly swung, and it was wonderful to be at the instrument, and, without seeing the lightship, to tell how the bow was pointing in relation to the lightship. Two things were necessary to make the invention of practical use. One had been shown to have been accomplished—namely, the receiver apparatus in the ships. That had been devised as the result of many years of work, and out of that large expenditure of time and money had come a delightfully simple apparatus. That was true of all successful inventions; they crystallised into a simple practical form, but those who had to do with the process of crystallisation had not a pleasant time. The ship fitting was complete, the apparatus in connection with the bell, the designs of the bells, and the apparatus for manipulating the bells; but unless the bells were operated at the critical point of danger, and unless ships were fitted with the receivers, the advantage of the invention could not be realised. At the Trinity House trials there was absolute agreement on the part of all who witnessed them that the invention was practically successful, and could be depended upon to locate within a quarter of a point the source of the sound up to 5 or 6 miles. The Paper now gave evidence that up to 10 miles the sound could be taken in and its source located. The question, therefore, arose whether with the increased safety to navigation and life and property at sea which could be ensured by the adoption of such a system, it was not worth the attention of all who were concerned with shipping. Trinity House had done its part; it had practically tested the invention, and had given to the shipowners of Great Britain the opportunity of seeing that the apparatus was useful. But until the feeling in the shipping community led to the demand for the equipment of the lightships round the coast, Trinity House would have to wait. At Liverpool the business had gone further than that, and he hoped the author would include in his Paper a list of the ships which had been fitted with the invention. At the present time the Cunard Company, the White Star Company, and, he believed, the Allan Company, had been fitting their ships with it. The lightships on the other side and the ships employed in the Atlantic trade had also been equipped. The North German Lloyd Company—which had a difficult coast—and the Hamburg-American line were also making use of the invention. But until shipowners could see it was worth their while to adopt the apparatus as a means of greater safety, accompanied by greater economy in the matter of insurance, it seemed that the matter was scarcely one for the inventors of the appliance, but for the shipowners themselves. They were the best judges of what was desirable. Fortunately, proof had already been given that the governing authorities of the leading steamship lines in the Atlantic trade answered in the affirmative, and were putting the apparatus into their vessels. It was a subject of remark that proprietors of twin-screw ships never failed to advertise that fact, so as to impress passengers with the resulting increased safety. The same was true of vessels which were well sub-divided into water-tight compartments, and recently he noticed mention was made by owners that their vessels were fitted with submarine signalling apparatus. Therefore, perhaps, it would not be long before those who entrusted themselves and their cargoes for conveyance across the seas would find shipowners making more extensive use of appliances of the nature of that under discussion. To Mr. Millet himself, he thought, all interested in shipping were immensely indebted, not only for giving such information as he had, but for the personal effort which he had devoted to the subject; for Mr. Millet was not by inheritance or previous training led to take up the subject—he did so more or less accidentally, and had been more interested in publishing books in Boston than inventing. Publishing he thought was a more happy occupation than hunting about the New England seas in foggy weather. Though the author frankly acknowledged the work done by the pioneers in the matter, upon Mr. Millet himself rested the greater part of the burden of bringing the invention to its present practical working condition. His (Sir William's) own conviction from observation and personal testing was that the apparatus could be trusted, and that it was a valuable means for increasing the safety of life and property at sea.

Mr. A. R. SENNETT claimed that he was the inventor of the system in reality, and handed to the chairman the specification of a patent taken out by him in 1892, in which, he stated, most of that explained by the author was set out, including the use of the bell under the water, the use of a diaphragm, and the use of the microphone. He wished to make one or two suggestions, because it was not yet too late to make some modifications in the apparatus. In 1890 he (Mr. Sennett) had his attention directed to the matter by a note read by Mr. Stevenson, engineer of Northern Lights, at the meeting of the British Association at Edinburgh. That gentleman said that one of the sirens off the east coast of Scotland was sounding continually in a fog, and a vessel was sent out to observe how the sound fell off. After going a quarter of a mile the sound fell off entirely and suddenly. On going several miles further the sound reappeared as strongly as at first. That revealed a point of great danger to navigation, and he felt sure of the reason. Prof. Tyndall's experiments made for Trinity House, which were published in the appendix to his book on Sound, revealed what Tyndall called "acoustic clouds," which were simply strata of different temperatures of air. Before the days of electricity it was difficult for the voices of even good singers to be heard at the back of the stalls, due to the screen of uprising heated air from the gas burners at the stage front. Every stratum of air at a given temperature had its own index of refraction. In Mr. Stevenson's experiments there was such a transparent cloud, which tilted up the sound of the siren. Fortunately, the conditions in the ocean were always constant, whereas in the atmosphere the reverse obtained. Mr. Millet had given the credit of discovering that the sound of submarine signals would pass through the walls of floating structures to Prof. Blake, of America, but 100 years ago crude experiments by Colladon and Sturm on the Lake of Geneva to ascertain the velocity of sound showed the same thing. They found that the best results were obtained when the mouth of the receiving trumpet was covered with a thin plate of iron. The most important point in the design was the use of a microphone. It was in the use of the microphone that he thought Mr. Millet's apparatus was capable of improvement. He (Mr. Sennett) had foreseen the necessity of eliminating the effect of all extraneous sound, and he concluded that the proper way to do that was to put the receiving instrument in isochronous unison with the transmitting instrument; the whole thing must be carefully tuned, and then the intensity of the sound received became more than quadrupled. That tuning was claimed in the second paragraph of his patent. On such tuning the whole success of wireless telegraphy had been proved to depend. What he had said was borne out by the author's statement that certain tanks gave better results than others, and acted as resonators. A siren, as against a bell, had the advantage that the lighthouse could be made to spell out its own name. He concluded by paying a high tribute to Mr. Millet's devotion and perseverance.

Mr. A. C. BROWN thanked Mr. Millet for his Paper, and explained and exhibited an apparatus which he himself made in 1887 with the same object. It was a submarine microphone. Behind the diaphragm was an air chamber in connection with a pipe open below to the water, so that the air-pressure within was the same as the water pressure outside. It was a very sensitive instrument. He had only tried it in rivers and canals, and it happened that it was being tested under the South-Eastern Railway arch when her late Majesty, Queen Victoria, passed over it, and he and his assistants were taken for dynamitards. The bell used was struck by hand, and also by electricity; the Morse code was signalled by it. Use might be made of the fact that sound would vary its pitch according as it proceeded from a receding or approaching ship. There might be some standard of sound on board ship, such as a tuning-fork, and when the sound synchronised with that one could know that a ship was right, and when it did not synchronise that it was wrong.

Mr. MILLET, in reply, said he would still have to claim for Mr. Blake the discovery that submarine sound waves would go through a ship and could be detected on the inside of it. He was familiar with Colladon and Stürm's experiments on the Lake of Geneva, but he had never been able to find any statement of the fact that the bell sounds were heard inside the boat used; a trumpet-shaped apparatus with a small diaphragm was lowered over the side of the boat. Mr. Blake's discovery was made in 1883. He (the author) had spent much time and money in tuning diaphragms, but it was impossible to make two bells of exactly the same dimensions emit the same sound in the water, whatever care was taken to make them alike. Such bells at 25 ft. and 30 ft. depth would give different notes, and in order to make the receiving apparatus synchronous it would be necessary to change it. If a sound could be detected 5 or 6 miles off that appeared to be good enough. On the "Lucania," going at 22 knots, and the "Kaiser Wilhelm II.," at 24 knots, with a tide of 4 knots or more, the apparatus worked satisfactorily. He distrusted anything which required delicate tuning. Sirens under water had been tried, but the bell was greatly superior because of the impact produced by the hammer. In the absence of impact it was sometimes difficult to detect the direction of the sound. Moreover, the bell note was more musical and carried better, and could be more easily distinguished from other sounds than could the siren.

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INVENTORS AND PATENTS.

The British inventor is a man with many grievances. For some of these he is to blame himself, others are due to an unsympathetic public, while a third class of hardships are occasioned by the patent law in this and other countries. The professional inventor and crank is largely responsible for the apathetic attitude towards new inventions and inventive genius generally. Manufacturers, capitalists and editors have a dread of the occasional visitor, enthusiastic over a crude idea but totally uninformed as to the means of carrying it out, and unable to grasp the conception that the cost of filling a "long-felt want" may be out of proportion to the benefits conferred by filling it. There is many a thing which is certainly possible in the broad acceptance of the word, but is yet impossible from the business-like and matter-of-fact point of view from which problems have to be considered in these days. It may happen that a good invention comes to be placed in the category of these futile and "wild-cat" schemes, and in these instances the grievance is of the first class to which we have alluded above, in which inventors have to suffer from the misplaced enthusiasm and incomplete work of some of their number. Still there is no doubt that, as a nation, we are inclined to be conservative, and sceptical as to the value of new inventions. "A prophet is not without honour, save in his own country and in his own house," and the British public as a whole, and even those in authority, are disinclined to attach value to an invention unless it comes with the stamp of foreign origin. An example of this is afforded by the statements made in the discussion on a Paper recently read before the Society of Arts and printed in this issue of *The Electrician*. The classical experiments by COLLADON and STURM, in which sound was conveyed a long distance under water in the Lake of Geneva, were remembered

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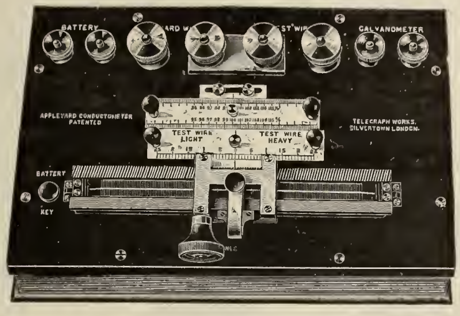
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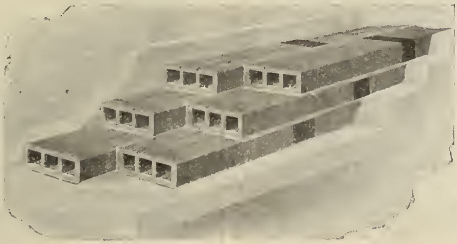

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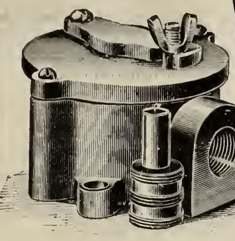

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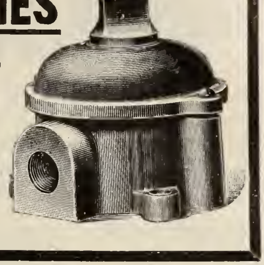

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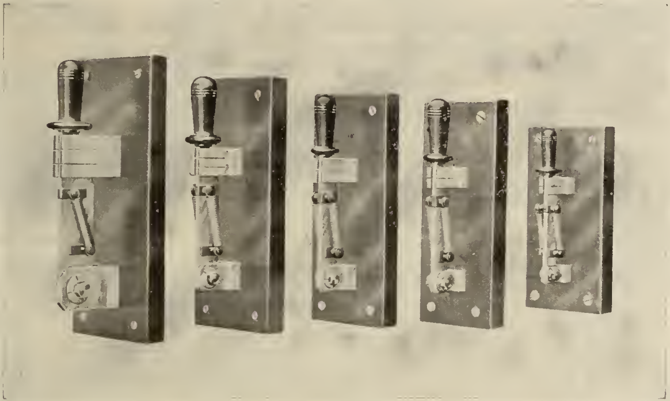

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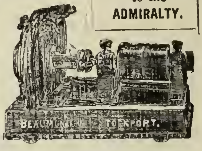

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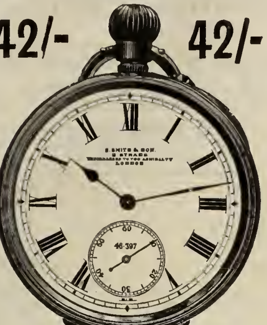

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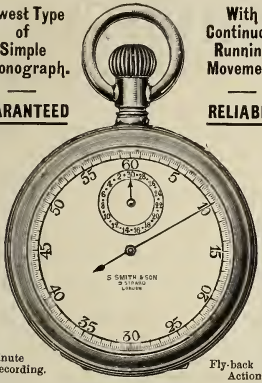

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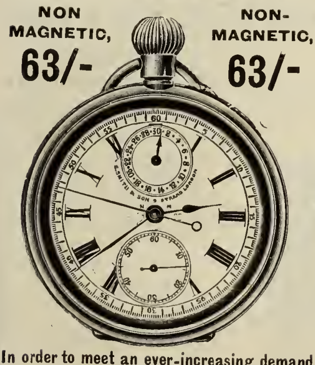

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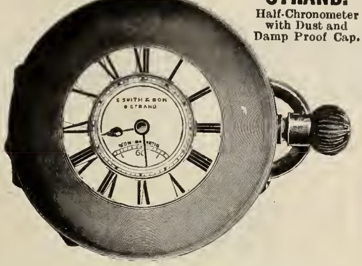

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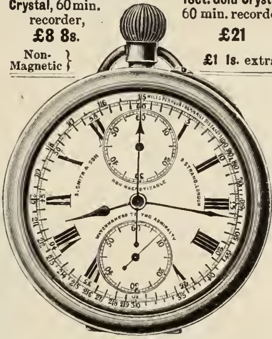

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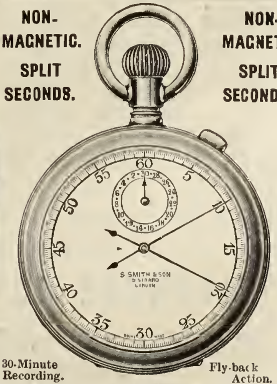

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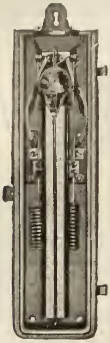

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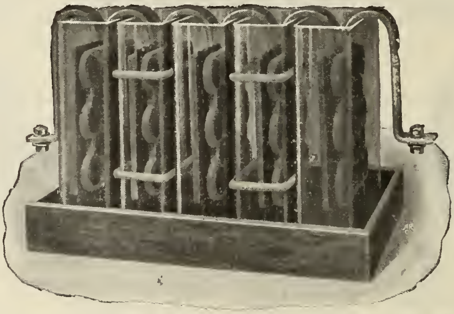

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when the microphone was discovered, and many additional investigations were then made. Two English inventors, at least, have during the past twenty years constructed and patented workable apparatus in which the microphone was employed to detect the approach of ships at a distance. These met with little recognition, and further work was therefore not expended in developing the idea. Now, however, apparatus built on precisely similar lines and perfected in a manner which does credit to the ingenuity and perseverance of those who have developed it, comes from the other side of the Atlantic, and is welcomed with enthusiasm. The mercury vapour lamp is a similar instance, and to some degree Hertzian wave telegraphy—although in these cases the inventions were not energetically pushed until the advent of the foreigner. Again, the chemical colour industry was a case in point. It is founded upon inventions of Dr. W. H. Perkin which were not appreciated at the time in this country, and the industry, therefore, found its home in Germany.

This brings us to the third grievance of the British inventor—which is, perhaps, rather more a grievance of the British manufacturer. Dr. Perkin's invention, neglected at first in England, was developed in Germany, and numerous patents for improvements by German inventors were taken out in this country. The owners of these patents manufactured in Germany for the British market, and the existence of the patents has greatly impeded the later progress of the chemical colour industry in Great Britain. For cases such as these there are two remedies: compulsory licences and compulsory working by statute. Provision is made in our Patents Acts for compelling a patentee to grant a licence if he does not manufacture in this country himself, but so far this has never been taken advantage of, and the clause remains practically a dead letter. Some countries enforce "compulsory working"—that is to say, their patent law provides that if the subject of the patent is not manufactured in the country within a certain number of years the patent becomes invalid. There is much to say in favour of this, but such a law has never been promulgated in Great Britain. In an article published in the "Financial and Commercial Supplement" of *The Times* recently Mr. G. F. Emery suggests a new point of view with regard to British patents held by foreigners and not worked in this country. Turning to the original statute passed in the reign of James I., he finds that the grant of a patent gives the patentee the right of the *sole working or making* within this realm, and he contends that although "the patentee by himself, his agents, or licencees, ... may make, use, exercise and vend the said invention," the right of vending is merely accessory to the other rights granted. By applying for the patent, the inventor, he says, represents that he intends to work or make the invention within this realm, and if he does not do so the patent has been granted on false representations and is therefore invalid; for "if the intention of the applicant is not to work or make a new manufacture within this realm, but to prevent others from doing so in order to secure a monopoly for the sale of foreign-made goods, it may fairly be said that by his prayer he has deceived the Crown." From this argument, Mr. Emery draws the conclusion that, if such a blocking patent were deliberately infringed by a British manufacturer such infringement could be defended with reasonable prospect of success in the Courts. There still remains the case, however, in which the applicant has not had in his mind the intention of using the patent in this way when he applied for it, in which case it can hardly be said that he made false representations. Mr. Emery has a way of meeting this difficulty also. Referring again to the statute passed in the time of James I., he quotes words which except inventions that are "mischievous to the State by raising prices of commodities at home," or to the "hurt of trade," or "generally inconvenient." Now, every patent granted bears the provision "that these our letters patent are on this condition that if at any time it be made to appear to us our heirs or successors or any six or more of our Privy Council that this our grant is contrary to law or prejudicial or inconvenient to our subjects in general—these our letters patent shall forthwith determine and be void to all intents and purposes notwithstanding anything hereinbefore contained." This provision, says Mr. Emery, seems admirably adapted to meet the case of the foreign-worked patent, which is, in fact, a monopoly for sale, and therefore in fact though not perhaps in form, is contrary to law, and by its mode of user is undoubtedly prejudicial and inconvenient to the subjects in general by making them dependent on a foreign supply and preventing the establishment of a home industry.

We trust that Mr. Emery's article is more than merely academically interesting, and that someone may have the temerity to put his conclusions to the test. The contrary point of view has long prevailed, however, and a foreign-worked British patent has always been held valid if no anticipation, want of subject matter, or disconformity between the provisional and complete specification could be proved. It is not only the colour industry that has suffered from foreign-worked patents, the development of electric power distribution in this country was considerably retarded, for instance, by uncertainty as to the position with regard to important patents relating to two- and three-phase working, and it was long after the manufacture of three-phase generators and motors was common in America and Germany that our own manufacturers were able to take it up actively. If the foreign-worked British patent is to become a thing of the past, all our industries will be benefited.

OBITUARY.

WILLIAM STRATFORD ANDREWS.

By the death of Mr. W. S. Andrews, which occurred at his residence, "Kincraig," Sevenoaks, Kent, on Friday last, telegraphy, land and submarine, has lost another of the few remaining links with the early work of the pioneers of this great industry. Mr. Andrews, who was in his 75th year, had taken an extremely active part in the development of telegraph enterprises up to 1902, when it will be remembered he resigned the chairmanship of the Western Telegraph Co., retaining, however, his directorship of that company and the Platino-Brazilian and River Plate Telegraph Companies until 1904. It was, however, with the management of the Indo-European Telegraph Co. that Mr. Andrews was so closely associated from its earliest days until his retirement from the Board last year. The following notes of Mr. Andrews' career, extracted from "The Electrician" Electrical Trades' Directory and Handbook, will be read with interest :—

> The long career of Mr. W. S. Andrews is intimately associated with the development of submarine telegraphy. His connection with this branch of industry began under Mr. C. V. Walker, then electrical engineer to the South-Eastern Railway Telegraphs, with whom Mr. Andrews worked as early as 1848. In the subsequent development of this important application of electricity to industrial uses, Mr. Andrews' place has ever been a prominent one. He has been responsible for many inventions, some of which have been patented and have met with considerable success. He is regarded as the doyen of telegraphy, and there is no man living who can point to more varied and interesting work in connection with this subject. The first serious work of Mr. Andrews' business career was of a literary character. He was for some years on the foreign staff of *The Times*, besides writing for other journals, but the strain proved too great, and he turned his attention to telegraphy. A constant student in the engineering branch of this work, he commenced in the early fifties by accepting the post of acting engineer to the Submarine Telegraph Co. This position he retained for eight years,

and then took charge of the repairing ship attached to submarine telegraph work for the Danish Government, and other work of similar character. During this period he was London secretary to the British & Irish Magnetic Telegraph Co., and gave assistance in extending telegraph communication with the Continent, and particularly in simplifying charges. In the fifties both the cables belonging to the Submarine Telegraph Co. were broken, and these repairs were effected by Mr. Andrews from luggers. This was considered at the time a feat of some magnitude. Mr. Andrews joined the United Kingdom Telegraph Co. in 1860 as manager and secretary, later on taking up the duties of electrician and engineer. This company was at the time in low water, but ultimately became thoroughly sound financially, and it was at this period that the Government took over the telegraphs. When the British Electric Telegraph Co. went into liquidation on its amalgamation with the British & Irish Telegraph Co., Mr. Andrews was appointed official liquidator and occupied that position for three years. At the date of the transfer in 1870 the ownership of the telegraphs was in the hands of three companies, the Electric Telegraph Co., the British & Irish Co. and the United Kingdom Co., plus one or two smaller and less important undertakings. The terms which were discussed by the Post Office representatives were formulated by Mr. Andrews, were accepted and were finally embodied in the bill without material alteration, and speedily became law. In 1870, after the transfer of the home telegraphs to the Government, Mr. Andrews joined the Indo-European Telegraph Co. as manager and secretary, and later (in 1884), in recognition of his services, he was appointed Managing Director with a seat on the Board. In its early days the Indo Company found a difficulty in earning sufficient revenue to cover expenses, and it was Mr. Andrews' work to bring about a reduction of various out-payments made to the Government in connection with land lines in this country, &c. These and other negotiations with the object of reducing the standing charges proved successful, and the Indo-European Co. became a thoroughly sound and regular dividend-earning undertaking. In the subject of the protection of submarine telegraph cables from careless and wanton damage Mr. Andrews has taken a lively interest, and as representative of the Indo-European and other companies at the International Telegraph Conferences which have been held from time to time in the chief capitals of the world he has, in association with other distinguished representatives of British submarine telegraph cable enterprise, shared in protecting successfully the interests of the companies. After thirty years of active service Mr. Andrews retired at the end of 1899 from the post of managing director of the Indo-European Co. His latest work in that position was to procure an extension of the company's Russian and Persian concessions for a further period of 20 years. In 1887 he was elected a director of the Western & Brazilian Telegraph Co., and in 1888 became chairman of the company. In 1898 the amalgamation of the Western & Brazilian Co. and the Brazilian Submarine Co. took place, and Mr. Andrews became chairman of the combined undertaking registered as the Western Telegraph Co., a position he retained until his resignation in 1902. Mr. Andrews joined the West India & Panama Co. in 1874, and became its chairman on the death of Mr. Earle in 1897. In 1895 the Amazon Telegraph Co. was established and Mr. Andrews was elected chairman. Mr. Andrews received recognition from the Persian Government in connection with his management of the Indo-European Co.'s service, by the Shah having conferred upon him the distinction of a Grand Officer of the Second Class of the Lion and the Sun.

The funeral service took place on Wednesday at the parish church, Sevenoaks, and was attended on behalf of the Eastern and Associated Telegraph Companies by Sir John Denison-Pender, Mr. J. Denison-Pender and Mr. W. Hibberdine; Mr. E. Steer Hodson represented the Western Telegraph Co.; Mr. F. C. C. Nielsen represented the Great Northern Telegraph Co.; Mr. John Ardron and Mr. P. Benton represented the Post Office; and there were several representatives of the Indo-European Telegraph Co.

THE EARTHQUAKE AND FIRE AT SAN FRANCISCO.

Comparatively little detailed information is as yet available regarding the extent of the damage to the electrical industries of San Francisco caused by the earthquake of April 18th and the fire which followed it, sweeping away the entire business quarter of the city except parts of the water front, destroying Chinatown and invading considerable portions of the residential districts.

The immediate effect of the earthquake and fire was to interrupt all the electric utilities carried on by the public service corporations in the vicinity. Gas pipes, electric light and power wires, railway circuits, telegraph and telephone systems were instantly interrupted and remained out of commission for several days.

The Western Union and Postal Telegraph Cos. both lost their headquarters at San Francisco, and were driven across the San Francisco Bay to Oakland, although it was not long before they re-established themselves in the stricken city or secured footholds also at such points as Goat Island in the bay, where the cables could be tapped. Throughout the following week thousands of messages have piled up in the hands of both companies, there being no means of delivering them to the addresses in San Francisco or Oakland, as there are no messengers to deliver the telegrams, and in almost every case it would have been impossible to find the persons for whom they were intended. All the officials of the great telegraph systems have been under tremendous strain since the occurrence, and are now able to announce rapid resumption of the service. The Postal Telegraph Co. swiftly installed a dynamo plant and telegraphic apparatus at Oakland, and has been making that city its headquarters for the vicinity, while the Western Union Co. had opened up offices in San Francisco itself by Tuesday of the following week and had several wires running into the city.

With regard to the telephone system, Mr. Fish, of the American Telephone and Telegraph Co., writes to the *Electrical World* as follows: "It will be some time before we can expect any definite information as to the condition of the telephone plant in San Francisco. At the present moment I believe that at least two of our exchange buildings escaped the fire, and that while they are somewhat shattered by the earthquake, they can be restored to service within a reasonable time. I am also informed that the Western Electric Co.'s building is not destroyed. The new switchboard in the central office is, in any event, not entirely destroyed. At last advices there had been no opportunity to go into details as to any of the buildings that were subjected to the fire." The new switchboard referred to is the largest in the world, and it was understood would have been ready for very early use. The telephone officials on the coast are doing their best to assure a swift resumption of service, realising its immense value at this juncture.

As is well known, San Francisco has a very extensive street railway system, and a large service for electric light and power. Both were, of course, immediately interrupted, and so far as known have remained out of business up to the present time, while it has been impossible to secure any very definite data as to the amount of damage done. The street car tracks were dislocated in every direction by the earthquake, and many of them have since been encumbered by the ruins of the shock and fire.

The *Street Railway Journal* states that the Bryant-street electric power station is in full operation; the North Beach power station is but slightly damaged, and that the two cable power houses, operating the Hays and McAllister-street lines, were not burned. As regards the loss of rolling stock, only seven out of a total equipment of 455 electric cars, and 75 out of a total equipment of 423 cable cars, were burned. The small loss of cars is explained by the fact that the heaviest earthquake shock occurred shortly after five o'clock in the morning, when most of the rolling stock was in the various car houses, which were situated in outlying suburbs. A portion of the shops and some few stores on hand were burned or damaged. The total general loss to all physical property of the railroads company is estimated at $2,000,000. Traffic on the Filmore and Sixteenth-street line was resumed on Saturday night, three days after the disaster.

Of the electric light and power plants, the generating stations of the United Railway & Investment Co. are safe, although the cable power house of the same company, which was shortly to have been abandoned, has been destroyed.

So far as can be learned, the plants of the Pacific Gas & Electric Co. and the California Gas & Electric Corpn. are practically intact. San Francisco is the centre of some of the longest hydro-electric power transmission systems in the world—230 miles—but also generates on the spot large quantities of current in the usual way.

The General Electric Co. appears to have suffered very materially from the fire following the earthquake. The only definite information received from the manager of the Pacific Coast territory states that so far as he knew all the members of the San Francisco organisation were personally safe, but everything else had gone. Similar stories could be told with regard to many of the large concerns in the electrical field, but the advices are still meagre. John A. Roebling's Sons Co., which has always carried a very large stock out on the coast, is understood to have lost it all, to the tune of several hundred thousand dollars, while the Allis-Chalmers Co. also reports the loss of its offices and of $20,000 at least in material.

Up to the present time no single case of loss of life has become known of anyone connected with the electrical industries.

For a time submarine cable communication with San Francisco was interrupted and advices eagerly sought for by residents on the Sandwich Islands, Australia, &c., were secured by sending messages the other way around the world. The Commercial Cable Co. is now able to report, however, that its underground lines in San Francisco are uninjured and that business has been resumed.

Despatches from San Francisco, dated April 24th, state that 80 men from the United States Signal Corps were at work on the telephone and telegraph lines, and that "within 24 hours probably four street car lines will be in operation in the city, and the streets of two extensive districts will be lighted by electricity. The United Railways assert that their lines are safe for operation, and the cars will be run perhaps to-day. The lights will be turned on as soon as the wires leading into the houses which might prove a source of danger have been cut. This work is progressing rapidly."

ELECTRIC TRACTION ON MAIN-LINE RAILWAYS.

A long article has been contributed to the *Street Railway Journal* by Mr. Philip Dawson, dealing generally with subject of electric railways in Europe. After summarising the conditions under which the various classes of rapid transit are carried out, especially in England, and giving some interesting statistics of the increase in numbers of passengers carried during late years, the author investigates the reasons which make it probable that electric traction will shortly be introduced on a very considerable scale on the main-line railways of Great Britain, at the same time considering what portion of their systems is likely to be electrified and the reasons which at present militate against such a change of motive power. One cause which has hastened the necessity for the improvement in local services of railways is the competition of the many electric tramways now paralleling sections of their lines. It is also pointed out that the terminal accommodation and number of tracks is in many cases insufficient to cope with the increased demand for suburban traffic caused by the immense increases in population in the large manufacturing centres of Europe. These requirements can only be met by the increased average speeds rendered possible by electrical working. A table of the main lines entering London is given, together with some interesting notes on the condition of the English main-line railways. It is pointed out that owing to the increase in population and consequent increase in the municipal and national expenditure, rates and taxes are constantly increasing, having risen from 2·9d. per train-mile in 1895 to 3·1d. in 1904. The total operating cost per train-mile, including maintenance, locomotive power, traffic and general charges, compensation, legal and miscellaneous, has risen from 33·26d. per train-mile in 1895 to 41·27d. per train-mile in 1904. During the same period the total receipts from all sources per train-mile has practically remained stationary, having been 49·47d. per train-mile in 1895 and 41·19d. in 1904.

The favourable results obtained since the electrification of local portions of the Lancashire & Yorkshire and the North-Eastern Railways are mentioned, but it is remarked that the conditions were rather different from those which would obtain in the case of any main-line London railway desiring to electrify a portion or the whole of its suburban system. The principal reasons given for the electrification in the cases mentioned were tramway competition and the desire of these companies to increase their traffic. Turning to France, the Orleans Railway is the only case of an electrified main line. Electrification in this case was brought about by the building of the new station at the Quai d'Orsay, which enabled the railway company to come nearer the centre of Paris, and which is connected with older stations in the outskirts, by means of a practically continuous tunnel. Here electric traction had to be installed, as steam trains could not have been run, and so all trains on their approach to Paris are hitched to an electric locomotive, which brings them into the terminus; it is only recently that the lines have been prolonged so that suburban electric service can be operated over it. The only other line in Paris which has been electrified is a suburban branch line of the Western Railway of France going to Versailles. It has very little traffic.

In Berlin the case is different, as the railways are owned by the Government, whose experiments with high-speed electric traction are well known. In Italy two comparatively long lines have been converted between Milan and Varese, but main-line services only run over a portion of the system. The Valtellina line is, of course, entirely operated by water power. In both cases electrification was the result of the Italian Government engineers deciding to investigate electric traction. In some of the American cases, too, such as the New York Central, electric working was adopted in consequence of long tunnels leading to the termini. It is thus seen that in all the chief cases of electrification of main lines, the railways were either forced to electrify because of special local conditions or that electrification was due to Government initiative and carried out at Government expense. It is probable the reasons which have hitherto caused the adoption of electric traction will not be those which will chiefly weigh in the future with railway companies when considering the electrification of their suburban services, and much depends on advantages and disadvantages possessed by the three electrical systems at present available. Dealing with the continuous-current, three-phase and single-phase systems in order, Mr. Dawson points out that notwithstanding the reliability and suitability of the continuous-current system for any weight of trains or rate of acceleration, it possesses the serious disadvantage of requiring, in order to comply with the Board of Trade regulations, not only a third rail, but in most cases a fourth rail as well. Also the capital cost is much greater than that of an equivalent single-phase system on account of the sub-stations required, but the operating costs are larger than in the case of the three-phase system. Regarding the relative cost of overhead and third-rail equipment the author says: "It has been held by some that the cost of overhead construction used with single-phase high-tension railways is greater than the cost of installing the third and fourth rail, but such statements do not bear careful examination, and, as far as Great Britain is concerned, where a fourth, as well as a third rail, is in most cases practically a necessity, it will be found that the cost involved by such a construction and by the necessary interconnection between the different rails which must be effected, is, if anything, larger than the very best and most solidly designed overhead construction."

The bulk of railway engineers in this country are also opposed to the use of a third rail for other reasons. The three-phase system requires the use of at least two overhead conductors, a disadvantage comparatively unimportant on such a line as the Valtellina Railway, which has no complicated junctions, but almost prohibitive in cases such as would be met in some of the London stations. Also the greater simplicity of the overhead work renders voltages up to at least 15,000 volts to be used on single-phase systems while it is not advisable to exceed 3,000 volts on three-phase systems. Referring to the possible gain to be obtained by recuperation, alternating-current railway motors are classified as follows:—

(1) Motors which can recuperate during braking or when going down hill, but which are economical without recuperation. (2) Motors which cannot recuperate except by the introduction of very considerable complications. (3) Motors which must recuperate if they are to be operated economically. The first of the above three types is represented by a compensated repulsion motor of the Winter-Eichberg type, as manufactured by the Allgemeine Elektricitäts Gesellschaft and Messrs. Lahmeyer. The second type is represented by what may be called a "plain" series motor, as manufactured by the Westinghouse Company, Siemens-Schuckert, Dr. Finzi, the Oerlikon Company and the General Electric Co. of America. The third type is represented by three-phase motors, and the arrangement adopted by Ganz & Co. in the concatenated or cascade system of control.

Some further notes then follow of the different varieties of single-phase motors, together with details of the motors for the London, Brighton & South Coast Railway. A comparison follows of the performance of two experimental three-car trains through a distance of 1,225 metres on a level and straight track. Each train was composed of two motor cars and one trailer car and was propelled by eight motors. The only difference was that one train was operated by direct current and the other by single-phase current. The comparative weight and the result obtained are given below:—

	Direct current.	Single phase.
Weight of three-car train, including 220 passengers	110 tons	117 tons
Add for revolving motors	9 per cent.	11 per cent.
Gear ratio	1 to 3·5	1 to 3·7
Average power factor	—	0·85
Watt-hours per ton kilometer	44·6	45·2 (41·3) if regenerating
Efficiency	72·8 per cent.	72 per cent.

The curves of the performance of the two trains clearly demonstrate the advantage of the use of a properly-designed single-phase motor as regards acceleration. Whereas with the direct-current motor it took 44·11 seconds to reach a speed of 34 miles per hour, with the single-phase motor equipment 34½ miles per hour were reached in 32·11 seconds. The curves also show that in the case of a direct-current motor the acceleration is only fairly constant for about half the total period of acceleration, after which it rapidly falls off, whereas, in the case of the single-phase motor the acceleration is practically constant throughout the whole period of acceleration. It will be seen that the maximum kilowatts are somewhat greater in the case of a single phase than in direct current, but it will be observed that this maximum comes at a later stage than in the case of the direct current and that the result of it is a higher rate of acceleration during the final period of acceleration. The diagram clearly proves that the single-phase motor is eminently suitable for heavy traffic and rapid acceleration, or, in other words, for handling suburban trains.

A list of the principal European electrified railways and a separate list of single-phase railways is given, together with some views of most of the latter. Amongst the special points noted in connection with the equipment of these is the provision of metallic hoops and guards on the top of the cars, all properly earthed, to provide against any possibility of the wiring coming down and injuring the passengers. This is particularly noticeable in the Stubaithal, Oberammergau and Spindlersfeld cars. Some notes are then given relating to the arrangement of the seating capacity and doors of electric railway cars, and the Paper concludes with the following remarks: "A careful survey of the present traffic conditions existing in and round our large towns clearly shows that the suburban railway systems must be operated electrically within the next few years, and the fact that one of the principal English railways, having termini in London, after most careful consideration, has finally decided to electrify its suburban system, upholds this view. Besides the disadvantages of the third rail and the greater costliness of direct current, as compared to single-phase current, this latter presents so many advantages that it would appear to be the only system which, with our present knowledge, will fill nearly all the requirements of railway men, and is therefore the most suitable for handling the suburban traffic of our main-line railways. Electrification of main lines, as far as long distance and goods traffic is concerned, may be made under special circumstances, but does not appear to be likely to be adopted in the near future, as far as Great Britain is concerned.

THE X ACCUMULATOR.

One of the accumulator manufacturers on whose tenders for the upkeep of battery the figures in the prospectus of the London Electrobus Co. which have given rise to so much comment and criticism are stated to have been based, is the "X Accumulator Co. (Ltd.)," of Chelsea. The battery is the invention of Mr. Emil Laurence Oppermann, who is stated to be a brother of the better-known Mr. Carl Oppermann. In view of the great merits claimed for the battery, the following extract from the Patent Specification (No. 25,902) is of interest :—

This invention relates to the manufacture of plates for secondary batteries or accumulators, and has for its object the formation of an active material for such secondary plates which shall eventually, after charge and discharge, become exceedingly porous and at the same time hard and tenacious, thus giving high efficiency in charge and discharge per weight of material employed, and at the same time a plate of great endurance which will not buckle or distort under abnormal conditions of charge and discharge.

To effect this, we make a mixture of the usual active oxide with animal hair or wool or equivalent material in a finely sub-divided condition, preferably when both are in a dry condition, so as to obtain as far as possible an intimate mixture with the hair or wool permeating the oxide in every direction.

In order to get the hair or wool into a proper sub-divided condition ready for mixture with the oxide, we grind the same in any suitable manner so as to ensure the length of any individual hair is not more than $\frac{1}{16}$ in., but the bulk is substantially in the form of powder. For example, we take hair felt and subject it to the grinding action of the moving surface of an emery wheel by which treatment the hair of the felt is reduced to powdered hair and short hair. The mixed material is then formed into a paste in the usual way. It has been found from actual experience that if the hair forms from $\frac{1}{2}$ to $1\frac{1}{2}$ per cent. of the mixture this is a proportion which gives satisfactory working results. The mixture can be built up into a plate on any convenient metallic grid foundation or frame.

The plate is then dried and formed by charge and discharge in the usual way.

It is found that the porosity of the active material is steadily increased by successive series of charge and discharge until the maximum porosity is obtained, and that this effect appears to be due to the gradual destruction of the hair or wool throughout the active mass under the electrolytic action. At the same time the active material becomes tenacious and metallic, and thereby eminently durable, although perforated throughout its mass by capillary holes, offering an immense active surface to the electrolyte.

It has further been found that the active material so formed is capable of internal expansion and contraction during charge and discharge, without the buckling or deformation of the plate as a whole.

We are aware that hair, wool and other substances have been used in combination with active oxide as binding agents, but we have found that when so used without sub-division referred to the important results as hereinbefore described are not obtained, and the plate is practically no better as to working capacity and life than ordinary plates in common use.

The claims are set out as follows :—

1st. A composite material for secondary electric battery plates consisting of a mixture of active material with hair, wool or like substance in a state of fine sub-division, substantially as described.

2nd. A plate for a secondary electric battery consisting of a grid or other device supporting a mixture of active oxide and hair, wool or like substance in a state of fine sub-division, substantially as described.

It is thus seen that the essence of the invention is simply to obtain as great an output as possible by increasing the porosity of the plates in order to offer a maximum surface of active material to the electrolyte. In an interview with the inventor, published in the *Financial Times*, it is stated that a battery of this description has been in constant use in an electric victoriette for over 11 months, during which time the battery was not washed out or repaired in any way. It ran 10,000 miles, and the negative plates are not yet worn out.

The batteries which it is proposed to fit to the 'buses of the London Electrobus Co. consist of 44 cells, each weighing approximately 80 lb. and having a capacity of 550 ampere-hours. These batteries are placed in two iron crates, placed parallel to one another underneath the body of the 'bus, and the power they contain is stated to be sufficient to run the 'bus over an ordinary route 30 miles without discharging the battery low enough to cause it harm.

These are larger than the batteries used at the first demonstration of the "Electrobus." The very small figure given for maintenance as compared with the result of experience with electric broughams and landaulettes is claimed to be partly due to the greater regularity of charging and discharging due to running on a fixed route with regular charging stations, as well as the improvements in the plates which are said to render buckling impossible, owing to the expansion and contraction being more equally distributed over the plate.

It is understood that the London Electrobus Co. has no monopoly over these batteries.

IMPROVED COMPENSATED REPULSION MOTOR.

In the English patent No. 4,845 of 1905, of which we give an abstract below, the Union Elektricitats-Gesellschaft describes some improvements in the compensated repulsion motor :—

To enable the motor of Fig. 1 to be supplied in one instance with high-tension currents and in another with low-tension currents, the circuit s would have to be broken in the manner shown in Fig, 2 and be fed with the low-tension current by means of the terminals k_2, k_2. In that case circuits p and m would be supplied with induced currents. Such an arrangement, however, does not offer any great advantage, as the tension which could be applied would not amount to more than from 150 to 200 volts, and also it would be preferable to keep the circuit s closed by means of a permanent connection. The arrangement proposed by the present invention and shown in Fig. 3 makes it unnecessary to break the rotor circuit s, as use is made of the exciting series transformer to transform a part or the whole of the energy with which the motor is supplied from the terminals k_2, k_2. The rotor winding s remains short-circuited, the stator winding p is connected with the secondary winding of the series transformer T, hitherto only employed to produce excitation, and the primary winding of the transformer T is joined in series with the exciting brushes of the winding m between the low-tension terminals k_2, k_2. The stator is fed by means of the series transformer, which changes the whole of the energy transmitted by the motor from low tension into high tension. The whole amount of the voltage available is divided between the exciting winding and the transformer in a proportion which corresponds to the impedance of both circuits. The impedance of the exciting circuit diminishes with the increase of the number of revolutions, whilst that of the stator, and consequently also that of the transformer, increases, and the latter appropriates a constantly increasing proportion of the total voltage.

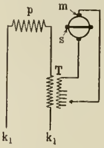

FIG. 1.

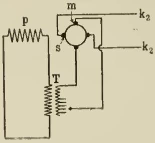

FIG. 2.

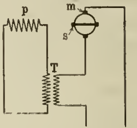

FIG. 3.

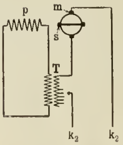

FIG. 4.

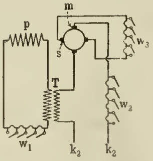

FIG. 5.

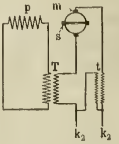

FIG. 6.

Figs. 4 to 6 illustrate different methods of regulating the motor. Fig. 4 illustrates the method of regulating the motor by changing the ratio of the series transformer. Here, again, an increase of the ratio of the secondary to primary—that is to say, of the number of turns of the high-tension winding to that of the low tension winding—corresponds to a smaller total impedance of the motor; that is to say, whilst the strength of the current remains the same the number of revolutions is increased. In place of the transformer with variable ratio, a single-coil series transformer or a transformer with adjustable coils, the so-called induction regulator or potential regulator may be employed. Or, as is shown in Fig. 5, the motor may be regulated by changing the total impedance by means of adjustable resistances w_1, w_2, w_3. The regulating of the resistances may, for instance, be effected by a gradual short-circuiting of their separate sections. Or, as is shown in Fig. 6, the motor may also be regulated by putting a potential, which is derived in some manner, for instance, through the intermediation of the transformer t, from the potential employed into the exciting circuit. Finally, as is shown in Fig. 7, the working winding p and the exciting winding m may be fed simultaneously from external sources. Fig. 7 shows the stator winding p connected with the terminals k_1, k_1, supplied with current from any local source such as a small alternator, and the exciting winding m connected with the terminals k_2, k_2. According to the magnitude and phase of both these potentials, the motor will either absorb current simultaneously from both sides or more energy will be absorbed from the one circuit than corresponds to the work done, and the surplus will be transferred to the other circuit.

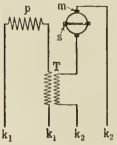

FIG. 7.

The date of application is March 8, 1905.

PARLIAMENTARY INTELLIGENCE.

◆

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

(Continued from page 106.)

Tuesday, May 8.

Mr. J. H. RIDER was first cross-examined by Mr. RALPH NEVILLE, K.C., on behalf of the electric lighting companies. He said he had adopted 6,600 volts primarily because this already existed at Greenwich, and, secondly, because this gave an economical supply over an area of six miles from each generating station. This distance from either Battersea or Greenwich included all the authorised distributors, and beyond this, at first, he did not expect to have to give much supply. Later, no doubt, a third generating station would have to be erected. He agreed that the economical radius of supply was roughly one mile for 1,000 volts and to this extent, perhaps, a higher pressure might have given cheaper supply to a further distance. It might be true, therefore, on this basis, that by adopting a higher pressure, the generating stations could be taken outside London, but apart from the fact of the tramway supply already existing, he was convinced that for an area like this the limit of economical supply was 6 or 7 miles. On the question of the frequency, Mr. Rider agreed that very few authorised distributors had a frequency of 25 ∽, but he could state confidently that it would be possible to transform his 6,600 volt 25 ∽ current to the frequency and pressure of any distributor.

Mr. NEVILLE: I will call evidence to prove that this is absolutely impossible as a business transaction.

Mr. RIDER, continuing, said that he had tried this, although not as a practical matter, but another witness would deal with this in detail.

By Mr. LLOYD, K.C., on behalf of the Administrative Power Co.: He had not calculated the amount of the railway load, but any addition to the total load which would keep the peaks down was an advantage. He had not, however, formed any estimate of the time within which a reasonable railway load would be acquired. Mr. Lloyd next raised the question of rapidity of service, and wished to know why it had taken five years to erect half of the Greenwich station, and that during three of those years energy had been purchased from companies. Mr. Rider explained this on the ground that a large site had had to be cleared at Greenwich as well as the reconstruction of the horse tramways, but it was no criterion, as the next half would be finished by 1908. Further questions were then put to show that the L.C.C. were handicapped in this scheme by starting with a power station for which the capital cost was much higher than would be necessary if a new and larger station were built to-day, and that the bulk customer would have to bear the cost of this. Mr. Rider pointed out that although he would probably not erect such a station as Greenwich was, there were great advantages in the possession of a tramway load. On the question of working costs, which were estimated as higher at Greenwich than Battersea, Mr. Lloyd put it that the tramway undertaking would have the advantage of the existence of the Battersea station, in a lower cost than at present, whereas the bulk customer would have to pay a higher figure by reason of the existence of Greenwich than if a new scheme were introduced. Witness disagreed with this, as he stated that the transmission, owing to Battersea station, would be much cheaper, and this would be an advantage to both. With regard to the carriage of coal, he said his cost of 9s. 6d. per ton was based upon his interviews with coal owners in London, and he anticipated that two 2,000-ton steamers would be able to get to Battersea.

Mr. LLOYD: Do you know that such a steamer with the masts and funnel taken off would just touch the top of Westminster Bridge if it rested on the bottom of the river?

Mr. RIDER said coal-carrying capacity did not depend upon depth, and special steamers could be constructed. He expected to enter into three year contracts for the coal at 9s. 6d. per ton. With regard to the voltage, he maintained that it was an economical one for the area to be covered.

Mr. LLOYD: I would suggest that it is economical for the tramways and for nothing else.

Continued cross-examination: There would be two 0·35 sq. in. cables to 25 distributing centres and two 0·2 sq. in. cables to two other centres. The diameter of a 0·35 sq. in cable was about 2½ in.

Mr. LLOYD: Do you know of the existence of 0·35 cables?—Yes, at Brighton.

For what purpose?—For carrying the energy from the new power station into Brighton.

Are they drawn in?—No. If you wish to assume that such a cable cannot be drawn in I disagree with you.

Mr. RIDER, under further cross-examination, said he had calculated the cables on the capacity of the two generating stations, and in doing this he had not had any plan before him of the probability of the demand. He had allowed for a maximum drop of 5 per cent. on the pressure. In reply to cross-examination to show that the scheme could not cope with the railway demand, and that extra cables would have to be laid which were not included in the estimates, Mr. Rider said that if, say, the Great Northern, Midland and London & North-Western Railways wanted to electrify their lines the scheme would have to be enlarged, but the laying of such additional cables would not cost, pro rata, as much as the original cables.

Mr. LLOYD: And you would have to break up the streets, as I am assuming that your four proposed ducts to the distributing centre for King's Cross would be full.

Continued cross-examination. He failed to see that duplicate routes for the mains were necessary. His estimates included duplicate mains, and this, in his opinion was all that was necessary.

During the course of subsequent cross-examination, The CHAIRMAN stated that the Committee would see that clause 35 did not enable the County Council to interfere with existing contracts.

[The provisions of clause 35 are explained at the bottom of p. 104 in last week's *Electrician*.]

Wednesday, May 9th.

Mr. RIDER'S re-examination was taken by Mr. Clode. In regard to the estimates for the transmission system, he said that these included laying cables to all the sub-stations. His system of mains was more efficient and simpler than a ring main, because he went straight from the power house to the supply centre. The risk of breakdown on high tension mains in London was practically nil, and therefore the system of duplicate mains proposed was the best for the purpose.

In answer to the Committee, Mr. RIDER said it was hardly correct to say that the Council was purchasing current from companies for the tramways at present. As a matter of fact, the Council only purchased steam.

Mr. WATSON RUTHERFORD said he saw some difficulty about new authorised undertakers coming into existence with the over-riding powers of clause 35 hanging over their heads.

Mr. RUTHERFORD put further questions as to the desirability that all the existing undertakers being in the same hands.

Mr. RIDER replied that this would have saved a considerable capital expenditure if such a course had been adopted originally, but in the present state of things this could hardly be brought about until the existing undertakers had paid off their capital. Then it would pay them to scrap their plant. In fact, it would pay many of them to scrap their plants now, on the question of price. He disagreed with the hon. member that there would be an appreciable rise in the temperature of the Thames in consequence of the condensing at Battersea. The difference in the temperature of the condensing water at Greenwich was only 10 deg. and it was hardly noticeable in the river itself. On the question of the policy of putting the stations far outside London, Mr. Rutherford mentioned several of the American schemes where transmission took place over many miles. With coal at 9s. 6d. in London he thought this was 4s. more than would be the price at the pit's mouth, and this might not be exceeded in the extra cost of transmission, whilst there would be no smoke nuisance in London. Mr. Rider could not agree with this.

Mr. RUTHERFORD: Your present Greenwich station is out of date?—Oh, no.

I was going to suggest that you should scrap it?—No; because it is a good and efficient power house.

Has not all plant put up within the past 25 years been out of date in five years?—I cannot agree with that.

Further questions: He believed this was the first power bill in which there was no price, but he thought that a power company had been granted a bill in which there was no compulsion to supply. His estimates had been based upon past experience, and taking pro rata increases.

Dealing with the memorandum of the Commissioners of Works, Mr. RIDER said that the Greenwich station would be completed whether the power bill went through or not. As to the arrangements at Battersea, he was convinced that these would obviate any damage to the London parks or the London air.

The CHAIRMAN said the Commissioners of Works were going to bring evidence as to the damage done by the products of combustion.

The CHAIRMAN also asked the promoters whether it was the intention to apply clause 35 to all authorised distributors, whether they took energy from the Council or not.

Mr. CLODE said it was, and also to the bulk companies, if they were distributors.

In answer to further questions, Mr. RIDER expressed some doubt as to whether the railway companies would take energy from an outside source for their main lines. The only custom likely in London was for the self-contained suburban lines. But this scheme would, he anticipated, be a perfectly paying one without the railway custom.

Mr. R. HAMMOND was the next witness, and his early evidence gave in detail the present conditions of electric supply in London. A series of tables were handed in dealing with the finance of the various undertakings, of which the following is a summary of the details:—

Undertakings.	*Capital expenditure.	*Maximum load in kilowatts.	*Plant capacity in kilowatts.	*Cap. ex. on gen. plant per kw. of plant capacity.	*Total capital exp. per kw. of plant capacity.
Local authorities—	£			£	£
1. Within County of London...	4,877,303	20,881	35,714	44·94	87·63
2. Outside County of London but within area covered by bill	1,725,143	10,931	22,340	36·74	72·43
Total	6,602,446	31,812	58,054	41·79	81·74
Companies—					
1. Within County of London...	11,613,809	80,195	120,026	51·67	96·76
2. Outside County of London but within area covered by bill	246,259	1,033	2,432	41·74	91·12
Total	11,860,068	81,228	122,458	51·47	96·65
Combined totals	18,462,514	113,040	180,512	48·35	91·85

* The columns showing the maximum load, plant capacity and capital expenditure per kilowatt do not include undertakings of which complete data are not available—viz., Bethnal Green, Marylebone, Woolwich, Bexley; nor undertakings having bulk supply—viz., Stoke Newington, Willesden and Chislehurst.

These figures were compared with the estimates put in by Mr. Rider. The total capital expenditure under the bill he should put at about £40, including generation, distribution and tranformation. Mr. Hammond then went into details of revenue, &c., of the various undertakings in the area of the bill. The results are given below:—

——	Units sold.	Revenue.	Aver. price charged.
Local authorities..	34,669,538	£487,026	3·37
Companies	94,932,208	1,535,813	3·38
Combined totals	129,601,746	£2,022,839	3·75

These figures are for the local authorities to March 31, 1905, and for the companies to Dec. 31, 1904. The expenditure on management by the undertakers inside London were analysed and were; 0·24d. per unit for the local authorities and 0·37d. per unit for the companies. The financial results of the various supply authorities inside and outside London for the same periods show that the local authorities have earned 0·98 per cent. on the capital expenditure and that the companies have earned 4·44 per cent. profit. At this point in his evidence Mr. Hammond gave details of the efforts at bulk supply in London and the prices now charged by such companies as Bromley to Chislehurt, North Metropolitan Power Co. to Willesden, and so on, many of which were prohibitive for power purposes. His opinion was that untransformed current should not cost more than 0·75d., and for transformed current 1·1d. or 1·2d. per unit. As an example of the want of facilities in various parts, Mr. Hammond cited Hendon, which, although within the area of the North Metropolitan Co., was unable to get a supply, in spite of the fact that the Power Co. had succeeded in getting the Local Government Board to refuse a loan for a municipal works by quoting a very low price. But terms had not yet been arrived at.

A lively discussion took place here between Mr. Hammond and Mr. Rutherford as to the tramway load being regarded as a valuable asset, as the peak coincided with the lighting peak, unless the tramways department were going to be charged more than it ought to be. If the supply was to be given at cost price, said Mr. Rutherford, he failed to see the advantage. Mr. Hammond explained at great length the advantage of such a load in reducing the stand-by costs. He disagreed with certain American engineers named by Mr. Rutherford (Pearson and Connett) that the tramway and power load should not be in the same station, and in this view Mr. Samuel Insull, of Chicago, thoroughly agreed.

Coming back to his tables again, Mr. Hammond said that since 1900 the increase of the maximum demand in kilowatts upon municipal stations in the area of the bill had been 346 per cent., and for the companies 113 per cent., or a total over the whole of 151 per cent. Similarly, the units sold had increased by 435 per cent., 166 per cent., and 215 per cent. respectively, whilst the figures for the increase in load factor were 2·8 per cent., 3·2 per cent., and 3·3 per cent. Mr. Hammond's estimate of the probable requirements of London in 1911 was 158,890 kw. in addition to the supply now given, or an output of 390,500,055 units.

Mr. RUTHERFORD: This scheme does not contemplate being able to give this supply?—No. Experts are somewhat discredited, and although this is my estimate, the Council preferred to work upon a more moderate estimate.

After giving an analysis of the various works costs of the London works, Mr. Hammond handed in tables, of which a summary is given below:—

Comparison of the Cost of Generation of Authorised Distributors, with the Price at which the Supply could have been given by the L.C.C.

Undertakers.	Units generated.	Total cost of generation.	Price at which supply could have been given by L.C.C.	Saving by taking L.C.C. supply.
		£	£	£
Undertakings within the County of London ..	173,252,926	1,216,308	683,131	533,177
Undertakings outside the County of London ..	22,373,756	145,898	101,182	44,716
Totals	195,626,682	1,362,206	784,313	577,893

Thursday, May 10.

Mr. HAMMOND continued his evidence, and dealt generally with a comparison of the merits of a scheme such as that proposed by the Additional Electric Supply Co., with a power station 50 miles away from London, and the scheme of the L.C.C. The Committee stopped him from giving all the details, but on the general balance between the various items of expenditure, Mr. Hammond estimated that there would be a balance of £73,000 in favour of the L.C.C. scheme as regards capital expenditure, with coal at 6s. per ton at St. Neots, which was the present price. In order to bring the two schemes on a level as regards initial outlay, the coal would have to be bought for 3s. per ton at St. Neots. This was for a 60,000 kw. station in both cases.

Cross-examined by Mr. Neville for the London electric lighting companies, witness stated that in his tables he had given figures for the local authorities to March 31, 1905, and the electric lighting companies to Dec. 31, 1904. This might not appear to be a very fair comparison, but he could not get any later figures. His estimates of price were on the assumption that the County Council would supply the peak load of the existing undertakers at the lowest price of £3. 12s. per kilowatt plus 0·2d. per unit. It would pay the Council to do this, even though they were only acting as a stand-by, although he could not answer for future policy. Personally, however, he thought that it would pay the existing authorities to come to the Council for more than their peak load. As a result of further questions,

Mr. CLEASE, for the London County Council, said it was not now intended to supply Government Departments nor street lighting authorities without the consent of the authorised distributors in each case.

In reply to the Hon. Evan Charteris, for the promoters of the Administrative County of London & District Electric Power Bill, Mr. HAMMOND said that the only scheme that he had had to do with in which three-phase energy was being used was at Dublin. He denied that the estimates were exceeded by £70,000. The difference between the original estimates and the actual cost was due to an extension of the scope of the scheme, and Local Government Board inquiries had to be held owing to the very great success of the undertaking. He did not know the capital cost, which counsel put at £60 per kilowatt. On the question of the railway load Mr. Hammond admitted that the provision, but estimates for railway load would be much too small for all the requirements of the London railways. As previously pointed out, a new application would have to be made to Parliament.

Mr. CHARTERIS pointed out that whereas under this bill only 60,000 kw. was provided for, for the total scheme, the Adminstrative scheme last year provided for this amount at once and an ultimate 350,000 kw. With the L.C.C. scheme delay would be inevitable from the railway point of view.

Mr. RUTHERFORD thought there would be a similar delay if the railway company wished to erect its own plant.

A large number of questions were put to Mr. Hammond, challenging the accuracy of most of the tables put in, but as both sides wished to proceed upon a different basis, no useful result was served.

Mr. RIGG, for the City of London, cross-examined Mr. Hammond, pointing out the analogy between the combination of the gas companies some years ago and a possible amalgamation between the existing electric supply authorities.

By Mr. JONES, for the North Metropolitan Electric Power Supply Co.: He maintained that the results of the work by the other power companies in the area was meagre. He had advised Edmonton Council some years ago to put up their own station.

Mr. JONES was pursuing some individual cases in which Mr. Hammond had advised Councils in the North Metropolitan Company's area to put up small individual stations, but

The CHAIRMAN interrupted by saying that he thought this was immaterial.

Mr. JONES replied that he was entitled to show, against Mr. Hammond's statement, that the comparatively small amount of bulk supply in his area was due, in many cases, to the advice of electrical engineers (including Mr. Hammond) that the Councils should put up small power stations.

Some discussion took place upon this point which was ended by counsel for the bill intimating that the point had been sufficiently put to prevent any objection on their part to evidence being given on it later.

Mr. JONES then went to the question of Mr. Hammond's prophecy in 1898, as to the Leeds works cost, when the load reached 5,000,000 units per annum. These costs, he showed, were higher when the load reached 7,500,000 units.

Mr. HAMMOND said that when the load reached 5,000,000, his prophecy was absolutely correct. There were reasons now why the works costs were higher. Although he could not give details of what were included in works costs at Leeds, he might suggest that if some proportion of capital charges were included no one could say nay.

Mr. JONES: Do you suggest that the accounts of the Leeds Corporation are improperly kept?—Not improperly kept. There has been an enormous increase in the capital expenditure at Leeds, and that is why the works costs are high.

By Mr. HARPER for the Middlesex County Council: He knew that manufacturers were leaving London, and the County Council wished to follow them up with a supply of electricity. The reason why many of the works were removing, was an extension of the garden city principle where the workmen could live under the fig tree and the honeysuckle.

Cross examination was continued urging the cutting out of the area of certain portions. Mr. Hutchinson, for the Kent Electric Power Co., put several cases to witness in which a supply had been contracted for at 0·6d. and 0·5d. per unit, with a view to showing that there had been no cause shown by the L.C.C. for competition.

The Committee then adjourned until Tuesday.

EMBANKMENT TRAMWAYS PASSED IN COMMITTEE.

Sir Lewis McIver's Committee of the House of Commons further considered the London County Council Tramways Improvements Bill on Thursday last week.

Mr. H. E. HAWARD produced the financial statement with regard to the tramway undertaking which the Committee asked for to enable them to come to a decision on the question of the Embankment tramways. The statement in question showed that on March 31, 1900, the first completed year after the Council took over the southern tramways, the profit, after meeting all charges, was £51,774, in 1901 it was £13,325 and in 1902 £9,062. In 1903 there was a deficiency of £2,251 and in 1904 there was a deficiency of £8,284. In 1905 there was a surplus of £7,055. It was contemplated that the accounts for the year ended March 31, 1906, would show a profit of £4,000, whilst the estimated profits for the year 1906-7 were £51,000. The deficits for the years 1903 and 1904 were due to the period of reconstruction of the southern tramways, and in a like manner a deficit was expected during the reconstruction for electric traction of the northern lines, which the Council now had taken over. These latter, however, would be met out of the profits on the southern system. When the whole of the northern lines were completed an annual surplus of £60,000 was anticipated after setting aside £87,000 a year for renewals, reserve fund, interest and sinking fund. Since April, 1894, a total sum of £293,592 had been carried to the relief of rates from the tramways under the control of the Council. During the last three years nothing had been carried to the reserve fund, but the Council was now building up a good reserve fund, which was invested in County Council stock. Since 1892 £3,141,319 had been spent on capital account on the southern tramways and £1,095,469 on the northern tramways, whilst a sum of £581,246 had been spent on general matters, including power supply, or a total of £4,818,034. The outstanding debt was £4,210,803, the capital repaid being £607,231. The further capital commitments were: Reconstruction of the northern system, £3,000,000; southern tramways, £1,000,000; completion of the Greenwich power station, £500,000; new lines, £1,100,000; a total of between £5,500,000 and £6,500,000. Therefore the total capital expenditure incurred or to be incurred on tramway account was £11,000,000.

On Friday Mr. HAWARD was asked several questions by the members of the Committee. He said he anticipated there would be a temporary deficiency during the reconstruction of the northern lines, but this would be more than made up by the profits in the south; and in these matters, he contended, the system as a whole must be considered in framing any estimate of profit and loss. He was quite satisfied that the expenditure contemplated in the future would give a return to the ratepayers, and especially when the whole system was at work, as with the Greenwich generating station working at its full capacity the cost of energy would be greatly reduced. Asked for comparisons as to the capital cost per mile in other towns, witness said that this would be fallacious, as the L.C.C. was the only authority which had reconstructed its lines for conduit traction. He might state as an example, however, that the London United Tramways cost £80,000 per mile, and this was on the overhead system.

Mr. LEWIS COWARD, K.C., pointed out that this cost included all the enormous expense involved in street widenings, whereas the L.C.C. only charged a portion of the street widenings to the tramway account.

In answer to further questions, Mr. HAWARD said the net debt of the County Council was £45,234,000, of which £38,546,000 was invested in unremunerative service and £6,687,000 was invested in remunerative services. In the present condition of things £31,916 was taken out of the rates year by year as interest and sinking fund on the monies borrowed. The total estimated profit from the lines proposed in the present Bill was £5,750.

MIDDLESEX COUNTY COUNCIL TRAMWAYS BILL.

The Committee proceeded to consider the bill of the Middlesex County Council, which proposes to construct the portion of the proposed Marble Arch-Cricklewood line from Kilburn Priory to Cricklewood in conjunction with the London County Council. As stated previously, an agreement has been come to between the London County Council and the Middlesex County Council on this point, and the only opposition now is from the Willesden Urban District Council and the omnibus proprietors who now run omnibuses along the route. The opposition of the Willesden Council is on the question of street widenings, and that of the omnibus companies, of course, relates to competition.

Mr. HARPER gave the facts of the case to the Committee, and went into detail as to the arrangements between the Middlesex County Council and the Metropolitan Electric Trsmways (Ltd.), by which the lines are leased to the latter on a profit-sharing system. Evidence was called in favour of the proposal, during which it was stated that the two Councils had agreed as to the system of through working on the joint line—*i.e.*, the portion inside the County of London would be fitted with overhead equipment as well as the conduit for the L.C.C. cars. This would only come about if it were thought more economical than fitting the cars with both equipments. The total cost of the Cricklewood–Marble Arch line will be £170,000, of which £81,000 will be provided by the Middlesex County Council and the remainder by the L.C.C. Road widenings will cost £95,000, of which £63,333 will be provided by the Middlesex County Council. The opposition to the scheme was then taken.

On Tuesday several short lines were considered, but no decision was given by the Committee. On Wednesday a lengthy discussion took place on clause 37 of the bill, which gives the Council the right to lay temporary rails above the surface of the roadway during the reconstruction of tramways. The chief opposition was by the omnibus companies of London on the ground that such an obstruction to the ordinary vehicular traffic was unfair. The reason for the insertion of this clause in the bill is that on one occasion such temporary rails were laid and an action in the High Courts resulted in the decision that the Council had no authority to lay them without Parliamentary powers. It was contended that the laying of temporary rails in the manner described was essential to the conduct of the tramway system during reconstruction.

The Committee's decision on the whole of the bill, including the Embankment tramways and the Edgware-road tramways was given yesterday (Thursday).

The CHAIRMAN said that the Committee found the preamble of the bill proved so far as it related to the Embankment tramways and the other tramways except the Edgware-road line. With regard to the Middlesex County Council proposal for the remainder of the line along Edgware-road, this would be rejected.

The Committee also sanctioned a temporary terminus opposite John Carpenter-street, on the Embankment near Blackfriars, pending the widening of Blackfriars Bridge, which will be carried out within five years, under the terms of the City Corporation (Blackfriars and other Bridges) Bill, the preamble of which was also found proved by the Committee. Clause 37 of the London County Council Tramways Bill, relating to the laying of temporary rails above the surface of the roadway during reconstruction was struck out.

Clauses were then adjusted, the most important relating to the reduction of one of the footpaths by 2 ft. on Westminster Bridge and the regulation of the traffic on special days over Westminster Bridge by the Commissioner of Police.

UTILISATION OF BLAST FURNACES GASES.

CUMBERLAND ELECTRICITY AND POWER GAS BILL.

This bill came before a Committee of the House of Lords, Earl Lauderdale in the chair, on Friday. It proposes the incorporation of a company for the purpose of generating electricity and power gas in Cumberland. Lands for generating stations are scheduled at Maryport, Workington and Cleator Moor. The capital of the company will be £450,000 in £5 shares, with borrowing powers to the extent of £150,000. The promoters are Arnold Lupton, William Frederick Smith, Joseph Thomas Pullen, William Hare, Thomas Smith Ritson, Joseph Highet, Richard Williamson, R. H. Williamson, Joseph Huntrodes, and Thomas E. G. Marley. The objects of the company are to supply electrical energy to authorised undertakers and persons requiring motive power supply, any current to be used for lighting the premises where power is supplied. The Board of Trade will be referred to in the event of any authorised consumer withholding consent to the company supplying any customer in that area. Authorised undertakers will be required to enter into a seven years' contract, whilst, as in the other power bills, in the event of any dispute as to price between the company and a power user, the Board of Trade will be asked to appoint an arbitrator. Power gas consumers will be asked to enter into a contract for five years. Interest out of capital during construction will be paid at the rate of 3 per cent. per annum to the extent of £20,000. Substantial commencement to be made with works within three years, and powers under the bill cease after seven years if a supply is not then given. The charges for electric supply will be at the rate of 10s. per electrical horse-power, which the company is required to give, and a sliding scale from 3d. to ¾d. per unit, according to quantity. For gas the charge will be 10s. per indicated horse-power, with a sliding scale from 3d. to ¾d. per gas unit.

The only opponents to the scheme were the Whitehaven Corporation, the Workington Urban District Council and the West Cumberland Tramways Co. An agreement has been come to with the Whitehaven Corporation, however, whereby the power company acquires the existing municipal electricity undertaking in that town, the purchase price being £25,000, the capital expended upon it. This purchase is to be completed, in instalments, by March 31, 1910, or sooner if the power company desires. After the completion of the agreement, the company, which will then become the distributors in Whitehaven, is not to charge any higher prices than are now in force. If the purchase is not completed within the period stated in the agreement, all rights of the power company in Whitehaven are to cease. The Committee sanctioned this arrangement.

With regard to the opposition of the West Cumberland Electric Tramways Co., this was also settled on terms. The company was authorised in 1901 to construct tramways and supply electricity, but has done nothing, in spite of several extensions of time having been granted. An agreement has been come to between the promoters of the present power company whereby the tramway company will be absorbed. The tramway company has raised £31,500 capital, for which the power company will pay £10,000, in instalments of £5,000 when it has raised £100,000 of its own capital, a further £2,500 when another £50,000 capital is raised, and the remaining £2,500 when another £50,000 capital has been raised. This agreement was also sanctioned by the Committee. The opposition of the Workington Urban District Council was agreed to be treated as a clause opposition.

Mr. ARNOLD LUPTON, M.P., in giving evidence in favour of the bill, said that it was proposed to erect three generating stations and to use the waste gases from the blast furnaces in the area in order to drive gas engines for producing electrical energy. Agreements had been made with the owners of three of the greatest ironworks for the supply of such gas for the purposes of the bill. It was estimated that 60,000 H.P. were running to waste from the blast furnaces, but half this quantity would be sufficient for the purposes of the bill. It was also intended to supply power gas from the same sources. This was a very suitable gas for compression, and there was no difficulty in its distribution. The Home Office had reported upon the fact that there was no restriction as to the amount of carbon monoxide in the gas and recommended that a provision limiting this to 14 per cent. or such higher percentage as might be approved by the Home Secretary in the interests of the public health. There would be a greater percentage than 14 per cent., but the promoters were willing to place themselves in the hands either of the Home Office or the Board of Trade as to the percentage, without stipulating any particular percentage in the bill. The 14 per cent. was specially intended to apply to Mond gas, whereas the gas which it was proposed to supply under the bill was a different class of gas altogether and contained from 29 to 33 per cent. of carbon monoxide.

After consultation the Committee decided to put it upon the promoters to secure the consent of both the Board of Trade and the Home Secretary to the quality of the gas supplied.

On Monday terms were arranged with the Workington Urban District Council, and the preamble of the bill was found proved.

LIGHT RAILWAYS BILL, 1906.

The following is the text of the bill which was introduced into the House of Commons by Mr. Lloyd-George last week, to amend the Light Railways Act, 1896:—

Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

1. The powers of the Light Railway Commissioners under the Light

Railways Act, 1896 (in this act referred to as the principal act), shall continue until Parliament otherwise determine.

2.—(1) If any order under the principal act is not confirmed by the Board of Trade on the ground that the proposals of the promotors ought to be submitted to Parliament in pursuance of sub-section 3 of section 9 of the principal act, the Board may, if they think fit, submit the proposals to Parliament by bringing in a bill for the confirmation of the order.

(2) If, while a bill confirming any such order is pending in either House of Parliament, a petition is presented against the order, the bill, so far as it relates to the order, may be referred to a Select Committee, or, if the two Houses of Parliament think fit so to order, to a Joint Committee of both Houses, and the petitioner shall be allowed to appear and oppose as in the case of private bills.

(3) On bringing a bill under this section for the confirmation of an order, the Board of Trade shall make a special report to Parliament with respect to the order.

3. This act may be cited as the Light Railways Act, 1906, and shall be read as one with the principal act, and the principal act and the Light Railway Commissioners (Salaries) Act, 1901, and this act may be cited together as the Light Railways Acts, 1896 to 1906.

The following forms the subject of a memorandum which was attached to the bill:—

Under the Light Railways Act, 1896, the powers of the Light Railway Commissioners were to continue in the first instance for five years only—*i.e.*, they were to cease at the end of 1901, unless continued by Parliament. It has been found necessary year by year to prolong these powers by provision inserted in the Expiring Laws Continuance Act.

Under section 9, sub-section 3, of the Light Railways Act the Board of Trade are directed to refuse confirmation of an order in cases where by reason of the magnitude of the proposals or of their effect upon an existing railway company or for any other special reason the Board are of opinion that the proposals ought to be submitted to Parliament. No machinery, however, is at present provided for bringing such orders before Parliament.

The present bill proposes: (1) to make the Light Railway Commission a permanent instead of a temporary body; (2) To enable the Board in cases where the order is one that would be confined apart from the operation of section 9 (3) of the Act of 1896, instead of dismissing the application to bring it themselves before Parliament in a confirming bill.

This would be a lessening of cost and a simplification of procedure.

LONDON TRAFFIC BOARD PROPOSAL.

A private member's bill to establish a London Traffic Board was introduced by Sir John Dickson-Poynder and read a first time on Monday. The bill provides for the establishment of a Board consisting of three members appointed by the President of the Board of Trade. These members would be required to devote the whole of their time to the performance of their duties under the act, and hold no office or employment under any local authority or other local administrative body having jurisdiction in Greater London or any company or person carrying on business within the same area, or be members of Parliament. The members of the Board would continue in office for a period of six years from their appointment and be eligible for re-appointment.

The duties of the Board are defined as follows: To take into continuous consideration the traffic of Greater London, in accordance with a general plan for its improvement. To make, not later than Jan. 31 in each year, a general report to the Board of Trade on the condition of the traffic of Greater London. In this general report the Board is to call attention to the deficiencies and defects in existing means of locomotion and transport in Greater London, and suggest improvements and additions necessary in relation to the following matters:—(*a*) The improvement of existing railways, the construction of new railways, and the provision of better railway facilities; (*b*) the improvement of existing tramways, the construction of new tramways, and the provision of better tramway facilities; (*c*) the improvement of existing streets and the laying out of new streets; (*d*) the removal of obstructions to traffic in existing streets; (*e*) the regulation and control of the breaking up of streets for the purpose of laying or altering pipes and other works; (*f*) the regulation and control of traffic in streets and the fixing of routes for particular kinds of traffic. The general report is also to contain a statement of the proceedings of the Board during the year terminating on the previous Dec. 31, and it is to be laid before both Houses of Parliament within fourteen days after the making thereof if Parliament is then sitting, and if not then fourteen days after the next meeting of Parliament. To make a special report to the Board of Trade in relation to the traffic of Greater London with respect to the following matters:—(*a*) Every private bill deposited in Parliament affecting the traffic of Greater London; (*b*) every application for a provisional order to be confirmed by Parliament affecting the traffic of Greater London; (*c*) every application to the Light Railway Commissioners for an order affecting the traffic of Greater London; (*d*) every matter affecting the traffic of Greater London specially referred to the Board for their consideration by either House of Parliament or by His Majesty's Government; every matter affecting the traffic of any part of Greater London specially referred to the Board for their consideration, with the previous approval of His Majesty's Government, by the local authority or road authority or other public authority for such part; all draft bye-laws and regulations submitted to the Board for their consideration in pursuance of this Act. These reports are also to be laid before Parliament and the Government departments and others interested.

All regulations and bye-laws relating to the traffic in the streets of Greater London, the removal of obstructions in streets, and the breaking up and closing of streets, before being confirmed would be submitted to the Board for their consideration. The Board would also act as arbitrators in the case of any differences arising between the Corporation of the City of London or any county, borough or district council and the undertakers of any railway or tramway, as to the proportions in which the expense of any new street or any street widening or improvement should be borne.

It is proposed to give the Board the power to hold such inquiries, make inspections, to require the attendance of witnesses, the production of documents, to administer an oath, and, when sitting in open court, to punish for contempt as if they were a court of record.

Each member of the Board would be paid a salary not exceeding £3,000 a year.

Nothing in the act is to affect the jurisdiction of the Railway and Canal Commissioners to hear and determine any complaints under the Railway and Canal Traffic Acts.

NORTH-WEST LONDON RAILWAY BILL.

This bill was considered on Tuesday for the first time by a Committee of the House of Commons, of which Mr. Compton Rickett is chairman.

The bill seeks to extend the tube railway authorised in 1899 from Cricklewood to Marble Arch, to Victoria on the southern end, as well as an extension of time for the already authorised line from Cricklewood to Marble Arch. Additional capital is sought to the extent of £1,050,000 and borrowing powers to the extent of £350,000.

Mr. BALFOUR BROWNE, K.C., who appeared with Mr. Moon, K.C., Mr. Hutchinson and Mr. Macassey for the promoters, first explained the reasons why the railway had not been constructed, which were mainly due, latterly, to the sittings of the Royal Commission on London Traffic. The report of that Commission had recommended the desirability of this line, hence the application for an extension to Victoria. The Brush Electrical Engineering Co. were interested in the extension, and the following were the estimates for the whole railway, with tunnels 11 ft. 8¼ in. diameter.

Works, &c.	£1,580,821
Electrical equipment	450,000
Legal and engineering expenses	120,000
Interest on capital during construction	200,000
Administrative and sundry expenses	20,000

The total capital of the company would be £2,250,000 with £650,000 borrowing powers.

THE TELEPHONE IN AGRICULTURAL DISTRICTS.

In a printed answer to a question by Mr. H. H. Marks in the House of Commons on Thursday last week, Mr. SYDNEY BUXTON, the Postmaster-General, stated that he had been in communication with the Board of Agriculture as to the best means of extending the telephone system in the fruit-growing districts of the country, and the circumstances of particular districts, to which the Board had drawn his attention, were being investigated. During the last two years the Post Office had opened 127 exchanges in country districts, and a considerable number of others were being constructed. He hoped that the arrangement lately announced by the Chancellor of the Exchequer, under which the Post Office would assume two-thirds of the liability under guarantees for the extension of the telephone trunk-wire system, would facilitate such extensions.

MISCELLANEOUS.

West Yorkshire Tramways Bill.—This bill was before a Committee of the House of Lords last week. The proposals of the bill are to construct a network of tramways connecting up Huddersfield, Halifax and Brighouse, and running powers are asked over the lines of the Huddersfield and Halifax municipal tramways. The gauge of the lines is 3 ft. 6 in., but as the Huddersfield lines were standard gauge it was proposed to lay an additional rail along one portion of the Huddersfield lines in order that they might run over these. To this the Huddersfield Corporation has agreed, and also to a proposal to transfer the authorised line to Brighouse to the company. The capital of the proposed company is £120,000, and the borrowing powers £40,000. Interest is to be paid out of capital during construction to the extent of £5,000 at 3 per cent. No purchase is to take place unless by agreement between all the local authorities concerned, and then only after 42 years. The promoters are the National Electric Construction Co. The opponents to the scheme were the West Riding County Council on the question of street widenings, and the Halifax Corporation regarding the compulsory running powers asked for. After hearing evidence in support of the bill for the Huddersfield Corporation, the chairman intimated that unless the promoters satisfied the County Council with regard to the road widenings the bill would not be allowed to proceed. An adjournment was accordingly made, after further evidence in support of the bill was heard, to enable the promoters to try to come to terms with the West Riding County Council. Terms were subsequently made as to road widening and running powers and the bill was allowed to proceed.

Southport-Lytham Tramroads Bill.—A Committee of the House of Lords had this bill under consideration on Friday last week. The Southport-Lytham Tramroads and Tramways Co. was authorised in 1900 to construct tramways connecting up Southport, Lytham and St. Annes, in Lancashire. Extensions of time have been granted on several occasions, and the present application was for a further extension of the period for the compulsory acquisition of lands until 1909, and for the construction of works until 1910 and 1911. The Southport Corporation opposed. After discussion, an agreement was come to whereby the company are granted an extension of six months for the construction of an embankment in Southport, and the powers respecting this shall cease if the works are not so carried out. In the event of this being complied with, the extension of time asked for under the bill as to construction of tramways along this embankment is granted. The extension of time for the construction of the remaining lines was granted, and the preamble of the bill declared proved.

Bury Corporation.—This bill was considered by a Committee of the House of Lords on Friday. It was an omnibus bill containing a section relating to the construction of some additional tramways, and also powers to supply electrical energy outside the borough boundaries with the permission of the neighbouring authorities. The financial proposals of the bill are to borrow £54,000 repayable in 50 years for construction, £12,500 for electrical equipment, and £15,000 for extensions to the municipal electricity works, both repayable in 30 years. After some opposition to the tramways, the preamble of the bill was declared proved.

St. Pancras Electricity.—This bill was passed by the Unopposed Committee of the House of Commons on Friday last week. The main object of the bill is to exempt the St. Pancras Borough Council from liability for damages in respect of nuisance caused by its electric generating station.

The Lancashire Electric Power Bill was read a second time in the House of Commons on Thursday last week. A debate on the second reading was avoided by a compromise with the large number of local authorities which own electricity works in the area covered by the bill, although there will still be opposition in Committee. The bill originally proposed to give the company power, subject to an appeal to the Board of Trade, to supply anywhere, but it has been agreed to avoid all towns having an electricity undertaking.

Ardrossan, Saltcoats & District Tramways.—This Scottish Tramway Provisional Order was considered by Commissioners appointed under the Private Legislation Procedure (Scotland) Act last week and was continued this week. The proposal is to construct a system of tramways connecting the towns in question, making a total length of 11½ miles in addition to a pier at Portincross, and to incorporate a company to carry out the work. Practically all the local authorities and almost all the landowners are in favour of the line. Among those opposing, however, were the National Telephone Co., the railway companies, and the County Council of Ayr. A very large amount of evidence was heard in favour of the scheme. Mr. Stephen Sellon, consulting engineer to the scheme, calculated that the receipts would be £2,040 per mile, and that a surplus of £1,221 per annum should be obtained. The only engineering features of interest were two railway level crossings, but several of these existed in England and he anticipated no difficulty therefrom. The opposition of the railway companies was against the level crossings, which, after hearing evidence, the Commissioners decided against. The preamble of the order was afterwards passed, including a clause allowing the promotors to run motor omnibuses between two specified points.

The Wallasey Tramways & Improvements Bill was read a third time in the House of Lords on Monday.

The Romford & District Tramways Bill has been withdrawn.

The Nottinghamshire & Derbyshire Tramways Bill was passed by the Unopposed Committee of the House of Lords on Tuesday. The bill seeks an extension of time for the construction of works and the acquisition of land authorised by the company's act of 1903, and also provides for a rearrangement of the capital of the company. Powers are also taken to sell certain tramways to the Mansfield & District Light Railways Co. and to the Nottingham Corporation.

LEGAL INTELLIGENCE.

Metallic Seamless Tube Co. (Ltd.) v. Simplex Steel Conduit Co. (Ltd.)

In re letters patent No. 28,632 of 1900, granted to L. Maxwell Waterhouse, and the Patents Acts.

This case came before the Court of Appeal (the Master of the Rolls and Lords Justices Romer and Cozens-Hardy) last week, on the appeal of the Simplex Steel Conduit Co. from a decision of Mr. Justice Buckley, reported in *The Electrician* for Nov. 24 last.

Mr. A. J. WALTER, in opening the case, said Mr. Justice Buckley ordered the patent to be revoked on the ground of want of subject matter. In electric lighting it was usual to have the wires cased, and under the fire insurance company's rules it was compulsory to do so. There were two systems of doing that—wooden casing and metallic pipes. The wires, in addition to being put in the casing, were covered with some insulating material. It occasionally happened that the covering of the wire got cut off, and then they had a bare wire, and if the metallic casing was exposed so that people could touch it, and it was not "earthed" somewhere, sometimes people were killed. They had not only to deal with the conduits, but there were a mass of fittings in connection with electrical work. When they came to an angle, and had to change the direction of the pipes, it was necessary to use screw fittings. In an electrical conduit the continuity of the inner surface was a matter of importance, and he explained that the invention consisted of a ferrule which was screwed at one end to go into the socket, and was always screwed. The other end was larger and had a plain socket which fitted an unscrewed pipe of the same size as the screwed end of the socket. The ferrule was split in such a way that when it was screwed up it gripped enough of the plain tube to make an electrical contact. The problem which the patentee laid himself out to solve was to devise an apparatus which would enable you to fit on piping of the same size, and so that you had the same size casing or tubing everywhere.

Mr. ASTBURY, K.C., for respondents, submitted that the decision of Mr. Justice Buckley was right and should be affirmed. He contended that there was no invention in what the patentees had done in this matter, and that having regard to prior specifications and to the state of public knowledge no invention was required to produce the method of uniting plain conduits to couplings and other fittings by means of a split, screwed bushing described and claimed in the specification, and that the patent was bad for want of subject matter. He submitted that the patentees failed for want of novelty and that the revocation order of Mr. Justice Buckley should be upheld.

Judgment was reserved.

In re J. T. Armstrong; ex parte T. M. de Bingham v. F. Salaman (trustee).

On Friday Mr. Justice Bigham heard an appeal in this case from the rejection of a proof for £10,000 for alleged breach of contract. The case arose out of an agreement to form a syndicate to sell Armstrongs' patent wireless telegraphic and telephonic apparatus, and the trustee had rejected the proof on a number of grounds—misrepresentation and failure to form a company, &c. Appellant made an affidavit, stating that he had ordered from bankrupt 5,000 sets of his apparatus, but had been unable to obtain them. He had interviewed people in all the principal towns in England, and had found that he could have sold the apparatus if he could have got it. Bankrupt's excuse for not supply the apparatus was that he was too busy on the Stock Exchange. He had spent about £10 a week in travelling over various counties in the north of England for about 18 months. A company was to be formed, to be called the International Wireless Telegraph & Telephone Co., and, in fact, it was registered with a capital of £175,000 in £1 shares, of which the debtor (Armstrong) was to take £120,000 fully-paid shares as his consideration. The shares had been allotted to him and his nominees, and had been dealt with on the Stock Exchange.

The APPELLANT (Mr. T. M. de Bingham) stated that he ordered 3,000 and 2,000 sets of the apparatus, but they were not delivered, and he had not seen any except at debtor's private residence. He formed a syndicate to work the invention.

His LORDSHIP thought the trustee was right in rejecting the proof. The agreements came into existence to enable appellant and bankrupt to form a company, but he did not believe appellant had the money to buy the patent rights, and the company was never properly formed. There was no damage shown, and the appeal must be dismissed, with costs.

Bastaple v. Metcalfe.

A Divisional Court (the Lord Chief Justice and Mr. Justice Darling) last week decided an interesting point in this case, which had been stated by the magistrates at Southampton.

On Oct. 31 last respondent (Metcalfe) was charged with having travelled on one of the Corporation tramcars without paying his fare. He had, in fact, paid 1d. fare, but before he had completed the journey he alighted, and after walking some distance got on another car travelling in the same direction and completed the journey. He refused to pay a second fare, and produced his original ticket. The justices refused to convict.

Mr. C. A. RUSSELL, K.C., said the appeal raised the question as to whether the magistrates were wrong in refusing to convict respondent for having infringed the Corporation's tramway bye-laws of 1897 by travelling on a Corporation tramcar without paying his fare. He contended that they should have convicted. The passenger had started from a principal point on the tramcar system, paying 1d. fare, which entitled him to travel to another place. He got off at an intermediate place, and after walking some distance he got on another car and travelled to the full extent for which he had paid the 1d. The journey had been broken, and respondent should have paid another fare, and therefore the justices should have convicted.

Their LORDSHIPS held that the magistrates should have convicted, and sent the case back with that direction.

Schulzinstein v. Manchester Corporation.

At Manchester County Court on Monday plaintiff sought to recove from the Corporation £43. 2s. 6d.—£10 for damage to goods, £1. 2s. 6d. paid for carriage of same, £7 paid for goods purchased in substitution of those lost and £25 for loss of use of goods owing to defendants' breach of contract. In December last plaintiff and his wife made arrangements to spend their holidays in Germany, and on Dec. 20 he requested them to convey his luggage to the Central Station to catch the express. The Corporation's agent promised this should be done. The luggage was duly called for in the morning, but did not reach the station until the afternoon, when it was refused as baggage for the express. The Corporation afterwards engaged forwarding agents to send it on to Berlin, but after a lapse of seven or eight weeks the goods were returned to Manchester without having reached the owner.

For the defence, the Corporation officials said that they could not guarantee to deliver a parcel at a specific time, and that to take seven hours to deliver a parcel at the Central Station from Stretford at Christmas time was not unreasonable delay.

Judge PARRY did not consider the delivery a reasonable one. The Corporation tramways department advertised "quick collection, rapid transit and prompt delivery." If they occupied seven or eight hours to convey a parcel 3 miles the advertisement was a fraud on the public.

For defendants it was submitted there was no special contract, and that no agent of the Corporation did or could guarantee that the parcel should reach a certain place at a specified time.

The JUDGE thought the Corporation had been negligent and gave judgment for plaintiff for £21 and costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A laboratory assistant is wanted in the department of electrical engineering of the Glasgow and West of Scotland Technical College. Applications to Prof. Magnus Maclean. See an advertisement.

A fitter is required in the electric light department by the Government of Lagos. Applications will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., on or before May 21. See also advertisement.

The governing body of Battersea (London) Polytechnic invite applications for the position of head of the department of electrical engineering from September next. Particulars from the secretary.

A commercial assistant is required for Birmingham electric supply department. Commencing salary £300, rising to £400 per annum. Applications to city electrical engineer and manager (Mr. R. A. Chattock, M.I E.E.), 14, Dale End, Birmingham, by 14th inst.

Hoylake & West Kirby Council require a chief assistant electrical engineer. Commencing salary £125, rising to £150 per annum. Applications by 18th inst.

Mr. R. F. Jewell, of Southwark, has been appointed chief engineer of the Gosport & Alverstoke Electricity Supply Co.

Mr. Brook Dyson has been appointed electrical draughtsman to Hackney (London) electricity department at £130 per annum.

Mr. A. Moir, staff engineer (first class) has been appointed by the Postmaster-General superintending telegraph engineer of the Midland district of Ireland in succession to Mr. H. Pomeroy, who has retired on a pension.

Australasia.—The "Australian Mining Standard" reports that the High Court of Australia has decided in favour of Melbourne Corporation in the action which, as we stated in a recent issue, was brought by the Melbourne Gas Co. to prevent the municipal electricity department from making two different methods of charging for electric current—*i.e.*, a flat rate of 4½d. per unit (or 7d. per unit for the first 45 hours' maximum demand per month and 2d. after).

Melbourne Corporation are recommended by the Electric Supply committee to apply for an order authorising the supply of electricity in North Melbourne.

Wellington (N.Z.) Council are about to raise a loan of £264,000, including £100,000 for electricity supply.

Negotiations for the purchase of the Adelaide Tramways Co.'s system by the Government are still proceeding. The Government offer £250,000 and the company ask £300,000.

At a recent meeting of the Commonwealth Cabinet, Mr. Groom, on behalf of the Postmaster-General, said the proposed regulations as to toll system of telephone charges, which had aroused so much opposition, were published, in accordance with the Statutory Rules Act, for the purpose of inviting criticism, and Mr. R. T. Scott, secretary to the Postal Department, said he hoped to recommend to the Minister a reduction of the charge for the use of public bureau telephones from 3d. to 1d.; that subscribers shall, after a certain number of calls at ½d. per call, pay only ¼d. each for any additional calls; and that subscribers shall be authorised to allow the use of their instruments by non-subscribers at a charge of 1d. per call.

The acting city electrical engineer (Mr. J. E. Donoghue) has presented a report to Sydney Electric Light committee, alleging that the electrical inspector to the Fire Underwriters' Association (Mr. A. E. Burgess) is not sufficiently exacting in his requirements with regard to the wiring of consumers' premises. Mr. Burgess, however, explains that as nearly all the installations wired previous to the issue of the association's new rules in 1904 (these rules are substantially those issued by the I.E.E., see "Electrician" Electrical Trades' Directory for 1906, p. 326) failed to satisfy the requirements of those rules, he (Mr. Burgess) had refrained from condemning the installations because they showed no serious defect and were suitable for the 110-volt pressure at which they were originally supplied by private companies, although not suitable for the municipal supply on the three-wire system at 240 volts.

An application by Prahran Council some time ago for authority to construct a tramway to serve the Prahran and Malvern districts was refused, but the representative councils of the two districts have now agreed upon the route for such a line, and will make joint application for powers to construct it.

Blackburn.—The salary of the borough electrical engineer (Mr. P. P. Wheelwright) has been increased from £300 to £350, rising by annual increments of £25 to £500 per annum.

Bradford.—The annual "Budget" of the Corporation was discussed on Tuesday:—

The chairman of the finance committee (Ald. D. Wade) said that £10,000 from the tramway renewals accounts had been hypothecated to relief of rates. The renewals account stood at £40,000 at the end of March, 1905, and from what appeared to be the probable balance to be carried to renewals account for the year just closed (anywhere between £15,000 and £20,000) it was believed by the officials who were best able to judge of the life of the permanent way and the requirements which might be made on the account, that there would not be such an immediate demand upon it as to forbid the appropriation of the sum in question. Therefore, the application of £10,000 could not be regarded as jeopardising the present strength and stability of the renewal fund, especially if future annual revenue balances carried to its credit maintained the level of the past two years. Quite apart from any discussion upon the question of what was and what was not profit, having regard to provision for contingencies and depreciation, the £10,000 was only a repayment to the ratepayers of a sum by which they had to subsidise the tramways in 1902 and 1903, when there was provided directly out of the rates £10,683 for tramway purposes, which included £6,000 in consequence of the regrettable accident on the Horton section.

Brighton.—The new electricity works at Southwick will be officially opened on June 10 by the President of the Local Government Board, Mr. John Burns, M.P.

Bristol.—On Tuesday the chairman of the Electrical committee (Ald. Pearson) presented a report recommending application for sanction to a further loan of £103,554 for extensions of the electricity undertaking.

Ald. Pearson said that £10,400 was required for additions at Temple Back works, £57,100 for additions at Avonbank works, and £40,800 for additions to the external system, including a special sub-station for the docks supply at Underfall yard. These items made £108,300, but there was a surplus, after completion of works authorised by previous sanctions, of £4,745, reducing the amount required to £103,554. He regretted the committee were not able to get their accounts out for last year's trading before bringing the report forward. They were now very much pressed, and they were not able to wait until the June meeting, when their yearly report, they hoped, would be ready. The equivalent of 195,940 8 c.p. lamps was connected (2,839 consumers), compared with 168,000 8 c.p. and 2,349 consumers two years ago. They had 285 miles of cable laid, against 227; the output estimated up to March last was 5,649,000 units, against 4,299,000. Their power load was increasing more quickly than their lighting load. To take a moderate estimate for the next two years beyond what had ordinarily been run for the last four years, they might have to provide for at least 750 H.P. a year, bringing it up to 1,500 for the two years. That meant that during the next two years they had to raise their capacity to 7,152 H.P., and to do that they had to provide additional machinery. They had 20 loans sanctioned by the L.G. Board, and they felt they were now in a position to close the first 12 of these loans absolutely. In the capital for which they now asked the large item of £57,100 was for the superstructure and engine room plant. Instead of putting in, as hitherto, plant with 1,000 kw. as the largest unit, they had decided upon 3,000 kw. plant for the new works. The position of their undertaking would not, he thought, when their accounts came out, be called unsatisfactory. He would like to anticipate to some degree the important report the committee would lay before the Council as to whethey they as a Council were taking sufficient money out of the profits to adequately provide a sinking fund for the whole of the money expended. They had Prof. Dicksee down to examine their accounts and to interview the secretary and engineer and report as to whether he thought the reserve for depreciation was adequate, and they found from Prof. Dicksee's report that they had provided a little more than it would be necessary to provide under ordinary circumstances in the case of a company.

The report was adopted.

Burgess Hill.—The Board of Trade, in extending the period of the Council's electric lighting order, 1901, for 12 months, intimate that no further extension will be granted.

Burton-upon-Trent.—The total receipts of the tramways department for the year ended March 31 were £16,111, a decrease of £1,040 compared with the previous year, the traffic receipts being £15,654, decrease £1,763. Expenses were £11,337, leaving a surplus of £4,773, and after paying interest and sinking fund, &c. (£5,003), and allowing £500 for renewals there was a deficiency of £230. 3,505,523 passengers were carried, against 3,878,269, car-miles run 434,944, traffic receipts per car-mile 8·24d. (against 9·21d.). There was a reduction of operating expenses per car-mile from 6·76d. to 6·24d. The income per car-mile was 8·88d. and the total expenses 9·01d Working expenses per cent. of income worked out at 70·24 per cent. The number of parcels dealt with was 41,163, an increase of 1,524. Repairs and track work have somewhat increased. The total capital expenditure to date is £99,680.

Carlisle.—On Tuesday the Corporation decided to apply for sanction to a loan of £5,500 for additional plant for the electricity works.

Cheltenham.—A member of the Council has given notice of a resolution:—

That it is desirable to consider the advisability of selling the electric lighting undertaking upon terms that shall reimburse the borough the full amount of capital moneys incurred, and also fully safeguard the nature and price of supply both for public and private lighting, thereby obviating further capital expenditure by the Council of the said borough, and the possible risks and disadvantages attendant upon the management and control of the said undertaking by the municipality.

Chester-le-Street.—The Council have received two tenders for public lighting—the Parish Lighting Co. for incandescent gas and the Northern Counties Electricity Supply Co. for electric lighting.

The Chairman (Mr. T. Storey) when reading the tenders caused merriment by observing that he wished they had the electric light on, or better gas, as he could hardly see to read the tenders, the light was so dim. The Electricity Supply Co.'s terms were for the erection of 60 lamps of 80 c.p. each and 181 of 40 c.p., the light to be on from dusk to daylight. Also further lamps of from 40 to 80 c.p. for certain thoroughfares. The tenders are under consideration by the Lighting committee.

Clacton-on-Sea.—The prices of current have been fixed at flat rates of 5d. per unit for lighting and 3d. for power.

Cleckheaton.—The Council have received sanction to a loan of £3,810 (out of £4,194) for electricity extensions.

Colchester.—In our last issue (page 109) we referred to the fact that a large outlay had been incurred on incandescent gas lighting in streets where electric lighting mains had been laid, and we unfortunately credited the Electricity Supply committee of the Corporation with this expenditure, which was, as a matter of fact, incurred by the "Lighting committee." Our error was due to the unbusinesslike arrangement by which two committees at Colchester are interested in the public lighting of the town. There is a special committee appointed to manage the electricity department, while another and antagonistic committee is in charge of the public lighting. The protest of the borough electrical engineer (Mr. A. R. Sillar) against the expenditure on gas lighting was fully justified under the circumstances, and we hope the outcome of his protest will be to place the Electricity Supply committee in charge of the street lighting arrangements. This modification of existing arrangements would certainly be in the ratepayers' interests.

Competition.—"The Electrical Contractor" is offering a prize of £5 for the best essay of from 1,500 to 3,000 words upon the subject of "Electricity versus Gas Lighting." Competitions to 20, Bucklersbury, London, E.C., by 15th inst.

Customs Decisions.—By recent customs decisions globes and shades for electric incandescent lamps imported into the Australian Commonwealth are classed as glassware and are subject to a duty of 20 per cent. ad val.

Damascus.—In a report on the trade and commerce of Beirut and the coast of Syria for 1905 Mr. Consul-General Drummond-Hay states that 10,000 tons of rails have been landed at Beirut for the new electric tramway now under construction at Damascus. There are in this part of the Near East a number of railway and tramway projects under consideration at the present time, and the intention appears to be to adopt electricity as motive power for the tramway schemes.

Dartford.—The Council seek powers to extend their tramways to Swanscombe, to join up with the Gravesend and Northfleet tramways.

Doncaster.—The Tramways committee reported to the Council on Wednesday that the working of the tramways undertaking for the past financial year showed a deficiency of £2,079 after payment of all expenses, including sinking fund and interest.

Dublin.—Last week the Corporation decided to introduce a uniform system of charging for electric current as an alternative to the maximum demand system.

The rates where the buildings are entirely lighted by electricity are to be: Hospitals 3½d., private residences 4d., clubs and private hotels 3½d., tobacconists' shops, supper & billiard rooms, &c., 3½d., hotels and licensed houses 3½d., public institutions other than hospitals, churches, and factories 3½d.

East Ham.—The flat rate of 3¾d. per unit for electric current for lighting is reduced to 3½d. from April 1.

Electrical Trades' Benevolent Institution.—An appeal is made on behalf of the funds of this trade charity, and to help the charitably disposed to appreciate the full value of the institution copies of the rules can be obtained from the National Electrical Manufacturers' Association, Ridler's-place, Blackfriars, London, S.E.

Electric Power in Mines.—Messrs. Hoskins & Llewellyn have recently substituted electric for steam power at their British Top Pits, Talywain. At the Golynos Pit up-to-date electric hauling appliances have been put down. A sub-station has been built near the offices at Talywain, in which the voltage of the electric current supplied by the South Wales Electrical Power Distribution Co.'s station at Cwmbran is reduced from 11,000 to 3,000 volts, which it is estimated will be sufficient for the present requirements at the pits. Electric driving will also be used for the sawmills, chaff-cutting machines and the blasts at the blacksmiths' forges. It is anticipated that ultimately the whole of the surface work will be done by electricity. There are 600 men employed at the pits, and the result of the present installation will undoubtedly be to greatly increase the output.

Electric Traction in China.—The "Financial News" reports that Mr. Lim Dat, a Chinese merchant, of Victoria, B.C., has organised among his countrymen located in British Columbia a $2,000,000 company to construct an electric railway on the overhead system from Canton to San Wu, China, a distance of 60 miles. The route of the proposed line is a populous one, Canton having a population of 2,000,000 and San Wu 500,000.

Electrical Exhibition.—Sheffield Electric Light committee propose to hold an electrical exhibition in the Corn Exchange in the autumn.

Faversham.—The Council have rejected a motion suggesting the disposal of the municipal electricity works to a private company.

Forthcoming Books.—Messrs. Archibald Constable & Co. will shortly publish a new book by Prof. H. C. Jones, of the John Hopkins University, entitled "The Electrical Theory of Matter and Radio-Activity."

Fulham (London).—A more modern plant is to be substituted for the present pump, &c., at the artesian well of the generating station, at an estimated cost of £300.

The shift engineers are to have their salaries raised to £2. 7s. 6d. per week.

Gelligaer.—The Board of Trade have refused the Council's application for a provisional electric lighting order.

Good Conduct Badges for Tramway Conductors.—The Stalybridge, Hyde, Dukinfield and Mossley Joint Electricity and Tramways Board have instituted a system of awarding good conduct badges to conductors with exceptionally good records at the end of three years' service, such badge to carry extra pay at the rate of ½d. per hour, the badge to be retained by the conductor only so long as he maintains his good conduct.

Great Northern & City Railway.—Hornsey Ratepayers Association have petitioned the directors of the Great Northern & City Railway Co. to extend their line from Finsbury Park to Alexandra Palace.

Great Yarmouth.—The Corporation have voted £500 to the borough surveyor (Mr. J. W. Cockrill) as an honorarium for extra services rendered in connection with the Corporation tramways.

Hackney (London).—The supply network is to be strengthened by the addition of a new feeding centre, at a cost of £1,352.

Hanley.—The borough electrical engineer (Mr. C. H. Yeaman) states in his annual report that

He would like to recommend a general flat rate or uniform price, but, in view of the general tendency to earlier closing, to the short lighting period of many consumers with large numbers of lamps, and to the difficulties of meeting a heavy load produced by the coincidence of the factory, shop, house, office and public lighting and motor supply in winter, and in the absence of a tramway load, it would not be feasible to sell to the more remunerative classes of customers at so low an average price as is now the case. The increase in the supply for power was not so apparent as it would have been had the connections taken place earlier in the year. The supply for power increased by 15,509 units, but the receipts decreased by £102. The average price received had been slightly reduced, but the present year will see a much greater fall owing to the system of restricted hour supply and other concessions to large and regular users of motors.

The expenses of production had been affected by several necessary changes in the routine operation of the works. Up to August, 1905, the day-load was taken by one of the 100 kw. Brush rope-driven sets. Complaints had been received that motors did not start up well or stand variations in load in a satisfactory manner, and during the spring these questions had been carefully investigated, with the result that it was found desirable to take the factory load on a heavily flywheeled engine. As the next larger set was the Ferranti-McLaren 300kw which stood in need of thorough overhaul, and the only others were the 500kw. to 600kw. Howden-Westinghouse and Ferranti sets, the decision necessarily caused a considerable increase in coal consumption and in the oil bill. The extra cost had been justified by the improvement in the working of motors, and without the change the increase in that class of business could not have been made. Other causes which tended to keep coal and oil costs up had been the inability of the Howden-Westinghouse set to give the full rated output at the electrical pressure required in the evening, and the condition of the Ferranti 600 kw. set.

The object it was most desirable should be kept in view was to supply electrical energy throughout the borough for all purposes at the lowest prices possible. The steady expansion of the undertaking could only be assured by meeting the competition of other illuminants and sources of power by reductions in the average price per unit. In order that such reductions might be made without risk of a loss in any year, it was necessary that extraordinary or special expenditure should not fall on revenue. Four Brush transformers which failed have been taken in part payment for one new and larger one. Three other transformers of 18 kw. each had been re-wound, but only gave safely 12 kw. each. These would very properly be dealt with as depreciated items. No amount had been set aside for depreciation, and only £619 had been placed to reserve (taken from the profit of 1904), of which £515 was shown in the 1904 accounts as having been spent. A reasonable provision should be made for future contigencies, and especially should depreciation be allowed on the plant and mains which had been in use from the opening of the works. Owing to the changes in design, improvements in manufacture and higher efficiencies now obtained from engines and alternators, and to competition and more general use of such machinery, which had brought down the price very much below the amounts paid for the older generating sets in the works, these did not possess at present anything like the value at which they were represented in the capital account, even if credit be taken for the repayments of sinking fund made against the loans out of which they were purchased. To produce electricity cheaply required plant of high steam efficiency, small oil consumption, and taking little repair. It was in those respects that manufacturers now excelled. While much of the older plant could be run for years, yet it became a question whether it paid to continue its use, involving much higher expenditure on coal, oil and repairs than would be paid if it could be gradually replaced. Plant bought on capital account could not be replaced during the currency of the loan, except out of revenue. However desirable it might be to reduce the cost of production, the means for doing so could only be found by appropriating surplus profits. There were also necessary alterations, such as the removal of the smaller sets to the destructor works, the replacement of copper pipes in the steam range, the enlargement and modernisation of the sub-stations, the protection of the works from fire, the relaying of the old rubber cables on the solid system, the conversion of the centre of the town to a three-wire system, and other works which would entail the expenditure of a considerable sum of money, but which were more of the nature of contingency or renewal items than ordinary maintenance or repairs. There were also the recent requirements of the Home Office, and the new 1905 regulations of the Board of Trade to be met. It was of great importance that the financial position should be safeguarded by providing out of surplus revenue for the unforeseen changes which had taken place. The profit for 1905 was £1,449; without the economies, it would have fallen to £901. The difference between the commercial or over-all cost of making and selling electricity and the amount received was the only kind of profit having any real existence. As several motors of old make, and therefore of an almost unsaleable type, are in stock, Mr. Yeaman recommends that the profits from this section should be applied to writing down the stock value.

The cost per unit sold amounted to 3·51d. in 1905 compared with 3·72d. in 1904. The works cost was 1·99d. The average price of all units sold in 1904 was 4·02d. and in 1905 3·77d. per unit. The profit was the difference between 3·77d. and 3·51d.

Hove.—The Council have decided to give consumers of electricity in Aldrington the option of a flat rate of 5d. per unit.

Huddersfield.—For the year ended March the total income of the tramways department was £74,495. 5s. 6d. (including passengers £71,431, parcels £967 and coal haulage £581), or 10·21d. per car-mile (against 10·09d. in 1904-5). Total working expenses (including general repairs and maintenance £14,580 and power £4,929) were £39,872. 12s. 3d., or 5·46d. per car-mile (against 4·89d.) The gross surplus was £34,622. 13s. 3d. After paying rent of leased lines and interest and allowing for redemption of debt the balance was £10,969. 17s. 5d. Depreciation at 3 per cent. absorbed £12,101. 15s. 5d, leaving a deficiency of £1,131. 18s.

Ipswich.—The accounts of the electricity department for the year ended March show capital expenditure £81,481, increase £4,708. The receipts from sale of current for lighting were £4,375, for power £1,036, and for traction £4,550, the total receipts being £10,103. Working expenses were £5,671, and the gross profit was £4,432. After meeting capital charges there is a deficit on the year's working of £410. There are no public electric lamps at Ipswich. The maximum supply demanded was 693 kw. There are 284 consumers (against 209) and the connections (including motors) are equivalent to 36,170 8 c.p. lamps (against 27,557). The aggregate horse power of motors connected is 437 (against 291).

The capital expenditure of the tramways department is £113,805, an increase of £1,806 on the year. The total receipts were £21,426. Working expenses were £16,254, or 5·968d. per car-mile (against 6·541d. in previous year). After meeting capital charges there was a deficit of £710. 5,255,373 passengers were carried (against 5,693 680), 653,617 car-miles were run (against 692,310), and 728,020 units of electricity were used, being 1·114 per car-mile (against 797,370 and 1·15 per car-mile). Total revenue per car-mile was 7·367d. (against 8·108d.). Mr. Frank Ayton, the engineer and manager, states in his report that the early morning workmen's cars, run to comply with statutory requirements, are a dead loss to the department. The decrease of car-mileage is 5·6 per cent and the revenue has decreased nearly 3½ per cent.

Light Railways.—An order reviving powers and extending the period for completion of works, &c., by the Canterbury and Herne Bay light railway order, 1903, has been submitted to the Board of Trade for confirmation. Objectoins by May 26.

London Street Traffic.—The L.G. Board have intimated that the Government are not yet in a position to express an opinion on the findings of the Royal Commission on London Traffic, and that, as no legislation can be anticipated this session on the subject, the President does not think it necessary to trouble the proposed deputation from borough councils to attend on the subject of the inconvenience caused by the opening of streets, &c. The President is to be asked to receive a deputation in the autumn in order that the views of the councils may be impressed on the Government before the details of any Government bill on the subject are settled.

Lower Bebington.—The Board of Trade, who have granted the Council an extension of 12 months for carrying out their provisional electric lighting order, 1902, have intimated that if at the end of this time no steps have been taken to put the order in force it will be revoked.

Malden and Coombe.—The question of supplying electricity in this district by Kingston-on-Thames Corporation is to be discussed between representatives of the two local authorities.

Manchester.—For some time past there has been much talk in local circles of irregularities at the Hyde-road car sheds of the tramways department. The general manager (Mr. M'Elroy) immediately upon hearing the rumour drew attention to the subject, and a full investigation has been made by a sub-committee, who report that what has occurred is of a trifling nature (not involving more than £10 in amount), and that the matter does not call for any detailed report, it being intended to make arrangements to prevent any similar irregularities in future.

Mansfield.—The Council have decided to apply for a loan of £6,000 for extensions of the electricity works—viz., £2,000 to meet excess expenditure, £3,000 storage battery, £1,000 for new feeder main for light railway, £1,700 mains and £300 water softening plant.

Middlesbrough.—We are glad to learn that the borough electrical engineer (Mr. H. M. Taylor) is now convalescent, after a severe attack of typhoid fever.

The net profit on the past year's working of the electricity department was £898. 9s. 7d. The total receipts were £13,657 (including £13,300 from the sale of electric current), an increase of £2,354. The cost of generation (including coal, wages, &c.) was £4,564; rates and taxes were £1,222, and management expenses £927, while interest absorbed £2,947. £1,174 was contributed to the rates, against £987 last year. The cost per unit sold was 1·22d., against 1·37d.

Municipal Telephony.—At the last meeting of Brighton Corporation, the Telephone committee reported having received a communication, signed by Councillor Saunders and 11 other members of the Council, requesting the committee to report to the Council the present state of the negotiations with the Postmaster-General. The committee resolved to inform Councillor Saunders that the committee are acting in conjunction with representatives of the other telephone-owning municipalities in the negotiations with the Postmaster-General, and are awaiting a further interview with him in the matter, but that before any arrangement binding upon the Corporation is come to, the committee will report to the Council upon the whole question.

Councillor Saunders said it had been stated in the press that certain negotiations had been opened with the National Telephone Co. for the purchase of the Corporation system. He had asked the chairman if it was correct, and the reply was that it was not so. Now he was in a position to say that negotiations had been opened. The ratepayers were entitled to know of the negotiations, and why they were broken off. The letter sent by himself and his fellow members asked for a report "upon the present state of the negotiations for the sale of the telephones undertaking," and had reference to negotiations with the company, and he wanted to know why they were broken off.

Councillor Black considered no harm could ensue if the Council was informed as to the present position of affairs, and they had a full and frank discussion, such as had taken place in other towns. He had been a regular attendant at the committee meetings, and he had not been informed, and the committee were not informed, and, as one of the small sub-committee entrusted with delicate negotiations with the Postmaster-General with reference to the sale of the undertaking, he asked if it was right to let one of the sub-committee to go up to town time after time, and withhold from him information that he ought to have.

Councillor Saunders here handed a letter to Councillor Hallett from the general manager of the National Telephone Co. (Mr. W. E. L. Gaine) which stated that the only negotiation which he had had with the Corporation respecting their telephone undertaking, took place last year during the sittings of the Select Committee of the House of Commons. These negotiations took place at certain meetings which were held at the Post Office, but nothing came of them. The representatives of the Corporation were, if he remembered rightly, the chairman of the Telephone committee, Mr. Ald. Carden, and the town clerk. Whether the company would be prepared now to negotiate for the purchase of the Corporation undertaking he did not know, and he was certainly not prepared to open any negotiation unless he was invited to do so. All he knew was that the longer the competition continued the greater would be the eventual loss which would have to be faced when the two systems were amalgamated, as ultimately they must be.

A lively discussion ensued, and Councillor Lintott refused to take the report back.

Ald. Carden explained that the meeting referred to in Mr. Gaine's letter took place in the G.P.O. buildings, London, in the presence of the Post Office Secretary, and it had reference to the agreement between the Post Office and the National Co., which was under consideration by the Select Committee then sitting, and to the terms on which the Corporation would withdraw their opposition. As soon as the negotiations came to any reasonable conclusion the information would be given to the Council, but it would be to the prejudice of the ratepayers to prematurely divulge the position of the negotiations. They were expecting another interview with the Post Office, and as soon as it had taken place he had no doubt the committee would report to the Council.

The report was then adopted.

The inquiry which was to have taken place this week into the Brighton Corporation's application for sanction to a further loan for telephone purposes, has been postponed to a date to be decided later.

At a meeting of Swansea Telephone committee on Tuesday the proceedings at the recent L.G. Board inquiry were considered:—

It was decided that the manager (Mr. A. G. Mackio) should prepare amended estimates for the consideration of the committee with a view to the holding of a fresh inquiry. It was decided to take counsel's opinion on the advisability of appealing to the House of Lords against the decision of the Court of Appeal on the subject of intercommunication.

In view of the decision of the Postmaster-General not to entertain the subject of the purchase of the Swansea municipal system without allowing for depreciation it was decided not to continue negotiations.

North London Tramways.—London County Council intend to forthwith complete the widening of Goswell-road from the Angel, Islington, to Fan-street, Aldersgate, and to relay the roadways and rails for electric traction.

Personal.—Mr. John Hesketh having been transferred from the position of electrical engineer for the State of Queensland to that of chief electrical engineer on the Postmaster-General's central staff, his address will in future be Postmaster-General's department, Spring-street, Melbourne, Victoria.

Presentations.—Mr. F. Mellor has been presented by the Oldham tramway staff with a writing desk on his departure for Swindon, where he becomes depot foreman.

On Wednesday evening Mr. Jas. Hill, chairman of Bradford Tramways committee, was presented by the officials of the department with an album containing 42 portraits and 20 views illustrating the various departments of the Corporation's tramway work, as a souvenir of his five years' chairmanship.

Salford.—For the year ended March 31 the tramway receipts were £226,013, or £14,912 in excess of 1904-5. Working expenses amounted to £144,195, leaving £81,818, an increase of £5,509.

£48,574 was expended for current. Interest and sinking fund contribution came to £40,623, rental to other authorities for running facilities £18,893, leaving a net balance of £22,303, which the Tramways committee have decided to dispose of as follows: In relief of rates £13,000, to depreciation and renewals £9,302. Since the Corporation took over the tramways £48,000 has been applied in relief of rates and £30,439 voted to depreciation and renewals.

South Africa.—The "British and South African Export Gazette" states that Messrs Hubert Davis & Spain have intimated that they cannot carry into effect their Bloemfontein tramway concession.

Mr. J. Mordy Lambe, the borough electrical engineer, recommends East London Corporation to re-build their electric power station at a cost of £45,000. The chimney shaft is reported to be in an unsafe condition, said to be due to the works being located on a morass of the Buffalo river.

Staffordshire.—Cannock Council have decided to transfer their electric lighting order to the Shropshire, Worcestershire & Staffordshire Electric Power Co., and Tamworth Council have come to a similar decision, the company paying the Council £200.

Sunderland.—The Corporation have withdrawn their opposition to the County of Durham Electric Power and the Newcastle-upon-Tyne Electric Supply Companies' power bills, as the promoters have accepted a clause that they "will not interfere with Sunderland in any way prejudicial to the ratepayers."

Sutton Coldfield.—The capital expended on the electricity department at the end of March was £39,154, an increase of £1,711 on the year. There were 420 consumers, against 361. The output was 292,427 units, against 255,037. 188,166 units were supplied for private lighting and power, the balance (104,261) being for public lighting. The receipts were £3,882, including £3,089 for private supply. The average price obtained for both public and private supply was 2·99d. per unit against 3·10d., and the cost of production was reduced from 1·89d. per unit to 1·62d. The trading profit increased from 3·88 per cent. to 4·70 per cent. on the average capital outlay, and amounts to £1,824. After paying interest and sinking fund the deficiency is £287. The total liabilities are put at £41,177.

Swanage.—A provisional electric lighting order for this district has been granted to the Bournemouth & Poole Electricity Supply Co.

Swindon.—The Council have decided to substitute tantalum electric lamps for 111 gas lamps in streets where electric mains have already been laid, at an estimated cost of £265. Tantalum lamps are also to be used for 85 of the existing reflector electric lamps, the cost of the conversion being £32.

Switzerland.—Out of a total import of electrical apparatus into Switzerland during 1905 amounting to £145,700 only a very small portion came from the United Kingdom. The imports in 1904 amounted to £137,000, of which the United Kingdom contributed £2,000.

Walmer.—The Council have referred to a committee Messrs. Foote & Milne's offer to take over the Walmer Electric Lighting Order, 1903.

Warrington.—The Council have received sanction to a loan of £7,000 for cables and house services.

West Ham.—Application has been made for sanction to a loan of £3,900 for tramway cables.

West Indian Telegraph Cable Projects—According to the Kingston correspondent of the London "Daily Chronicle," Messrs. A. E. Depass and W. Gillespie, two prominent West Indian merchants, have been elected to represent Jamaica at a congress of the Chambers of Commerce of the Empire, which is to be held in London in July. These gentlemen have, it is stated, been instructed to support a project for establishing direct cable communication between England, the West Indies and British Guiana, and are also instructed to urge upon the Imperial Government the necessity for an Imperial contribution to all British-West Indian telegraph cables.

York.—The gross income of the electricity department for the year ended March was £11,409 and the expenses £6,415, leaving a net balance of £4 993. After paying interest and sinking fund (£7,260) the deficit is £2,267. The loans sanctioned amount to £100,850, the total amount borrowed is £90,741 and the amount repaid £10,109.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Accrington Council invite tenders for supply of machinery in connection with (1) Lancashire boiler plant, (2) high-speed generating plant, at their electricity works. Specifications, &c., from the borough electrical engineer (Mr. Harold Gray), to whom tenders by noon 22nd inst. See also an advertisement.

Manchester Electricity committee invite tenders for the supply, delivery and erection of seven 150 kw. single phase transformers and high and low tension switchboards for sub-stations. Specifications from the secretary of the Electricity Department, Mr. F. E. Hughes. Tenders addressed to the Chairman of the Electricity committee, to the Town Hall, Manchester, by noon 23rd inst. See also an advertisement.

Coventry Corporation invite tenders for supply and erection of Lancashire boilers, economiser, steam and water pipes, mechanical stoker, two 600 kw. and one 300 kw. alternators and two-phase motors. Specifications, &c., from the city electrical engineer (Mr. Joseph A. Jeckell), Sandy-lane, Coventry. Tenders to the town clerk (Mr. Geo. Sutton), Hay lane, Coventry, by 10 a.m. 24th inst. See also an advertisement.

Oldham Corporation Electricity committee are prepared to receive offers from firms who will appoint the Corporation their agents for the sale, hire and hire-purchase of motors, radiators, cooking appliances, &c. Tenders to the borough electrical engineer, Mr. S. Wilmott Newington, Electricity Offices, Oldham (from whom particulars can be obtained) on or before noon May 15. See an advertisement.

Belfast Tramways and Electricity committee invite tenders for battery boosters, balancers and switch-gear. Specifications, &c., from the city electrical engineer (Mr. Victor A. H. M'Cowen). Tenders to Sir Samuel Black, Town Hall, Belfast, by 11 a.m. 21st inst. See also an advertisement.

Bristol Electrical committee invite tenders for (*a*) one 3,000 kw. (6,000 volt) three-phase turbo-alternator, with condensing plant; (*b*) one 500 kw. and (*c*) two 300 kw. motor generators or rotary converters (6,000 volts a.c. to 500 volts d.c.); (*d*, *e* and *f*) extensions to e.h.t., h.t. and l.t. switch gear: (*g*) 30 ton electric travelling crane; (*h*) water-tube boilers, with economisers, mechanical stokers, superheaters, induced-draught plant, &c.; (*j*) boiler feed pumps; (*k*) extension to coal conveyor; (*l*) steam and water pipe work; (*m*) water tanks; (*n*) steel troughing and fixing for protection of cables in subway; (*p*) annual supply of joint and junction boxes. Tenders from manufacturers only. Intending tenderers should communicate with the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, who will furnish further particulars.

The Lancashire & Yorkshire Railway Co. require tenders by 10. a.m. 23rd inst. for erection of electricity sub-station and battery station buildings at *Aintree*. Specification from the Secretary, Hunt's Bank, Manchester.

Edinburgh Corporation invite tenders for arc lamps for street lighting. Specifications, &c., from the city electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh. Tenders to the Town Clerk, City-chambers, Edinburgh, by May 14.

Leyton District Council invite tenders for radial axle trucks, bodies, electrical equipment and assembling. Tenders must be delivered to the Council meeting to be held at the Town Hall, Leyton, on May 29 at 7 p.m.

Bedford Corporation invite tenders from cable makers for the supply of high and low tension cables for 12 months. Tenders to the borough electrical engineer (Mr. R. W. L. Phillips), Cauldwell-road, Bedford, by noon May 23.

Swansea Corporation invite tenders for the supply, delivery and erection of one 600 kw. c.c. steam generator, with condensing plant, exhaust pipes, valves, connections, &c. Tenders to the town clerk (Mr. Jno. Thomas), Town Hall, Swansea, by noon May 29.

Carlisle Electricity committee invite tenders for traction battery, reversible booster and motor-driven balancer. Tenders by noon 24th inst.

South Shields Corporation want tenders by noon June 2 for wiring schools.

Islington (London) Council want tenders by noon 23rd inst. for Midland bituminous small coal for the electricity department.

Glasgow Corporation want tenders by 10 a.m. 22nd inst. for the erection of an electricity sub-station at Springburn.

Johannesburg Town Council is prepared to receive tenders for supply and delivery (after erection for inspection at makers' works) of three electric watering cars for the Council's tramway system, together with various spare parts. Tenders are to be f.o.b. at any port suitable for shipment for South Africa, and separate prices must also be given for (*a*) delivery of cars and spare parts at Johannesburg and (*b*) erection of cars complete at Johannesburg. Tenders to the town clerk (Mr. John Dove), Municipal Offices, Johannesburg, to reach him by June 16. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Mordey and Dawbarn), 92, Victoria-street, Westminster, London, S.W.

Tenders will be received up to June 13 by the Chairman of the Tender Board, Control and Audit Office, Parliament-street, *Cape Town*, for supply of telephone wire and cable, including ½ ton bronze wire No. 18; 5 miles bronze braided aerial No. 18; 2,200 yds. cable V.I.R., 20/10, 2 pairs; 1,100 yds. cable V.I.R., 20/10, 8 pairs; 440 yds, cable V.I.R., 12 pairs; 440 yds. cable V.I.R., 16 pairs; 440 yds. aerial cable, dry core, 52 pairs; and ½ ton galvanised steel wire No. 11. Forms of tender and copies of specification from Controller of Stores, G.P.O., Cape Town.

Tenders are invited by the *South Indian Railway Co.* for supply of various stores, including electric stores and sundries. Specifications, &c., from 55, Gracechurch-street, London, E.C., to which address tenders by 15th inst.

TENDERS RECEIVED AND ACCEPTED.

Lewisham (London) Council received the following tenders for two single-phase electric motors for driving chaff-cutting and corn-crushing machines: British Thomson-Houston Co., enclosed motors (*accepted*), £156. The same company tendered for unenclosed motors at £136. 8s. 9d., the General Electric Co., at £120. 10s. and the British Westinghouse Co. at £140.

Battersea (London) Council have accepted the following tenders: Gilbert Arc Lamp Co., 20 arc lamp globes 8s. 6d. each; Babcock & Wilcox, two self-recording steel tube mercury thermometers with capillary wire and necessary containers £29.

Islington (London) Council have accepted the tender of the British Insulated & Helsby Cables at £10,391. 12s. for supply of cable required for the arc lighting extension recently authorised. Eight tenders were received.

Islington (London) Council have also accepted the following tenders: Sloan Electrical Co., carbons; De Grelle, Houdret & Co., arc lamp globes; Ferranti Limited, transformers.

Victoria Pier Co., Blackpool, who have decided to adopt "Excello" flame arc lamps for lighting the pier this summer, have entrusted Messrs. Baxendale & Co, Manchester, with the order for the lamps.

For the erection of tramcar sheds and repair shops Leyton Council received 14 tenders, varying from £12,178 to £14,948, and the lowest, that of W. Manders (of Leyton), was accepted.

Southwark (London) Council have accepted the tender of the Switchboard Co. for two circuit-breakers for the feeder switchboard at £41. There were two other tenders at £96 and £117 respectively.

Gillingham (Kent) Council have accepted the tenders of the Electrical Co. and Mordey, Fricker & Co. for meters, and that of W. H. Willcox & Co. for oils.

Brighton Corporation have placed the order for twelve months' supply of incandescent lamps with the Zurich Incandescence Lamp Co. at 8½d. each. There were five tenders, ranging from 7d. to 9¾d. per lamp.

York Council have accepted the tender of Cox-Walkers for the installation of telephones, fire alarms and tell tales at Naburn Asylum at £513.

Leyton Council received 32 tenders varying from £2,288 to £4,085 6s. for roof trusses for the new car-sheds, &c., and the second lowest, that of Dorman, Long & Co. (at £2,732. 16s. 3d.) was accepted.

Canterbury Council have accepted the tender of Chamberlain & Hookham for meters for the ensuing year.

Salford Council have accepted the tender of Thermit Limited for supply of 500 welded portions of tramway rails at £1 each.

Sydney Finance committee recommend the acceptance of the tender of Gibson, Battle & Co. for an automatic electric lift for the town hall at £925. The Waygood Elevator Co.'s tender, at £817, was the lowest for an ordinary electric lift, but Gibson, Battle & Co.'s was the lowest in the automatic class.

Stoker Contracts.—For the new chain grate (Bennis-Miller-Bennett patent) orders have been placed with Ed. Bennis & Co. (Ltd.), Little Hulton, Bolton, and 28, Victoria street, London, S.W., as follows:—

Four chain-grate stokers for Calcutta, three chain-grate stokers for Kensington & Notting Hill electric light and power station, and two chain-grate stokers for Clarke, Chapman & Co., Gateshead-on-Tyne.

The following contracts for stokers and compressed-air furnaces have also recently been placed with Ed. Bennis & Co.:—

Four stokers and c.a.f. for Victoria Mills, Chorley; two stokers and camel furnaces (repeat order) for the Mutual Spinning Co., Heywood; two stokers and c.a.f. for Fletcher Bros., dye works, Halifax; two stokers and c.a.f. for R. Smith & Sons, Kidderminster; two stokers and c.a.f. for R. H. Symington (Ltd.), Market Harboro'; four stokers and one camel furnace for Curtis & Harvey's gunpowder works, near Rochester; two stokers and c.a.f. for Howard & Bullough, Accrington; 10 stokers and c.a.f. with necessary gearing and driving arrangements for Bloemfontein (S. Africa) Corporation electricity works.

The above contracts cover the supply of 28 stokers and compressed-air furnaces, camel furnaces, &c., in addition to the new chain-grate stokers.

Linolite.—The Linolite Co. have just delivered 360 ft. of linolite to Messrs. Waring & Gillows for part of their new premises in Oxford street, and have recently delivered 450 ft. to Messrs. Belshaw & Co. for country-house lighting.

Electric Power at Railway Works.—The Natal Government Railways have decided to put down a modern electrical generating station at their Durban works, and the complete contract for the turbo-alternators and surface condensing plant has been placed with Messrs. Willans & Robinson (Ltd.), Rugby, who are manufacturing the plant for Messrs. Hubert Davies & Spain, the chief contractors to the Natal Government Railways.

BUSINESS NOTICES.

Mr. Geo. Vaughan Fowler has retired from the firm of J. G. Statter & Co. The remaining partners continue under the old style.

The partnership between John da Costa & Etlinger Bros., electrical engineers, Durban and Port Elizabeth, has been dissolved Etlinger Bros. continue the Durban business and Mr. da Costa the Port Elizabeth establishment.

Geo. Wm. Green and Richd. Poole, electrical and mechanical engineers, Crown Works, Guildford-street, Lambeth, London, S.E., have dissolved partnership. Debts by Mr. Green.

W. C. Richards & J. Martial (trading as the Natal Electric Co.), Pietermaritzburg, have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

Thos. C. Hodgkinson (trading as Electro-Neurotone), 186, Goldhawk-road, Shepherd's Bush, London, W., has been adjudicated bankrupt. First meeting of creditors May 16 at Bankruptcy-buildings, London, W.C., and the public examination at same place on June 14.

Last week the public examination took place of Arthur Herbert electrical engineer, formerly of 30, Kirby-street, Hatton Garden, London, carrying on business in partnership with William Carter. Unsecured debts £194. 9s. 10d., assets nil.

In the London Bankruptcy Court last week Mr. Registrar Hope heard an application for the discharge of Albert E. Hodgson, 94, Victoria-street, London, S.W. Debtor attributed his failure to liability under guarantees given for the benefit of the British Power Traction & Lighting Co., of which he was formerly a director. Discharge suspended for three years

The trustees in the failure of Alex. Gavan Inrig, electrical engineer, 16, Bruce-grove, Tottenham, has been released.

Claims against the Taunton & West Somerset Electric Railways & Tramways Co. (Ltd.) are to be sent by June 15 to Mr. P. N. Gray, Donington House, Norfolk-street, London, W.C

In the liquidation of the Telescriptor Synd. (Ltd.), the High Court has authorised a first and final distribution to creditors of one fully-paid share in the Surrey Synd. (Ltd.) for every £1 owing; and to shareholders one fully-paid share in the Surrey Synd. (Ltd.) for every 20 shares held by them in the Telescriptor Synd. (Ltd.)

Mr. J. Butterfield, 2, Darley-street, Bradford, has been appointed receiver and liquidator in the voluntary liquidation of the Sun Fan Co. (Ltd.), Longside-lane, Bradford. A statement of the trading profits and loss accounts for the period from June 30, 1905, to April 23, 1906, is published. The principal cause of failure is stated to be the costs and damages incurred in the recent action, Davidson v. the Sun Fan Co.

A meeting will be held on June 13 at 46, John-street, Sunderland, to receive an account of the winding up of the Wear Electrical Engineering Co. (Ltd.)

Sale by Auction.—Messrs. Horne & Co., 8, Delahay-street, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on May 24, at 11 a.m., some unserviceable and obsolete stores, including iron, brass, copper, gun-metal, lead, zinc and other metals, electric cable and appliances, telegraph instruments, gutta-percha, indiarubber, oil, &c. Catalogues may be obtained at the War Office, Pall Mall, at the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. Further particulars are given in an advertisement.

Plant for Sale, &c.—Messrs. Richard Sizer (Ltd.), engineers, Hull, advertise for sale two Willans-E.C.C. combined electric power and lighting sets.

Tynemouth Corporation are willing to receive tenders for the purchase of a 600 kw. steam generator (continuous current) which they have for sale owing to their having arranged for a bulk supply. The plant is new, and is still at the respective makers' works, where it can be seen by appointment. Some particulars are given in an advertisement, and full details can be obtained from the borough electrical engineer, Mr. C. Turnbull, electricity works, Tynemouth.

Some shop-soiled arc lamps and brackets, telephone instruments, and incandescent lamps are advertised for sale in another column.

Messrs. A. & F. Pears (Ltd.), 71-75, New Oxford-street, London, W.C., advertise for sale some electric lighting plant, including two Crossley gas engines (14 H.P. and 7 H.P.), two dynamos (Lahmeyer and Thomson-Houston), switchboard, instruments, &c.

Messrs. G. Elliott & Co., 186-188, Long-lane, Bermondsey, London, S.E., have for sale two Holmes and one Ellwell-Parker dynamos, also Johnson & Phillips dynamo and steam engine, some electric motors, &c. See an advertisement.

New vacuum drying apparatus, with steam heating pipes, is advertised for sale.

Business for Sale.—The business of A. J. Harris & Co. (Ltd), electrical and mechanical engineers, dynamo and motor manufacturers, Bradford, is advertised for sale as a going concern. Particulars from Mr. Geo. Walker (Messrs. Armitage & Norton, C.A.), Halifax Commercial Bank-chambers, Bradford.

Premises to Let.—Messrs. R. D. & J. B. Fraser, Princes-street, Ipswich, advertise a spacious factory to let.

Basement premises at 7, Finsbury square, London, E.C., are advertised to let.

Messrs. Hillier & Parker, 99, Regent-street, London, W., advertises to let part of small show-room and offices in the best part of the West End.

Agents Wanted.—An old-established firm of lift makers advertise for electrical engineers to act as agents in provincial towns of Great Britain and Ireland for their electric lifts.

Catalogues, &c.—The General Electric Co. have ready an interesting sheet illustrating and describing battery lamps for amateurs and decorative work for use with primary batteries and small accumulators.

H. T. Boothroyd, Hyslop & Co., Bootle, have ready a new price list of C.C. electric motors and generators; also bulletin S, which gives outputs and speeds and specification of direct-coupled generating sets for ship, mill and warehouse lighting, &c. The former list has some excellent illustrations.

Elliot Bros., Lewisham, London, S.E., have ready a new pamphlet (A.C. 71) describing their type F.F. alternating-current ammeters, voltmeters and wattmeters. These instruments are on the dynamometer pattern, spring-controlled with balanced movement and dead-beat action. Their construction is such as to make them practically independent of the wave form and periodicity of the circuit on which they are used. The list is illustrated. Pamphlets A.C. 82 and A.C. 83 are also ready, describing respectively type R.R. and type Q.Q. alternating-current recording ammeters, voltmeters and wattmeters, switchboard type and portable type. These instruments are of similar pattern and construction to the F.F. section.

Messrs. Peto & Radford have prepared a new price list of accumulators, and we illustrate herewith in Fig. 1 the plate used in the construction of the P. & R. "armoured" accumulator. These plates, which are specially constructed for use on auto-cars, are enclosed in an armour case or envelope of lead, with sheets of perforated celluloid or ebonite to prevent pieces falling away. A is the case or armour, B the pasted plate, and C two pieces of perforated celluloid or ebonite slipped in each side to hold in any loose paste and prevent short-circuiting by pieces falling across and bridging two plates. Fig. 2 shows the "Ashtead" form of plate with holes at the edges to allow for the escape of gases. The "Ashtead" accumulator, of which this plate forms the basis, is intended for use in automobiles, motor launches, medical work, &c. The list is a very complete one and numerous forms of P. & R. accumulators are illustrated and described, as well as a quantity of accessories for motor vehicles and other purposes.

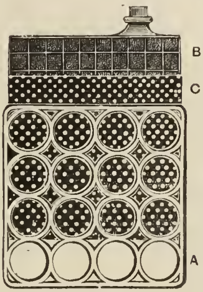

Fig. 1.—P. & R. Armoured Accumulator Plate.

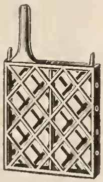

Fig. 2. "Ashtead" Plate

J. H. Heathman & Co., Parsons Green, London, inform us that they hold the largest stock and variety of ladders, steps, trestles, portable telescopic scaffolds, trucks and handcarts. A complete catalogue of these goods is available.

G. M. Boddy & Co., 18, Newington, Liverpool, forward us a sheet list illustrating a number of lamps manufactured by the firm. There is a good illustration of the "Radiance" lamp, for which the makers claim several advantages. An adapter is also illustrated designed to enable fancy lamps with M.B.C. or M.E.S. to be burnt on standard B.C. holder. A provisional patent has been applied for for this adapter. Radiator lamps and candle flame and fancy lamps are also shown. Mr. G. M. Boddy reminds us that he has been engaged in the manufacture of electric incandescent lamps for over 10 years.

Imports.—The following are official values of imports of electrical machinery, material and apparatus imported into this country during April, 1906 :—

Electrical machinery, £37,217 (a decrease of £13,847); telegraph and telephone cables, £12,092; telegraph and telephone apparatus, £30,140; other electric wires and cables (rubber insulated), £3,391; (with other insulations), £9,237; other electrical goods and apparatus, £35,897. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £90,757 (increase, £12,165), and for the four months ended April 30, £399,238 (increase £58,366).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on May 2 to 8, with the ports of destination :—

Africa—Alexandria, £33; Delagoa Bay, £2,759 (including £2,655 telegraph poles; Durban, £2,941 (including £2,709 telegraph material). *Argentina*—Buenos Ayres, £2,721 (including £1,336 telegraph material); Rosario, £274. *Australasia*—Adelaide, £55; Christchurch, £27; Fremantle, £148; Perth, £250; Sydney, £1,210 (including £70 telegraph material). *Belgium*—Ostend, £50. *Brazil*—Rio Janeiro, £73; Santos, £900 (including £148 telegraph material). *British Guiana*—Demerara, £10. *Bulgaria*—Varna, £130. *Burma*—Rangoon, £154 (including £100 telegraph material). *Canada*—Montreal, £85. *Ceylon*—Colombo, £106. *China*—Hankow, £1,520; Shanghai, £1,790; Tientsin, £140. *Denmark*—Copenhagen, £50. *Germany*—Bremen, £20. *Gibraltar*, £43 (including £10 telegraph material). *Greece*—Corfu, £41 (telegraph material); Syra £132 (telegraph material). *Holland*—Amsterdam, £184 (including £135 telegraph material); Flushing, £20. *Hong Kong*, £448. *India*—Bombay, £1,199; Calcutta, £1,123 (including £50 telegraph material); Karachi, £365; Madras, £87. *Japan*—Kobe, £775; Yokohama, £781. *Malta*, £55. *Portugal*—Lisbon, £248 (including £15 telegraph material). *Roumania*—Braila, £16; Galatz, £291. *Spain*—Bilbao, £258. *Straits Settlements*—Penang, £34 (telegraph material); Singapore, £26. *Turkey*—Constantinople, £60 (telegraph material); Smyrna, £29 (telegraph material). *Uruguay*—Monte Video, £127. Total £21,788, against £37,577 in the corresponding week last year (May 3 to 9).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.(

"Proceedings of the Royal Society." Series A. Vol. LXXVII. No. A518. Mathematical and Physical Sciences. (London: Harrison & Sons.) 3s.

"Die Elektrolyse geschmolzener Salze." Part III.: "Elektromotorische Kräfte." By Richard Lorenz. "Monographien über angewandte Elektrochemie," Vol. XXII. (Halle a. S: Wilhelm Knapp.) 10 m.

"The Finances of Gas and Electric Light and Power Enterprises." By William D. Marks. 3rd edition. (Philadelphia: The Author.) $2.50.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension Australasia & China Telegraph Co. (Ltd.)

The sixty-fifth half-yearly ordinary general meeting of this Company was held on Wednesday, under the presidency of Sir John Wolfe Barry, K.C.B.

The GENERAL MANAGER and SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, the minutes of the sixty-fourth half-yearly ordinary general meeting, which were duly confirmed and signed by the Chairman, and also the auditors' report.

The CHAIRMAN then said: Gentlemen, before entering on the subject of the report, I should like to say how much grieved we all are at the recent death of one of the pioneers in cable enterprise. I allude to our old friend Mr. W. S. Andrews, who for so many years was chairman of the Indo-European and Western Telegraph Companies, filling those posts with conspicuous success to the shareholders, with marked advantages to the telegraphing public, and with unfailing courtesy and consideration for the members of the boards which he directed. Mr. Andrews was for 55 years connected with telegraphic work, and possessed complete knowledge of all its principles and details, and it seems fitting that on this, the day of his funeral—which Sir John Denison-Pender is attending on behalf of the Board—we should, while expressing our lament at his decease and sympathy with his family, put on record our high appreciation of his public and private virtues.

Turning to the affairs of the Company, the gross revenue for the half-year under review amounted in round figures to £317,000, against £332,000 for the corresponding period of 1904, showing a decrease of £15,000. This result, I am glad to say, is not due to any falling off in traffic receipts, which, as a matter of fact, show an increase, but is owing to the revenue in 1904 having been exceptionally augmented by contract work and other special sources. With respect to the expenditure, the working and other expenses amounted in round figures to £135,000, against £150,000 in the corresponding period of 1904, showing a decrease of £15,000, or a similar amount to the reduction in the revenue, and the one is thus a set-off against the other. The reduction in expenditure is principally due to the repairs to our cables having been exceptionally few and unimportant during the past half-year, and to the credits for charter work in connection with the maintenance of cables for other telegraph administrations having been somewhat larger than usual. Comparing the figures of receipts and expenditure for the whole of the year 1905, the result is as follows: The gross receipts amounted to £666,000, against £632,000 in 1904, showing an increase of £34,000. The ordinary expenditure for the year was £271,000, against £291,000 in 1904, or a decrease of £20,000, due to the causes already mentioned. Consequently the Company's financial position for 1905 shows an actual improvement over the previous year to the extent of £54,000 (applause). The net profit for the past half-year was £163,982, and after adding to it the credit balance of £42,081 brought forward from the previous half-year, there remained an available balance of £206,063. The usual quarterly interim dividends of 2s. 6d. per share were paid during the past year, and it is now proposed to distribute a final dividend for the year of like amount, making a total dividend of 5 per cent. In addition a bonus of 4s. per share will be paid, making a total distribution for 1905 of 7 per cent. We have also been able out of the profits for the past year to place £150,000 to the general reserve fund (£100,000 for the June half-year and £50,000 for the December half-year), and to carry forward £21,000 (cheers). The whole of our extensive cable system is in good working order, except the two cables between New Zealand and Australia, which at present are both interrupted, the duplicate cable possibly having been damaged by volcanic action. This has necessitated the transmission by the British Pacific cable of the traffic between New Zealand and Australia. Our cable ship "Recorder" has been despatched from Singapore to effect repairs, and it is expected that communication will be restored by the end of next week.

Since I last had the pleasure of addressing the shareholders, statements have appeared in the newspapers in reference to a pooling agreement between the Pacific Cable Board and this Company, and to other important negotiations in connection with the Company's position in Australia. As the statements were somewhat meagre and obscure, I propose to supplement them by giving the shareholders a little additional information on the subject. It will probably be remembered that shortly before Federation was established in Australia, the Company entered into agreements with certain of the State Governments by which, in consideration of most important additions, both physically and otherwise, to the telegraphic facilities of Australasia, we secured the right, practically in perpetuity, to collect and deliver telegrams direct from and to the public in Adelaide, Sydney, Perth, and Hobart, and to transmit such telegrams in Australia without the intermediary of the Government offices. This principle has long been recognised in this country as being of importance to the full development of cable telegraphy, and is applied to foreign as well as to British telegraph companies. The same arrangement was agreed to by the Victorian Government, but the agreement had not been signed when the Pacific Cable was opened for traffic. Serious opposition was raised on behalf of the British Pacific Cable to our exercising these rights in Melbourne, and soon after the Commonwealth was established the Prime Minister (Sir Edmund Barton) entered into negotiations with us which resulted in an agreement being signed in 1903 enabling the Government under certain conditions to give notice after 10 years for determining our direct dealings with the public in the four State capitals, and at the same time extending the principle to Melbourne and Brisbane, so as to put all the State capitals of Australia on the same footing. The agreement was made subject to approval by the Federal Parliament, pending which approval the Company was allowed to tentatively open public offices in Melbourne and given the use of a special wire on the Government line between Adelaide and Melbourne, and this arrangement has been in operation for the last three years. The agreement was promptly approved by the Federal House of Representatives without a division, but the Senate delayed coming to a decision in order that a conference of the Pacific Cable partners might first be held to consider certain questions which had been raised in connection with the Company's agreements with the State Governments. After several postponements the conference was eventually held last summer, and its conclusions were embodied in a Parliamentary paper issued shortly afterwards. One of the conclusions favoured an arrangement being come to between the rival interests, and the basis of a pooling agreement was subsequently discussed and practically arranged between the Pacific Cable Board and the Company, but it was not favourably entertained by all the Governments concerned, and the proposal has apparently fallen through. In December last the Senate again considered the agreement of 1903 negotiated by Sir Edmund Barton, and approved it, subject, however, to the Company accepting an amendment which, in the opinion of your Directors, most materially altered the intentions of the parties; consequently the Company had no alternative but to reject the amendment, and thus terminate the agreement. The Government have now put an end to the tentative arrangement by closing our public offices in Melbourne, thus debarring the mercantile community in that city from the advantages enjoyed by the telegraphing public of Sydney, Adelaide and Perth, where our direct dealings with the public continue, in accordance with our agreements, and are much appreciated. I am glad, however, to say that most of the Melbourne merchants are marking their telegrams "via Eastern" and they are therefore, in accordance with the rules of the International Telegraph Convention, being loyally handed over by the Government to our Adelaide office for transmission by our route, and no delays are apparently being experienced. I believe, however, that the Melbourne merchants are not pleased at being placed in a less favourable position than that occupied by the mercantile firms of Adelaide, Sydney and Perth, as most business men prefer to deal directly with a commercial organisation such as ours rather than with a department of Government, however enlightened and efficient it may be (hear, hear).

I do not think I have much more to say in addition to what I have already intimated except that, so far as we can see, the traffic is passing satisfactorily between Melbourne and this country, and your Directors do not anticipate any loss of revenue (cheers). I am sorry that the arrangements have not gone through in the way that we anticipated, but still we are favourably placed in the other capitals of Australia, and I venture to hope that the interests of the Company will not in the long run suffer. If any shareholder wishes to ask any question, I shall be delighted to answer him to the best of my power. I will now conclude by proposing: "That the report and accounts of the Directors now submitted be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income tax, payable on 10th inst., making with the previous distributions a total payment of 7 per cent. for the year 1905."

The Marquess of TWEEDDALE, K.T., seconded the resolution, which was at once unanimously agreed to without discussion.

The retiring Directors, the Hon. George Peel and the Marquess of Tweeddale, were re-elected, and the retiring auditors, Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. Welton, Jones & Co., were re-appointed.

It was proposed by Mr. O'BEIRNE and seconded by Mr. JOHN NEWTON and carried unanimously that a hearty vote of thanks be accorded to the Chairman, Directors and Staff, and after a few remarks in reply from the Chairman the proceedings terminated.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—At the meeting yesterday, the chairman (Mr. H. Drake), in moving the adoption of the report (given in our last issue), said that at the last meeting he had been able to tell the shareholders that the business was then much more prosperous than it had been in the previous year, and the accounts now submitted fully verified what he then said. The profits were £22,000 more than in the previous year. Referring to the accounts and balance-sheet they would find that the share capital, debenture stock, reserve and machinery renewal account remained as before. Bills payable were £132,000, against £67,000. Trade creditors and other liabilities were £95,000, against £74,000. Profit and loss account stood at £65,171, against £45,281. On the other side of the account they had their property at Erith (after allowing £13,000 depreciation and the transfer of £1,709 worth of land at Leigh) amounting to £313,991. The item of goodwill appeared as nil. This meant that the sums paid for patents had been charged to profits, but their standing at nil in no way diminished the actual value of their patents. Stock in trade at Erith stood for £100,705, compared with £115,480, which was satisfactory seeing that they were doing more business and yet managed to cut down the stock. Expenditure on contracts in course of execution and patterns stood at £113,966, against £98,251. Cable drums remained about the same. Money retained by Corporations for due fulfilment of contracts was £115,323, against £94,356. Cash at bank and in hand and bills receivable amounted to £59,759, which compared with £19,342, which was again very satisfactory. Shares and investments in other companies at or under cost stood at £76,796, against £57,913. The Anchor Cable Co. stood in the books at £87,308, which was an increase of about £1,200. The profit and loss account showed that the profit for the year, after deducting all charges on manufacturing accounts, contracts, &c., was £124,541, compared with £94,163 in the previous year. They had to set against that the general expenses, £28,652 ; auditors' fees, income tax, repairs and maintenance of plant and buildings, &c., £45,446, leaving £79,094, added to £23,406 brought forward, or £102,501. After meeting the necessary charges the available balance was £65,171, and the directors proposed to declare a dividend on the ordinary shares of 10 per cent,, together with a bonus of 5s. per share, carrying forward £13,921.

Mr. T. O. Callender said the company's business in Great Britain had improved considerably in the latter part of the year, but the copper market had been against them as the unprecedented rise in the price of that metal had deterred customers from placing orders, they believing that a fall must soon take place, and that they would, therefore, gain by waiting. He was afraid, however, that indications did not tend that way, and that they must look for a continuance for some time to come of the present high price of copper. This would certainly restrict business to some extent. Still there was a considerable number of mains which must be laid, and he hoped their company would get a fair share of the business. With regard to the accounts for the current year, he was quite satisfied with the results of their operations. Trade had been good and satisfactory, and they had reasonable hope of a good year. Outside this country, India had always been a field to which they had given great attention and in the latter part of last year the assistant manager went out and was for some time looking after the interest of the company in that part of the world. The result was that they held the premier position there, and all the important orders requiring heavy underground mains had, almost without exception, been placed with their company. They had also secured contracts in Shanghai and Rangoon, and they had laid mains in practically all the British outposts in the East. They had, at the same time, been developing their connection in South America. In addition to a large contract mentioned in the report they had secured one in Bahia Blanca, and since the balance-sheet was issued he had secured a contract from Buenos Ayres. Their Mexican business kept fairly good, and during the current year they had had the somewhat unique experience of receiving a very large order from St. Petersburg. In fact all over the world, except where they were shut out by prohibitive tariffs, they were doing everything necessary in the company's interests. With regard to the Anchor Co. the works and business had been put into excellent condition, and the time was near at hand when the shareholders would be asked to incorporate this with Callender's Co. They had also acquired an interest in the St. Helens Cable Co., which helped them in many ways and gave them a commanding position in the electrical industry.

CASTNER-KELLNER ALKALI CO. (LTD.)—For the year ended March 31 the net profit (after allowances for keeping up works, plant and machinery in a state of efficiency) is £68,847. 7s. 3d., added to £12,797. 16s. 11d. from 1905, leaving an available balance of £62,548. 5s. 10d., and the directors recommend that £30,000 be appropriated to depreciation reserve and that a dividend at the rate of 8 per cent. be paid for the six months to March 31 (making 6 per cent. for the year) leaving £14,548. 5s. 10d. to be carried forward. The directors have increased a part of the company's plant, and have obtained suitable premises at Wallsend-on-Tyne, where the necessary electric power will be supplied on advantageous terms.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The net revenue for the past year to April 30, after deduction of expenses, amounts to £205,718. 7s. 3d., and makes, with £1,643. 4s. 9d. brought forward, a total of £207,361. 12s. From this there has been distributed £131,769. 8s. 10d. in interim dividends, leaving £75,592. 3s. 2d. The directors recommend payment of a final dividend of 3s. per share on the preference and of 5s. per share on the ordinary shares, making 6 per cent. (less tax) on the preference and 5½ per cent. net on the ordinary shares for the year, leaving £4,499. 16s. 2d. to be carried forward.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—At the meeting on Wednesday, Mr. A. H. P. Stoneham said that more than 3,300,000 people were carried on their system during 1905, and that the car-miles travelled were 683,827, the receipts averaging upwards of £1,000 per week (total for the year £53,512). They had made a new agreement as to power supply, under which they were to get electrical energy at 2¾d. instead of 4d. per unit. The profit for the year was just under £16,000, and by the saving of £4,000 in the cost of power they anticipated a profit of £20,000 during the current year. The track had quite recently been lifted in several places and the sleepers examined ; many of the poles had also been examined, and although the poles and sleepers had been in use for upwards of seven years, they were certified to be in an absolutely perfect state and totally untouched by the white ant, which showed the merit of using Australian Jarrah wood for tramway construction.

LANARKSHIRE TRAMWAYS CO.—An extraordinary meeting will be held on the 17th inst. to consider a resolution authorising the raising of £54,000 additional capital (part of the additional capital authorised by the Lanarkshire Tramways Order, 1903) by the issue of 5,400 new shares. The directors have decided to proceed at once with the construction of the Cambuslang extension, which will bring the company's lines quite close to those of Glasgow Corporation, and it is expected that the line will be completed and opened for public traffic in August. To meet the expenditure the directors now offer to the shareholders, at par, 4,300 shares at £10 each.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—Mr. A. M. Hood Walrond, at the statutory meeting on Wednesddy, said that subscriptions were invited in February for £300,000 of capital, of which £250,000 was in construction debenture stock and £50,000 in shares. Within an hour the debenture stock was over subscribed. They had secured a suitable site for the generating station in Madras, and had appointed as chief engineer Mr. E. C. St. John, who had sailed for India. They were receiving many applications for power and light in Madras, and the board were considering whether it might not be worth while to erect temporary buildings to enable them to supply current as early as possible. Under their contract with Messrs. Crompton & Co. they expected to begin to supply electricity in the autumn of next year, and that the whole contract would be completed by the spring of 1908.

MANSFIELD & DISTRICT LIGHT RAILWAY CO.—At the first meeting last week, Mr. W. S. B. McLaren said since the tramways were opened they had carried more than 1,000,000 passengers, and he thought they would carry something like 2,000,000 passengers in the 12 months. When they had only 4⅓ miles of line open their earnings were at the rate of £101 per week, and when they had 7⅓ miles open their earnings were at rate of £205 per week. For the the nine weeks during which 9 miles had been open their earnings had been at the rate of £290 per week, showing that with each extension their earnings had satisfactorily increased. The proposal to carry coals on their system had excited much local interest. A Corporation committee reported in the first instance in favour of the proposal, and the Board of Trade were, he believed, favourably inclined to it. But at a recent meeting of the Council the committee's recommendation was reversed under a misapprehension of the actual facts. They had only been in operation a few months, but they had already earned more than their preference dividend.

NORTH OF SCOTLAND ELECTRIC LIGHT & POWER CO. (LTD.)—During the year 1905 the lamp connections in Montrose increased from 15,160 to 17,542 8 c.p., and in Brechin from 12,081 to 15,019 8 c.p. The Inverness undertaking commenced supplying current in May last and the number of lamps connected at the end of the year was 5,322 8 c.p., a total for the three towns of 37,883 8 c.p. lamps. The result of the year's trading (including £431.15s.4d. brought forward) shows a gross profit of £2,901. 14s. 6d., and £1,569. 5s. 3d. is available for distribution. The directors recommended a dividend of 2¼ per cent.

PENARTH ELECTRIC LIGHTING CO. (LTD.)—At the recent meeting the directors' report for 1905 stated that the capital expended during the year was £1,770. 13s. 6d., bringing the total to £25,668. 6s. The gross revenue was £1,590. 12s. 2d. and the expenditure £1,153. 10s. 10d., leaving a profit of £437. 1s. 4d. The installations connected to the mains at Dec. 31 last represented 9,055 8 c.p. lamps, an increase of over 25 per cent. during the year. An agreement has been entered into with Penarth Council for public lighting. Owing to the increasing output, an addition to the plant will be necessary at an early date.

RAWORTH'S TRACTION PATENTS (LTD.)—The first annual meeting of this company was held last week, and we have been supplied with a copy of the chairman's speech, from which we make the following extract :—
It was unusual for a company exploiting a patent to pay a dividend after the first year's working, but their company was capitalised on a moderate basis, and as the vendor's interest was made dependent on the success of the company almost the entire cash resources of the company had been available for the purposes of the business. The profit on completed contracts and orders was £4,372. 18s. 11d., or with sundry other receipts £4,428. 3s. 2d. The expenses were £2,523. 0s. 5d., and the amounts written off came to £636. 6s. 2d., leaving £1,268. 16s. 7d. After providing for the preference dividend, it was proposed to pay 4 per cent. on the deferred ordinary shares. As regards the property of the company, that is, the inventions, it had been known for many years that the shunt-wound motor was a desirable traction motor, but no successful application of the shunt motor for traction purposes had previously been made. The series motor achieved no success until the present series parallel controller could be entrusted to be used by an ordinary car driver. The shunt motor up to the present was in the same position, and waited for the controller. The regenerative controller as now made by the company for the shunt motor was to all appearances like the series parallel controller, and they believed it would prove equally efficient and trustworthy. The directors considered the outlook of the company promising. They had, no doubt, many difficulties before them, as was always the case when introducing anything new on to the market which came in competition with old-established practice and conditions, but these difficulties would be overcome.

SAO PAULO TRAMWAY, LIGHT & POWER CO.—The gross earnings in 1905 were $1,908,405, an increase of 34 per cent. on 1904. Operating expenses were 40 per cent. of the revenue, net earnings being $1,238,473, an increase of 31 per cent. on the year. There have been paid four quarterly dividends of 2 per cent.

SUBMARINE CABLES TRUST.—The revenue for the year to April 15 last amounted to £25,057. 12s. 7d., and the expenses to £1,153, leaving a balance of £23,904. 12s. 7d., to which is added £92. 14s. 3d., from last account, making £23,997. 6s. 10d. After providing £18,962 to meet payment of coupons, £4,920. 11s. has been transferred to redemption fund, leaving £114. 15s. 10d. to be carried forward. During the year 41 certificates have been redeemed by purchase in the open market, with the surplus funds of the Trust, costing £4,920. 11s. as above mentioned.

URBAN ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week Mr. F. E. Gripper said the past year had been a bad one for electrical companies. There had been a considerable falling off in current supplied, but the year's working generally showed good progress. Their net profits were £26,297. Interest absorbed £9,185, leaving £17,111. The amount required to pay the 5 per cent. guaranteed preference and ordinary dividend was £24,702, and the balance of £7,590 had been paid by Edmundson's Electricity Corpn. Capital expenditure was £148,000 over last year.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 last states that the gross receipts amounted to £50,808. 17s. 11d., against £42,337. 6s. 6d. in 1904. Working expenses were £31,114. 6s. 2d., compared with £28,118. 3s. 2d. After providing £6,800 for interest there remains £12,894. 11s. 9d., added to £766. 14s. 7d. brought forward, making £13,661. 6s. 4d. Of this £10,000 has been placed to general reserve and £2,000 to maintenance ship's reserve, leaving £1,661. 6s. 4d. to be carried forward.

WESTERN TELEGRAPH CO. (LTD.)—The report of th directors for the half-year to Dec. 31 last states that the revenue amounted to £296,664. 11s. 9d. and the working expenses to £128,006. 8s. 4d. After providing £14,162. 12s. for debenture stock and debenture interest and sinking fund, and £4,978. 15s. 5d. for income tax, there remains £149,516. 16s., added to £3,131. 11s. 7d. brought forward, making £152,648. 7s. 7d. Interim dividends amounting to £62,379 have been paid, and, after transferring £80,000 to general reserve and £5,000 to maintenance ships' reserve, there remains £5,269. 7s. 7d., which is carried forward.

NEW COMPANIES, STATUTORY RETURNS.

NEW COMPANIES.

AUTO SYND. (LTD.) (88,652).—Reg. May 5, capital £10,000 in £1 shares, to acquire and turn to account certain patent rights known as "Auto-Mixte" (System Pieper), to promote companies, &c. Mr. W. Marshall is sole director and may retain office while holding 100 shares. Reg. office, 30, Moorgate-street, London, E.C.

COX-WALKERS (LTD.) (88,588.)—Reg. May 1, capital £10,000 in £1 shares (ordinary or preference), to adopt an agreement for the acquisition of the businesses carried on as Cox-Walkers and Cox-Walker and Sons, and to carry on the business of electrical, automobile and general engineers, manufacturers of and dealers in electrical, engineering and other goods, apparatus and appliances, &c. First directors: Edward Cox-Walker (gov.), Edgar Cox-Walker, and T. M. Cox-Walker.

ENGINEERING, ELECTRIC & CONSTRUCTION SYND. (LTD.) (88,633.)—Reg. May 4, capital £100,000 in £1 shares, to construct, equip and control electrical power and light supply works, telephonic, telegraphic, water and hydraulic power works, railways, tramways, factories and other works, and to carry on the business of mechanical and electrical engineers, contractors, &c. First directors: C. G. Arbuthnot, H. L. Arbuthnot, H. R. Arbuthnot, L. G. Arbuthnot and W. R. Arbuthnot.

SCOTTISH ELECTROBUS CO. (LTD.) (88,617.)—Reg. May 2, capital £100 in £1 shares, to adopt an agreement with the X Electric Accumulator Co. (Ltd.), and to carry on the business of motor car, omnibus, van and cab proprietors, &c.

THAMES IRON SYND. (LTD.) (88,626.)—Reg. May 3, capital £4,500 in £1 shares, to acquire from Sherard Cowper-Coles interests in certain inventions relating to the manufacture of iron cylinders, tubes and similar articles and to the electro-deposition of iron, and to carry on the business of iron masters, iron merchants, steel makers and converters, founders, electricians, engineers, suppliers of electricity, &c. First directors: A. M Alexander, M.Inst.C.E., G. C. Mackrow, D. Urquhart and A. F. Hills. Reg. office, Thames Ironworks, Victoria Dock-road, Canning Town, E.

STATUTORY RETURNS.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—In return to March 5, capital is £2,100,000 in 130,000 preference, 130,000 ordinary, 80,000 City undertaking preference and 80,000 City undertaking ordinary shares, all of £5 each, of which 80,000 preference, 80,000 ordinary, 80,000 City undertaking preference and 70,000 City undertaking ordinary have been taken up. £5 per share has been called up on the preference, ordinary and City undertaking preference and £1,200,000 has been received. £350,000 is considered as paid on 70,000 ordinary. Mortgages and charges, £436,000 4 per cent. debenture stock and £472,000 City undertaking 5 per cent. bonds.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—Return to March 14, gives capital as £400,000 in 74,000 ordinary and 6,000 preference shares of £5 each, of which 49,436 ordinary and 6,000 preference have been taken up. £5 per share has been called up on 37,770 ordinary and 6,000 preference and £218,850 has been received. £58,330 is considered as paid on 11,666 ordinary. Mortgages and charges, £175,000 debenture stock.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—In return to March 28 capital is £1,200,000 in 40,000 preference and 80,000 ordinary shares of £10 each, of which 40,000 preference and 70,595 ordinary have been taken up. £10 per share has been called up and £1,105,950 has been received. Mortgages and charges, £800,000.

HOVE ELECTRIC LIGHTING CO. (LTD.)—According to return to March 29 capital is £100,000 in 20,000 shares of £5 each, of which 15,000 have been taken up. £5 per share has been called up on 13,000 and £3 on 2,000, and £72,008 has been received, including £1,008 paid in advance of calls. Mortgages and charges, £44,600.

HOWARD ASPHALT TROUGHING CO. (LTD.)—In return to April 12 capital is £20,000 in 19,000 ordinary and 1,000 deferred shares of £1 each, of which 1,007 ordinary and 1,000 deferred have been taken up. £7 has been received and £2,000 is considered as paid. Mortgages and charges, nil.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—Return to April 9 gives capital as £500,000 in £1 shares, of which 256,127 have been taken up. £1 per share has been called up on 191,127 and £191,127 has been received. £65,000 is considered as paid on the remainder. Mortgages and charges, £25,000.

NATIONAL TELEPHONE CO. (LTD.)—Return to March 8 gives capital as £6,000,000 in 15,000 first and 15,000 second preference shares of £10 each, 250,000 third preference and 90,000 ordinary shares of £5 each, £2,000,000 preferred stock and £2,000,000 deferred stock, all of which have been taken up. £10 per share has been called up on 12,220 first and 15,000 second preference, and £5 per share on 221,716 third preference and 90,000 ordinary shares, and the full amount on £1,281,326. 13s. 4d. preferred and £562,653. 6s. 8d. deferred stock, and £3,674,760 has been received. £2,325,240 is considered as paid on 2,780 first and 28,284 third preference shares and £718,673. 6s. 8d. preferred and £1,437,346. 13s. 4d. deferred stock. Mortgages and charges, £3,698,593.

NORTHWICH ELECTRIC SUPPLY CO. (LTD.)—Return to March 12 gives capital as £25,000 in 5,000 shares of £5 each, of which 3,629 have been taken up. £18,145 has been received. Mortgages and charges, £11,000.

OXFORD ELECTRIC CO. (LTD.)—The capital in return to March 16 is £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each, of which 20,000 ordinary have been taken up. £5 per share has been called up on 13,200 shares and £67,550 has been received, including £1,550 paid on 310 forfeited shares. £34,000 is considered as paid on 6,800 shares. Mortgages and charges, £50,000 (2,907 preference shares have since been allotted, subject to payment in cash).

A. REYROLLE & CO. (LTD.)—Return to March 5 gives capital as £20,000 in 12,000 ordinary and 8,000 preference shares of £1 each, all of which have been taken up. £1 per share has been called up on 5,000 ordinary and 8,000 preference, and £12,800 has been received, leaving £200 in arrears. £7,000 is considered as paid on 7,000 ordinary shares. Mortgages and charges, nil.

CITY NOTES.

MEMORANDA (May 10).—Bank rate 4 per cent. (since May 3, 1906). Price of silver 31d. per oz. Consols $89\frac{1}{16}$—$89\frac{3}{16}$ for money, $89\frac{5}{16}$—$89\frac{7}{16}$ for account; $2\frac{1}{2}$ per cent. annuities $88\frac{1}{4}$—$88\frac{1}{2}$. Consols Pay Day, June 1. Stocks and Shares Continuation Day, May 29; Ticket Day, May 30; Pay Days, May 11 and 31; Mining Share Carry-over Day, May 28.

ARGENTINA.—The Cia Electrotecnica Argentina has been formed, with a capital of $500,000, to take over the business of P. Scapusio & Co.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books of this company will be closed from 18th to 31st inst. inclusive, preparatory to payment of interest due June 1.

DEUTSCH-UEBERSEEISCHE ELECTRICITATS GESELLSCHAFT.—This company is increasing its capital from £360,000 to £720,000 in order to develop its electrical enterprises in Monte Video and Chili.

GESELLSCHAFT FUR ELEKTRISCHE UNTERNEHMUNGEN (BERLIN).—A dividend of $7\frac{1}{2}$ per cent. has been declared for the year 1905.

KRAFTUBERTRAGUNGSWERKE RHEINFELDEN.—A dividend of 7 per cent. has been declared for the past year, against $6\frac{1}{2}$ per cent. for 1904.

LAND-UND-SEE KABELWERKE A.G. (COLOGNE-NIPPES).—A dividend of 8 per cent. has been declared.

MEXICAN CONSOLIDATED ELECTRIC CO. (LTD.)—During the week $7,500,000 general consolidated first mortgage 50-year 5 per cent. gold bonds were offered for sale at £93. 10s. for a $500 bond.

OSWESTRY ELECTRIC LIGHTING & POWER CO. (LTD.)—A dividend of $4\frac{1}{2}$ per cent. has been declared.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold by this company for the quarter ended Lady Day is returned at 2,377,044 units, estimated to produce £32,684, against 2,332,361 units, which produced £33,333 in the corresponding period of 1905.

STOCK EXCHANGE NOTICES.—The Stock Exchage Committee have been asked to appoint a special settling day in and grant a quotation to a further issue of 20,000 £5 (£1 paid) shares of the *Calcutta Electric Supply Corpn. (Ltd.)*, and also to grant quotations to £1,133,000 4 per cent. perpetual debenture stock of the *Great Northern, Piccadilly & Brompton Railway Co.* (in lieu of Speyer Bros. scrip certificates now quoted), and a further issue of £225,000 6 per cent. preferred stock and £225,000 deferred stock of the *National Telephone Co. (Ltd.)*

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors recommend a dividend of 4s. per share on account of arrears of dividend on the first preference shares.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 5	1,246	- 100	49	65,356	- 387
Airdrie	April 27	216	+ 6	17	8,650	+ 379
Anglo-Argentine	May 6	15,692	+ 1,289	18	270,282	+ 27,5.9
Ashton-under-Lyne Corp.	April 28	294	- 23	5	1,895	+ 356
Ayr Corporation	" 28	275	- 95	37	14,372	- 109
	May 6	202	- 26			
Baker St. & Waterloo Ry.	" 5	1,414	...	8	11,889	...
Barnsley	April 27	138	- 83	17	2,667	+ 19
Barrow	" 27	203	- 97	17	3,616	+ 232
Bath Electric Trams, Ltd.	May 2	618	+ 21	18	12,265	+ 1,934
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	" 5	599	+ 256	5	2,695	+ 746
*Birmingham & Mid.	April 27	1,294	- 984	17	23,440	- 6,333
Blackburn Corporation	May 2	872	+ 69	¶5	5,767	+ 542
Blackpool Corporation	" 3	445	- 119	4	4,078	+ 372
Blackpool and Fleetwood	" 5	808	- 34	18	4,909	+ 236
Blackp'l St. Anne's & Lytham	" 3	220	- 6	§6	5,184	+ 685
Bolton Corporation	" 6	1,915	- 1	5	10,886	+ 423
Bournemouth Corporation	" 2	1,385	+ 209	†5	7,712	+ 2,295
Bradford Corporation	" 5	4,197	+ 173	5	22,815	+ 1,397
Brighton Corporation	" 6	817	- 126	5	4,724	- 1,2
Bristol Trams & Carriage	" 4	4,678	+ 3	12	55,764	+ 3,073
Buenos Ayres & Belgrano	" 6	3,763	- 50	18	61,156	+ 4,574
Buenos Ayres Elec. Trms	April 7	1,351	+ 279	14	19,791	+ 4,312
Burnley Corporation	May 5	1,162	+ 109	5	6,193	+ 425
Burton Corporation	" 6	295	- 10	§5	1,524	- 92
Bury Corporation	April 29	820	...	4	4,106	...
Calcutta Tramways Co.	May 5	R43,657	+ R5,154	18	R787,889	+ R81,862
Camborne-Redruth	" 5	102	- 3	1	102	+ 61
Cardiff Corporation	April 28	1,784	- 504	5	9,963	- 529
	May 5	1,876	- 28			
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	April 27	59	- 80	17	1,105	+ 336
Central London Railway	May 5	6,830	- 66	18	122,821	- 4,091
Chatham & Dist. Lt. Rys.	" 3	575	- 50	†18	10,551	- 212
*City of Birm'gh'm Tram Co.	April 27	4,920	- 1,629	17	87,972	- 4,462
City & South London Rly.	May 6	2,686	- 68	18	52,094	+ 67
Colchester Corporation	" 3	175	- 7	36	7,273	- 1,383
Cork Electric Trams Co	" 3	424	- 39	18	7,515	- 33
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	April 26	180	- 81	4	607	+ 86
Devonport & Dist. Trams	" 27	409	- 109	17	7,038	- 350
Dover Corporation	May 5	201	+ 6	5	1,159	+ 90
Dublin & Lucan Railway	" 4	99	- 1	‡18	1,741	- 94
Dublin United	" 4	4,859	+ 51	‡18	82,293	+ 1,855
Dudley—Stourbridge	April 27	721	- 545	17	13,222	+ 313
Dundee Corporation	May 2	981	+ 137	§50	47,519	+ 5,080
East Ham Council	" 5	832	+ 63	5	4,707	+ 710
Exeter Corporation	" 4	239	- 98	5	1,366	+ 20
Gateshead & Dist. Trams	April 27	876	- 130	17	15,533	+ 757
Glasgow Corporation	May 5	15,944	+ 827	49	752,171	+ 50,750
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	April 27	203	- 99	17	3,508	+ 164
Gt. Northern & City Rly.	May 5	1,783	+ 133	18	32,465	+ 1,276
Greenock & Port Glasgow	April 27	667	- 49	17	10,028	+ 744
Halifax Corporation	May 2	1,330	+ 183	5	7,650	+ 471
Hartlepool Tramways	April 27	243	- 72	17	4,387	+ 267
Hastings Elec. Trams Co.	May 3	610	...	18	8,126	...
Huddersfield	" 5	1,329	+ 170	5	7,514	+ 867
Hull Corporation	" 5	2,112	+ 64	5	11,073	- 73
Ilford Dist. Coun.	" 5	444	+ 18	5	2,537	+ 209
Ilkeston Dist. Council	" 2	109	+ 3	5	589	- 4
Ipswich Corporation	" 5	368	- 13	5	2,033	+ 8
Isle of Thanet Co.	" 5	372	- 43	30	8,847	- 782
Keighley Corporation	" 3	130	+ 13	43	6,140	...
Kidderminster & District	April 27	89	- 75	17	1,645	+ 22
Kilmarnock Corporation	May 5	140	- 11	51	7,836	...
Kirkcaldy Corporation	" 2	195	- 17	9	1,892	- 19
Lanarkshire Trams Co.	" 3	815	+ 175	†18	14,983	+ 8,413
Leamington	April 27	142	+ 60	17	2,403	+ 1,117
Leeds Corporation	May 5	5,770	+ 309	5	30,717	+ 2,172
Leicester Corporation	" 5	2,035	+ 175	18	37,068	+ 3,840
Leith Corporation	April 28	457	+ 253	50	19,316	+ 13,321
	May 5	414	+ 247			
Liverpool Overhead Rly.	" 6	1,381	- 194	18	25,088	- 1,830
Liverpool Corporation	April 28	10,918	+ 647	17	175,683	+ 5,537
*London County Council	" 28	24,291	+ 9,455	4	107,701	+ 52,990
London United	May 4	5,433	+ 198	†18	943,28	+ 557
Lowestoft	" 5	117	- 18	32	4,112	+ 128
Maidstone Corporation	" 3	89	- 21	5	525	- 56
Manchester Corporation	" 5	12,236	+ 278	5	65,011	+ 8,578
Mersey Railway	" 5	1,752	+ 97	18	30,877	+ 1,662
Merthyr	April 27	179	- 102	17	8,106	- 30
Metropolitan Dist. Railway	May 6	8,071	+ 740	18	143,186	+ 8,240
*Metropolitan Elec. Trams	April 27	3,110	+ 342	17	50,701	+ 16,738
Middleton	" 27	280	- 214	17	5,178	+ 370
Nelson Corporation	May 5	133	+ 8	6	781	...
Newcastle-on-Tyne Corp.	" 5	3,763	+ 188	5	19,809	+ 887
Newport (Mon.)	" 5	563	+ 10	5	8,067	+ 168
Northampton Corporation	" 4	381	- 4	5	2,028	+ 41
Oldham, Ashton & Hyde	April 27	490	- 214	17	8,932	+ 332
Oldham Corporation	May 6	1,663	+ 96	6	10,416	+ 455
Perth (N.B.) Corporation	" 2	123	...	25	3,669	...
Perth (W. A.) Elec Trams	" 4	1,528	+ 90	‡18	27,443	+ 1,825
Peterborough	April 27	101	- 110	17	1,790	- 103
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	May 5	1,575	- 193	5	9,357	- 115
Potteries	April 27	1,704	- 76	17	29,431	+ 1,637
Preston Corporation	May 2	623	+ 65	...	...	...
Reading Corporation	" 3	555	- 29	...	...	...
Rochdale Corporation	" 5	882	+ 360	5	5,171	+ 2,285
Rotherham Corporation	" 3	440	+ 74	5	2,292	+ 189
Rothesay	April 27	136	- 102	17	1,378	+ 299
Salford Corporation	May 9	4,156	+ 36	5	22,901	+ 199
Sheerness	April 25	53	- 34	17	834	- 142
Sheffield Corporation	May 6	4,992	+ 353	6	30,614	+ 1,916
Southampton Corporation	" 2	834	- 48	†5	4,185	+ 131
Southend Corporation	" 2	290	- 14	5	1,556	+ 69
Southport Tramways	April 27	256	- 197	17	4,342	+ 120

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	April 27	696	- 286	17	13,291	+ 2,036
Stalyb'dge, Hyde, &c., Jt. Bd.	..	...	...	...	...	...
Stockport Corporation	May 4	796	+ 323	5	4,578	+ 1,817
Sunderland Corpn.	" 6	1,236	+ 60	5	6,753	+ 484
Sunderland & District	...	...	...	...	...	...
Swansea Trams	April 27	776	- 183	17	12,600	+ 4,247
Swindon Corporation	May 2	161	- 14	¶1	877	80
Taunton	April 27	41	- 24	17	705	- 22
Tynemouth and District	" 27	195	- 126	17	3,085	+ 1
Tyneside Trams Co.	May 2	368	+ 36	18	6,800	+ 435
Wallasey District Council	" 5	701	- 35	5	3,806	+ 100
Walsall Corporation	" 5	482	+ 45	16	8,789	+ 655
Warrington Corporation	" 3	347	+ 80	5	1,803	+ 175
West Ham Corporation	" 3	2,012	+ 563	5	11,805	+ 1,562
Weston-super-Mare	April 25	86	- 76	17	744	+ 55
Wolverhampton Corpn.	May 2	758	...	5	4,068	...
* Wolverhampton District	April 27	349	- 2 0	17	6,565	+ 596
* Worcester	" 27	215	- 136	17	4,120	- 367
Wrexham	" 27	80	- 48	17	1,642	- 48
Yorkshire W.R. Trams	May 6	765	+ 93	18	13,252	...
Yorkshire Woollen District	April 27	792	- 130	17	14,131	+ 4,886

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., May 9.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to May 9. Highest.	Business, Week to May 9. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shares	8⅛—8⅝	4 11 0	Ap, Oct	8 3/32	8 13/32
5	2/9	Do. 5½% Cum. Pref.	5⅞—6⅛	4 10 0	—	6 1/16	6 1/32
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	141⅝	141½
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	—	..
5	..	Brisbane Electric Trams. Invest Ord.	⅞—1⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅛	6 1 4	—	4 3/32	4 1/16
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	113 —116	4 13 9	—	..	..
St.	6%	†British Columbia Elec. Rlwy. Def. Ord.	116 —119	5 2 2	—	116½	..
St.	5%	Do. Pref. Ord. Stk	109 —112	4 9 3	—	..	..
100	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	108½	107¾
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	102%—104%	4 6 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	105½	..
5	3/0	Buenos Ayres and Belgrano Ord.	3¼—3½	5 10 0	—	3 11/32	..
5	3/0	Do. 6 per Cent. "A" Cm. Pref	5⅝—5⅞	5 2 6	—	5 23/32	..
5	3/0	Do. "B"	5 —5½	5 7 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	101 —103	4 17 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	102 —106	5 4 3	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	103 —105	5 14 0	..	100	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	9⅛—9⅝	4 3 0	—	9½	9⅛
5	2/6	Do. Nos. 105,001 to 137,610	8½—9	4 9 0	—	8⅞	8⅝
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 8	—	..	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	†Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 —97%	5 2 6	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 —93	..	..	..	..
St.	..	Do. 6% "B" Ditto	83 – 88	..	..	..	..
1	..	Lisbon Elec. Trams Ord.	1 3/16—1 1/4	..	..	1 3/32	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	103 – 105	4 14 8	Ja, Jul	-	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —108	4 12 6	..	-	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	140 – 143	..	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	99½	98¾
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	.	.
5	8/3	Calcutta Elec. (1-50,000)	9⅛—9⅝	4 5 4	—	9 11/32	9⅛
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½– 3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	8¼—8½	—	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	95 —97	5 2 6	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	112 – 115	5 4 0	..	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref. ex 7½d. on a/c of arrears	⅞ –1	6 0 0	—	-	..
1	1/0	Rand Electric	1¼ – 1⅜	—	—	-.	..
1	..	River Plate Electricity Co. Ord.	⅜ ½	--	..	..	..
1	1/2⅝	Do. 6% Non. Cum. Pref	1⅛ 1 3/16	..	..	.	..
St.	5%	Do. 5% Deb. Stock	101 – 103	4 17 0	..	102½	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	--	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 – 103	4 17 0	..	101½	--

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 9.	Rate % Yielded.	Dividend Due.	Business, Week to May 9. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d			
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	11 7/16	11 3/8
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 3 3	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛—8⅝	4 18 0	..	..	..
St.	4½%	† Do. Do. 1st Debs	101 —104	4 7 6	—	101¾	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¼—9¼	5 8 6	—	8 13/32	8⅜
5	8/6	Do. 7 per Cent. Pref.	8¼—9¼	3 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 —105	3 16 3	—	4⅝	4 3/8
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	102	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 —4½	5 0 0	—	..	..
5	2/3	Do. Do. (1903)	4 —4½	5 0 0	—	—	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —109	4 2 6	Jn, Dec ..	..	..
10	7/0	City of London Electric Lighting Ord.	10½—11	5 9 0	Feb, Aug	10 9/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 6	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	102	101
5	4	County of Durham Elec. P.D. Ord. £3 pd.	3 —3 1/32	4 0 0	April, Oct	.	..
5	5%	† Do. Do. 5% non cum. pref.	5⅛—5⅜	4 15 3	April, Oct	5¼	..
10	6/0	County of London Elec. Supply Ord.	8 —9	5 11 0	—	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¼	4 18 0	Mar, Sept	11½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	..	..
St.	4½%	† Do. Second Deb. Stock Prov. Certs.	99 —101	4 9 0	..	..	..
5	8/6	Folkestone Electricity Supply Co. Ord.	8⅛—8⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	—	..
5	5/0	Hove Electric Lighting Ord.	8¼—8¾	5 5 0	..	—	..
St.	4½%	†I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	9½—10½	4 15 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4⅘	London Electric Supply Ord.	2 —2½	4 0 0	—	2 7/16	2 9/32
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	98 —101	3 19 2	Mr, Jn, S, D	100	99½
5	10%	Metropolitan Electric Sup. Ord.	8 —9	5 11 0	April, Oct	8⅝	8¼
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 2 0	Jan. July	5 5/16	5⅜
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 8	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 —103%	4 7 4	—	102½	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞—11⅛	5 14 9	Feb, Aug	..	..
100	..	Do. 4½% Deb.	103 —104	4 7 0	Jan, July	103	..
5	8%	Newcastle Elec. Supply Ord.	7⅜—7⅝	5 6 8	Feb, Aug	7½	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾—5⅞	4 6 8	Feb, Aug	5¾	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	..
1	8%	Northern Counties Elec. Sup.	15/16—31/32	3 3 2	Mar, Aug	15/16	29/32
100	..	Do. 4½% Deb.	101 —102	..	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	9 —10	6 5 0	Feb, Aug	9 5/16	9½
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	7½	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	3 5/16	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 —106	4 5 0	—	..	.
5	2/6	Urban Electric Supply Ord.	4¼ 4¾	5 5 0	—	4⅜	4¼
5	2/6	Do. 5% Cum. Pref.	4 15/16—5 1/16	4 14 0	—	4⅞	4 27/32
St.	4½%	Do. 4½% 1 Mort. Deb.	102 —104	4 6 6	..	103	102
5	6/6	Westminster Elec. Sup. Ord.	9¾—10¼	6 7 6	Mar, Sept	10	9⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16—5 9/16	4 10 0	..	5 15/32	5 5/16
5	..	Do. Issued at 7/6 premium all paid	5 5/16—5 9/16	..	..	5 15/32	—
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 —96	4 3 4	..	95½	94
1	1/0	†Bath Elec. Trams Pref. Ord.	⅞—1	4 17 0	..	..	—
1	0/6	Do. 5% Cum. Pref.	15/16—1 1/16	4 12 3	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 —103	4 7 3	..	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	102¾	..
10	8½%	Bristol Tramways and Carriage Ord.	15½—15¾	5 15 2	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10¼	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	6 —7	4 5 8	—	6 13/16	6 9/16
10	6/0	Do. 6 per Cent. Cum. Pref.	8⅞—9⅜	6 8 0	Feb, Aug	9 3/16	9
St.	5%	Do. 5 per Cent. Perpetual Debs	112 —116	4 10 0	..	112	..
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock	93 —95	4 14 9	..	93½	..
St.	4%	Central London Ordinary Stock	88 —90	4 10 0	June, Dec	101	88⅜
St.	4%	Do. 4 per Cent. Pref. Stock	99 —101	3 19 0	..	100⅜	99⅝
St.	4%	Do. Deferred Stock	78 —81	4 18 8	..	80	—
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 —95	4 4 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 —5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	40 —42	4 8 0	Feb, Aug	41¾	40½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	† Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	105¾	104
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	—
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾—4¼	9 8 4	..	..	—
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs.	8 —9	4 8 11	—	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	—	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	106½—107½	4 8 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2¼—2¾	9 8 6	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16—8 13/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9¼—9¾	5 2 6	—	9⅝	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 —99	4 1 0	—	99	96
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	—	Metropolitan Elec. Trams Def.	⅛—¼	..	—	3/16	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	15/16	..
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	..	..
5	—	New Gen. Tract. 6 per Cent. Cum Pref	½—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	8 —9	5 15 0	..	8	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8 —9	5 11 0	Feb, Aug	8¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	103 —106	4 5 0	—	—	—
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	95	..
..	5%	Underground Elec. Rys. Co. of London	95 —98	5 2 0	..	96⅛	..
St.	3½%	Waterloo and City Ord.	99 —102	3 3 8	June, Dec	..	..
St.	4½%	Yorkshire W.R. El. Trs. Co. 4½% 1st Debs.	95 —97	4 18 0	—	95½	95

Shre.	Last Dividend	Name.	Price Wed., May 9.	Rate % Yielded.	Dividend Due.	Business Week to May 9. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.		£ s. d.			
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord .. xd & bonus	3¾—4	5 0 0	..	4	3⅞
1	7½d.	† Do. Pref	1½—1⅝	3 14 0	..	1 9/16	—
5	4/0	British Insulated & Helsby Cables Ord.	6½—7	5 14 0	July, Feb	6½	—
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 —107	4 4 0	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞—2⅜	..	..	2 3/32	1 15/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 —85	4 14 0	..	..	..
2	1/0	Brush Electrical Engineering	⅝—⅞	..	March ..	11/16	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	—	..
5	5/0	Callender's Cable Con. Ord.	11 —12	4 3 4	Jan, July	11¾	11½
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6	4 3 4	Jan, July	5⅞	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	109	..
1	4½d.	Castner-Kellner Alkali Co.	1 1/16—1 3/16	5 1 6	..	1 3/32	1⅛
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 —100	4 10 0	—	..	..
1	2⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	—	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 1/16—2 3/16	3 8 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%—99%	5 1 0	Jan, July	—	..
5	10/0	Dick, Kerr & Co. Ord.	1¾—1⅞	5 8 0	Sept	—	..
5	3/0	Do. 6% Cum. Pref.	1 13/16—1 15/16	4 6 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	—	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	—	Feb, Aug	1 19/32	..
5	2/6	Do. (£5 paid)	2½—3	—	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	8 4 6	H'lf-yearly	3¾	..
5	3/0	Do. 6 per Cent. Cum. Pref.	5 —5½	5 9 0	..	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	104	..
2	1/7½	Electric Construction Co.	1 9/16—1 13/16	9 6 0	July	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅜—9⅞	5 3 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 —98	4 1 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12½—13½	5 11 0	Feb, Aug	13	12⅞
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 —111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½—59½	..	..	58½	57½
10	15/0	India Rubber, Gutta Percha, &c., Wks.	17 —18	2 17 2	Feb, Aug	17¼	17 1/16
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	..	..
1	7½d.	† Do. 6% Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 10 0	..	99¼	..
12	[illegible]	Telegraph Construction & Mainten'ce.	32 —34	5 6 0	Mar, July	34	32½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16—2 9/16	5 15 0	..	2 9/16	2½
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1¼	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	114 —117	4 5 3	—	117	115
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	105 —107	3 14 8	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 —108	4 3 8	—	..	..
5	—	Willans and Robinson Ord.	1¾—2¼	—	Apr, Oct	—	—
5	—	Do. 6 per Cent. Cum. Pref.	3 —3½	—	Apr, Oct	..	—
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 —85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	3¾—4¼	—	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	84½	..
St.	35/0	Anglo-American	66 —68	4 16 8	F, My, Ag, N	67¼	66¼
St.	30/0	Do. Preferred	114 —115	5 4 6	F, My, Ag, N	115¼	114
St.	10/0	Do. Deferred	24 —24½	..	F, My Ag, N	24¼	23
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	96½—97½	4 1 3	Jn Ap, Jy, O	97¾	96⅞
10	5/0	†Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	8 9/16	8½
10	10/0	† Do. Preference 10 per Cent.	17 —18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable.	16¼—16¾	4 5 0	Ja, Ap, Jy, O	16⅝	16⅜
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	142 —145	4 16 6	Ja, Ap, Jy, O	144½	142
St.	17/6	Do. 3½ per Cent. Pref. Stock	89 —91	3 17 6	Ja, Ap, Jy, O	90¾	90
St.	4%	† Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —108	3 14 0	May, Nov	107¾	106
10	2/6	Eastern Extension	14½—15	4 13 6	Ja, Ap, Jy, O	14 27/32	14⅝
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	107	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 3	Feb, Aug	..	—
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) Ex coupon 66 ..	17 —19	6 8 0	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. Red.	101 —103	4 7 3	June, Dec	..	..
25	52/6	Indo-European Ex all.	56 —58	5 12 1	May, Nov	57⅜	..
100	$1	Mackay Companies Common	65 11/16—66 1/16	3 0 6	Jan, July	—	..
100	4%	Do. Preference	73 15/16—74 3/16	5 8 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	1 5/32	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 —103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾—10¼	4 17 6	..	..	—
2½	—	West Coast of America	⅝—⅞	..	—	13/16	..
100	4%	Do. 4 per Cent. Debs.	100 —102	3 18 3	Jan, July	100	..
10	—	West India and Panama	⅝—¾	..	May, Nov	⅝	..
10	6/0	Do. 6% 1st Pref.	8 —8½	7 1 0	May, Nov	8½	8⅛
10	—	Do. 6 per Cent. 2nd Pref.	6 —7	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan. July	..	..
10	3/0	Western Telegraph	14 —14½	4 17 6	Mr, Jn, O, D	14⅝	14
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	[illegible] —104	3 17 0	..	102½	..
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	7⅞—8⅛	4 18 0	August ..	8⅛	8
1	0/4⅘	†Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	0/6	† Do. 5% Pref.	⅞—1	5 0 0	..	..	..
St.	5%	National Co. Pref. Stock	108 —110	5 9 0	—	109¼	108
St.	5%	Do. Def. Stock	108 —110	4 11 0	—	109	108
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	13¼	12¾
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	12½	11½
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅜—5⅝	4 9 0	Feb, Aug	5½	5 7/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	99¼	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 6	—	105	104½
1	0/7½	Oriental	1⅜—1½	4 0 0	April, Oct	—	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	1¼	—
St.	24/7⅜	Do. 4% Red. Deb. Stock	99 —101	3 19 0	..	100½	100¼
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	..	..
5	3/0	United River Plate	7 —7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —112	4 9 8	June, Dec	—	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	—	..	..
10	2/0	Globe Telegraph and Trust	11 —11½	4 16 0	Ja Ap, Jy O	11½	11
10	3/0	Do. 6 per Cent. Pref	14¾—15	4 0 0	Ja, Ap, Jy, O	15	..
10	6%	Submarine Cables Trust (Cert.)	126 —129	4 18 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

It is long since there has been a good discussion on arc lamps and arc lighting at the Institution of Electrical Engineers, and the opportunity afforded by Mr. Andrews' Paper was therefore welcome. Unfortunately, however, full advantage was not taken of this, and the numerous technical points in the construction and use of "flame" arc lamps, about which information is much needed, were left untouched. In the Paper itself, it is true, Mr. Andrews told us a great deal with regard to the Carbone lamp, but this lamp is admittedly more suitable for the lighting of large interiors than a competitor of the chemical-carbon arc lamp for street lighting. Not only were the practical questions neglected, but the physicists did not avail themselves of the occasion, as well they might, to bring our knowledge of the physics of the electric arc right up to date. Much has been done since the publication of Mrs. Ayrton's book on the subject, and we should have listened with interest to a physical explanation of the phenomena that occur in the flame arc. Perhaps these things are reserved for the Royal Society or the Physical Society, and, in the meantime, we must be content with Mr. Patchell's figures which demonstrate the enormous advances that have been made in the efficiency of arc lighting during the past few years.

◆

In the face of these figures and of the result of the "competition" at Charing Cross station, we read with amazement the statement made by Mr. R. H. Bicknell, the Local Government Board inspector, at an inquiry at Newcastle. This gentleman admitted that he was not an electrical engineer, but stated that the Local Government Board's electrical experts had gone into the matter of street lighting very carefully, and that the Board was under the impression that no station had yet been able to supply electricity to give as good a light as "the incandescent gas" at the same price. We have read accounts in the daily papers of an extensive reorganisation having been set on foot at the Local Government Board by its energetic President who represents Labour in the present Ministry, but we have yet to hear of the appointment of electrical experts on that body. In London, electricity supply companies have obtained contracts for street lighting with the older types of arc lamps in competition with the gas companies and high-pressure gas lamps, and the flame arcs have now left the gas lamps far behind, so that we take the liberty of inferring either that the "electrical experts" of the Local Government Board, whoever they may be, are not well-informed on the subject, or at any rate that the impressionable Local Government Board has received an impression that is unfortunately a false one.

◆

Electric lighting engineers will welcome the substantial reduction in the price of Tantalum lamps which we announce this week. Their price in this country has been diminished from 5s. to 2s. 9d., and this will doubtless considerably extend their sphere of utility. The efficiency of these lamps is so great, and there is such good promise of competing metallic filament lamps being put on the market that it will certainly pay to employ pressures of 110 volts instead of 220 volts for all private self-contained electric light installations, and even on public electricity supply systems in which the extent of the low-tension distributing networks is not great. In the course of time, no doubt, we shall have 220-volt metallic filament lamps of ordinarily low candle-powers, but it may be some years before these are developed, and in the meantime the "unit" of light that can be supplied at one point by two tantalum lamps in series is too high except for very large rooms and for street lighting.

The case for the London County Council Electric Power Bill had been completely put before the Hybrid Committee of the House of Commons at the close of yesterday's sitting. While the scheme as a whole does not meet with our approval, we cannot but express our admiration of the manner in which the engineering part of the problem has been worked out by the technical officers of the Council and the experts called in to their assistance. The site of the Greenwich power house is almost an ideal one for obtaining cheap coal and condensing water, and its chief disadvantage is that it is in London where the buildings have had to conform with the London Building Act and where rates are extremely high, for the London County Council itself cannot be absolved from these burdens. The capital expenditure has been high, but a station has been provided which can certainly be run far more economically than many of the electricity works of the existing undertakers. It is true that a new works, commenced to-day, would certainly be able to show considerable improvement both in lower capital and lower works costs over the one at Greenwich, but if the London County Council is to furnish the bulk of the electrical energy used in London and the surrounding area, there can be no doubt that the project based on an extension of the Greenwich works is the proper one.

On the other hand, notwithstanding the engineering ability displayed by its officials, the London County Council has given ample proof that it is not the body to undertake with success a commercial venture of this magnitude. Its general methods are costly, and, of necessity, its movements are slow. The objections against the Bill are numerous. No railway company would care to buy power from the London County Council, nor do we believe that Parliament will pass a Bill that provides for the supply of electric power in a wide district outside the Council's own area. Then again, it would be unfair to grant the principle of compulsion being exerted on the existing electricity supply companies who have acted as pioneers, and some of whom will, even under existing conditions, be unable to have paid their shareholders a proper return on the money invested in them by the time of the expiry of their Orders in 1931. Passing over numerous other reasons for withholding our support from the present measure, we come back to the important one of cost. Notwithstanding any estimates to the contrary which may be placed before Parliamentary Committees, the public will remain unconvinced that the London County Council could build up such an undertaking and work it on a more economical basis than a joint stock company. The companies who have been seeking similar powers have all been willing to be bound down to supply at a certain scale of charges, but the London County Council, although it mentions extremely low rates in its estimates, cannot bind itself in its Bill to supply at any particular price; for there is a clause in the Bill, for the protection of the ratepayers, to the effect that if the undertaking does not show a profit after five years' working the prices have to be raised accordingly.

The Industrial Freedom League has issued a circular, headed "The Road to Ruin," protesting against the London County Council electric power scheme, ostensibly in the interests of the London ratepayer. In its anxiety to prevent municipal trading, however, the League has worded its circular in such a way as to be capable of doing considerable harm to those very industrial undertakings whose freedom it should endeavour to protect, for it is practically an attack on the whole business of electric power supply on a wholesale basis. We quote:—

> Of the many similar schemes for which powers have been granted to private companies in various parts of the country, only one can show satisfactory financial results—namely, the Newcastle-upon-Tyne Electric Supply Co. (Ltd.) About half of the others have not even been able to raise their capital, and the remainder, such as the Yorkshire, South Wales, and Lancashire undertakings are very far from being able to pay dividends. The South Wales Electrical Power Distribution Co., which is the most advanced of those named, reported at the recent fourth annual meeting that, on a total expenditure of £804,010, the gross revenue for the year was only £11,413, and there is now a total debit balance of £28,886.

Apart entirely from our attitude towards the London County Council power scheme, we must protest strongly against this action of the Industrial Freedom League. The League has done good work in checking municipal competition with existing industries, but if one of its methods is to disparage a young and promising industry in the eyes of the public, the harm it will do will be immeasurably greater than the benefits it confers, and members of the electrical community should immediately withdraw their support from the association.

The *Light Railway and Tramway Journal* of May 4th contains an article by Mr. J. A. Panton on corrugations in rails, which corroborates the opinions to which we have recently called attention, that this troublesome form of wear originates from incipient skidding. The article brings forward one cause of the action, which is peculiar to electrically-driven tramcars and rail motor-cars—viz., the application of the motive power to one end of each driven axle through the intervention of a gear wheel and pinion. The author correctly points out that this method of driving tends to cant the axles out of square, the wheel on the geared end leading its partner. As the two axles on a car or bogey will be canted in opposite directions, the effect is to produce a lateral thrust, grinding the flanges of the leading wheels on the outside and those of the trailing wheels on the inside. Mr. Panton gives sketches of wheel tyres showing that this occurs. The amount of the canting depends upon the degree of slack as between the axle and the motor armature, and it is easy to understand that chattering may be set up when the wheel flanges set across the rail grooves sufficiently to strike both sides. The burring over of the rail-table into the groove is doubtless partly due to the action described.

Mr. Panton suggests gearing each end of the axle, which should prevent the canting; and there can be no doubt that such symmetrical driving would be an improvement. That it would obviate corrugation we cannot agree, because there are other causes of chattering and incipient skidding. On some tramways corrugations commence where braking is frequent and violent, and that such braking produces incipient skidding is certain. There are also the facts that corrugation is rather common on cable tramways, and not unknown on steam railways, proving that the initial causes are not one but various. The harder the rail surface the less it will yield to these influences, and as some of them are apparently unavoidable special attention should be directed to the use of rails sufficiently hard and non-ductile.

Personal.—We are glad to announce that Prof. Perry is rapidly getting well and will certainly be able to make good use of his arm. He is at present at Clacton-on-Sea, and cannot return to London much before the end of May.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Tangier—Cadiz	Feb. 17, 1906
Paramaribo—Cayenne	April 20, 1906
Sydney—Nelson	April 26, 1906
Cape Haitien—Puerto Plata	May 15, 1906

Madame Curie.—It is announced that the Governing Board of the Paris University have decided to maintain the chair of General Physics held at the time of his death by M. Curie, and have named his widow as his successor. The Minister of Education has signed a decree accepting this proposal and appointing Madame Curie to the vacant chair.

The San Francisco Earthquake and Fire.—According to the *Electrical World*, telegraphic and telephonic service in San Francisco is being rapidly resumed, and fortunately the underground wires and cables have been found generally to be in good condition. Arc lighting has been resumed in the Protrero district, and some of the tramways are again running. In addition to the losses sustained by electrical firms mentioned in our last issue, the Westinghouse Electrical and Manufacturing Co. reports the loss of its offices and warehouse, together with some $160,000 worth of stock.

Long Distance Telephony.—A New York paper, commenting on a proposal to connect New York and San Francisco by telephone, points out that, even if the technical difficulties were overcome, the demand for telephonic communication between New York and California would not be sufficient to justify the establishment of a line, as business hours in New York and San Francisco only coincide for about one hour per day, so that the line would be idle 23 out of 24 hours. For this same reason, moreover, the price that would have to be charged for messages would be prohibitive as compared with telegrams.

The Newcastle Local Section of the Institution of Electrical Engineers.—The annual meeting of the Newcastle Local Section of the Institution of Electrical Engineers was held on Monday last. The committee's report was read and adopted, and the following officers and committee for ensuing year were elected :—

Chairman, Mr. H. L. Risely. *Vice-Chairman*, Mr. J. Pigg. *Past Chairmen*, Mr. G. Stoney, Mr. E. Eugene Brown and Dr. W. M. Thornton. *Committee*, Messrs. C. S. Vesey Brown, W. D. Hunter, J. F. C. Snell, J. H. Holmes, W. A. Clatworthy, L. E. Buckell, A. L. E. Drummond, F. O. Hunt, F. C. Kidman, J. F. Lamb, W. McLellan, R. E. Robson and F. Tremain. *Hon. Sec.*, Mr. C. Faraday Proctor.

Metallic Filament Lamps.—According to the *Electrical World*, metallic filament lamps of various sizes for voltages up to 130 volts, with an efficiency of $2\frac{1}{2}$ watts per candle-power, are being manufactured by the Tipless Lamp Co., of New York. The filament is the invention of Mr. H. J. Jaeger, who has experimented with metallic filaments since 1894. The carbon filament as at present made is employed as a cathode on which the metal is deposited, the process being secret; the filament is then subjected to a high temperature. The lamps are claimed to have a life equal to that of the 3·1 watt incandescent lamps on the market, and the special 8 c.p. train-lighting lamp is stated to have a life of from 400 to 500 hours.

The Supply of Selenium.—An article in the *Engineering and Mining Journal* says that selenium, which was discovered in 1817 by Berzelius in flue dust from certain pyrite burners and lead furnaces, has hitherto been regarded as of rare occurrence, but that its incidental concentration in the "silver slime" obtained in electrolytic copper-refining has made it possible to produce it in quantities worthy of consideration. The matter is of importance owing to the fact that the use of the material for photometric and other purposes is now passing beyond the laboratory stage. One American copper refinery is said to be recovering selenium at the rate of several hundredweight per month. The probable available supply of American selenium is given as from 20 to 30 tons per annum, and the price is from 3 to $4\frac{1}{2}$ dollars per lb.

"Electrical Fires."—A statement has been published in some daily newspapers that the recent fire at Lord Derby's stables, Newmarket, was caused by the fusing of electric wires. We are able to state that an inquiry into the circumstances has revealed the fact that the double-pole main switch was off at the time when the fire originated. Moreover, it was switched on again and the light was used to see to get the horses out of the stables, and was then switched off again. The distribution board and all fuses for the part of the building which was burned down were intact. Lord Derby's electrical engineer carried out the installation, and it has since been looked after by Messrs. Baily, Grundy, & Barrett, of Cambridge and Newmarket. The insurance company is quite satisfied that the fire was not due to electricity.

Thunder.—At a meeting of the Royal Meteorological Society on Tuesday, Mr. R. G. K. Lempfert read a Paper on "The Development and Progress of the Thunder Squall of February 8, 1906." This squall was first noted at Stornoway soon after midnight, and the last station in England to feel its effects was Hastings, over which it passed at about 4 p.m. The rate of progress was nearly uniform, though it increased somewhat in the south-east of the country, where the thunder and hail storms were most intense. The average speed of advance of the line of squall was about 38 miles per hour. The most marked feature of this squall was the sudden shift of the wind in the course of a few minutes from south-west to north-west, and it was during this period that the thunderstorm occurred, accompanied by a rise of barometric pressure and a fall of temperature.

Underground Telegraph Wires.—The following letter has been sent by the Postmaster-General to the secretary of the Association of Chambers of Commerce of the United Kingdom, in reply to a memorial in favour of laying all trunk wires underground so as to obviate the delays caused by storms breaking down the overhead wires :—

Sir : The Postmaster-General has had before him the memorial of the Associated Chambers of Commerce in favour of more extended construction of underground telegraph trunk lines, which you sent to him on the 26th ult. In reply I am to state that the underground line between London and Glasgow has now been completed. It was begun, as the Chambers of Commerce are no doubt aware, in the year 1896-97, and reached Birmingham in 1900. In 1902-3 it reached Warrington, and at that point it cut an existing underground line between Manchester and Liverpool. It has now been continued to Glasgow through Carlisle. The spur line to Manchester has been continued through Bradford to Leeds. In the south an underground line has been laid from London eastwards as far as Chatham, and westwards as far as Slough, and thence a pipe, but not yet a cable, as far as Reading. During the present year the Postmaster-General hopes to extend this pipe-line to Bristol and to provide a cable as far as Chippenham. The intention is to carry this line into Cornwall, to the landing places of important Atlantic and Mediterranean cables. The Postmaster-General trusts that the Chambers of Commerce will see in such a programme evidence of a desire to extend the underground system of telegraphs as rapidly as he reasonably may. He is, however, bound to adhere to the view expressed by his predecessor in the letter addressed to you on the same subject on April 13th of last year, that Parliament could not at present be asked to sanction a larger expenditure than that which is now contemplated, and, further, that the Post Office could not proceed economically with greater rapidity than it is proceeding now.

The Design of Electric Machinery for Fiery Mines.—In a long and interesting series of articles in the *Elektrotechnische Zeitschrift*, Herr R. Goetze describes experiments which were undertaken in a mine at Gelsenkirchen to determine how electric motors and switch gear ought to be protected so as not to cause explosions in fiery mines. He comes to the conlusion that this danger can be entirely avoided by suitable design. Switches, fuses and resistances ought, as a rule, to be totally enclosed and immersed in oil, while starting and regulating resistances, which are frequently in use, may also be screened by a wire gauze. This in its turn must be protected from mechanical injury. Motors must be totally enclosed and of robust design. It is not advisable to protect individual parts of the motor only. Accumulator traction is permissible if the cells are suitably enclosed. Compressed air, if available, may be supplied to the interior of the motor when it will keep the inside of the motor free from explosive mixtures. In this case a switch arrangement ought to be provided which will automatically disconnect the motor should the supply of compressed air fail. A continuous supervision of the motors is most essential. Induction motors with short-circuited rotor are not absolutely safe, and the author mentions some cases in which the burning out of the coils of such motors might have led to serious consequences.

A Large Water-power Station in Japan.—The rapid progress of electrical engineering in Japan is well shown by the new generating station which the Tokio Electric Light & Power Co. are constructing on the Tamagawa River, about 20 miles from Tokio. This station, according to the *Electrical Review* of New York, will be not only larger than any existing power house in the country, but involves the use of the highest pressure as yet employed in Japan. Five 3,900 kw. Siemens-Schuckert three phase 6,600 volt 50 cycle alternators are being installed coupled to Escher Wyss water wheels. The switch gear is of General Electric motor-operated oil-break type controlled from a separate five-panel desk board, and generally similar to that employed in the New York Interborough station. The transformer equipment at the generating end of the line consists of nine 2,000 kw. General Electric transformers, arranged for stepping up the voltage to 35,000 for transmission when connected in mesh or 57,000 when star-connected. For the present the former arrangement will be adopted, but eventually a 57,000 volt transmission is to be used. In the receiving station just outside the town the voltage will be reduced to 11,000 volts. From this station on the outskirts of the city all wires will be laid underground to various small distributing stations located about the city. As in the case of all electrical installations in Japan the work is subject to a rigid Government inspection, both before and after construction. This rule is an interesting one and covers all work of this character, whether it is fostered by private companies or the Japanese Government.

Metallic Filament Lamp Patents.—Three American patents have been recently granted to W. von Bolton covering a wide range in the field of metallic filament lamps. According to the *Electrical World*, two of the claims read as follows: "An incandescing body for electric glow lamps, consisting of a drawn wire of metallic tantalum." "Substantially pure metallic tantalum possessing the qualifications of homogeneousness and ductility." The following description of one of the methods employed to prepare the metals is of interest: In order to obtain a coherent metallic body of metal of the vanadium group, the amorphous powder of the impure metal is mixed with paraffin as a binding substance. The plastic mass is then pressed into the desired shape. The resulting body is placed in an oven to drive out the binding substance. The body is then heated by means of the electric current in the absence of air, in order to form a homogeneous ductile metallic body. It is stated that the use of a binding substance may conveniently be avoided by condensing the amorphous powder under sufficient pressure. For the purpose of obtaining tantalum in a ductile state the compressed powder of the metal is secured between clamps of tantalum which are connected to the terminals of a source of electrical energy. The metal commences to fuse as soon as an electric current of sufficient intensity is passed through the compressed powder, and molten beads drop off as the fusing proceeds. The fusing process is conducted in a vacuum as perfect as can be obtained. It is stated that if pure raw material is used for the purpose, and if all impurities are kept away during the fusing process, the tantalum metal so obtained will have such a high degree of ductility that it can be rolled into very fine sheets and drawn into the finest of wires.

A Moving Coil Galvanometer for Alternating Currents.—H. Abraham describes in *Comptes Rendus* a moving coil galvanometer for measuring alternating currents of the order of 0·01 micro-ampere in which the field is excited for an alternating current of the same frequency as that to be measured, by means of a small transformer. The apparatus was constructed with the collaboration of J. Carpentier. The general arrangement is similar to the ordinary d'Arsonval galvanometer. The alternating field magnet induces currents in metallic parts of the instrument which tend to react on the moving coil circuits so that if there is any dissymmetry in the construction, the moving coil is lightly deflected one way or the other. This effect can be compensated for by placing in the air gap a small metal sheet in a correctly-adjusted position. If the magnet be excited and the moving coil short circuited with a low resistance, it instantly takes up a position when it is not traversed for any flux. If moved from this position a powerful directing couple is produced, due to the current induced in the coil. This couple, which is due to the lag in phase of the induced current, would considerably reduce the sensibility of the instrument, but is avoided in actual use by including a capacity shunted for an adjustable resistance in the moving coil circuit. By over compensating with too large a capacity, an instability couple is produced which opposes the torsion of the suspension, so that a smaller net controlling couple can be obtained than that corresponding to the suspension alone. In one instrument constructed, the moving coil had a resistance of 200 ohms and a period of swing of 10 secs. The compensation of the electrical directing couple was affected by a 0·5 microfarad condenser shunted with 2,000 ohms. The sensibility with a scale at 1 metre distance was 275 millimetres per micro-ampere.

The First Electric Railway in Bolivia.—According to the *Street Railway Journal*, the Bolivian Government inaugurated some months ago, at La Paz, Bolivia, the Bajada Extension of the Ferro–Carril de Guaqui á La Paz (Guaqui–la Paz Railway), a metre-gauge line connecting these two towns. This is the first electric railway in Bolivia, and it is probably the highest in the world. The extension completes the chain of communication by railway and steamship between La Paz and the port of Mollendo on the Pacific Coast, and has already proved itself to be an important link in this chain. Almost all of the Bolivian importations enter at Mollendo, and are shipped over the Southern Railway of Peru to Puno, on the Peruvian side of Lake Titicaca (12,000 ft. elevation). Transhipment is made across the lake to Gnaqni, Bolivia, and from here over the Guaqui–La Paz Railway to the "altos" (13,400 ft. elevation) overlooking the city of La Paz, the central plaza of which is 1,500 ft. below. The only approach to the city is from above, and formerly all goods were carried from the railway terminus to the city by mule teams, and passengers travelled by coach, a distance of some 8 km., over a bad road. The lower terminus of the Bajada Extension is situated about 1 km. from the centre of the city, and power house and car house about 1½ km. along the line. At present the equipment consists of two 150 kw. D.C. generators, belted to Premier gas engines furnished by the Power Gas Corpn., of England. A Mond gas producer plant is used. The generators are provided with collector rings to give a three-wire 250 volt distribution for lighting purposes during the night. The rolling stock consists of two Brill cars for first-class passengers, two Brill cars for second-class passengers, each of which is mounted on Brill 21-E trucks and fitted with double motor GE-53 equipments, and one Brill 25 ft. vestibule baggage and express car, mounted on Brill 27-G trucks and fitted with four-motor GE-53 equipments. Each passenger car can draw one trailer up the hill and the baggage car two trailers. The downward journey is a question of brakes, and to hold back the trailers the electric cars are equipped with Stirling power brakes and air compressors, the latter operating Westinghouse air brakes on the freight cars. It was also desired to have track brakes, but the lack of space at the bottom of the car, due to the narrow gauge, made this difficult. The line throughout its entire length is a series of curves; in fact, the longest piece of straight track is only about 1,000 ft. Added to this there is an almost continuous grade of 6 per cent. from the lower end of the line to the railway station on the "alto." The line is single track, with overhead trolley construction, and, although the station on the "alto" is only about 2 km. from the lower station, the 1,500 ft. difference in level necessitates a tortuous route almost 9 km. in length.

Wireless Telegraph Notes.—As a result of the action of the Newcastle Chamber of Commerce a wireless telegraph station is almost completed on the coast at Cullercoats (a few miles to the north of Tynemouth). It is announced that in a few days the station will be able to send or receive messages on all systems to or from a distance of 200 miles.

In the October number of the *Bulletin* of the Assoc. des Ingénieurs Electricien (Montefiore) appears a long and well-illustrated article by M. A. Briffaux on experiments carried out in Belgium with the portable wireless telegraph sets of the "Telefunken" (Braun-Siemens and Slaby-Arco) system. The experiments were conducted under the auspices of the Compagnie de Télégraphistes du Génie. A great portion of the article consists of a description of the apparatus and a discussion of the theory of the parts, and presents little novelty. It will be remembered from previous descriptions that the portable station comprises three light two-wheeled one horse cars, carrying amongst them a 4 H.P. petrol motor, a 220 volt alternator, a transformer, sending and receiving apparatus and materials for balloon and kite work. Experiments were carried out over flat and over hilly country, a permanent station being fixed at Antwerp, while the other station was placed successively at Ghent, Namur and numerous other places. Tables are given which record the general experimental and the weather conditions and the efficiency of the signalling. The results may be summarised shortly. First, as regards the distances worked over, the maximum distance covered was 157 km., but this was over hilly country and was managed with great difficulty when coherers were used. Greater distances could be accomplished with the electrolytic detector of Schlömilch used with the telephone. Next as regards the benefits of syntonisation. In these experiments a wave-length of 1,050 metres was used, and tuning was carefully effected by the use of the ondameter. Nevertheless, frequent and great disturbances were on nearly all occasions received from some of certain fixed stations under the State administration, stations emitting such different wave-lengths as 1,250, 450 and 75 metres respectively, and no modification of capacity and inductance at the experimental stations made the elimination of these disturbances possible. The author is of opinion that this is largely due to the fact that in a compound transmitter, coupled electromagnetically on the Braun method, two wave-lengths are present, and, besides (and more important), resonance in electrical systems never approaches near to that sharpness familiar to acoustic resonance. The author also complains bitterly, on occasion, of atmospheric electrical disturbances, and, further, of the great difficulties that balloons and kites offer in bad weather. But he has some praise for the performance of the stations with respect to rate of signalling, which was normally at the very considerable speed of 15 to 20 words per minute.

Finsbury Technical College Old Students' Association.—A general meeting of old students was held at the Technical College, Finsbury, last Tuesday evening, May 8th, at which Sir Owen Roberts, took the chair. About 120 old students attended this meeting to discuss the proposal to form an Old Students' Association. In a short opening speech Sir Owen Roberts promised his hearty co-operation, and then called on Mr. P. V. McMahon, M.Inst.C.E., engineer to the City & South London Railway, to propose the following resolution :—

"That an Old Students' Association be formed for (*a*) the promotion of social intercourse ; (*b*) the advancements of the interests of the Technical College and of past students ; (*c*) mutual help."

This was seconded by Mr. T. J. Underhill, chief inspector of Victualling Stores to H.M. Navy, and was carried unanimously. Mr. J. L. Baker, hon. secretary of the London Section of the Society of Chemical Industry, then proposed and Mr. C.E. Holland, seconded the next resolution which was—

"That the draft scheme of the Organising Committee be provisionally adopted, and that it be an instruction to the Council to draw up a constitution and bye-laws, and to submit them to a general meeting."

The following draft scheme was proposed :—

The officers of the Association shall be a President, to be chosen annually in turn from each department ; Vice-presidents, not to exceed six, of whom at least one shall be chosen from each department ; and three Secretaries, chosen by the members of the Association.

Each department shall elect a Standing Committee of nine members to deal with purely departmental matters (*e.g.*, the registration of members seeking or offering employment) who shall nominate five (of whom at least one shall be an evening student) of their number to serve with the officers as a General Council.

It is suggested that the appointment of a Standing Social Committee and a Consulting Committee composed of members of responsible position, to act with the principal and professors of the college in advising, arbitrating and helping old students in difficulties, should occupy the early attention of the Council.

All past students of the college shall be eligible as members or associates, but no one shall remain an associate who has left the college more than five years. Past members of the staff and members of the governing body of the Institute shall be eligible for full membership, and all present members of the staff shall be honorary members.

The subscription shall be 10s. 6d. per annum for members and 5s. for associates.

After much discussion the resolution was passed with the following amendments :—

(1) That there should be one class of members only. (2) That the subscription be 5s. for London members and 2s. 6d. for country members.

During the discussion Sir Owen Roberts said that he felt sure that various City companies would give financial support to the movement, and that he would put the matter before the Court of the Clothworkers' Company, which he represented. The business of electing the officers of the Association was then proceeded with, and Mr. A. H. MacCallum proposed and Mr. R. G. Pelley seconded Dr. M. O. Forster, F.R.S., as President of the Association. Dr. Forster's name was received with much enthusiasm and he was unanimously elected. The following officers were then proposed by Mr. MacCallum and seconded by Mr. Pelley, and were duly elected :—

Vice-Presidents.—Sir Owen Roberts ; Prof. J. Perry, F.R.S. ; C. G. Redfern (Mechanical) ; P. V. McMahon, M.Inst.C.E. (Electrical); H. D. Richmond (Chemical). *Treasurer.*—Prof. W. E. Dalby, M.Inst.C.E. *Secretaries.*—S. E. Gritton (Mechanical), E. W. Moss (Electrical), J. W. Brooker (Chemical).

Five members from each department to serve on the Council.—*Electrical*—A. C. Eborall, H. W. Handcock, Ll. B. Atkinson, F. H. Nalder. *Mechanical*—A. H. MacCallum, H. M. Waynforth, B. Chatterton, M. de Ville. *Chemical*—J. L. Baker, G. T. Morgan, M. Priest, W. J. Pope, A. R. Ling.

The newly-elected President then proposed a vote of thanks to Sir Owen Roberts for kindly acting as chairman. Prof. S. P. Thompson, F.R.S., &c., in seconding the vote, which was very heartily accorded, gave a short history of the movement and said how pleased he was to see the Association thus formed.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, May 18th.**

Royal Institution.

9 p.m. Evening Discourse by Prof. A. Schuster, F.R.S., on "International Science."

SATURDAY, May 19th.

Birmingham and District Electric Club.

7:30 p.m. Ordinary Meeting at the Colonnade Hotel, New-street, Birmingham. Papers to be read : "Electricity Supply from the Commercial Standpoint," by J. A. Jeckell.

MONDAY, May 21st.

Society of Chemical Industry : London Section.

8 p.m. Meeting in the Rooms of the Chemical Society, Burlington House, London. Paper to be read : "The Problem of the Electro-Chemical Fixation of Nitrogen," by Prof. Philippe A. Guye, of Geneva.

WEDNESDAY, May 23rd.

Society of Arts.

8 p.m. Ordinary Meeting. Paper to be read : "The General Supply of Electricity for Power and other Purposes," by James N. Shoolbred.

THURSDAY, May 24th.

Institution of Electrical Engineers.

8 p.m. Annual General Meeting at the Society of Arts, John-street, Adelphi, to receive the annual report of the Council and statements of accounts for the year ending December 31, 1905, and to announce the election of the new council.

FRIDAY, May 25th.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda : (1) "Colour Phenomena in Photometry," by J. S. Dow ; (2) "Exhibition of an Automatic Arc Lamp," by H. Tomlinson and the Rev. G. T. Johnston ; (3) "The Theory of Moving Coil and other kinds of Ballistic Galvanometers, by Prof. H. A. Wilson ; (4) "Exhibition of a Bifilar Galvanometer free from Zero Creep," by A. Campbell.

LONG FLAME ARC LAMPS.

The discussion on Mr. Andrews' Paper before the Institution of Electrical Engineers on "Long Flame Arc Lamps" was concluded on Thursday, May 10th. The Paper and first part of the discussion was published in our issues for May 4th and 11th. Mr. W. M. Mordey was in the chair at the meeting of May 10th.

Mr. W. DUDDELL asked what a soft carbon exactly was. Was it mechanically soft, or electrically soft, or what was the softness? His own experiments on the use of alternating currents and adding impurities showed that what was really wanted was to add some volatile salt, preferably one of the alkali metals, to the cores. He had found that using salts of the potassium or sodium groups enormously increased the apparent conductivity of the arc flame and enabled a lower voltage to be used. In fact, so far from requiring a soft core, a piece of hard glass enabled a very much lower voltage to be used than with an ordinary core. His next point was with regard to the absorption by the mist. Had Mr. Andrews made any quantitative measurements of what this was? His curves showed the total theoretical light and the actual light. Was the difference supposed to be absorption or not? With the ordinary carbon lamp he was of the opinion that the absorption was not very large, but it might be different with the flame arc lamp. He was interested in the mechanism which Mr. Andrews showed for obtaining the magnetic field to deflect the arc in a suitable manner, and he would like to ask Mr. Andrews if he could explain exactly what this hemispherical magnetic field consisted of. For instance, if they took a spherical body and considered the top part only, was the hemispherical field to be assumed to be radiating from two poles, north and south, and going longitudinally round the body, or was it to be supposed that the field was radiating from two long poles which were part of the circle but going on straight parallel planes from one side to the other of the sphere? Were the lines of magnetic force part of the longitudes or were they such lines as would be obtained by cutting up the sphere into a series of parallel planes? If they knew exactly what the shape of this field was, it might turn out that there was some very easy methods of making it, and it would be very useful, he thought, for a great many purposes for which arc lamps were used for projectors and things of that sort. The photo of the arc shown by the author, in which the arc was burning between two separate craters in parallel, seemed to have great physical interest (Fig. 7), because in the ordinary way one looked upon the arc as being unstable and that two could not be burned in parallel. He would, therefore, like to know what exposure was given as it was possible that the arc was first burning on one crater and jumped over to the other very quickly whilst the exposure was going on. He had tried to burn two arcs in parallel but had never been able to observe the effect even momentarily. The first one was out long before he had succeeded in striking the second. Fig. 25 was very interesting as showing some records of how arcs strike between two poles and showing the light given by the vapour column. In Fig. 25, slip C, at the topmost point of all, on the left-hand side, there was a little point which was apparently the top of the negative crater. On the right-hand side there was another point belonging apparently to the positive crater and there was a strip joining the two together. This was no doubt taken on a film which was travelling uniformly. Was that slant the measure of the rate at which the vapour column became incandescent, because if it was, it gave some idea of the rate at which the ions were travelling across that arc? M. Blondel, years ago, had made a large number of photographs using a slip and a rapidly-moving plate, and by that means he determined the rate at which arcs were lighted up. These early results showed that the arc started to light up from the negative first, and then from the positive, the two meeting in the centre. He used alternating current of 100 frequency and solid carbons. Perhaps Mr. Andrews would give some physical explanation of C in Fig. 25.

Mr. L. GASTER referred to the Vogel lamp which had two carbons working in an enclosed globe containing an amalgam of mercury. With this lamp, a life of 1,600 hours had been obtained, and its efficiency was 0·2 and 0·4 watts per candle. This greatly improved the effect of the colour of the ordinary mercury vapour lamp. The question of colour was serious. Arc lamps varied so much that it would have been better if Mr. Andrews had given an indication of the colour he would like. Carbon makers had no difficulty in giving any colour, and he was afraid that it was taken too much for granted that the absorption of light by the globes was 40 per cent. Researches by Westerdale and Prentice shewed that on the average it was not so high and that it varied with the nature of the glass. It would be interesting to know Mr. Andrew's reason for the figure he had given, because Solomon and others differed from him.

Mr. JUSTUS ECK (Union Electric Co.) took exception to the expression "candle-power per ampere." It seemed a pity that such a lax statement should come from the Institution. The question of arc lamps was quite involved enough with "maximum candle" and "mean hemispherical" and "spherical" to have this possibility added to it to mislead the general public, who were the buyers in the first instance and very often the sufferers later on. He would like to see it a rule that all lighting devices were sold by their mean hemispherical or mean spherical candle-power, together with a statement of the consumption measured at the meter, and the number of lamps that could be burned on the very many and varying central station voltages throughout the country. It was true that all people who had interests in supplying and fixing devices for the consumption of current had regretted the raising of the voltage from 100 to 200 and 250, but in his experience there were ways of getting over this difficulty. In many cases, where lamps were required for special display purposes, he had used, for interior lighting, lamps of half the ampere capacity, and in some cases enclosed arc lamps, connected in series when the light was required only inside, and at night paralleled in pairs and connected in series with outside lamps of double the ampere capacity. The most interesting question in the Paper was the solution of the question of projecting the light from the crater of the arc lamp in the direction required for illumination. A few months ago he saw a projector constructed somewhat on this principle, with the carbons at right angles and also a magnetic blow arrangement, and in this case the positive carbon was fixed in the axis of the reflector or the lens, thus taking advantage of the principle that had been made clear in the Paper. Coming to the Carbone arc lamp, he said he would like to know if there was any air circulation over the carbons, and whether the temperature was raised or lowered in consequence of this circulation of air or absence of circulation. In fact, it would be interesting to know what the temperature of the arc was. So far as he could remember, in Mrs. Ayrton's classic book there was a description of an experiment made with direct-current arcs burning pure carbons with a baffle plate of clay above the upper carbon, and it was found there that, although the temperature was raised, the efficiency of the light was not increased. It would be interesting to know exactly what was done in this lamp. Further than this, was there any possibility of enclosing the lamp so as to obtain still longer life or would this mean a sacrifice in the luminous efficiency? Already one speaker had touched upon the question of the quality of the carbons, and he would like to know if the author had made any experiments with regard to the different qualities of carbons for this class of light—*i.e.*, different qualities of pure carbons not salted or impregnated. Fig. 23 of the Paper was stated to give the illumination per squre foot. He did not know exactly what was meant by this because it seemed that the illumination per square yard would give an equally interesting curve—in fact, the same curve. With regard to Dr. Wedding's tests, mentioned in the Paper, he had not had an opportuninty of reading these, but he would like to know what were the actual efficiencies of alternating-current arc lamps of this type. He had reason to believe that the efficiency was exceedingly poor, and not nearly approaching that of the direct-current arc as one might be led to believe on looking through this Paper. The question of the products of combustion of yellow flame arc lamps had been touched upon. He had had considerable experience of lamps of that type both for indoor and outdoor work, and he thought that it generally solved itself in this way: viz , that such places requiring arc lamps of such high power were generally sufficiently well ventilated, either automatically or purposely. He had one instance in his mind, which happened last winter. There were 100 of these lamps in one large enclosed building, a draper's. A large number of people attended the Christmas sales, and he took the trouble to go himself to see if any ill effects were experienced. He also asked the shop assistants, because the lamps were alight all day, but no bad effects could be traced. The very fact that a sensitive throat quickly detected the products of combustion was more or less a safeguard, because it would call such forcible attention to the matter long before there was anything really dangerous or poisonous in them. In fact, he did not quite understand where the poison was that had been mentioned. The last page of the Paper was exceedingly interesting to him, because it gave measurements made with a 25 period circuit. He woud like to know whether there had been any effect upon the eye of the observer, and whether such a current was as suitable or suitable enough for practical purposes.

Mr. E. E. HOADLEY (Maidstone) said he wished it to be understood that he was looking at this matter purely from the point of view of a central station engineer who was responsible to the rate-paying public for the lighting of the streets in a town. His first point was that the wattage consumption of existing flame lamps—viz., 800 watts—was far too high for general use in the smaller towns. There were very few towns where the streets were of sufficient width or importance to warrant the erection of such large units of light, and what he would like the people who were responsible for the introduction of flame lamps to consider was the production of a reliable flame lamp consuming about 250 or 300 watts. With regard to the use of pure carbons, as they were called, in these Carbone arc lamps, Mr. Andrews had stated that in the generality the chemical flame carbons suffered from flickering for the first four or five minutes. He had been making experiments prior to replacing all the existing co-axial carbon arcs in Maidstone with flame arcs, and he had not found any trace of flickering or the slightest trouble. He would like to impress upon arc lamp makers the importance of getting a greater length of burning than was usual with most of the ordinary flame arcs. Perhaps this could be obtained either by the use of a magazine feed or, possibly, by enclosing the flame arc, although he was afraid from its very nature this latter would not do. In most of these chemical arcs the products of combustion must be got rid of, and, if they were not got rid of, the enclosing globe, whether it be large or small, would very soon be obscured. Whilst the colour of the Carbone arc was exceedingly good for some things, he had, during the past few weeks, been making inquiries of "the man in the street," and in nearly all cases he had been met with the answer that the pale golden light—not the bright orange light given out by some of the chemical arcs—was very much preferred to what was generally known as the white light of the Carbone or any other arc lamp. At Maidstone there were in the streets flame arc lamps running on the same circuits in actual series with the 10-ampere Brockie-Pell lamps, and the yellow light from the flame arc was very much preferred. But for lighting drapers' shops, for instance, the white light of the Carbone lamp was to be preferred. He had spoken to one or two large drapers, and they had said that whereas the flame lamp was very useful for advertising purposes it was totally unsuitable for inside lighting where colour matching had be carried on. He would like to confirm what Mr. Eck had said with regard to the action of the chemical fumes given off by flame lamps. He had made experiments in a room with 20 lamps, which were alight for a good many hours a day, but he had certainly not noticed any effect either upon the throat or eyes. He presumed that the noxious gases which would be noticed first would be either hydrochloric acid gas or hydrofluoric acid gas which would be given off by the salt-impregnated carbons or carbons impregnated with calcium carbide.

Mr. W. H. PATCHELL (Charing Cross, City & West End Electricity Supply Co.) said he thought that we had another instance of the benefits of competition in the state of the flame arc lamp at present. Years ago we were content to rest on our laurels for the time being, having captured the street lighting from the gas companies. Then they got their high-pressure gas system, and it looked as if we should have to take a back seat. But he thought we might be allowed to flap our wings upon the success which electric light had achieved at Charing Cross station. As a consequence of the collapse of the roof, the directors were compelled to reconsider their system of lighting, due to the different level at which the roof would be put up. The gas company got the ear of the railway directors, and his company had had a tight fight over it, but the result had been eminently satisfactory. There was a competition, for the gas company persuaded the directors not to take the word of the electric lighting company, but to have an exhibition and competition, and they had trials on several evenings. The electric light company had eight Sale-Onslow high-pressure gas lamps to compete with. He put up five Oriflamme arc lamps, and price for price they beat the gas company hollow. On the night that the matter was settled they had the directors of the railway company on the platform, and first each of the gas lamps were turned on, and afterwards each of the electric arcs, and if they had heard the "oh!" of the people each time the arc lamps were turned out there was no need to wait to hear the result. On the basis of price for price the electric arcs gave 45,000 c.p. as against 20,000 c.p. for the gas lamps. He had been going in for these arc lamps for a long time, and had made a good many tests. He had a few figures which might be interesting. These showed the cost per 1,000 c.p.-hour with current at 2d. per unit :—

Type.	Watts.	Cost per 1,000 c.p.-hour.
Oriflamme	350	0·4d.
Weinert	350	0·55d.
Excello	470	0·57d.
Santoni	420	0·7d.
Carbone lamp	1,000	1·0 (excluding trimming and carbons).
Open arc	500	1·5d.
Enclosed arc	500	2d.
Enclosed midget arc..........	250	3d.

He had been much struck when in the States last year that there were practically no flame arc lamps, and he attributed that to two causes. One was that the lighting was almost entirely in the hands of the big companies, and the enclosed lamp was favoured, due to the lesser labour, for this lamp would burn longer hours, and the companies seemed to appreciate that better, because one man could trim 600 lamps, whereas here 40 lamps was considered ample for one man. This applied both to street lighting and store lighting. Another reason for their not having the flame lamp in the States was—and this had been confirmed by the engineer of one of the largest American undertakings—that they simply did not know what high pressure gas was. He would like to give one or two hints to the makers of flame arc lamps. Three out of four of the lamps that he had tried were, first of all, prohibitive on the cost of carbons; and, secondly, they did not burn long enough hours. This latter was a very important point, and it showed that the magazine arc lamp was the lamp that they would have to put their money into. He had not, so far, however, found the gas and fumes from flame lamps cause any deleterious effects. The maintenance he had found, after running a good many, was a mere bagatelle. There also appeared to be a prejudice against the yellow lamp, but that was only a question of getting the carbons. When he started using arc lamps twenty years ago they used to be all sorts of colours of light. Very often it was a greenish colour, which was afterwards explained by the condition of the carbon-holders. His experience of the Oriflamme arc lamp did not bear out Mr. Andrew's statements that flickering could not be overcome. If the carbons were properly cored, there was absolutely no flickering. He must admit that there had been a little difficulty with the carbons, but they must not blame the arc lamp makers for that. When they first began to use cored carbons, the carbons were very often delivered without the cores. The ash given off was a little greater with the chemical than with the pure carbon, but not enough to affect the efficiency of the lamp. The cost of carbons was an important matter, but the carbons he was using cost 0·09d. per lamp-hour, which was pretty close to the figure of the ordinary arc lamps. Mr. Hoadley had mentioned the consumption of the Carbone lamps, which was in the neighbourhood of 1,000 watts. He quite agreed that this was too high for general use, although it was suitable in some cases. The figures he had given showed that there were 350 watt chemical arcs of various makes, some of which were working particulary satisfactorily, but the Paper did not state whether the Carbone lamp could be made in smaller sizes.

Mr. HAYDN HARRISON : Do your figures include carbons or not?

Mr. PATCHELL : No.

Mr. HARRISON : And are they for mean spherical candle-power?

Mr. PATCHELL : Yes.

Mr. E. W. COWAN said that he had, in the course of experiments, succeeded in lengthening considerably the life of the Carbone lamp by semi-enclosing it. He had obtained a life of 53 hours with 9 mm. and 7 mm. carbons. This, however, tended to deteriorate somewhat the beauty of the light and its steadiness. With inclined carbons there was a tendency, when the lamp was much enclosed and there was not much combustion going on, for the crater to change its position rather rapidly from one point to another, and this introduced a little flickering, which, however, was not noticeable at a distance, but to which Mr. Carbone, who wished to keep to a very high standard with these lamps, objected. Probably he would get over it, but Mr. Carbone had told him that he had obtained 300 hours' life, without enclosing, in a lamp which had not yet been put upon the market. With regard to some of the remarks made by Mr. Duddell as to the field, he thought one of Mr. Andrews' illustrations answered these. As far as he could remember the lines were longitudinal between the poles, and although he did not know at all certainly why this particular form of blow-out gave a shape which was of such advantage, it might possibly be due to the fact that the arc was attracted or pulled out by the magnetic field, instead of being pushed out or blown out; and perhaps the splitting out of the flame like this might be partly due to the field coming on the exterior of the arc rather than on the interior. Some questions had been asked as to whether it was possible to make these lamps in smaller sizes. He had seen smaller sizes, and he knew of no physical reason. But the reason why the makers had stuck to the larger size in the first instance was that they wished to compete with the chemical carbon lamp and give as beautiful a display of light as possible. Concerning the colour: Dr. Schwartz, of Manchester, had compared the spectrum of the lamp with the spectrum of daylight—such as was got in Manchester—side by side in a differential spectroscope, where they could superimpose one plate of the spectrum above the other, and neither Dr. Schwartz nor himself had been able to detect the least difference between the two.

Mr. W. M. MORDEY said he agreed with Mr. Patchell as to the timeliness of the arrival of this new lamp, He remembered when Mr. Bailey gave his lecture on arc lamps at the Electrical Exhibition a few months ago he had pointed out that this lamp had arrived just at the time the ordinary arc lamp was being driven out of the field by the serious competition of improved gas lamps. He thought they had a good deal to thank the gas companies and gas engineers for, and he hoped they would have more to thank them for, and that they would keep up their competition. Gas lighting was just as scientific as electric lighting and it was a case of give and take. Gas engineers had learned something from the electrical engineer, whilst, on the other hand, if it had not been for the gas mantle we should never have had the Nernst lamp. Now we had the flame lamp, which was, he thought, going to keep the field for electric lighting. The question of the absorption by globes had been mentioned. He thought the best way to study that was to walk about the streets until they found a lamp with a broken globe and notice the patch of lightness which came from the hole as compared with the rest of the globe. There was not much further evidence needed of the very large absorption that took place in ordinary globes. In giving the summary of his Paper the author had been good enough to refer to a suggestion made by him (Mr. Mordey) in 1892 for using lamps with carbons as they were now arranged in these lamps, and to deflect the arc magnetically. He would like to say, however, that he was entitled to no credit for that suggestion. Many of them would remember that one of the first instances of modern arc lighting in London was the Rapieff lamp at *The Times* offices, where there were inclined carbons, and, he believed, a magnetic deflection. Then they all knew that the first serious arc lighting was by the Jablockhoff lamp, which had the carbons side by side. Unfortunately for the lamp the light was all thrown upwards. If Jablockhoff had applied the magnetic principle and deflected the light downwards these lamps might still have been in use. His own experiments in 1892 had been made with a view to improving the lamps in projectors. One great difficulty with ordinary projectors for small torpedo boats was that it was impossible to get a very good effect without greatly heating the projector. He found by his experiments that there was an enormous improvement by deflecting the arc and by letting the crater stare right into the reflector. Some of them would probably remember the old testing works in Victoria Works. He remembered having a lamp arranged there so that the crater could be seen. It was a 10 ampere lamp, but looking at the lamp from the other end of the room it looked exactly like a 50 ampere lamp, it was so brilliant and so different. He made a lot of experiments, but came to grief over them because he found that the long horn which formed on the negative and the deep crater that was formed on the positive made it impossible to get a reasonably constant light in a projector. He then started off on a series of experiments, rotating the two carbons slowly by a little electromagnetic arrangement in order to prevent the horn and the crater forming, and in order to get the crater and the negative tip always in the same position. But he got no further with it, and he was not entitled to the least credit for the suggestion to use inclined carbons with magnetic deflection. He would like to suggest to anybody who was more interested in projector work the taking up of experiments on some such lines. He thought it might be found that, with the improved carbons that were obtainable, it might be possible to get a result a good deal better than anything now obtainable in ordinary projector work. Mr. Andrew's Paper had interested him very much for many reasons. He was glad to see, as an old advocate of alternating-current methods, the very good showing that the alternating current arc apparently made. His own experience was that for a given amount of energy, the result that was got by ordinary alternating arcs was almost entirely due to the fact that with alternating currents, and under the same other conditions, there was a much longer arc for the same voltage, and the light got out much better. He was also interested on account of the views expressed by the author as to the usefulness of the negative tip. One had only to deflect a pair of carbons in the direct-current arc to see that the negative area, although, perhaps, not so bright as the positive crater, was a very useful light-giving surface, and it was rather curious that it should not have been realised from the first. He remembered some lamps at the old Aquarium, in the very early days, supplied by the great house of Siemens, in which it was frankly taken for granted that the negative gave no light at all, and Sir William Siemens therefore substituted for it a hollow copper rod through which water was circulated to keep it cool. The light was entirely obtained from the positive crater in that way. He was sure that they all regretted that Mrs. Ayrton was not present, but they were proud that their one lady member should be a recognised authority on this very important subject of arc lamps.

Mr. LEONARD ANDREWS, in reply, said that the Carbone lamp was first brought to his notice at Hastings, and it had then struck him as possessing some new physical features. A few months ago he had occasion to go to Berlin where the lamp was made, and he got a great deal of information which he had included in the Paper, and it had struck him as being so much of a departure on what had previously been written on arc lamps that it was worth while to bring it before the Institution for discussion. He thought it would not do to read a Paper on that one lamp only, and he tried to make the Paper applicable to all flame arc lamps. He also had made a considerable number of experiments with chemical carbon arcs, and had described a few of them in the Paper which had struck him as being original. He had hoped that the makers of other lamps would have come forward and given some information. But he was sorry to say that he had learned very little about chemical flame lamps during the discussion. Coming to the points raised in the discussion, Mr. Andrews first dealt with Mr. Trotter's objection to Fig. 1. He must apologise to Mr. Trotter, for the curve was inaccurate, owing to repeated re-drawing, but his only object in showing that curve was to give a reminder that Mr. Trotter had shown what a very large percentage of the light was absorbed by the negative. Mr. Trotter had questioned the figure for the intrinsic brilliancy of the crater and mentioned that he had found 64 c.p. per square millimetre. The figures he himself had given were taken from Dr. Fleming's book. He had seen that reference of Mr. Trotter's before to 64 c.p. per square millimetre, and it had puzzled him very much, because it was widely different from the results given by other authors. Mr. Trotter had also found that with a 25 ampere 50 volt lamp he got a candle-power of 1,400 at an angle of 45 deg. This seemed to show that there was an error in the photometric measurement, and not through any appreciable variation in the intrinsic brilliancy, because he found that by calculating out the area which Mr. Trotter gave in his explanation, that the candle-power per watt was only 0·64, which was very much lower than the results that any other author had obtained, and if it was correct it simply emphasised his point that a very much higher efficiency was obtained with downward feeding carbon lamps. If, instead of 64, Mr. Trotter had taken 158 (Mr. Andrews' figure) and his own area, he could then have brought the candle-power up to 1·58 candles per watt, which was approximately the figure taken in the Paper. Therefore, he did not think it was so much that there was a big variation in the intrinsic brilliancy, but it might be taken that the photometric measurements were incorrect. Mr. Haydn Harrison's contribution was very interesting because it dealt with a point that he was sorry had not been discussed more, the question of top lighting. Dr. Schwartz, of the Manchester Technical School, had sent him a copy of a very interesting contribution to the *Journal* which dealt with this point very clearly. Mr. Harrison last week had urged horizontal lighting. Mr. Harrison had made the same point in his own Paper at Manchester and he had a very interesting reflector which gave a horizontal light. In this respect any flame lamp was advantageous. In Berlin he noticed that in one of the squares lighted by two or three chemical carbon flame lamps, put on a pole which was probably 50 ft. or 60 ft. high, the effect was very fine indeed and very comfortable for seeing.

Mr. HARRISON asked Mr. Andrews if he had seen the high mast in Bournemouth. The public, however, had practically insisted on the lamps being placed on low masts.

Mr. PATCHELL said that Detroit probably took the record for high lamp-posts.

Mr. ANDREWS said the Bournemouth mast was made by the Brush Company many years ago. But ordinary arc lamps had been erected which threw the light around, and underneath the arc the posts were very dark indeed. If flame lamps had been erected, the public would have been satisfied, for all the light that was wanted below the lamps would then have been obtained. The curve in Fig. 23 had been referred to by several speakers. The expression "illumination per sq. ft." in the Paper should not have been used. He merely meant to give an illustration of the point that by putting up the lamps very high and using unobscured globes, a light was obtained on the ground that was not blinding. Mr. Duddell had asked what he meant by soft core. He could only say that he was quoting Mrs. Ayrton. When he started on this Paper he knew practically nothing about arc lamps, and consequently he read Mrs. Ayrton's book right through and saw a number of very interesting references to the difference between the soft crater and the hard crater. Mr. Duddell was probably right in suggesting that the arc was intermittent in the case in question. It was supposed to be an instantaneous photograph taken with a hand camera, but, although he used the quickest shutter, there would be quite time for the arc to change from one to the other. He had, however, made a number of experiments of this kind and always at that voltage there were apparently two arcs in parallel. Mr. Duddell wanted to know what he (Mr. Andrews) knew about absorption by mist. He did not know anything beyond what Mrs. Ayrton stated in her book. The only test that he had been able to make of mist absorption at all was the deduction given in the Paper in which he had taken the intrinsic brilliancy and the areas, and inasmuch as that, theoretically, was a small amount more than was actually obtained, it appeared to him reasonable to deduce that the difference was absorbed by the arc mist. Mr. Duddell had also raised the question of the meaning of the slant, but he was afraid that he hardly thought the subject so interesting as Mr. Duddell suggested. His impression was that the slant was due to the fact that the two craters were not parallel with the paper, one being always in front of the other. He had only made one experiment to determine to what extent the fumes of the chemical carbon lamp where poisonous. He was trying some experiments with one of these lamps in rather a small room, but he got such a splitting headache every time that he concluded he had been poisoned. Mr. Gaster had also stated that if he would only specify the colour, the carbon makers could give anything asked for. He had attempted to give a definition in the Paper. It appeared to him that the colour desired for some purposes was not that necessary for other purposes. For many purposes the yellow was preferred whilst white was suitable for others. With regard to the absorption of globes, Mr. Mordey had made the very remark that he himself intended to have done. When he was at Hastings he always used to be getting into trouble when a hole appeared in one of the globes. His committee used to say that this was evidence of the dirty condition of the globes. But it was not the cleaners; it was the obscurity of the glass. He had explained in the Paper the use of the term candles per ampere, and central station engineers would appreciate it. There were cases where a tradesman only wanted two lamps, and if he had to have two lamps across a 200 volt circuit, if each lamp only had 50 volts he had to absorb the rest in wasted energy. It should be considered that that energy was part of the wattage consumed by the lamp, although this did not apply in all cases by any means. Mr. Eck also raised the question of air circulation. He did not think there was any air circulation, and he was inclined to think that the enveloping hemispherical flames did tend to prevent the air getting at the crater. Someone made experiments years ago with blowing on the crater and cooling it, but the area of the crater was diminished, so that if the heat were kept in, and the air prevented from getting at it, it did tend to somewhat higher efficiency. With regard to the efficiency of alternating-current arcs, he could not remember where he saw the Paper of Wedding's which dealt with this. He believed it was in *Science Abstracts*. It was dealing with chemical carbon lamps, and his point was that it was due to the use of the downward-feeding carbons. Mr. Eck had asked as to the effect upon the eye with 25 periods. If they looked at the arc, flickering could be distinctly seen, but it was not so bad as with coaxially-arranged carbons. He quite agreed with Mr. Hoadley that smaller power lamps were necessary, for there was very little demand for a 10 ampere 800 watt lamp. So far it had been impossible to get lamps of lower wattage. This was simply due, as Mr. Cowan had explained, to the fact that the inventor liked to see all his lamps giving a mass of light. But there had been a promise of smaller wattage lamps. On the question of enclosing these lamps he thought it would be almost impossible to do this; at present the makers felt it was. Curiously enough, Mr. Patchell's figures practically corresponded to his theoretical deductions for different lamps for current consumption. For street lighting he admitted that the Carbone lamp was not so good as the chemical carbon lamp.

The author was accorded a hearty vote of thanks at the conclusion of the discussion.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

INTRODUCTORY.

The ignition of blasting charges by electricity is in some measure of particular interest to electricians, quite irrespectively of any connection which they may have with the practical side of the subject. It is associated intimately with the earliest history of electricity, with the first frictional machine, the first primary cell, and the first dynamo. Whether the idea of igniting gunpowder by electric sparks originated in that sporting attitude of mind which, our friends tell us, is expressed by the phrase "let's go and kill something," or if indeed the contrary thought lay nearer to the truth, is not of any consequence.

A rapid survey of the principal points of historical development † will afford a useful key to the difficulties which have hindered the progress of this art. In 1745 Dr. Watson, F.R.S., is reported to have ignited gunpowder by means of electric sparks, but in the practical application of electric firing difficulties presented themselves which rendered ignition uncertain.

"Powder requires for its ignition either the close proximity of a considerable heated surface, or the continued application of heat for a brief period" (Sir F. Abel, "Practical Applications of Electricity," 1882-3, p. 114), and it was this time element in the problem which the earlier experimenters overlooked. Sir Chas. Wheatstone, in a classical experiment on the duration of an electrostatic spark, found that its maximum duration did not exceed $\frac{1}{24000}$ second; consequently the only result of a discharge through a heap of powder was to scatter it violently about. Dr. Benjamin Franklin seems to have partially overcome this mechanical action by encasing the powder and crushing those grains lying immediately in the line of discharge.

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* From a forthcoming book to be published by "The Electrician" Printing & Publishing Co. All rights are reserved.

† The historical development of the art is treated at length in the author's Papers on "Electric Blasting" in the *Trans.* Inst.M.E. (Vols. XIV., XV. and XVI.), extracts from which have been made by permission of the Council of the Institution of Mining Engineers.

Little, if any, further progress was made until after the discovery by Volta of the primary cell. The thermal effect obtained by interposing in the circuit of a voltaic battery a short piece of wire of relatively high electrical resistance was noticed by Mr. Robert Hare (Prof. of Chemistry Univ. of Philadelphia) about 1822. Dr. Oersted's historic discovery and Faraday's subsequent development of it led to the introduction of magneto exploders by Wheatstone, Henley and others.

From about 1840 onwards the progress of the art of electric blasting alternates between improvements in mechanism for producing the necessary current and improvements in the means of initiating an explosion. Whilst one party developed apparatus which depended for its operation on the heating effect of current, another group, notably in Austria, sought higher efficiency in systems of ignition by sparks. In this way were evolved the two distinct methods now known as high and low-tension systems. (It will subsequently be seen that, although the expression "high tension" is in common use, the phrase has long since lost its original meaning.)

FUSES.

It is doubtless sufficiently well known that an explosive preparation is not exploded by bringing into direct contact with it an electric spark or red-hot wire. The duty of an exploder is to produce ignition within a small tube called a fuse. This fuse (which is buried within the mass to be exploded) consists in general of a paper tube about $1\frac{1}{4}$ in. long and $\frac{1}{4}$ in. full in diameter, having attached to it a pair of connecting wires 36 or more inches in length. It contains, in contact with an electrical firing device, either a merely combustible or an explosive powder, or both, according to the nature of the blasting charge which has to be "fired." The two classes of fuse are perhaps best defined by reference to the igniting medium, which connects the wire terminals within the fuse casing.

A HIGH-TENSION fuse is one having its terminal wires bridged by a combustible and conductive composition of relatively high electrical resistance, as shown in Fig. 1.

A LOW-TENSION fuse is one having its terminals metallically connected as in Fig. 2, the connection being surrounded by and in contact with a combustible mixture.

In the case of *high-tension fuses*, ignition occurs in the following manner: Electrical energy at the fuse terminals (technically, the *fuse-head*) is, owing to the insufficient conductivity of the bridging composition, converted into heat energy. The heat cannot dissipate with sufficient rapidity, therefore the temperature rises to the point of ignition of the bridge (which is also the *priming*); the latter then bursts into flame and initiates the required explosion.

With *low-tension fuses* the wire bridge is similarly heated, and so ignites the priming with which it is in contact.

It should be observed that a simple fuse, as already described, whether of H.T. or L.T. type, only suffices for the ignition of an explosive of the gunpowder class—that is to say, an explosive which may be fired by the simple application of sufficient heat. Explosives for use in coal mines have, however, to conform to the provisions of an enactment known as the "Explosives in Coal Mines Order," the said order being issued by H.M. Home Secretary and revised from time to time so as to include in its "Permitted List of Explosives" any new preparations which have passed the official tests.

These "permitted explosives," amongst which may be instanced *Nobel Carbonite*, *Monobel-powder*, *Roburite*, *Bobbinite*, and explosives for use in quarries (which are not required to pass an official test) such as *gelatine dynamite*, *blasting gelatine* and compressed gunpowder, are roughly divisible into three classes, each of which explodes in a manner peculiar to itself.

It is probably a point of common knowledge that the explosive effect is a function of the speed of combustion, and thus the different classes of explosives form series passing from a stage bordering on simple combustion to a stage of true detonation.

To produce *detonation* of an explosive charge, an addition is made to the electric fuse in the form of a metallic cap partly filled with fulminate of mercury.*

As bearing on the strength of detonator required it would appear that the resistance of an explosive (when made up in its usual cartridge form) to the initiation of that almost instantaneous combustion or resolution into the gaseous state which is called *detonation* is roughly proportional to its chemical stability.

A sectional view, showing a type of H.T. detonator fuse in common use, appears in Fig. 3, where DC represents the copper detonator case and F the fulminating mixture. A fuse is inserted in the tube, the metallic cover is compressed by a pair of pliers near the opening, in order to prevent tampering with the fuse, and the whole is rendered waterproof by a luting, C, akin to Chatterton compound, which covers the opening and stiffens the wires at a point where they would otherwise have a tendency to break. Detonator fuses, both high and low tension, are further classified according to the weight of fulminating mixture which they contain.

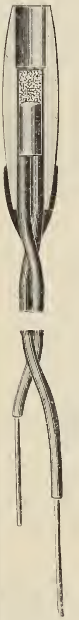


FIG. 1.—HIGH-TENSION FUSE.

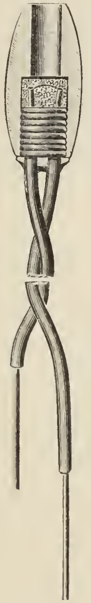


FIG. 2.—LOW-TENSION FUSE.

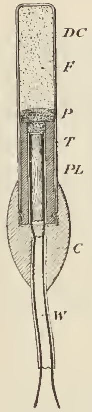


FIG. 3.—HIGH-TENSION DETONATOR FUSE.

The proper detonator to be used with any explosive on the "permitted list" is specified in the current "Explosives in Coal Mines Order." That most frequently used, viz., "No. 6," contains 15 grains of a mixture of fulminate of mercury and potassium chlorate. The No. 7 and 8 sizes contain 23 grains and 30·9 grains respectively of a similar composition.

The conducting wires (see W, Fig. 3) are usually of No. 22 S.W.G. copper or tinned iron, made up in various lengths to suit different depths of bore hole. What may be termed a standard size is 36 in. This length advances by gradations of 6 in. up to 2 yds., or even longer if required for special purposes. The insulation may be single or double cotton or jute, treated with preservative compound, or it may be of gutta-percha or other suitable medium if the fuses are required to be used in wet places.

In order to comply with a suggestion that was made to the Departmental Committee on the Use of Electricity in Mines, large numbers of fuses are now placed on the market having white covered wires. Fuses are liable by reason of miss-fire shots or in other ways to become lost when used in mines. The proposal that fuse wires should be made white, instead of black as formerly, therefore seemed to offer a simple and common sense way of reducing a risk. It would appear, however, from some observations which the author has made, that the change may have actually resulted in the introduction of an additional danger. To supply white fuse wires, makers are using paraffined cotton insulation. This is more readily ignitible than the earlier class of covering, and if it were set alight by the flame from a blasting shot serious consequences might conceivably ensue.

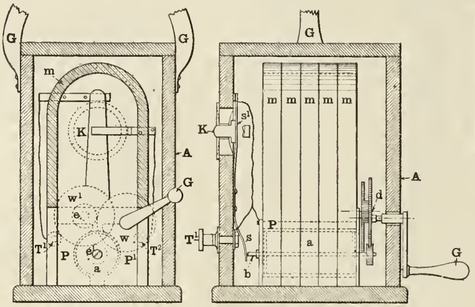
---

* This compound has the chemical formula $Hg_2C_2N_2O_2$. It is extraordinarily unstable. It explodes when heated to about 360°F., when scratched by a pin, and when brought into contact with an electric spark; or with concentrated sulphuric and nitric acids.

An enormous volume of work has been expended on the improvement of electric fuses. Sir Frederic Abel alone devoted 11 years to the production of a H.T. fuse, and many other workers have laboured on this small line of activity. Mr. F. W. T. Brain, of Cinderford, Glos., to take one more instance, has been associated with the development of electric blasting and the manufacture of fuses and detonators for more than 30 years, and has introduced many improvements in details. Mr. Brain's name is probably better known to many readers of *The Electrician* as the pioneer in the application of electric power transmission in mines.

EXPLODERS.

Almost everyone amongst the pioneers of electrical engineering appears to have designed an exploder. Frictional machines, induction coils, all kinds of primary and secondary cells and magneto-induction machines have at one time or another done practical service. Modern practice, however, confines itself to the use of (1) Magneto and dynamo exploders, (2) "Dry" or accumulator cells and (3) Current from power mains. A safety method of employing the latter source of power will subsequently be described, although the application of it in mines is not encouraged, on account of the ever-present possibility in unskilled hands of accidental ignition.



End Elevation. Side Elevation.

Fig. 4.—Davis Magneto Exploder.

Magneto Exploders.—Magneto exploders may be divided into three types: (*a*) In which current is induced in coils of wire surrounding the poles of a permanent magnet by suddenly detaching therefrom a soft iron armature; (*b*) In which a coil-wound armature is rotated between the poles of a permanent magnet; (*c*) In which a coil-wound armature is rotated between the poles of an electromagnet as in an ordinary dynamo.

Type (*a*), although examples are still used abroad, may be dismissed as lying outside modern practice.

Types (*b* and *c*) include all mechanically operated exploders now in general use. The best known of these may, perhaps, with advantage be examined in detail. Type (*b*) embraces the class of magneto exploders, examples of which are to be found in probably every British colliery where electric shot-firing is practised. Fig. 4 illustrates in section a magneto exploder made by Messrs. John Davis & Son. In the above-mentioned figures a shuttle armature, *a*, is shown, mounted in gun-metal bearings, concentrically with soft iron polar extensions, P, P¹. The latter pieces, which serve to distribute the magnetic field, are enclosed by the legs of five horse-shoe magnets, arranged with their positive poles together on one and their negative poles together on the other side, so as to form a powerful compound magnet.

A high armature speed is attained by suitably arranged toothed wheels, W, W¹, E, E¹, the main driver being actuated by a detachable handle, G, to comply with the recommendations of the Departmental Committee on the Use of Electricity in Mines. The opposite side of the hardwood containing case carries terminals, T¹, T², and a firing key, K. A diagram showing the circuit distribution common to this and other magneto exploders (except that the condenser shown below the dotted line *x* . . . *y* is usually omitted) is shown in Fig. 5.

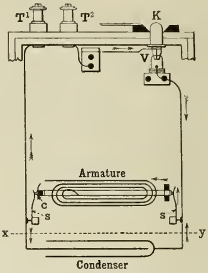


Fig. 5.—Diagram of Magneto Exploder Connections.

This exploder can be wound for either high or low-tension firing, and weighs 7 lbs.

A great deal of thought has been expended of late years on the production of light-weight machines, in order to meet the special conditions under which they have to be used in mines. Messrs. Davis & Son make another magneto exploder similar to that already described but neater in appearance and only weighing 4½ lb. It has an aluminium cover. The same firm have recently placed on the market a new type which is both smaller and lighter than those heretofore described. It is a four-shot magneto exploder of small dimensions (4½ in. × 3½ in. × 4 in.), and weighs under 4 lb. The armature pinion is rotated through a radial ratchet by half a turn of the handle from left to right. When this half-revolution is completed and the maximum armature velocity thus attained, contact is made automatically with the firing line. By the use of this device there ceases to be any necessity for a press button, and the risk of miss-fire shots through making contact with the firing circuit before a sufficiently high armature speed has been attained is considerably lessened. This exploder has been christened the "Davis Derby," and is provisionally protected.

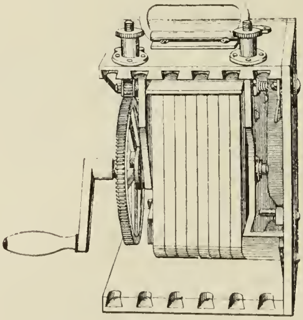


Fig. 6.—Siemens Magneto Exploder.

Fig. 6 exhibits the construction of an exploder manufactured by Messrs. Siemens Bros. & Co. This pattern was specially designed to meet the demand for an economical and reliable appliance for industrial blasting operations. It will be seen that the permanent magnets, of which there are eight in the size illustrated, are inverted, and that the armature is carried at the top of the case. The advantages of this apparently useless modification lies in the greater freedom from vibration secured for the magnets, and consequently less frequent necessity for re-magnetisation and repairs.

(To be continued.)

THE CALCULATION OF POLYPHASE INDUCTION MOTOR WINDINGS.

BY F. T. CHAPMAN, B.Sc.

The performance of an induction motor can be regarded from two points of view, which are more or less independent of each other—viz., (1) power factor and overload capacity; (2) efficiency and heating.

The present article is concerned with the first of these only, and its object is to indicate a rapid method of determining approximately the most suitable winding, from that standpoint, for a motor whose mechanical dimensions are already fixed.

Fig. 1 represents the ideal circle diagram, in which OA = magnetising current. OB = ideal short circuit current. OD = stator current under full load. DE = watt component of OD. CF = maximum possible value of DE. Then the ideal overload capacity, which we will call k, = CF/DE.

The lengths of OA and OB, and the relative position of D on the circle, can all be altered by varying the winding, consequently, also, the power factor at full load and the overload capacity. Since the pole pitch, length of stator and clearance are supposed already fixed, and the number and character of the slots may be predicted, the leakage factor (σ) can be estimated.

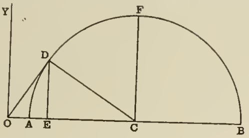


FIG. 1.

Suppose the winding is so chosen that the power factor shall be a maximum at full load, represented by OD. Then OD is tangent to the circle, and CD is perpendicular to OD. The angle OCD = ODE = DOγ = ϕ and the overload capacity.

$$k = \mathrm{CD/DE} = \operatorname{cosec}\phi = \mathrm{OC/OD}.$$

$$\text{Now OC} = \frac{\mathrm{OA}}{2\sigma} + \mathrm{OA} = \frac{\mathrm{OA}(1+2\sigma)}{2\sigma}, \text{ and}$$

$$\mathrm{OD}^2 = \mathrm{OC}^2 - \mathrm{CD}^2 = \mathrm{OA}^2\left\{\frac{(1+2\sigma)^2}{4\sigma^2} - \frac{1}{4\sigma^2}\right\} = \frac{\mathrm{OA}^2}{\sigma^2}(\sigma+\sigma^2)$$

$$\mathrm{OD} = \frac{\mathrm{OA}}{\sigma}\sqrt{\sigma(1+\sigma)},$$

$$\therefore\ k = \frac{\mathrm{OC}}{\mathrm{OD}} = \frac{1+2\sigma}{2\sqrt{\sigma(1+\sigma)}}.$$

Fig. 2 is a curve showing the value of this ideal overload capacity in terms of σ for motors designed to give their maximum power factor at normal full load. If the motor is designed to give its maximum power factor at some fraction δ of full load, the value of k determined from the curve must be multiplied by δ to give the corresponding overload capacity.

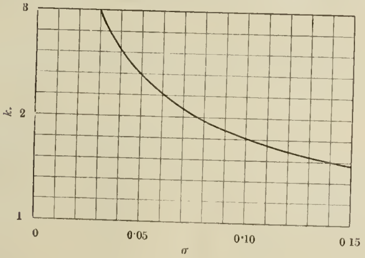


FIG. 2.

In what follows we shall consider a three-phase motor and make use of the symbols:

d = internal diameter of stator (or external diameter of rotor) in inches. l = gross length of stator stampings, in inches. Δ = radial clearance, in inches. n = speed in revolutions per minute. $\sim$ = frequency of supply. η = efficiency of motor (which can be estimated with sufficient accuracy at the outset). w = watts output per phase. V = voltage per phase. C = watt current at full load per phase. a = magnetising current per phase. T = number of turns in series per phase. t = average ratio (for stator and rotor) $\dfrac{\text{tooth width}}{\text{tooth pitch}}$ at face of iron. f = total reluctance air-gap and iron per magnetic circuit ÷ reluctance of air-gap per magnetic circuit.

The value of f lies between 1·1 and 1·25, being about 1·17 in ordinary cases.

Among these quantities we shall have the following relations:

$$\mathrm{C} = w/\eta\mathrm{V} \text{ and overload capacity } k = \frac{a}{2\sigma}/\mathrm{C}.$$

$$\therefore\ a = 2k\sigma\mathrm{C}, \text{ or } a = 2k\sigma\frac{w}{\eta\mathrm{V}}. \quad . \quad . \quad . \quad (1)$$

The number of lines per pole $= \dfrac{\mathrm{V}\times 10^8}{4{\cdot}2\times\sim\times\mathrm{T}}$ and the number of poles $= 120\sim/n$.

$\therefore$ total number of lines crossing air-gap

$$= \frac{\mathrm{V}\times 10^8}{4{\cdot}2\times\sim\times\mathrm{T}}\times\frac{120\sim}{n} = \frac{\mathrm{V}}{\mathrm{T}n}\times 2{\cdot}858\times 10^9$$

and the average density in the air-gap $= \dfrac{\mathrm{V}}{\mathrm{T}n\pi dl}\times 2{\cdot}858\times 10^9$.

To get the actual maximum density in the air-gap we must divide this expression by t and by a fraction which is about 0·6. If we call this quantity β we get

$$\beta = \frac{\mathrm{V}}{\mathrm{T}ndlt}\times 1{\cdot}516\times 10^9. \quad . \quad . \quad . \quad . \quad (2)$$

The maximum value of the ampere-turns per pair of poles

$$= 2\Delta\,.\,\beta\,.\,f\,.\times 0{\cdot}313.$$

The number of turns per phase per pair of poles $= \mathrm{T}\times n/60\sim$.

$\therefore$ the virtual magnetising current per phase

$$a = \frac{\beta\times 0{\cdot}626\Delta\,.\,f\,.\,60\,.\sim}{n\,.\,\mathrm{T}\,.}\times\frac{0{\cdot}707}{2} = \frac{\beta\,.\,\Delta\,.\,f\,.\sim}{n\,.\,\mathrm{T}}\times 13{\cdot}27.$$

Substituting for β from equation (2) we have

$$a = \frac{\mathrm{V}\,.\,\Delta\,.\sim.\,f\,.}{\mathrm{T}^2.\,n^2.\,d\,.\,l\,.\,t\,.}\times 2{\cdot}01\times 10^{10},$$

and finally substituting for a, from equation (1), and transposing, we get

$$\mathrm{T} = \sqrt{\frac{\mathrm{V}^2.\,\eta\,.\,\Delta\,.\sim.\,f\,.}{w\,.\,n^2.\,d\,.\,l\,.\,t\,.\,k\,.\,\sigma\,.}}\times 10^5. \quad . \quad . \quad (3)$$

In the case of two-phase motors several coefficients are different.

The number of lines per pole $= \mathrm{V}\times 10^8/4\sim\mathrm{T}$, the ratio of the maximum density in the air-gap to the nominal mean is $1{\cdot}9\times\dfrac{1}{t}$ instead of $1{\cdot}67\times\dfrac{1}{t}$, and the virtual magnetising current per phase

$$a = \left(\frac{\text{max. amp. turns per pair of poles}\times 60\sim}{n\mathrm{T}}\right)\times\tfrac{1}{2}.$$

These lead us to

$$\mathrm{T} = \sqrt{\frac{\mathrm{V}^2.\,\eta\,.\,\Delta\,.\sim.\,f}{w\,.\,n^2.\,d\,.\,l\,.\,t\,.\,k\,.\,\sigma\,.}}\times 1{\cdot}3\times 10^5.$$

Thus, by using suitable values for f and η, we can at once derive approximately the number of turns per phase which will give any desired overload capacity k. If it is required that the motor shall be working at its maximum power factor at full load, or any given fraction of full load, then the proper value of k to use in the formula can be obtained from Fig. 2 as explained above. It should be remembered that, owing to the resistance of the stator winding, the actual overload capacity will be less by some 5 or 10 per cent. than the ideal, and allowance should be made for this when choosing the value of k to be aimed at.

IPSWICH CORPORATION ELECTRIC SUPPLY AND TRAMWAY DEPARTMENTS.

The report of the chief engineer and manager to the Ipswich Corporation Electric Supply and Tramway Departments for the year ending March 31, 1906, part of the accounts from which were briefly summarised in our last issue, reveals a considerable reduction in works costs below the previous year's working. The figures now compare favourably with the average of 176 other provincial municipal undertakings for 1904-5 as shown in the table below:—

—	Coal, &c.	Oil, waste, water and stores.	Wages of workmen.	Repairs and maintenance.	Total works costs.
Ipswich	0·46	0·030	0·296	0·142	0·928
Average of 176 towns	0·55	0·076	0·280	0·231	1·137

During the year an additional boiler has been installed and brought into use; but the new 500 kw. engine and dynamo has not yet been finally taken out of the contractors' hands; it is however available for use. Two panels have been added to the switchboard since the last report, and considerable extensions have been made to the mains.

The report of the tramway department states that the percentage decrease in car-mileage was 5·6 per cent., whereas the total takings have decreased by 8·9 per cent. The average revenue per car-mile has thus decreased by just under 3½ per cent., owing to a variety of local causes. The working expenses have, however, been reduced on last year's figures by 13·9 per cent.

In this case, also, a comparison was made with the average obtained from the 1904-5 accounts of 55 Corporation systems in various parts of the country. As the price charged to the tramways department for power varies so greatly in different towns, this item is omitted in the comparison, which is as follows:—

Ipswich........................	4·297d. per car-mile.
Average for other towns	4·789d. „ „

These figures include all working expenses except cost of power.

The following table, which gives the items which go towards making up the total works costs, together with the management charges, redemption fund, &c., is extracted from the accounts of the supply department:—

	Year ending March 31, 1905.	Year ending March 31, 1906.
Units sold for private lighting	268,915	235,749
Units sold for power		159,734
Units sold for tramways	797,370	728,020
Total units sold	**1,066,285**	**1,123,503**
COSTS PER UNIT SOLD.		
Generating Costs.		
Coal and other fuel	0·608d.	0·460d.
Oil waste, water and stores	0·078d.	0·030d.
Wages	0·251d.	0·254d.
Repairs and maintenance	0·093d.	0·095d.
	1·030d.	0·839d.
Distributing Costs.		
Wages	0·012d.	0·012d.
Repairs, stores, &c	0·026d.	0·047d.
	0·068d.	0·089d.
TOTAL WORKS COSTS	**1·098d.**	**0·928d.**
Management Charges.		
Rents, rates and taxes	0·083d.	0·073d.
Salaries, stationery and establishment charges..	0·217d.	0·204d.
Insurance	0·008d.	0·006d.
	0·308d.	0·283d.
TOTAL COSTS (excluding capital charges)..	**1·406d.**	**1·211d.**
Interest....................................	0·568d.	0·622d.
Sinking fund	0·396d.	0·412d.
TOTAL COSTS (including interest & sinking fund)......................	**0·964d.**	**2·245d.**

The total working expenses, as analysed above, were £5,671, and the total receipts were £10,103, giving a balance of £4,332. Of this, £2,910 was absorbed in interest, and £1,826 was required for repayment of loan and £105 for instalment of cost of renewal of boiler settings. The amount received by a grant from the rates was £1,230, so that the excess of income over expenditure was finally £821.

An analysis of the capital expenditure up to March 31st is given below:—

Account.	Total March 31, 1906.	£ per kw.	Per cent. of total.
Buildings	£26,881	17·8	33·1
Machinery	34,583	22·9	42·4
Accumulators	1,322	0·9	1·6
Mains and services	16,985	11·2	20·8
Meters, &c............	1,151	0·7	1·4
Instruments	90	0·0	0·1
General expenses	489	0·3	0·6
Total	£81,481	53·8	100·0

The number of consumers is 284 with a connection equivalent to 36,170 8 c.p. lamps. Private motor connections amount to 437 B.H.P. Of the 1,243,839 total units generated, 77,284 were used on the works and 48,052 unaccounted for. The maximum lighting load was 420 kw. and the maximum traction load 434 kw. Plant of a capacity of 1,511 kw. is available in the station.

The following figures are extracted from the tramway department accounts:—

	Year ending March 31, 1905.	Year ending March 31, 1906.
Total passengers carried..............	5,693,680	5,255,373
Total car miles......................	692,310	653,617
Total number of units used	797,370	728,020
Units used per car mile	1·15	1·114
Number of cars in stock..............	36	36
Total mileage of track................	..	10m. 1,438 yds.
Costs per Car-mile.		
Traffic expenses	3·535	3·062
General expenses....................	0·626	0·606
Repairs and maintenance	0·653	0·629
Power (at 1½d. per unit)	1·727	1·671
Total working expenses	6·541	5·968
Special expenditure consequent on street improvements	..	0·130
Total	**6·541**	**6·098**

The total expenses analysed above amounted to £16,608. The total receipts were £21,426, giving a balance of £4,818 Of this, £4,215 was absorbed in interest and £1,313 was required for repayment of loan. A grant was received from the rates of £1,320, so that the excess of income over expenditure was finally £610. An analysis of the capital expenditure up to March 31st is given below:—

Account.	Total up to March 31, 1906.	Per cent. of total.
Permanent way	£59,301	52·1
Overhead equipment	10,268	9·1
Feeders and mains	5,569	4·9
Buildings and fixtures	13,982	12·2
Workshop tool and sundry plant	1,530	1·3
Cars and other rolling stock	21,615	19·0
Miscellaneous	1,539	1·4
Total..............	£113,804	100·0

From the above it will be seen that the capital expenditure on permanent way per route-mile is approximately £5,470, on overhead equipment £948 and on feeders and mains £513. A description of the Ipswich Corporation electricity works is contained in *The Electrician*, Vol. LII., page 196.

MECHANICAL DESIGN OF COMMUTATORS FOR DIRECT-CURRENT GENERATORS.

BY R. LIVINGSTONE.

Considering the importance of the mechanical design of a commutator, it is surprising that so little has been published bearing directly on this subject. Engineers seem to have confined themselves to the problems of the electrical design and the process of manufacture, and to have left the mechanical design severely alone. By mechanical design I do *not* mean descriptions of current practice.

A commutator to be entirely satisfactory should:—

1st. Have an ample wearing depth of copper, and be so designed that when worn down to the limit the stresses in the materials will not be unduly increased.

2nd. Be built together so rigidly that a blow on the surface with a light hammer will not displace any bar.

3rd. Be so designed that the strains due to initial tension, expansion and centrifugal force will be well within the elastic limits of the materials, so that there will be no permanent set and consequent loosening of the bars on cooling down.

4th. Have mica of such a quality and thickness between bars that the copper and the mica will wear uniformly.

As regards the first requirement, it is customary to provide from $\frac{3}{4}$ in. radial wearing depth on small machines to $1\frac{1}{2}$ in. on large machines. Judging from the wear on well-kept commutators, this allowance is certainly ample. If every commutator, however, is designed to last the same length of time, and the amount of wear on a bar due to sparking and friction every time it passes under a brush is a constant, then the wearing depth should be

$$=cNn \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

when N = revolutions per minute,

n = number of brush spindles,

and c = a constant depending on the desired life of the commutator.

For ordinary generators a value of $c=0·005$ to $0·0055$ may be taken when getting out a design for a new machine. Of course such a formula as the preceding, although of interest, is of very little use, as the consulting engineer usually specifies the allowance for wear which must be made. The type of construction shown in Fig. 1 seems to be the type which best fulfils the second portion of the first requirement.

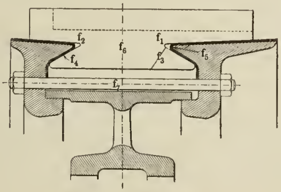


FIG. 1.

As regards the second requirement, the only way to provide for this is to design the commutator so that a tension in the bolts of 12,000 lb. per square inch will give a pressure on the mica, between bars, of 25 D lb. per square inch when D = the diameter of the commutator in inches.

The third requirement is of the utmost importance, and requires the greatest care in design to ensure that it will be fulfilled.

The last requirement is one which experience shows to be fulfilled by using soft mica about 0·03 or $\frac{1}{32}$ in. thick between bars of hard drawn copper.

Stresses in Commutators.—The causes of stress in the different parts of a commutator are centrifugal force, initial tension, and expansion due to heating. In the following investigations I will obtain expressions for the stress at different points, taking the causes in the above order.

Centrifugal Stresses.—In Fig. 1 the points f_1, f_2, &c., are the portions which are under highest stress. In most cases it will be sufficiently accurate to regard the section as solid material 1 in. thick; the taper on the bars being usually extremely small. Again, as the centrifugal force and the modulus of the section both vary directly as the thickness of the bar, taking a section 1 in. thick will practically give the same stresses as taking the actual thickness of the bar.

The centrifugal pull of 1 lb. of any material revolving at N revs. per min. and at a radius of gyration of ρ inches is $=0·00002838\rho N^2$.

Then, as copper weighs 0·32 lb. per cubic inch, the centrifugal pull of 1 cubic in. of copper will be $0·00000908\rho N^2$. Let this $=$ P.

Stress at f_1. (Fig. 2.)

$$\text{B.M.}=\text{P}\left\{\frac{xl^2}{2}+\frac{l^3\tan\theta}{6}\right\}.$$

$$Z=\frac{(x+l\tan\theta)^2}{6}.$$

$$\therefore \quad f_1=\frac{\text{P}l^2(3x+l\tan\theta)}{(x+l\tan\theta)^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Now, as x becomes less due to the wear of the bars, f_1 will gradually increase to a maximum value and then begin to decrease.

The point where the stress is a maximum may be found as follows:—

$$\frac{df_1}{dx}=\frac{3\text{P}l^2(x+l\tan\theta)^2-2\text{P}l^2(x+l\tan\theta)(3x+l\tan\theta)}{(x+l\tan\theta)^4}$$

for a maximum value of f_1, $\frac{df_1}{dx}=0$ and from above equation we find that

$$x=\frac{l\tan\theta}{3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Substituting this value of x in equation (2) we obtain for maximum stress,

$$f_1=\frac{9\text{P}l}{8\tan\theta}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now the deflection of this portion of the bar at the outer end is another point we must consider, as, apart from the strength of the material, the overhanging copper must be *stiff*.

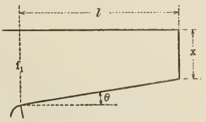


FIG. 2.

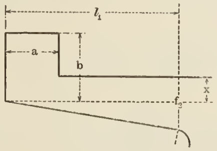


FIG. 3.

For small angles (θ) the following will give the deflection with sufficient accuracy:—

If δ = deflection in inches $=\dfrac{fl^2}{2\text{E}(x+l\tan\theta)}$

then at max. f, $\delta=\dfrac{27\text{P}l^2}{64\text{E}\tan^2\theta}$ . . . . (5)

when E = Young's modulus of elasticity for copper.

Stress at f_2. (Fig. 3.)

$$\text{B.M.}=\text{P}\left\{ab\left(l_1-\frac{a}{2}\right)+\frac{l_1^3\tan\theta}{6}+\frac{x_1(l_1-a)^2}{2}\right\}$$

$$Z=\frac{(l_1\tan\theta+x_1)^2}{6}$$

$$\therefore \quad f_2=\frac{6\text{P}\left\{ab\left(l_1-\frac{a}{2}\right)+\frac{l_1^3\tan\theta}{6}+\frac{x_1(l_1-a)^2}{2}\right\}}{(l_1\tan\theta+x_1)^2}. \qquad (6)$$

This stress also will increase as the commutator wears down and the point where stress is a maximum may be found as follows:—

In equation (6) let $ab\left(l_1-\frac{a}{2}\right)+\frac{l_1^3\tan\theta}{6}=\text{C}$, then

$$\frac{df_2}{dx_1}=\frac{6P\left\{(l_1\tan\theta+x_1)^2\frac{(l_1-a)^2}{2}-\left(C+\frac{(l_1-a)^2}{2}x_1\right)2(l_1\tan\theta+x_1)\right\}}{(l_1\tan\theta+x_1)^2}$$

now for maximum value of f_2, $\frac{df_2}{dx_1}=0$,

$$\therefore \quad x_1=l_1\tan\theta-\frac{4C}{(l_1-a)^2},$$

substituting for C its value

$$x_1=l_1\tan\theta-\frac{4ab\left(l_1-\frac{a}{2}\right)+\frac{2}{3}l_1^3\tan\theta}{(l_1-a)^2}. \quad . \quad . \quad (7)$$

In most cases, however, the stresses will increase right up to $x_1=0$, and in such a case f_2 must be computed with a value for x_1 determined by the limit of wear.

Stress at f_3.—Before going into the stress at this point I will briefly investigate the stress in the form of cantilever shown in Fig. 4. It is a customary mistake to calculate the stress in this form of cantilever in the section X – X. Now, this is *not* the section where the stress has a maximum value; the section where the stress is a maximum is at an angle α depending on the ratio D/L.

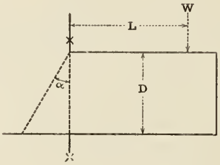


FIG. 4.

In Fig. 4 $\quad \text{B.M.}=W\left(L+\frac{D}{2}\tan\alpha\right),$

$$Z=\frac{D^2}{6\cos^2\alpha}$$

and

$$f=\frac{6W\cos^2\alpha\left(L+\frac{D}{2}\tan\alpha\right)}{D^2},$$

then by a simple differentiation we find that for maximum value of f

$$\frac{D}{L}=\frac{4}{\sec^2\alpha\cot\alpha-2\tan\alpha} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

By plotting the ratios D/L as ordinates and angles α as abscissæ we obtain the curve shown in Fig. 5. This curve will be found very useful in such a case as the "V" portion of a commutator. I would point out that although the maximum stresses at f_1 and f_2 are slightly greater than the values given by equations 4 and 6, the angle α in these cases is so small that the difference is negligable. This is not so, however, when the ratio D/L is so large as it is at f_3. It will also be noticed from equation 8 that the limit of the angle α is 45 deg.

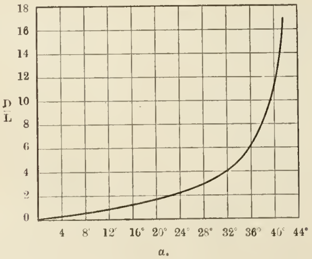


FIG. 5.

The stress at f_3 can now be easily obtained.

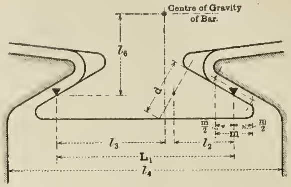


FIG. 6.

Let B = area of whole bar, then from Fig. 6 the load on the front "V" $=PB\frac{l_3}{L_1}$

$$\text{B.M.}=\frac{PBl_3l_2}{L_1},\ Z=\frac{d^2}{6}.$$

$$\therefore \quad f_3=\frac{6PBl_3l_2}{L_1d^2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

The pressure on the mica "V" ring per square inch will be

$$f_4=\frac{PBl_3}{L_1m}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

(To be continued.)

The Prevention of Electrolytic Corrosion of Condenser Tubes.—A somewhat unusual feature has been introduced into the equipment of the Long Island power station of the Pennsylvania Railroad Company to prevent the serious deterioration of condenser tubes which is apt to occur where salt water is used for circulation in surface condensers. This trouble is aggravated by the fact that the water and the body of the condenser form a convenient path for stray electric railway currents getting back to their own power station some distance away through the condenser intake and the water of the harbour on account of the proximity of the water mains which connect the power station equipment to the city piping station to the tramway track. According to the *Street Railway Journal*, the method adopted to prevent corrosion consisted first in diverting as large a proportion as possible of the current by providing a shunt circuit between the incoming water-pipes and the water flume. This was done by the insertion into the water main of a short piece of pipe with an insulating joint at each end, and connecting these by a stout cable carried to the intake. Such current as might leak from the pipes to the water contained in them thus had an opportunity to get back into the harbour without going through the piping system and the condensers. To neutralise the effect of such current as might still leak past the insulating joints, a small booster generator was provided, driven by a 220 volt motor. The positive pole of the booster was connected to the heavy earthed shunt cable mentioned above, and the negative pole was connected to seven different points on each condenser, with an adjustable rheostat in each of these branches of the negative circuit. This superimposed voltage can be adjusted by means of the rheostats exactly to counterbalance the E.M.F.s due to the brass tubes, the iron shell and the salt circulating water, together with the stray E.M.F.s from outside. A small switchboard panel is provided for each condenser, with the seven rheostats mounted on it, each of which is connected by a separate negative lead to a different section of each of the three condensers. A differential voltmeter is provided which can be plugged to each of these sections of the negative circuit, there being a separate rheostat in each circuit. By adjusting the rheostats for each section it is possible to keep the potential at zero in all of them.

ON THE MEASUREMENT OF ILLUMINATION.

Herr F. Uppenborn describes in a recent issue of the *Elektrotechnishe Zeitschrift* a series of tests which were carried out by the Munich electricity works to determine the distribution of light in a schoolroom illuminated by two arc lamps. Before going into the tests the author referred to various instruments for measuring illumination. In Fig. 1, which represents one such instrument the light penetrates through the frosted glass plate *p*, and is reflected by the mirror S on to the photometric screen P, behind which is a standard lamp NL. The photometer is calibrated empirically by illuminating the plate *p* by a lamp of given candle-power at a certain distance.

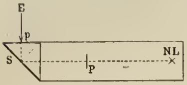


Fig. 1.

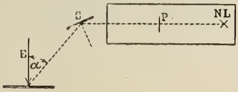


Fig. 2.

Another arrangement is shown in Fig. 2, in which *p* is a plate of cardboard, plaster of Paris, &c., of as white a colour as possible. The light, which comes from the direction E, is here diffused, part part of the diffused light being reflected by the mirror S on to P. The plate must be of sufficient size to prevent all light from the neighbourhood of the plate from falling on S. Although the distance between the plate and S may have any value, it is advisable, for practical reasons, not to adopt a larger distance than about 1 ft. 8 in. It is also well not to make the angle *α* too large, as reflection, effects may otherwise occur.

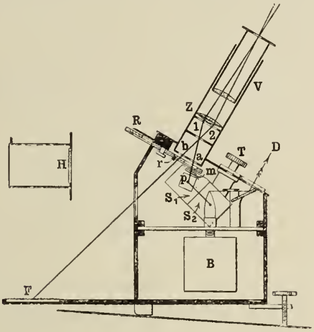


Fig. 3.—Marten's Illumination Photometer.

Figs. 3 and 4 represent the Martens photometer, which is stated to be especially handy for carrying out illumination measurements. F is a plate of plaster of Paris, and is placed where the illumination is to be measured. B is a benzine lamp, whose light is reflected by the mirrors s_1 s_2 and the small reflecting prism *p* on to the frosted-glass plate *m* from which the rays fall through the aperature *a* on to the part marked 1 of the double prism Z. Rays from F are directed by the aperture *b* on to part 2 of the double prism, and the illumination of parts 1 and 2 is rendered equal by regulating the illumination at *m*. This is done by suitably shifting the system of mirrors s_1 s_2. R is a disc of a number of smoked glasses *r* and serves to increase the range of measurement.

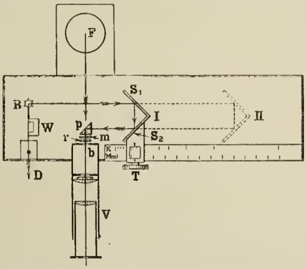


Fig. 4.—Marten's Illumination Photometer.

Fig. 5 is a plan of the schoolroom, whose height is 13·1 ft. During the measurements, the three windows shown were covered with blinds of a light colour. The position of the two arc lamps, which illuminated the room indirectly, are shown by the two large circles, the distance of the arc from the ceiling being 3 ft. 2½ in. in all cases. The figures at the positions indicated by full-black points were obtained by direct measurement, while the figures at the positions marked by small circles were obtained by interpolation. Of the two pairs of lamps experimented with, one pair consisted of differential arc lamps of the Krizik type supplied by the Siemens-Schuckert Company, while the other pair consisted of shunt arc lamps by the Polyphos Company. All lamps were provided with enamalled reflectors of the open pattern. The underlined figures give the illumination in lux* for the Krizik lamps, and the figures not underlined refer to the Polyphos lamps. It will be gathered from the Table below, in which further experimental data are tabulated, that the shunt arc lamps were not as good as the lamps of the differential type. This is due to the fact that the arc in the shunt lamps had to be adjusted to a smaller length. In consequence, a comparatively large portion of the light was screened by the negative carbon. It is also stated that the shunt arc lamps did not burn as steadily as the differentially-controlled lamps.

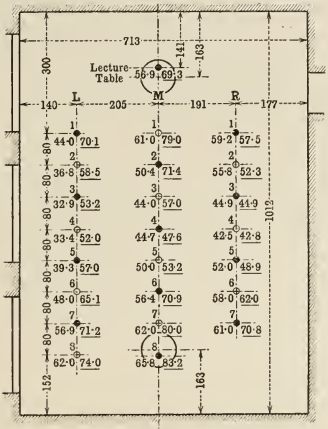


Fig. 5.—Plan of Schoolroom.

——	Polyphos lamps.	Siemens-Schuckert lamps of the Krizik type
Mean illumination in lux..	50 7	62·2
Mean current in amperes..	10·69	10·64
Max. current fluctuations...	+2 62% and −2·44%	+0·85% and −0 96%
Average supply voltage ..	113·4	113·1
Max. voltage fluctuations...	+0·97% and −0 53%	+0·79% and −0·97%
Average voltage at the lamp	39·7	44·1
Maximum fluctuations....	+1·76% and −1 26%	+0 45% and −0·68%
Watts per lux and square metre of floor..........	0·332	0·269

THE DEVELOPMENT OF THE WESTINGHOUSE COMPANY'S SINGLE-PHASE RAILWAY SYSTEM.†

The single-phase railway system is now definitely established as an important factor in the railway field, and it will be a matter of interest at this juncture to retrace from the first beginnings the various stages of the Westinghouse Company's system up to the present development.

Early in the year 1893 the problem was investigated, and designs were prepared by Mr. B. G. Lamme for a single-phase railway motor. This machine was designed for 16⅔ cycles and for an output of 30 H.P. at 200 volts. It was provided with a laminated field core having 12 poles, without slots or compensating winding. The armature was of the commutator type without auxiliary resistance in the leads. This motor was completed and thoroughly tested, its operation being fairly satisfactory.

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* A lux is the illumination produced on a surface at a uniform distance of 1 metre from a source of luminous intensity of 1 unit.

† From the *Electrical World* of New York.

In 1897 specifications were prepared for a 40 H.P. 60 cycle 200 volt single-phase series motor, and two of these machines were completed. They were of the inductively-compensated type, and were used with narrow brushes.

In the year 1900 the single-phase railway problem was again attacked, this time with a view to reaching a final solution. For the purpose of making exhaustive tests on a scale comparable to actual railway conditions, specifications were completed in 1902 for a 100 H.P. motor, which was operated with very gratifying results at a frequency of $16\frac{2}{3}$ cycles per second. The armature of this machine was provided with auxiliary leads placed away from the armature core in the space between the core and the commutator. The auxiliary leads were given a resistance such that the decrease in the loss due to the short-circuit current was much more than the increase in loss caused by the introduction of the resistance in the path of the main-line current, so that the total loss was less with the leads than without them. On account of this action, combined with the spark-preventing features of the leads, the term "preventive" has been applied to the auxiliary leads. The armature winding was later altered so that the preventive leads were placed in the bottom of the main core slots. The field core was constructed with projecting poles, in which holes were cut transversely to the direction of armature rotation in order to aid in reducing the cross magnetisation and in decreasing the armature reactance.

It was on the strength of the tests made with the motor just mentioned that the Westinghouse Company accepted the contract to supply single-phase equipment for the Washington, Baltimore & Annapolis Railway. The specifications for the motor for this system called for an eight-pole 100 H.P. machine, to be operated at 700 revs. per min. by $16\frac{2}{3}$ cycle current at 200 volts. The projecting field poles were slotted and in the slots was placed a so-called "compensating" winding. The preventive leads were arranged in the main slots immediately under the armature winding. Although 12 of these motors were completed and tested in the shop with satisfactory results, they were never placed in commercial service, due solely to the financial failure of the companies interested in the W., B. & A. Railway.

In order to determine experimentally the factors which limit the capacity of the single-phase motor, it was decided in 1902 to construct a 300 H.P. machine for testing purposes. This motor was provided with eight poles, and operated at 600 revs. per min. under an impressed E.M.F. of 400 volts. The projecting field poles were slotted; when $16\frac{2}{3}$ cycle current was used with the machine no winding was placed in the slots, but for 25 cycle current it was found desirable to use a compensating field winding in order to improve the power factor. Two armatures were built for the motor. In one of these the preventive leads connected between the armature winding and the commutators were placed outside of the armature core, while in the other the leads where placed in the same slots with the armature coils.

Owing to the desirability of using the same frequency for the single-phase railways as that in common use for motor purposes, and to the excellent results obtained with the compensated motors at this frequency, it was decided to build the standard single-phase motors for 25 cycles. In 1903, specifications were completed for a 150 H.P. six-pole 250 volt motor to operate at 700 revs. per min, with 25 cycle current. The preventive leads used with this machine were placed in the main armature slots. The field was provided with a compensating winding connected permanently in series with the armature. This motor, which was the forerunner of the present standard single-phase machines, was sent to Sweden, where it is now in use. The standard motors have been built according to specifications prepared as follows: 100 H.P. four-pole 225 volt, 1903; 75 H.P. four-pole 250 volt, 1904; 50 H.P. four-pole 250 volt, 1904. In these motors was introduced the present construction in which the compensating winding is placed first in slots in the projecting field poles, in order that the field coils, which are afterwards placed around the projecting poles, can be removed at any time without disturbing the compensating coils.

In regard to the methods used for controlling the motors, it is interesting to note that with the first 100 H.P. motor built for testing purposes there was employed a simple drum controller which varied the voltage obtained from the taps on a transformer winding. On the Washington, Baltimore & Annapolis Railway it was the intention to use an induction regulator for varying the voltage. On the present standard equipments the induction regulator has been abandoned, and the step-by-step method of control is used. Several factors have contributed to this change. An induction regulator possesses fewer advantages at 25 cycles than it does at $16\frac{2}{3}$ cycles; the step-by-step control is much preferable for equipments which must at times use direct current, and it lends itself most readily to electro pneumatic unit-switch operation. Moreover, some form of multiple-unit control is necessary with many types of equipment, and the electro-pneumatic unit-switch system affords at once, and without change, convenient means of control from any desired point to which low-voltage wires may be led.

The cause for the change from $16\frac{2}{3}$ cycles to 25 cycles was given above. It may be noted in this connection that it is more difficult to design a motor for 25 than for $16\frac{2}{3}$ cycles, and that any satisfactory 25 cycle motor can be operated with $16\frac{2}{3}$ cycle current. The designers hold that for services where the choice of frequency is not limited by reason of existing installations—that is, for the locomotives under steam railway conditions—it is preferable to use the lower frequency so as to simplify the design problem and to improve the performance of the equipment. During the period required for the introduction of the single-phase system, it is more or less necessary to consider the interconnecting of the new system with the old, and a frequency of 25 cycles is practically demanded for certain installations. There are, however, reasons for believing that the time will arrive when single-phase railways will be electrically separated from other power equipments, in which event a lower frequency can be selected.

AMERICAN CABLE PRACTICE.

Two interesting Papers casting considerable light on American cable practice were presented at a meeting of the American Institute of Electrical Engineers on April 27th.

Mr. Wallace S. Clark in "Comments on Present Underground Cable Practice" condemned the earthing of the cable sheath at each manhole in the case of low-tension cables, but we believe that the majority of the mains engineers in this country will not share his opinion. He says:—

> The amount of current carried by the sheath is greatly increased, producing a drop in electromotive force between ground strips sufficient to cause a flow of current to earth at some intermediate point in the duct and in sufficient volume to give trouble. In case of a burn-out, the continuity of the sheath aggravates the trouble. Whether the initial fault is in the duct or in a manhole, the tendency of the arc is to travel along the cable and without a sufficient volume of current to operate safety devices, if such are in the circuit. If at any point another continuous metallic sheath comes within reach of the travelling arc, the fine earth it offers insures two cables out of service. Almost every large installation can furnish from its history a serious and expensive experience, illustrating this point. Further, during the burn-out a heavy current flows in the sheath and this may leave the sheath by arcing to earth on some perfectly good section of cable, melting a hole in the lead.
>
> The volume of current carried by these low-tension conductors in regular practice is so large that in many cases circuit-breakers or fuses will not operate with the current due to the short circuit. The ammeters are a poor guide, especially in railway work. In many cases the outside end of the line is solidly connected to a network which is capable of furnishing all the energy needed to maintain the arc after the defective cable is disconnected at the station end; so we cannot depend on protective apparatus as used to-day for prevention of these troubles.
>
> Omitting the sheath will cure all the above ills. To do this would bar paper, leaded jacketed cables absolutely, and would increase the depreciation account if some type of cable insulation needing lead only, as wood needs paint, were used. Abandoning the lead entirely is an economic possibility with only very large conductors, where it may be cheaper to renew the insulation on a non-leaded cable, say once in ten years, than to renew a lead jacket cable once in twenty years. These figures are, of course, merely used for comparison, for there is little accurate knowledge as to the life of insulated cables. If, therefore, we are compelled to use a lead sheath, the writer believes that it should be interrupted by some form of insulating joint on low-tension cables.
>
> If this plan is carried out, a serious difficulty is the inability to test the insulation of the cable. This may be met by the use of an insulated wire —proof or pressure wire—in the outer layer of strands forming the copper core.* Such a wire should be insulated with some material like treated paper susceptible to the absorption of moisture. For the purposes of initial tests when cable is installed, the joints in the sheath may be bridged by fine fuse wires, which are afterwards removed. Several methods of utilising the pressure wire are suggested below:
>
> (*a*) The outer end of the pressure wire is insulated, in which case periodic tests of this wire for insulation resistance will show any incipient fault in the main conductor. Between tests the wire can be connected to a drop annunciator or other signalling device which will become operative in case of a burn-out, since the pressure wire will become "alive" before any great amount of energy flows through the fault. It might also be made to operate a current-interrupting device.
>
> (*b*) The wire may be used to read the pressure at the far end of the line. The potential on the wire being opposite to that on the conductor in which it is embedded. A burn-out would reverse this potential and either make the wire "dead" or of the same potential and sign as the main conductor.
>
> This change in potential could operate devices as above outlined under heading (a). If used in this way, the pressure wire would have to be disconnected at the far end for insulation tests; a much easier operation, however, than the disconnecting and insulating of the main conductor, and one not interfering with working the line.

Since, in the case of high-tension mains, protective devices are set so as to act more promptly, and as such cables can be protected against a reversal of current, so that the arc at the fault is not maintained by energy derived from the network or sub-station, he recommends that the metal sheath on high-tension cables should be earthed, realising also that this is necessary to prevent danger to life, "and also risk of puncturing the insulation by cumulative static charge." In America, it appears that rubber-insulated cables are still employed to a considerable extent for underground work. The author gives the following table of puncturing voltage, insulation resistance, and electrostatic capacity tests to show that these factors are not very good guides as to the durability of the insulation.

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* This plan has been adopted by Agthe and Kallmann in Germany, and a modification has also been suggested by Charpentier in France.—E. J. F.

Relative amount of rubber.	Breakdown E.M.F.	Insulation resistance, megohms per mile.	Capacity, micro-farads per mile.	Relative deterioration in one year in elastic limit.
1	17,000 volts	534	2·0	66 per cent.
2	19,000 ,,	1,185	1·2	30 ,,
3	18,000 ,,	1,150	1·0	20 ,,

The above figures are based on 12 tests of each class; they are quoted, not to show absolute values, but to make clear the point that the cheaper grades of insulation do not retain their elasticity. It should be noted that rubber compounds change quite rapidly at first, and that the rate of deterioration becomes less with time.

The author continues:—

An idea of the life of a rubber cable leaded and operating at 11,000 volts, 25 cycles, is presented below through the kindness of Mr. H. Alverson, superintendent of the Cataract Power & Conduit Co., Buffalo.

——	Cable No. 2.	Cable No. 3.
In service November 23, 1897	21,493 ft.	21,493 ft.
Added January 22, 1899	10,559 ft.	10,559 ft.
Total in service from January 22, 1899	32,052 ft.	32,052 ft.

BURN-OUTS.

December 28, 1897, Cable No. 2, 20 ft. from end of pole line; cause no end-bells.

May 11, 1898, Cable No. 3, same as No. 2.

May 2, 1899, Cable No. 3, 8,931 ft. from end; cause, not ascertained.

October 12, 1899, Cable No. 3, 14,845 ft., end in joint.

1900, none.

1901, none.

May 17, 1902, cable No. 2, 14,224 ft. from end in cable vault; mechanical injury.

1903, none.

September 19, 1904, cable No. 2, 14,204 ft. from end; labourer drove gas pipe into conduit and cable.

1905, none.

March 27, 1906, none to date.

In May, 1900, cable No. 2 was tested with 22,000 volts for 24 hours.

Size of cable, 3/0; conductors, three; insulation on each conductor, $\frac{9}{32}$ in. thick; no over-all jacket.

The most noticeable fact brought out is that, although most of the cable is more than eight years old, there is no indication of any electro-chemical or other electrical action weakening the ability of the insulation to withstand the working pressure.

Further, these cables originally operating alone are now in multiple with some 32 miles of three-conductor cables, and therefore subjected in all probability to more severe strains due to surges than when first installed. These are, I believe, the oldest working rubber-insulated, 11,000 volt, three-phase cables in use to day.

These data on rubber insulation are important, if, as the writer believes, cables for very high tension will be made with combined insulations of varying capacities, rather than with a homogeneous insulation of any insulating material now in use.

The Paper concludes with a specification adopted by the American Rubber-covered Wire Engineers' Association.

The other Paper is by John Langan on "Standardising Rubber-covered Wires and Cables," He points to the inapplicability of the rule in the "National Code" or Board of Fire Underwriters' Rules in which it is laid down that samples of rubber-covered wire must stand for five minutes 3,000 volts for every $\frac{1}{64}$ in. thickness of insulation—that is to say, that, for instance, a No. 14 wire which calls for a thickness of "wall" of $\frac{3}{64}$ in. should stand a test of 9,000 volts. He also suggests that many cheap insulating compounds may be saturated with mineral or vegetable oils just for the purpose of standing high potential tests, and that this does not, of course, effect a durable improvement in the insulating quality of the material. He likens such a cable to a "doped" horse. This author also concludes his Paper with specifications, which he recommends, for cables for working pressures of 600, 3,500, 5,000 and 11,000 volts respectively.

Those of our readers who desire to consult the full Papers, will find them in the April number of the *Proceedings* of the American Institute of Electrical Engineers.

ON A METHOD OF OBTAINING CONTINUOUS CURRENTS FROM A MAGNETIC DETECTOR OF THE SELF-RESTORING TYPE.[*]

BY L. H. WALTER, M.A.

Magnetic detectors of electric waves can, for the purpose of considering their action, roughly be divided into two classes according as the magnetic mass or core to be acted upon by the electric oscillations set up in the receiving conductor upon the arrival of waves is situated outside the influence of the magnetising field at the time when such oscillations are acting, or is all the time in the magnetic field. In the first case, the energy available as a result of the action of the oscillations is limited to that represented by the remanent magnetism in the core, while in the second case it can be derived in part, though not wholly, from the external field.

Detectors belonging to the first class have been designed which are capable of giving unidirectional currents—practically continuously, as in the case of Fleming's quantitative detector,[†] or intermittently, as unidirectional impulses, in Marconi's more recent relay-operating detector. Although no details have been published relating to the latter, a cursory inspection of the instrument exhibited at the Royal Institution in 1905 showed it to belong to this class.

Detectors of the second class, in which the magnetic mass is generally either taken through a slowly performed complete cycle of magnetism or else subjected to continuous reversals in a field of constant strength—exemplified respectively in Marconi's cyclic flux and moving band forms of detectors—present other advantages, the chief among which are automatic action and the derivation of part of the energy from the external field. No method of obtaining a continuous current from such detectors has, however, hitherto been devised, such as could be used for rapid recording work, although Tissot has described an arrangement of Marconi's cyclic flux detector by which indications were received on a ballistic galvanometer.[‡] For this reason the use of these self-restoring detectors has up to the present been limited to telephonic reception, the alternating impulses produced as a result of the action of oscillations, prohibiting the employment of a relay or recording instrument. This drawback was pointed out by Marconi in his 1905 Royal Institution lecture.

In view of the above it was considered that a description of a method by which the author has succeeded in obtaining continuous unidirectional currents from a detector of this type might prove of some interest.

The method was arrived at as a result of experiments in connection with an instrument previously described,[§] to determine the cause of the increase of hysteresis loss as a result of the action of oscillations. It was found that the increase is due to a great extent, if not entirely, to the increase of induction produced, to which increased induction a largely augmented hysteresis loss corresponds at the field strength employed. Working on this basis, it was thought that such an increase of induction might serve as a means of furnishing continuous unidirectional currents, by generating a unidirectional (commuted) E.M.F., *i.e.*, by making conductors cut the lines of force in a magnetic field, and causing the oscillations to act upon a magnetic mass undergoing reversals of magnetism in the magnetic field of the generator, whereby the E.M.F. generated should be augmented; a second equal E.M.F. being opposed to the first so that normally there is no external P.D. In such a case a continuous unidirectional current should be obtainable during the time that the oscillations are acting upon the magnetic mass.

An experimental apparatus was accordingly made, a diagrammatic plan of which is given in Fig. 1. Two ebonite bobbins, BB_1, mounted on the same spindle are rotated in the field of two horseshoe permanent magnets NS, N_1S_1, these bobbins being wound, in a similar manner to those illustrated in connection with the pivoted bobbin detector previously referred to, with some feet of steel wire of suitable resistance. A winding of two coils, W, W′, at right angles to one another, of a hundred turns, is placed on each bobbin, at right angles to the plane of the steel wire winding, as in a drum armature, corresponding coils—*i.e.*, W and W_1, W′ and W'_1—being connected in such a way that the E.M.F.s generated are equal and opposite. The ends of the windings are connected to the segments of a four-part commutator, C. (For the sake of clearness only one pair of corresponding windings, of one turn each, is shown connected in Fig. 1.) The steel wire windings of the two bobbins are exactly alike, the ends of one winding being insulated, while those of the other are connected to a pair of slip-rings, *rr*, and brushes, by means of which the oscillations can be passed through the winding.

On testing this apparatus in the normal condition, with the armature driven by a small electric motor, and no oscillations acting, there was no P.D. at the brushes, the zero of a sensitive Ayrton-Mather galvanometer connected to the terminals TT remaining undisturbed. On waves arriving a steady deflection on the galvanometer was obtained, in a direction corresponding to an increase of E.M.F. generated by the armature (bobbin) acted upon by the oscillations. On the oscillations ceasing the galvanometer deflection returned to zero. The effect naturally was very small in the first experiments, but it has been found that by suitably designing the magnetic winding and proportioning the turns in the armature winding a quite considerable sensibility is obtained, and this is continually being improved upon. The usual speed employed is about five to eight revolutions per second; higher speeds have been tried and give a larger effect, but the zero is not so steady.

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[*] Paper read before the Royal Society April 5th, communicated by Prof. J. A. Ewing, F.R.S.

[†] Roy. Soc. *Proc.*, Vol. LXXI., p. 398, 1903.

[‡] *Comptes Rendus*, Vol. CXXXVI., p. 361, 1903.

[§] Walter and Ewing, Roy. Soc *Proc.*, Vol. LXXIII., p. 120, 1904.

The model illustrated is not adapted to give the best results, this form having been chosen solely for convenience in construction. A considerable length of the winding on the armature is "dead" wire, and hence in a new model being constructed the armatures resemble small Gramme ring structures, in which the wire is more effectively utilised.

The results obtained with the first form of the apparatus led to the idea that the magnetic mass might be located elsewhere in the magnetic circuit of M, such as at B in Fig. 2, undergoing slow continuous reversals at the most favourable speed, and an ordinary ring armature, A, be used, which latter could then be run at a much higher speed so that a proportionately greater external P.D. as a result of oscillations acting could be anticipated, two identical generators opposed to one another, of course, being employed, as in the previous method. The few experiments made in this direction have, however, not given good results up to the present, but this is considered to be due rather to the experimental apparatus employed than to the inapplicability of the method.

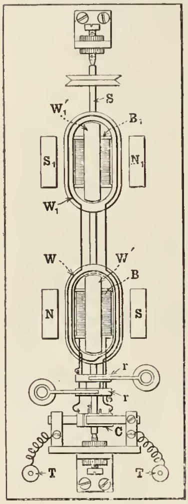

FIG. 1.

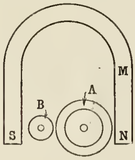

FIG. 2.

Since in many cases it may be desirable to receive signals or indications simultaneously by means of a telephone as well as recording them, a telephonic receiver may be connected so as to take off the current produced as a result of such signals at some point before it is commuted into unidirectional current, as the alternating current is better adapted for actuating the telephone. When a relay alone has to be actuated, however, it may be advantageous to so arrange matters that the generated E.M.F.s do not exactly balance, and a small initial current, insufficient to actuate the relay, passes all the time through it. By this means the impulse resulting from the action of oscillations has only to supply little more than the current required to effect the actual movement of the relay tongue or coil, the steady current always passing being sufficient to almost start it from its position of rest. The change can be rapidly effected by a very slight shift of the brushes.

While the author's method of passing the oscillations directly through the magnetic winding leads to a very simple mechanical construction, there is nothing to prevent the older, more general, method being made use of in which they are passed through a separate copper wire winding on the outside of the magnetic core (co-directional oscillations). Since this Paper was written the author has seen a proof of a Paper giving the results of recent experiments by J. Russell,* on the effect of co-directional and of transverse electric oscillations on the magnetism of sheet iron. These results tend to show, if applied without discrimination, that the iron at the low field employed is more sensitive to the co-directional oscillations; but the experimental conditions as regards the transverse oscillations, which latter are produced in a solid mass of metal, and hence are nearly entirely dissipated in the form of eddy currents, are so entirely different from the circular magnetisation obtained by the author's method, in which the value of the magnetisation at the surface of the magnetic wire carrying the oscillations varies inversely as the radius of the wire, that a comparison cannot be made. A combination of the two methods appears to offer additional advantages, but has not yet been tried.

THE ELECTRICAL EQUIPMENT OF THE NEW YORK HIPPODROME.

A good example of a large modern theatrical installation is to be found in the electrical equipment of the New York Hippodrome. The main stage is 200 ft. wide and 60 ft. deep and an extension of the "apron" is large enough to accommodate two circus rings 42 ft. in diameter. Below this is a tank 14 ft. deep into which the movable "apron" may be submerged to any desired depth. The greater portion of the main stage consists of a movable platform held up by hydraulic cylinders supplied by a three-throw pump below the stage driven by a 40 H.P. 220 volt motor and working in conjunction with two accumulators, the movement of which controls the starter. The tank is filled by three motor-driven centrifugal pumps with a combined capacity of 8,000 gallons per minute. One of these is driven by a 40 H.P. motor and two by 16 H.P. motors. Other motors for various purposes about the building aggregate over 450 H.P., including four ventilating fans each driven by a 25 H.P. motor.

The lighting system presents some points of novelty. Over 20,000 incandescent lamps are installed, excluding special and miniature lamps for stage use and the exterior illuminated signs. Eighteen transformers are provided for supplying miniature decorative lamps at a low voltage, and there are a very large number of plug sockets for temporary lighting, both on the stage and elsewhere. The ordinary incandescent lamps are arranged on 934 circuits, controlled for the most part from the stage and dimmer switchboard and partly from the general house board in the office. The motors are supplied through eight circuits, and there are 14 plug-socket circuits exclusive of the system for the stage. All the wiring is in conduits with outlet and panel boxes. There are three incoming supply boards, one of which is for alternating current. These boards merely contain the meters and main cut-out switches and fuses. Heavy feeders are carried to the general house switchboard, and individual feeders are also carried directly to the lamps in the basement, which, being required continuously, are thus kept independent of the house board. The stage and dimmer board is supplied through six large feeders, and a smaller feeder supplies the motors in the basement for auxiliary service and the lighting circuits in the dressing-rooms. The supply boards are interconnected by a heavy tie line in case of failure of either one. All the lamps visible in the auditorium, with, of course, the exception of the ruby exit lamps, are controlled from the stage and dimmer switchboard, and from here are also controlled all the ceiling and side lights, the footlights, border lights and miniature lights on the stage. The borders are of large proportions, over 3,700 lamps being used in the borders alone. These are arranged on 296 circuits, delivery to the drops being made through multi conductor cables of 75 No. 12 wires for the first seven borders, and of 100 No. 12 wires for the rear four borders. Electrical methods are used for handling the heavy scenery and working the drops. An elaborate crane system has been installed, running on four concentric semi-circular tracks. Each trolley carries a 2 H.P. traversing motor and a 3 H.P. hoisting motor. All these motors are controlled from the floor of the stage by means of pull ropes. There is, in addition, in each wing a set of hoists for lifting set pieces of scenery, drop curtains, &c. Each hoist carries eight winding drums and is driven by a 3 H.P. motor. The motor is connected to a shaft extending the whole length of the hoist frame, and the shaft of each hoist drum has a worm wheel driven on a vertical shaft. The upper end of the shaft carries a paper cone, and the motor-driven shaft carries two wooden cones for each winding drum, one on either side of the cone on the worm shaft, so that the drums may be driven in either direction. The lever actuating this friction device is released at the required moment by a knot on the hoisting rope. There are in all some 60 of these drums, each of which can exert a pull of about 800 lb.

The stage switchboard is very complete, and is situated in a gallery 25 ft. above the stage floor. The operator's board is made up of two panels containing 112 push-button switches which control as many solenoid switches on a board in the rear of the operator's board. These latter switches control the stage lighting circuits. To the left of the operator's board is a panel controlling the current for energising the solenoids. At the top of the panel is a main switch and three triple-pole single-throw switches below which are arranged 24 switches for separate banks of solenoids which control different coloured lamps. To the right of the operator's board is the alternating-current switchboard, which is connected with its own supply board in the basement. The board in the operator's gallery controls the circuits for the miniature stage lamps, and this service can be used as a reserve for emergency in case of failure of the direct-current supply.

The push-button switches are arranged in duplicate rows, there being two rows for controlling the white lamps, two for red lamps, two for blue and two for green. This arrangement enables the operator to set the lamps for one scene while another scene is being enacted, the switches for the following scene being disconnected from the solenoids. To throw in the new set of lamps one switch on the board to the left is opened and another closed. This, however, is too slow a method for changing the stage lamps, inasmuch as it necessitates the opening and closing of switches for each colour of light. The smaller panel is, therefore, equipped with throw-over switches, by means of which the change may be made almost instantaneously, all colours being thrown in simultaneously.

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* Roy. Soc. Edinburgh *Proc.*, Vol. XXVI, No. 1, 1905-6.

The larger operating panel is divided into two parts by a row of dimmer handles, there being a row of dimmer handles across the top, and another row across the bottom of the panel also. The dimmers can either be worked by hand or arranged for motor operation. On a framework behind the board are mounted four variable-speed motors, each driving a screw carrying a nut. The nut is connected by a link to a lever on the shaft of the dimmer handles causing it to rotate as the nut moves backward or forward. Beneath the screw are snap switches, which are thrown by the nut when the latter reaches the end of its traval in either direction, so that the dimmers are not injured through the negligence of the operator.

All the lamps controlled from the stage are connected through dimmers, and each bank of dimmers is connected to a set of different coloured lamps. Each dimmer shaft carries a pulley which is connected by belt to 76 200-light theatre dimmers in a gallery above the switchboard. Interlocking handles control these pulleys permitting any circuit to be thrown out as desired. The motors operating the dimmers are controlled by starting boxes, located at the bottom of the smaller panel, the switches being set on a separate panel over the board. On the solenoid board is also installed a master solenoid switch which may be operated from a number of emergency switches placed in various parts of the house This switch controls the lamps which stud the proscenium arch and which are sufficient to light the whole theatre adequately in case of accident. The lamps are connected to both the direct-current and alternating-current main, a relay on the back of the alternating-current board in the basement connecting the circuit automatically to either service in case of the failure of one.

The auditorium is lighted by over 3,000 incandescent lamps. For the lighting of the stage both arc and incandescent lamps are used in large numbers. In the border lights over the stage are 3,700 32 c.p. lamps, one half of which are white, the others being red, blue and green. In the footlights are 600 32 c.p. incandescent lamps, 300 white and 100 each of blue, red and green lamps. At the side of the proscenium are 148 32 c.p. lamps, and in mirror troughs are 50 50 c.p. lamps. The mass lights which form a rim around the arch consist of 178 50 c.p. mirror trough lamps. There are 125 portable trough strip lights, each containing 12 16 c.p. lamps used in all scenes in addition to 12 borders made up of 12 32 c.p. lamps each of which throw light upward in order to kill shadows made by the border lights and projector. Over 150 stage pockets are connected, some through resistance for arc lamps and others through dimmers for incandescent lamps. In the centre of the gallery are two 10 ft. colour boxes provided with eight colour screens and 25 arc lamps, 20 of which require 30 amperes each and the others used for "spot" light work consume 50 amperes each. There are two bridges on either side of the balcony, each bridge containing 12 arc lamps. Ten of these are used behind colour boxes and consume 30 amperes each, and the two used for strictly "spot" light work require 50 amperes each. In the dome of the ceiling are two 75 ampere searchlights for lighting the fountains from overhead. On either side of the apron are eight 6 in. colour boxes, each lamp consuming 30 amperes; there are in addition four mirror-back reflector lamps for the ballets which consume 50 amperes each. Back of the proscenium arch curtain line are two double bridges on either side of the stage. Each lower bridge has six 6 in. projectors consuming 50 amperes each, and on the upper bridges are eight mirror-back reflector lamps consuming 50 amperes each. Over the centre and back of the proscenium arch is a 30 ft. swinging bridge on which are 14 50 ampere arcs, and over the switchboard are six 50 ampere arc lamps. Miscellaneous applications of electricity include curling iron and cosmetic heaters in all the dressing rooms, there being 400 combined sets in use. The irons used for pressing the thousands of costumes used in the ballets are also electrically heated. In addition there are 28 ceiling fans and 18 stand fans in use during the warmer months. It is worthy of note as showing the enormous current consumption by arc lamps alone that the number of 9½ in. cored carbons used weekly in the arc lamps is about 2,500.

The St. Louis International Electrical Congress.—The *Electrical World* announces that a cheque for $2,052, the balance remaining after paying expenses of the St. Louis Electrical Congress, has been handed to the American Institute of Electrical Engineers. It is intended that the fund shall be known as the "International Electrical Congress of St. Louis, 1904, Library Fund," and that the annual income shall be expended in the purchase of foreign or non-American electrical literature for the institute library.

ADELAIDE TRAMWAYS.

Our Adelaide Correspondent writes as follows :—

Negotiations have taken place between the Premier, Mr. T. Price, and a committee of the directors of the various tramway companies of Adelaide, with a view to the purchase by the Government of the whole of the lines en bloc by mutual agreement, instead of by compulsory arbitration piecemeal as the statutory septennial period of each section came around; and on April 3rd it was announced that an agreement had been come to at the figure of £280,000 for the whole of the lines, which comprise about 70 miles of track. The agreement naturally has no effect until properly ratified, but the Premier has pledged himself to obtain the necessary parliamentary sanction next session, while the directors of all the companies will recommend to their shareholders the acceptance of this sum. The tramways of Adelaide comprise seven separately worked systems, five owned by public companies, and the other two private owned, being, however, quite distinct lines with no means of intercommunication at present. Nothing is required, however, but a few junctions to allow of the whole being worked as one compact system. The following is a list of the lines, with their paid-up capital and market price at the current share quotations of the end of March :—

Company.	Paid-up capital.	Current value.
Adelaide & Suburban Tramway Co. ..	£130,000	£117,000
Unley & Mitcham ,, ..	31,250	35,375
Parkside ,, ..	23,750	22,250
Hyde Park ,, ..	13,500	15,000
Hindmarsh & Henley Beach ,, ..	29,866	7,218
Goodwood ,, .. Payneham & Paradise ,, ..	30,000 (say)	30,000 (say)
Total....................	£258,366	£226,843

Whilst the agreed selling price shows that the companies will get a good price for their lines, on the other hand it is said that over £300,000 has been spent on construction, &c., while last year's dividends (assuming 4 per cent. profit on the private lines) averaged about 6 per cent. Under the abortive Snow scheme of 1902 the price agreed upon with several of the companies was at a rate of about 30 per cent. above the present agreement, and when the Jenkins Government talked of purchasing, the prices asked by the companies totalled £416,000, so that, on this basis, the Government have no reason to complain. The directors consider that they might reasonably have expected an award of £300,000 to £315,000 under arbitration, but that the legal expenses involved and the losses due to one part of a system being taken before the remainder, warranted their accepting the lower figure when they found that the Premier was resolute in refusing to advance to £300,000. It will be remembered that a Melbourne syndicate recently proposed to take over the lines for conversion at £250,000, so that the Government would have no difficulty in getting an offer at £280,000, if prepared to forego a few of the more rigid clauses hitherto deemed essential. A municipal scheme seems the only feasible one at present, since Parliament is very peculiarly constituted just now. Certain political difficulties exist, however, but no doubt in the near future the various municipal councils who are affected by the tramways will consider their course of action, when the prospects of the successful formation of a municipal trust will become more evident. It certainly appears that a company prepared to take over the entire construction and equipment of the lines for electric traction under municipal supervision, and to operate them for the first few years, paying a rent sufficient to cover interest and sinking fund (as has been arranged with several English towns), might receive liberal treatment from the municipalities, as, undoubtedly, a large section of the ratepayers will be adverse to taking too great risks, and there is at present no large system of municipally-worked trams in Australia, the nearest approach thereto—the state-owned electric lines of Sydney—being by no means too successful.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Principles of Electric Wave Telegraphy." By Dr. J. A. Fleming, F.R.S. (London: Longmans, Green & Co.) 24s. net.

"The Practical Testing of Dynamos and Motors" By Charles F. Smith. Second Edition. (Manchester: The Scientific Publishing Co.) 5s. net.

"Journal of the Institution of Electrical Engineers." April, 1906, No. 177, Vol. XXXVI. Edited by G. C. Lloyd. (London: E. & F. N. Spon) 5s.

"Notes on Electrochemistry." By F. G. Wiechmann. (New York: McGraw Publishing Co.) $2 net.

"Electric Transmission of Water Power." By Alton D. Adams. (New York: McGraw Publishing Co) $3 net.

"High-tension Power Transmission: A Series of Papers and Discussions presented at the International Electrical Congress in St. Louis, 1904." Second volume. (New York: McGraw Publishing Co.) $2.50c. net.

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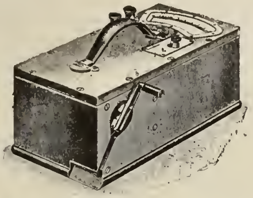

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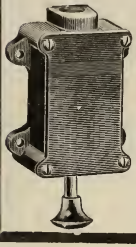

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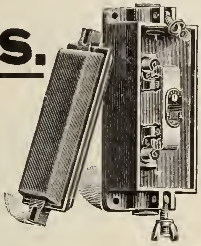

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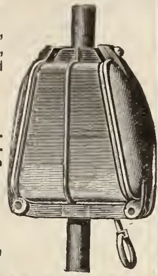

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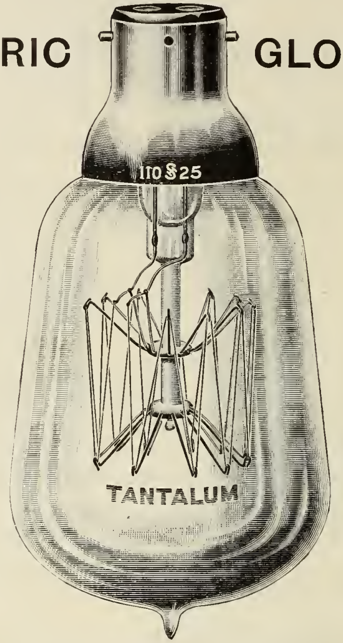

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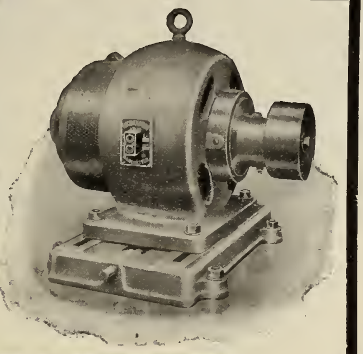

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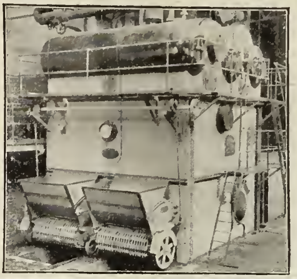

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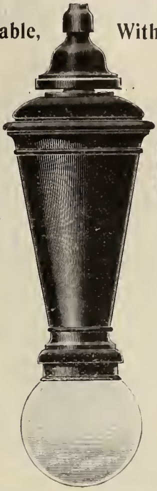

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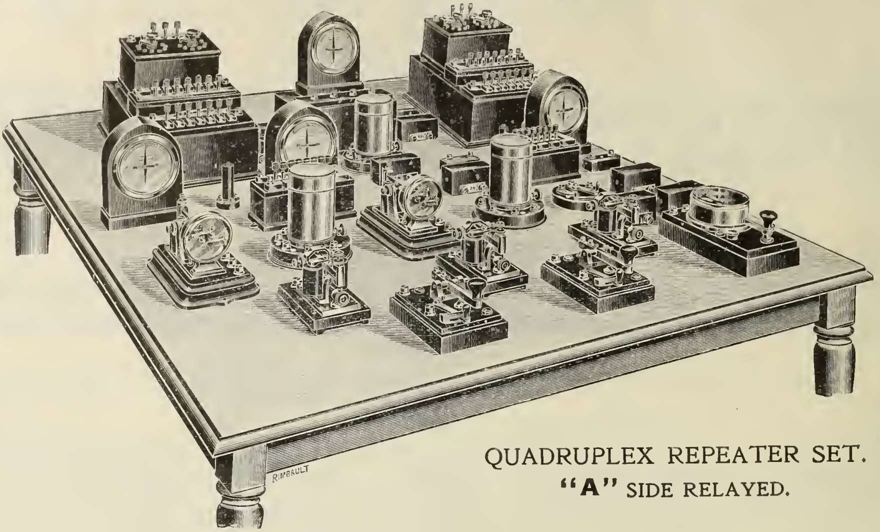

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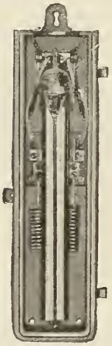

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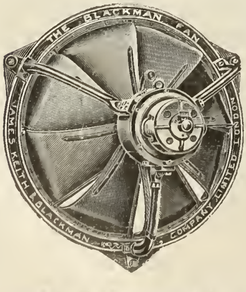
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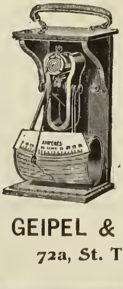

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72a, St. Thomas Street,
LONDON, S.E.

Let us then look more in detail into the manner in which the newer form of driving is applied. In all works except those of the smallest proportions, the change over from steam or gas engines to electric motors is not effected by simply taking out the old engine and replacing it by an electric motor of equal power. One great advantage of electrical driving, apart from the cheapness attendant on the possibilities of centralised production, is the ease with which the power may be sub-divided and applied when and where it is required about the works, without the intervention of long lines of shafting and multiplicity of belts and other forms of gearing, so that the average overall efficiency of transmission throughout the works is improved. The earlier examples of electrical works driving showed little originality and consisted simply in putting down a few constant speed motors in various parts of the works and belting them to sub-divisions of the existing shafting. It is only comparatively lately that full advantage has been taken of the extreme flexibility obtainable, and of the great variety of conditions of torque and speed under which electric motors of various descriptions can be designed to work. The possibilities of driving separate machines by separate variable-speed motors under the best conditions are now being more fully grasped, and striking changes in machine shop practice are taking place. It is now possible to effect by electrical methods adjustments of speed which were practically impossible by purely mechanical means, and it is becoming increasingly common to design special motors and switch gear, which practically form part of the machine tools with which they are associated. Again, the capacity of electric motors producing large torques for starting and other purposes during short periods renders them particularly suitable for some classes of work which would otherwise present a difficulty. A factor which has conduced to some extent recently towards the perfection of variable speed continuous current motors is the introduction of auxiliary commutating poles, which render possible by field regulation alone a much greater range of speed variation, with ordinary supply voltages, than was the case formerly, owing to the diminution of sparking with weak fields. Another point to which increasing attention has been paid of late is the careful proportioning of the series and shunt windings of compound-wound motors in order to obtain a torque-speed characteristic as suitable as possible to the work to be done.

A great deal of the increased facilities for variable speed working is due to improvements in the design of the switch gear. Controllers can now be obtained working either direct or, in the more complicated cases, through the medium of relay circuits and solenoid switches or contactors, by means of which practically any series of operations of one or more motors can be controlled by a single handle. A comparatively simple example is the plain series-parallel controller, which can be employed either to put different motors into series or parallel, or for use for obtaining different speeds with double commutator motors. Good examples of the more complicated forms are found in some of the controllers specially designed for those large printing presses in which very low starting speeds are desirable. A feature in some of these designs brings out another advantage incidental to electric driving, that is the ease and certainty with which the motors may be stopped or started from any part of the machine by means of push-buttons, and, indeed, in some cases the entire control is effected by these buttons. In the case of large tools there is a growing tendency to provide several motors driving different motions of the machine to the great simplification of the mechanical gear. Other methods of speed-control for special purposes involve the application of variable voltage obtained from an auxiliary motor generator, such as the Ward-Leonard and similar systems, but these hardly come within the range of ordinary works driving equipment.

The case of alternating-current motors presents some different problems, but here also recent advances have made much greater flexibility available. The oldest form, the synchronous motor, is useless for most purposes on a supply system with fixed frequency, although there are special circumstances in which its use may present advantages, as, for example, where a large single motor at a distance is fed from a single generator, and it is possible to start it up without the intervention of any switch gear by running the generating set slowly up to speed. The alternating-current motor most frequently used at present is, of course, the polyphase induction motor, behaving, as to its torque-speed characteristic, very much as a continuous-current shunt motor, but without its capabilities for speed variation and field regulation. Speed adjustment can, it is true, be obtained, but by less economical methods than in the case of continuous-currrent machines. Here, again, much greater attention is being paid than formerly to the production of motors with torque speed relations specially arranged for the work they have to perform by giving suitable values to the motor resistances. The expedient of changing the grouping of the stator windings to alter the effective number of poles has been occasionally adopted for cases where two or three fixed speeds are desired, and for a limited number of purposes the cascade system may be employed. A great future, however, awaits the alternating-current commutator motor. This is being developed in its single-phase forms for torque-speed characteristics similar to either shunt-wound or series-wound continuous-current machines, but most of these forms are only suitable for comparatively low frequencies.

It is not, however, only by their adaptability and convenience for driving machine tools of more or less usual types that electric driving has affected machine-shop practice, but there are other ways in which its influence has been felt. The "portable tool bed," now found in many of the larger engineering shops is a direct outcome of the introduction of self-contained machine tools with their own motors attached, which can be moved about and brought to any part of a large casting, and the electrically-driven traveller has contributed in no small degree to the convenience of the operation. The same principle of bringing the tool to work instead of the work to the tool is also found in the miniature electric drilling, milling and grinding machines which are now used in so many classes of work. Substantial advance in machine shop methods can only be attained by the mechanical engineers duly considering the requirements of their colleagues who design the motors, and the electrical engineers in their turn giving full consideration to the objects which the combination has to serve.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.

Electricity Meters: their Construction and Management. By C. H. W. Gerhardi. (London: "The Electrician" Printing & Publishing Co.) 1906. 9s. nett.

Mr. Gerhardi's book on Electricity Meters is a notable addition to "The Electrician" Series. The author has exceptional qualifications for writing with authority, owing to his position as chief of the testing department of one of the largest supply undertakings in existence, which, moreover, operates on both alternating and direct-current systems. In order to avoid writing a volume of unwieldy proportions, he wisely refrains from including an historical survey, but confines himself to descriptions of the most prominent types in use to-day, while his criticisms of these types display complete impartiality.

It may be added that the author appears to be familiar with the position of almost every screw in every meter dealt with. The book is expressly intended for those engineers who are connected with meters and their management both in health and sickness, and therefore mathematics and scientific dissertations are carefully avoided. It is eminently readable throughout, and there is not a single chapter which the supply engineer cannot read with pleasure and profit.

The introduction opens with a few simple definitions and elementary principles of D.C. and A.C. measurement and proceeds to discuss various methods of classification, finally deciding on three main groupings of meters for A.C. and D.C. supplies and meters equally suitable for both supplies. The next chapter is devoted to A.C. meters. After discussing the general principles underlying A.C. working, the author clearly traces, with the aid of diagrams, the operation of the magnetic fluxes due to the series and shunt coils and the devices used to force the two fluxes into quadrature. Then follows a detailed and accurate description of 11 representative types. The reader should have been informed, however, that in the case of one of these types, though in fairly large use, the makers have discontinued the manufacture. The description concludes with valuable data of the internal losses, pressure drop and torque, the latter being given in gramme-centimetres. In a later chapter the author describes two extremely neat but simple forms of apparatus designed by himself for the measurement of torque. Since the work is not concerned with ancient history, no mention is made of such well-known types of meter as the Shallenberger ampere-hour and the old Aron pendulum meters. Three-phase meters are represented by two leading types.

The next chapter describes 10 good examples of continuous-current meters, including two of the electrolytic type. The details of losses, &c., are rather less complete than in the preceding chapter, and one or two defects in meters of certain types might have been alluded to, such, for instance, as the possible splashing of mercury by short circuits, and the possibility of error arising in certain cases owing to the stray field set up by the current in the leading-in cables, which error may be considerable. In one electrolytic meter the author notes the recent modification of the gauge cone to overcome the shaking over of the mercury under vibration, a fault in older types once pithily described as follows. "You come home in a temper and bang the door, and it costs you half-a-crown!" Later in the book the author refers to the danger from crystallisation of the liquid and the makers' experiments to overcome this trouble. Notice is also taken of the drawback of this type of meter owing to the frequent loss of the permanent record on resetting the meter.

Chapter IV. discusses meters suitable for both direct and alternating-current measurement, and describes several types. The author carefully explains the methods of compounding to overcome initial friction, and discusses the danger of "creeping" due to over compounding.

The next three chapters are devoted to descriptions of meters of the prepayment, double tariff and tramcar type, and also demand indicators are dealt with. These chapters are accurate, and show the author's intimate knowledge of every detail. There are, however, two types of meter deserving of mention to which no reference is made by the author. One is the battery meter for measuring both discharge and charge currents, usually consisting of two meters in series with a ratchet-and-pawl arrangement, which only allows current in one direction to be measured: the other is the hour meter, a simple and cheap arrangement, which only measures the duration of the load and is specially suitable for arc lamps, street lighting, &c.

Chapter VIII. deals with the choice of a type of meter, and might, with advantage to the reader, have been considerably amplified. The author discusses six good qualities which every meter should have, and might have referred to other "points" of a good meter, such as immunity from interference by stray fields, vibration and change of frequency, and also the necessity of good insulation and prevention of the possibility of being tampered with. Further, the author's remarks on "accuracy" are somewhat scanty and give no guidance on percentage errors at various loads. The author considers the shunt losses often appear to be of exaggerated importance: with this many station engineers will agree; he might have added that the series losses, reaching a maximum as they do on the peak, are frequently underrated.

The next few chapters are devoted to a full discussion of the arrangement of a Meter Department, the testing apparatus most suitable for the purpose and the maintenance, testing and reading of meters, and a full diagnosis of the diseases to which meters are susceptible, together with prescriptions of remedies to meet almost every ailment. The author evidently draws on his own large experience, and his full details of the arrangements for the equipment of a successful organisation will be studied with deep interest. Some engineers will possibly criticise his use of D.C. and A.C. supplies of various voltages in close companionship on the same test board, but generally the author's arrangements are so carefully thought out as to leave very little room for criticism.

Chapter XI. opens with the remark that the Board of Trade limit of accuracy is $2\frac{1}{2}$ per cent. on either side—a statement on which considerably more information might be imparted. Many supply engineers are probably not even aware of the fact that the Board of Trade issues elaborate rules for meter certification and tests for the guidance of authorised inspectors, and it is to be regretted that Mr. Gerhardi did not reproduce these rules in extenso as they form a valuable guide to meter testing. The figures laid down by the Board of Trade are as follows:—

> A meter should be considered by the inspector to be a correct meter if being a meter intended for more than 3 amperes, the error at one-tenth of its full load and above this point does not exceed + or − $2\frac{1}{2}$ per cent. In the case of meters intended for currents not exceeding 3 amperes, the error must not exceed + or − $3\frac{1}{2}$ per cent. The inspector should generally satisfy himself as to the accuracy of the meter by testing, say, at three different loads, which may be taken at about one-fifth, one-half and four-fifths of full load.

In the list of general conditions to be fulfilled before the Board of Trade approval can be given, the following occur:—

> Meters in which the current for maximum load exceeds 3 amperes should not have an error exceeding 2 per cent. (+ or −) at any point from one-tenth full load to full load.
>
> To facilitate the certification and use of simple and inexpensive forms of meter, suitable for currents not exceeding 3 amperes, the foregoing conditions may be somewhat relaxed. For such meters at any point from one-tenth load upwards the variation from accuracy must not exceed 3 per cent. above or below.

The reader will note the difference of $\frac{1}{2}$ per cent. between the Board of Trade figure and the inspector's figures. It is to be hoped that Mr. Gerhardi will devote a special chapter in future editions to these very suggestive instructions issued by the Board. The author shows various correct and incorrect methods of connecting meters in series for testing, and explains the method of making long-hour tests while avoiding the considerable consumption of current necessitated by the ordinary method. Chapter XII. contains practical instructions and useful hints for testing in situ. Chapter XIV. deals with cleaning and repairs, the greater portion of the chapter being taken up with commutator meters. The last chapter is devoted to bookkeeping, and the author indicates the number of records necessary to trace the life of a meter from the cradle to the grave, and favours a combination of book and card systems. Finally, the book concludes with a number of specimen forms for meter bookkeeping and a list of meters approved by the Board of Trade.

Summarising, Mr. Gerhardi is to be heartily congratulated on the result of his labours: the few errors are those of omission. Every station engineer may read the book from start to finish with pleasure and profit, and there are few indeed who will not find something to learn and copy in his own organisation. It only remains to add that the printing and reproductions are worthy of the high reputation of the publishers.

T. P. WILMSHURST.

Whittaker's Electrical Engineers' Pocket-Book. Edited by KENELM EDGCUMBE. 2nd edition. (London: Whittaker & Co.) 3s. 6d.

It is a little difficult to classify this pocket-book; it is not a text-book nor an electrical "Molesworth," nor yet a book for practical engineers, but combines the characteristics of all three. The scope is certainly not narrow, for it attempts to cover the entire field of electrical engineering with a little general mechanical engineering also. Various parts have been written by different well-known men who have done their work well, although there is considerable overlapping of subjects.

A large amount of matter devoted to elementary dynamo and motor designs could be cut down with advantage, as those who are specially interested in that branch of the art would draw their information from some of the works dealing exclusively with machine design. Extensive chapters are devoted to traction and transmitting, and these subjects are well treated, though some of the data and conclusions are somewhat out of date. On p. 337 it is stated that a lower periodicity than 40 periods per second cannot be used for incandescent lighting on account of flickering; as a matter of fact, there is no perceptible flicker with 25 ∿ and 16 c.p. lamps, or even 8 c.p. 100 volt lamps, a matter worthy of remembering with so many large supplies at that periodicity.

Switchboards are treated in some detail, though the only type of high-tension gear illustrated is the now obsolete Ferranti cellular board. In the chapter on electric traction an acceleration of 1½ ft. per second per second is given as a practical limit; the Liverpool overhead railway accelerates up to 4 ft. per second per second, and 3 ft. per second per second is quite common.

Dealing with controllers, no mention is made of the multiple unit system now almost invariably used for heavy traction. If in the next edition a little more up-to-date information and data were given the book would be more useful; the fact that it has so soon reached a second edition shows it meets with a favourable reception in the electrical world.

High-Tension Power Transmission. Second volume. (New York: McGraw Publishing Co. 1906.) $2 50c. net.

A short time ago an interesting collection of Papers relating to high-tension power transmission, read before the American Institute of Electrical Engineers, together with discussions and other data furnished by members, was published in one volume. The book now before us represents the sequel to this, in the form of the Papers and discussions on the same subject at the International Electrical Congress at St. Louis in 1904. Although the whole of the contents of the present volume have already been published in the official *Proceedings* of the Congress (and a number of them in *The Electrician*), many people interested in the subject will find it convenient to have them collected in a smaller volume, uniform in size with the previous collection of Papers and discussions. A useful feature of the book is a short index of subjects and authors.

Wireless Telegraphy. By W. J. White. (London: T. C. & E. C. Jack). 1s.

The avowed object of this book, which is one of the "Shilling Scientific Series," is to give the general reader an account of the principles and practice of the latest form of telegraphic transmission. In two introductory chapters the "general reader" receives his electrical education, and is rapidly conducted from the "pith ball" portion of the subject to the principles of electromagnetism and the action of ordinary telegraph instruments. The early earth conduction and induction forms of "wireless" are dismissed in a few pages, and after some explanatory notes on electric waves, we have more or less detailed descriptions of the Marconi, Telefunken, Lodge-Muirhead, De Forest and Fessenden systems, which, although not containing all the detail of recent developments that might be found in a treatise of a more highly technical nature, are clearly written and give a good idea of the different arrangements adopted. In comparing the systems, it is necessary to read between the lines and bear in mind that in some cases methods have been introduced not on account of their superiority over others, but by reason of the desire of the rival "inventors" to avoid each others patents. This explains many divergencies in practice which would otherwise confuse the stranger to the subject. Each system has its own good points, but the commercial enmity which has prevented their combination, and thereby retarded the progress of the industry, is much to be regretted.

Continuous-current Armatures. Alternating-current Windings. By C. Kinzbrunner. (Harper & Bros.: London and New York. 1906). Each volume 3s. 6d.

By omitting all purely academic matter and dealing only with windings which are universally used in practice, Mr. Kinzbrunner has succeeded in giving a clear and readable account of continuous-current windings and alternating-current windings in two volumes of small size.

Continuous-current windings are dealt with in the first book, which is based throughout on the winding formulæ elaborated by Prof. Arnold. These formulæ are quoted without proof, but practical men, for whom the book is chiefly intended, are not likely to quarrel with the author on this account. Numerous examples and winding diagrams are given to show how the formulæ are employed. Many useful data on the mechanical construction of continuous-current windings and armatures are contained in the second and third chapters of the book.

The second volume deals with the theory and mechanical design of single and polyphase-current windings, and finishes up with a chapter on insulating materials. In the general introduction the author defines a cycle as half a complete wave—a definition which is not in agreement with usually accepted notions. By an evident oversight the armature of the rotating field alternator depicted in Fig. 4 is shown short-circuited upon itself.

Technical Dictionary in Six Languages. Vol. I. By P. Stülpnagel. (London: A. Constable & Co.) 5s. net.

This is the first volume of the Deinhart-Schlomann series of technical dictionaries in English, German, French, Italian, Spanish and Russian, and deals with general mechanical engineering terms, or, as the full title puts it, "the machine elements and the most frequent tools for metal and wood-working." The next volume will deal with electrical terms, and succeeding parts are to be issued covering other branches of engineering. The general arrangement permits of great compactness considering the number of languages. The words are arranged in order of subject matter, and whenever possible a small drawing or diagram in the centre column of the page illustrates the article in question, the names for which are given German, English and French on the left-hand side, and in Russian, Italian and Spanish on the right. At the end is an alphabetical index, where the words of all the languages except Russian are given in alphabetical order against references to the pages and parts of the pages where their equivalents are to be found. The Russian words, owing to the different alphabet, are contained in a separate index. On the whole, the work seems carefully prepared, such small faults as there are being mainly those of omission.

The Telegraphists' and Telephonists' Notebook. By J. Smith. (London: S. Rentell & Co.) 1s. net.

The author has undertaken a task of some difficulty in attempting to compress a large amount of miscellaneous information into his small shillingsworth. The arrangement is somewhat haphazard and the indexing most imperfect, so that it is very hard to find the facts required without some searching. In addition to this, the information is not always accurate. For example, the chemical symbol of phosphorus is given as Ph. instead of P, and, amongst the list of elements, water is given with the symbol Aq. Much of the information is of the most vague character—for example, the statement that "Sulphuric acid dilute has a resistance of 1·05 ohms per cubic centimetre," which is useless without some further definition of the strength of the mixture. Altogether the book would have been improved by greater care in its preparation, as in its present form it cannot be said to be either accurate or well arranged.

Radiography. By S. R. Bottone. 2nd Edition. (London: Whittaker & Co.) 3s. net.

In this book the production and applications of Röntgen rays are treated somewhat from the point of view of the intelligent amateur. The introductory part, in attempting to be simple and intelligible, is confusing and not always accurate: for example, at the front of p. 19, Röntgen and cathode rays are spoken of as being one and the same thing. A large part of the book is devoted to instructions in the making of induction coils. The section on tubes deals more with vacuum tubes of historic patterns than with the essentials of the modern tube suitable for practical Röntgen ray work. Further chapters deal with the construction of a very elementary form of Wimshurst machine, to which is added a long quotation from another writer on the Holtz influence machine. Recipes are then given for the preparation of fluorescent screens, and some useful practical manipulatory details both as to the treatment of tubes and the photographic part of the subject. The concluding chapter on theoretical conclusions does not by any means represent the latest views on the subject, nor does it dispose of the confusion of cathode and Röntgen rays in the earlier part of the book. The illustrations are numerous, but of poor quality.

Practical Physics. By W. R. Bower and J. Satterly. (London: W. B. Clive.) 4s. 6d.

In this addition to the "Tutorial Series," the authors have provided a course of experiments in the measurement of physical quantities and illustrations of physical laws adapted for students with no previous laboratory experience. The experiments are for the most part intended to be performed in a fully-equipped laboratory, but some are specially marked as suitable to be performed by the student at home. After preliminary exercises in measurements of mechanical quantities, three short chapters deal with sound, heat and light respectively. The remainder of the volume, some 130 pages, deals with magnetism and electricity, and recapitulates most of the familiar elementary experiments. In this part of the book a larger proportion is descriptive of apparatus. The descriptions and instructions are concise and clear, and should be useful in supplementing the work of the laboratory demonstrator, who in a large class is unable to give more than a limited amount of personal attention to each individual student.

MEASUREMENTS OF ATMOSPHERIC ELECTRIC POTENTIAL.*

BY C. CHREE.

The Paper contains an analysis of the atmospheric electricity results at Kew from selected days—usually 10 a month—during the seven years 1898 to 1904.

The days were chosen as representative of fine weather conditions, all days being excluded when rain fell or negative potential was recorded. By means of regular observations with a portable electrometer, the curve readings from the Kelvin water-dropping electrograph were converted so as to give the potential gradient in the open, in volts per metre. All the data: mean monthly values, diurnal inequalities, &c., are given in absolute measure (volts per meter). This is believed to be the first occasion on which this has been done. The diurnal inequalities for individual months and for the whole year are represented by curves. These are mostly exceedingly smooth, thus showing that a sufficient number of years' data have been included to give satisfactory results. The curves all show two distinct daily maxima and minima. The minima occur in all the months near 4 a.m. and 2 p.m. The times of the maxima are more variable, the day interval between the forenoon and the evening maximum being longer in summer than in winter.

The month showing the highest mean potential gradient is December, but the amplitude of the diurnal inequality is greatest in February. Whilst the amplitude of diurnal inequality, when considered absolutely, is greatest in the mid-winter months, the ratio in which it stands to the mean daily value is least at this season.

The diurnal inequalities for the several months are analysed in Fourier series, with 24, 12, 8 and 6 hour terms. The 12-hour term is, in general, the most important, especially in summer; the changes in its amplitude and phase angle throughout the year are comparatively small. The 24-hour term is more variable. It is much larger in the winter than in the summer months, and its phase angle varies greatly throughout the year.

The diurnal range, the 24 hourly differences from the mean for the day, and the amplitudes of the 24 and 12 hour waves, have their annual variation expressed in Fourier feries, with annual and semi-annual terms. In all cases the annual term proves to be the more important.

Attention is given not merely to the regular diurnal changes, based on mean results from a number of days, but also to the phenomena exhibited by the individual days themselves. It is found that the difference between the highest and lowest hourly values is, on the average, 2½ times the amplitude of the regular diurnal inequality, and is, in fact, fully larger than the mean value for the day of the potential gradient.

The difference between the values of the potential gradient at successive midnights of the selected days, when taken irrespective of sign, averages about 43 per cent. of the mean daily value. When taken algebraically, there seems a slight tendency in the potential to rise during the selected days in December and January, but, taking the year as a whole, the mean non-cyclic element is exceedingly small.

The possible influence of various meteorological elements is considered from several standpoints. The influence of temperature is found to be much the most marked, there being a clear association of high mean potential and large diurnal range of potential with low temperature in every month of the year, except the hottest (July). In the winter months there is also an association of high potential with low wind velocity and high barometric pressure, but the association in these cases is much less clear.

Some of the data are compared with older data for Kew, obtained by Everett. In some respects there is fair agreement, but conspicuous differences exist. The results are also compared with other data given in a recent important memoir by Mr. A. B. Chauveau, for Kew and Greenwich, and for a number of stations in Italy and France, especially the Bureau Central Météorologique and the Eiffel Tower in Paris.

An appendix makes a minute comparison of the diurnal inequalities of potential and of barometric pressure at Kew. A somewhat striking resemblance between the diurnal changes in these elements was pointed out by Everett in 1866, which possesses increased interest of late years, owing to Elster and Geitel's discovery that air extracted from the soil is usually markedly ionised, and their consequent suggestion that the variations of barometric pressure may influence the potential gradient by facilitating or retarding the escape of this ionised air into the atmosphere.

Everett's original comparison was between potential data from Kew and barometric data for Halle, both for the mean diurnal inequality from the whole year. Both elements are, in reality, considerably dependent on local conditions, and it thus seemed important to employ data for the same place. Mean diurnal inequalities were thus got out for each month of the year for the barometric pressure at Kew, making use of the data published in the "Hourly Means" of the Meteorological Office for an 11-year period, 1890 to 1900. This enabled a really critical comparison to be carried out with the potential gradient. The result shows decisively that the similarity between the diurnal inequalities of the two elements is confined to the 12-hour terms; the 24-hour terms present, in fact, diametrically opposed phenomena in the two cases. The afternoon minimum and the evening maximum of potential are in every month notably in advance of those of barometric pressure, and the 12 hour potential wave is about an hour in advance of that of barometric pressure throughout the whole year. Thus, if any relationship of cause and effect exists between the *regular* diurnal changes in the two elements, the pressure change would seem to be the effect, the potential change the cause.

CORRESPONDENCE.

WAVE SHAPES AND THREE-PHASE TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the Correspondence column of your issue of January 5th last, Prof. F. J. Dykes gave an oscillogram showing the effect of load upon the voltage distortion in a set of Y-connected transformers. The result obtained by him was that the distortion was only of importance at very light loads. I was not able to understand the reason for this result, and until lately was also unable to repeat the experiments described on page 135 of *The Electrician* for November 10, 1905, with load conditions. I find, however, that the distortion in a "star to star" connected system is independent of load, and persists even with full load on the transformers.

I enclose tracings of two sets of ondograms: Fig. 2 shows the no-load conditions. A is the voltage wave across one transformer of the T_1 group in Fig. 1 of the article referred to. B is the voltage wave across the corresponding member of the T_2 group, while C represents the voltage between the unconnected neutrals. Fig. 1 shows the full non-inductive load conditions. Here A is the load current, B and C being as before.

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* Abstract of a Paper entitled "A Discussion of Atmospheric Electric Potential Results at Kew from Selected Days During the Seven Years 1898 to 1904," read before the Royal Society, March 15th.

It will be seen that load has had here no effect on the distortion. There appears to be no reason why loading the transformer between phases should eliminate the flux harmonic,

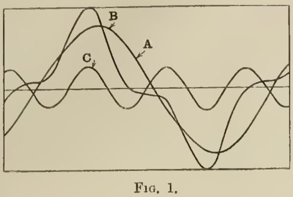


FIG. 1.

as the load current evidently can contain no triple term, such as would be necessary to effect this. Possibly an unbalanced inductive load (such as a single-phase transformer with open

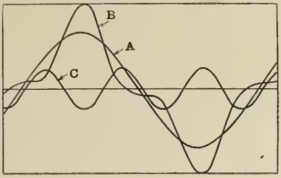


FIG. 2.

secondary) would, by introducing a third in the current, modify matters. But on a balanced or non-inductive load the distortion must still exist.—Yours, &c., R. C. CLINKER.

Rugby, May 14.

P.S.—In the ondograms the phase of the triple harmonic was accidentally reversed 180 deg. between the time of taking the curves.

DIRECTED WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 4th inst. you published a Paper by G. Marconi "On Methods whereby the Radiation of Electric Waves may be mainly Confined to Certain Directions . . ."

I beg to inform you that these methods and the results arrived at are not new; devices based upon them have been patented both in France and in America, in 1900, six years ago.

I and Capt. Ferrand, of the French artillery, have witnessed experiments identical to those described by Marconi, which were carried on near Dijon by the inventor in 1900. This inventor was Mr. Garcia, a French electrical engineer, who had at that time realised that, when working a horizontally-stretched antenna, the energy of the vibrations of the ether spread around this antenna in such a manner that the equipotential surfaces were something like cones having the antenna for axis; and the transmitting power was a maximum along this axis, and decreased rapidly on each side so as to be approximately nil at 45 deg. from the axis. Similarly, Mr. Garcia inferred from his tests that a similar law prevailed with receiving antennæ. According to this principle, he devised an apparatus intended, in his opinion, to signal only in certain directions, and tendered it to the French Government to be mainly used on board the warships. Mr. Garcia patented his invention, and full specifications may be obtained both in the French patent No. 301,264, 1900, and American patent No. 795,762, 1905.

I know by my witnessing these tests of Mr. Garcia, and every one will make sure by reading these patents, that there is no sensible difference between the methods and results of Mr. Garcia in 1900 and those indicated by Mr. Marconi in 1906.—Yours, &c., F. GALLIOT.

Dijon, May 14.

[We have referred to the American Specification (No. 795762) of Manuel Rodriguez Garcia and find the patentee describes a system of wireless telegraphy in which a number of inclined radiating air wires are employed giving an effective sphere of action limited to a solid angle. It is mentioned that the point from which they radiate may be on the ground, and one of the wires may lie horizontally on the ground although the effective zone will extend to the greatest distance if one wire is inclined downwards. Particular adaptations for shipboard use are described, and a special device for connecting and disconnecting the antennæ and their receivers. The claims are set out as follows:—

1. In a system of wireless telegraphy, a plurality of groups of antennæ, receivers therefor, and a commutating switch device, arranged and adapted to establish simultaneous communication between two symmetrical antennæ and their corresponding receivers and to break connection between the antennæ and their receivers.

2. A commutating-switch device, a plurality of groups of antennæ, receivers for said groups of antennæ and two capacities which are equivalent to each other, the said switch device being arranged and adapted to establish communication between two antennæ, and said capacities and to break all connections between the capacities and the antennæ.

3. The combination with a metal case and receivers therein of a non-automatic device for decohering the receivers without breaking the continuity of the said metal case.

—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

◆

TELEGRAPH (CONSTRUCTION) BILL.

In the House of Commons on Thursday last week, the Postmaster-General introduced a Bill to Amend the Telegraph Acts, 1863 to 1904, with respect to the construction and maintenance of telegraphic lines. A similar measure was introduced last year, but did not go beyond the first reading. The present bill is as follows:—

Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons in this present Parliament assembled, and by the authority of the same as follows:—

1. If the owner, lessee, or occupier of any hedge or bank which forms the boundary of any street or public road along which the Postmaster-General desires to construct or maintain or is constructing or maintaining a telegraphic line, or of any land (being within 20 ft. of any such street or road and not being common land or land dedicated to the recreation of the public) which is not enclosed on the side of the street or road, refuses or fails to give his consent to the construction of the line on, over, along, or across the hedge, bank, or land, within one month after being required to do so by notice from the Postmaster-General, a difference shall be deemed to have arisen between the Postmaster-General and that owner, lessee, or occupier, and secs. 3, 4 and 5 of the Telegraph Act, 1878, shall apply accordingly as if it were a difference arising under that Act.

2. Those provisions of sec. 21 of the Telegraph Act, 1863, which (as amended by sec. 3 of the Telegraph Act, 1892) are not of general application, shall be of general application, and extend to rural districts and to public roads as well as to streets; but in the case of a street or public road in a rural district the publication of notice required under sec. 23 of the Telegraph Act, 1863, shall be substituted for the publication of notice under sec. 21 of that act.

3. The provisions of sec. 2 of the Telegraph Act, 1892, shall apply where, on the application of the Postmaster-General, the Railway and Canal Commission are satisfied that owing to the refusal or failure of any person being the occupier, lessee, or owner of any land or building to consent to the construction or maintenance of a work by the Postmaster-General, telegraphic communication cannot be supplied to any district or place, except at unreasonable cost or on unreasonable conditions.

4.—(1) Where any tree overhangs any street or public road and obstructs or interferes with the working of any telegraphic line constructed along that street or road or will obstruct or interfere with the working of any telegraphic line about to be so constructed, the Postmaster-General may give notice to the owner of the tree or to the occupier of the land on which the tree is growing, requiring him to lop the tree so as to prevent the obstruction or interference.

(2) If within 21 days from the service of notice by the Postmaster-General the owner of the tree or the occupier of the land on which the tree is growing gives a counter-notice to the Postmaster-General objecting to the lopping of the tree, a difference shall be deemed to have arisen between the Postmaster-General and that owner or occupier, and secs. 4 and 5 of the Telegraph Act, 1878, shall apply accordingly as if it were a difference under that Act.

(3) If on the expiration of 21 days after notice is given by the Postmaster-General under this section, the owner or occupier has not complied with the notice, and has not given a counter-notice under this section, or if the authority determining a difference under this section make an order in that behalf, the Postmaster-General may himself cause the tree to be lopped, and sec. 7 of the Telegraph Act, 1863 (which relates to compensation), shall apply to the exercise of that power by the Postmaster-General.

5.—(1) In this act, any expressions to which a special meaning is attached under the Telegraph Acts, 1863 to 1904, or any of them, shall have the same respective meanings in this act; and the expression "hedge" or "bank" includes any ditch adjoining to the hedge or bank as if it was part of the hedge or bank.

(2) Sec. 12 of the Telegraph Act, 1878 (which relates to the printing, authentication, and service of notices and other documents, shall apply for the purposes of this act as it applies for the purposes of that act.

(3) This act may be cited as the Telegraph (Construction) Act, 1906, and may be cited with the Telegraph Acts, 1863 to 1904.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

(*Continued from page 144.*)

Tuesday, May 15.

Mr. R. HAMMOND was re-examined, and one of the points he dealt with was the capital expenditure which would be necessary by the authorised distributors if this bill were not passed. This expenditure would be distributed over small works, and the final result would not be so economical as if it were spent on one scheme, such as this. Mr. Hammond also gave the following comparison between the proposed scheme of the L.C.C. and that of the St. Neots scheme of the Additional Electric Supply Co. for a supply of 85,500 kw. :—

Items.	L.C.C. scheme.	St. Neots scheme.
Land	£90,000	£11,250
Buildings	721,740	412,000
River work	116,181	10,000
Machinery and plant	1,169,947	1,068,000
Overhead transmission to Enfield	..	555,600
Step-up and step-down transformers, switchgear and cables	..	180,000
Land and bridges at Enfield	..	50,000
Transmission system to supply centres, &c.	1,065,187	2,355,280
Interest on capital during construction	105,000	202,000
	£3,268,055	£4,844,130

The plant at St. Neots would have to be 120,000 kw. in order to provide for the standby, as against 114,000 kw. for the L.C.C. scheme, but the cost would be less, because the plant would be in larger units and in one station. The assumption in respect to the overhead transmission was 50 miles, the wires being carried upon steel lattice towers at least 45 ft. high, with a working pressure of 30,000 volts. The underground transmission under the St. Neots scheme was taken at 11,000 volts, owing to the length being twice as long as was proposed by the L.C.C. The estimated total working expenses on an output of 85,500 kw. maximum load at one time, with a load factor of 35 per cent., or 262,143,000 units per annum, were 0·4618d. per unit for the L.C.C. scheme and 0·558d. per unit for the St. Neots scheme. The generating costs are put at £232,141 and £178,728 for the L.C.C. scheme and St. Neots respectively; the transmission costs at £16,500 and £82,280 respectively; capital charges at £202,847 and £300,700; management and office, £10,300 in both cases; and rent, rates and taxes at £42,760 and £37,000 respectively; the totals being £504,548 for the L.C.C. scheme and £609,008 for the St. Neots scheme. It had been assumed that 283,400,000 units would have to be generated at St. Neots, the extra being to cover the loss on the overhead transmission and transformation. The cost of the maintenance of the overhead system was put at 5 per cent., in view of the cost of patrolling the line and maintaining the lattice towers and insulators, and easements were charged at £250 per mile per annum. Rents, rates and taxes are taken at a lower figure for the St. Neot's scheme after allowing for the rating of the transmission system and the increased rating cost of the more extensive underground system. In most of the other items the same charges have been assumed.

On the question of the area, Mr. RUTHERFORD suggested that it was very unfair to take what the County Council considered to be the best portions of the outside counties, and so prevent any of these counties asking for similar powers in their area to those now being sought by the L.C.C., Mr. HAMMOND said he did not think the scheme would do harm to any of the counties outside.

Mr. RUTHERFORD : But supposing they think you will do them harm, and they evidently do, for they are opposing you here?—I am afraid I find a little difficulty in answering that question.

Mr. RUTHERFORD next referred to the apparent inconsistency between the views expressed as to the reduction of the smoke nuisance in London by the erection of large generating stations and supplying in bulk to existing distributors. Mr. HAMMOND said he did not share the view that the present smoke nuisance as concerned the existing undertakers would be mitigated, but, with a cheaper supply of electricity, the number of manufacturing works using steam would be very much reduced.

In the course of a detailed criticism by Mr. RUTHERFORD of Mr. Hammond's table given above (many of the questions, however, being based on misconception), Mr. Rutherford was referring to the carrying capacity of the overhead wires.

Mr. HAMMOND : The Board of Trade limits the carrying capacity of one cable to 2,000 kw.

Mr. RUTHERFORD : But you know that the Board of Trade regulations are absurd?—Oh, I do not say that.

But you know they are?—I do think it might be raised to 8,000 kw., as is the case at Shawinigan.

In answer to Mr. Richard Bell, Mr. HAMMOND stated that the Council, under this scheme, could supply the London, Brighton & South Coast Railway Co. on a 16 hours' use at 0·35d. per unit, to which would have to be added the cost of transformation.

Mr. RUTHERFORD, in the course of further questions, suggested the possibility of converting direct from 50,000 volts to 500 at the consumer's sub-station, say, for tramways, and so reducing the capital expenditure on the St. Neots' scheme as proposed by Mr. Hammond. Mr. HAMMOND, however, entirely disagreed with this as being commercially possible. The usual way, and only way, to deal with such a system was to step down (say to 11,000 volts) and then transfer further and convert for distribution.

Mr. J. F. C. SNELL, chief electrical and tramways engineer to the Sunderland Corporation, and one of the consulting engineers engaged on this scheme, at first dealt with the advisability of having the generating stations away from London, and said that, in his opinion, the cost of transmission would so outweigh the other advantages that coal would have to be purchased at 9d. per ton to enable an equally economical supply to be given to that possible with the power stations in the positions proposed in London. He concurred in the evidence of the previous witnesses, and on the special point of the transformation of the energy from 6,600 volts to any other kind, Mr. Snell said that this problem had been quite solved. The Chicago Edison Co. and the Niagara Co. were generating two-phase current at 35 cycles, and from that were supplying three, two and one phase at 35 cycles, two and one phase at 60 cycles, and one phase at 125 cycles. The one other matter dealt with by Mr. Snell related to the suggestions that a figure ought to have been given for the electrical energy transformed. He had made calculations as to this, and had compiled a table giving these prices which were based upon what he considered fair figures for such conversion. As an example, he quoted that, whereas by the prices suggested by the Council a user for 4·8 hours with a load factor of 20 per cent. would get his energy for 0·69d. untransformed, on his calculations of what transformation would cost this energy should actually cost the consumer 1·03d. per unit.

Wednesday, May 16.

Mr. H. E. HAWARD, controller to the L.C.C., was called with regard to the adverse reports upon the scheme which were made by the Finance committee. He explained that the original report of this committee was admittedly made without the full details of the scheme before it, and even at the time of the second report the Finance committee was not in a much better position. He thought these reports dealt quite broadly with the financial position. The scheme as now submitted to Parliament had never been placed before the Finance committee. The total capital expenditure estimated under the bill was 2½ millions, a good deal less than the Finance committee anticipated when they first gave consideration to the question, and this expenditure would be spread over five or seven years, and he could not say that this would form a very serious addition to the present capital commitments, and would certainly not form a serious objection to the scheme. The capital anticipated by the Finance committee was 3½ millions spread over a much smaller period. In any event, this sum would have had to be raised on loan by the local authorities for the extension of their works, and would necessarily be spent much less efficiently. He saw no difficulty in raising the money proposed under the bill on satisfactory terms if the undertaking were carried on in a proper manner. He certainly thought the undertaking would be self-supporting.

The CHAIRMAN : You have gathered that from your engineers?—Yes.

Mr. HAWARD then dealt with the constant applications for loans which were made by the Borough Councils for extensions to their electricity works. He said the Finance committee had felt considerable difficulty on this matter, in view of the frequent developments in the electrical industry, and it was not considered satisfactory that small loans should be continued, so that some method of obviating this should be taken in hand. At present the local authorities had on loan from the Council for electric lighting purposes about £5,000,000, but there was on the part of the Council a strong objection to the continued development of the existing methods.

The CHAIRMAN : Has your Council ever refused to sanction a loan for this purpose?—No, but we have never yet had to deal with anything except to meet the requirements for a year or so.

Continuing, he considered the estimates of capital and revenue reasonable ones. The periods of the various loans were: Land, building, &c., 60 years; generating plant, 25 years; boilers, economisers, &c., 20 years; tools and meters, 10 years. The amount raised by the Council during the past 10 years was £33,000,000, and the average price was £3. 3s. 6d. The last issue cost £3. 8s., including all expenses. He therefore thought the rate of 3½ per cent. taken in the estimates was a fair one. It would be about 3 per cent. cheaper than a company could raise it.

The CHAIRMAN here stated that a report had been received from the Treasury as to clause 42, which permitted the paying of £105,000 out of capital during construction. This was considered unprecedented, and had been condemned by the Select Committee of 1902 on Loans. The Lords Commissioners of the Treasury were of the opinion that the application of this principle to the L.C.C. ought only to be allowed in the present case if exceptional grounds were shown.

Mr. HAWARD said there were several precedents in the year of 1902.

The CHAIRMAN : Since the passing of the report referred to?—I do not know the date of the report.

Mr. BALFOUR BROWNE then cross-examined on behalf of the electric lighting companies of London. He put in a list of several electric power companies which had been sanctioned a few years ago, but which had not yet raised a penny in capital. Was this a good prospect?

Mr. HAWARD : I do not see any analogy between the two cases. The best answer is that several companies are anxious to supply London with electricity.

By the Hon. J. D. FITZGERALD, for the Administrative County of London & District Electric Power Bill : The total indebtedness of the L.C.C., exclusive of the loans to the borough councils which was a further £18,750,000, was £45,240,000, of which £38,500,000 represented unremunerative undertakings. He did not agree with the view that the continual expenditure of the Council had affected its credit, notwithstanding that the 3 per cent. stock now stood at 91, whereas last year it was 97. Other securities had also fallen. It might be the fact that the 3 per cent. stock of the Liverpool and Birmingham Corporations stood higher than the L.C.C., but these authorities had not been in the market for some time.

Mr. FITZGERALD: And we see the consequence.

In answer to further questions, Mr. HAWARD said he would, as the financial adviser to the Council, advise that the amount of support likely from the authorised distributors should be ascertained before a very large expenditure was incurred.

In this connection there was some discussion on clause 35, which gives the Council the right to appeal to the Board of Trade as to the price charged by any authorised distributors; it was made quite clear that more than one member of the Committee regards this clause as giving a power of coercion, and that, to that extent, the bill could not be termed a "permissive" bill. Mr. HENRY NORMAN said that many authorised undertakers who might not take a supply from the Council if this clause were omitted would be practically forced to do so if the clause were left in.

Mr. EDGAR HARPER, the statistical officer to the County Council, spoke as to the interconnection for all purposes of London and the outside districts, and from this maintained that the outside area in the scheme should remain included.

Thursday, May 17.

Mr. JOHN HALL, Chairman of the Electricity committee of the Bethnal Green Borough Council, said that this body obtained a provisional electric lighting order in 1899. A site had been purchased, and a scheme costing between £40,000 and £50,000 was advised. It did not appear that the undertaking would be a financial success, however, and the matter was dropped. Offers were then invited from the Charing Cross, West End & City Electricity Supply Co., which has bulk supply powers in Bethnal Green, and also from the Shoreditch, Hackney, Poplar and Stepney borough councils for a supply in bulk. Whilst the replies were under consideration, the proposals of the London County Council were heard of, and it was now felt that the L.C.C. should have the power to supply in bulk, and they would prefer to take a supply from the Council.

In cross-examination, Witness said that the offer of the Charing Cross Co. was 1d. per unit, and that the Borough Councils named had replied they had no powers, although they would be prepared to negotiate on favourable terms if the Bethnal Green Council could obtain the necessary Parliamentary powers.

Mr. G. MARLOW REED, chairman of the Finance committee of the Wood Green Urban District Council, said that the North Metropolitan Electric Power Supply Co. had offered them a bulk supply in 1903 at 2·5d. per unit, which the Council had refused. A subsequent application to the Local Government Board for a loan for a municipal undertaking had been refused. He felt that the existence of the L.C.C. scheme would give him a second string.

Cross-examination was conducted by Mr. TYLDESLEY JONES to show that Mr. REED'S attitude throughout had been one of hostility towards the North Metropolitan Power Co., irrespective of price, and this the witness admitted. He also stated that he had not been given permission by his Council to give evidence on their behalf. Negotiations were being carried on with the Hornsey Borough Council for amalgamation in that district, and a supply from that district was also possible.

Mr. JOHN BODGER, chairman of the Ilford Urban District Council, also spoke in favour of the bill. The Ilford Council had an electricity supply undertaking as well as a tramway undertaking, and there was a considerable balance. He had no hesitation in saying that the Ilford Council would prefer to take a bulk supply, on terms, rather than to extend their works.

Prof. T. E. THORPE said he had been requested by the First Commissioner of Works to attend and give any information that the Committee might desire to have with respect to the effect more particularly of sulphurous acid upon plant life. He said he had had no experience of the Greenwich station and had not examined the other electric power schemes. He could only speak in general terms of the effect of the burning of coal on plants. Taking the case of the Battersea station, where 240,000 tons of coal would be burned annually, he said that as coal contained about 1 per cent. of sulphur which in burning gave twice its weight of sulphurous acid, it meant that practically every 1 cwt. of coal gave about 2 lb. of sulphurous acid. This found its way into the air and eventually was brought down by the rain and affected vegetation and buildings, by being converted into sulphuric acid. The suggestion that he had to make, in order to obviate the dangers referred to, were, in the first place, that the consumer of the coal should minimise the amount of sulphur by having the coal properly screened and hand picked. Of course, this was already done to a certain extent in order to get a certain calorific value and a reasonable proportion of ash. In addition, he suggested that the amount of sulphur should not exceed a reasonable proportion, and that the addition of a small amount of lime water to the coal would considerably minimise the amount of sulphurous acid that escaped from the combustion. Of course, from some points of view the erection of large generating stations would minimise the amount of coal burned; but on the other hand, this would have the tendency to localise the products of combustion and make their effect more serious in special areas. If the generating stations could be placed away from London all the better.

In answer to the Chairman that the engineers of the Council think that the addition of lime water to the coal would cause so much clinker as to make the suggestion unworkable, Prof. Thorpe said the quantity would be so small as to cause no ill effect.

With regard to Sir A. B. W. Kennedy's suggestion that the effect of the products of combustion at the works of the Central Electric Supply Co. were negligible owing to Welsh coal being burned, he pointed out that tests made years ago gave the Welsh coal as having a greater percentage of sulphurous acid than many others. The figures that had been obtained were as follows: 16 samples of Welsh coal, 1·42 per cent; 8 samples Derbyshire coal, 1 per cent.; 28 samples of Lancashire coal, 1·42 per cent.; 17 samples of Newcastle coal, 0·94 per cent.; 8 samples of Scotch coal, 1·45 per cent.

Mr. COWARD, for the L.C.C., pointed out that the engineers to the scheme had selected Newcastle coal, which showed the best result in the above table.

In answer to further questions by the Committee, Prof. THORPE stated that there were about 4 tons of CO_2 to the ton of coal, which, although not deleterious, was not necessary. In mild weather the atmosphere had a downward draught, and so the products of combustion would be brought down before they had time to disperse, no matter how high the chimney.

Two other witnesses were called from the Office of Works and gave corroborative evidence. They advocated some method of control at the hands of the Office of Works, which should be given by the insertion in all such bills of the proposed clause issued in the memorandum published by the Commissioner of Works. They could not state definitely the nature of the control. They had had no experience of stoking with the addition of lime.

After Mr. J. F. C. Snell had been recalled on some points of detail concerning the Sunderland undertaking,

Mr. CLODE, for the promoters, said that this was the case for the bill.

The first opposition taken was that of the Willesden Urban District Council.

Mr. TYLDESLEY JONES addressed the Committee, claiming the exclusion of Willesden from the area. He gave the history of the Willesden undertaking, from the granting of the provisional order to the Council, the erection of the generating station, and its subsequent transfer to the North Metropolitan Electric Power Supply Co. Mr. Jones was going into details, when

The CHAIRMAN said it would be better if he would at first show how the London County Council could supply Willesden without consent.

Mr. JONES said that under sections 2 or 3 of clause 11, competition was possible.

The CHAIRMAN said that the Committee would amply protect the Willesden Council against any competition, and clause 11 would be amended later, if necessary.

Mr. JONES then went on to discuss the probability of the L.C.C. unfairly competing with the North Metropolitan Power Co., which now supplied Willesden, and undercutting prices all through the area of the Power Co. This might have a serious effect upon the stability of the Power Co., and perhaps ultimately leave the Willesden Council at the mercy of the L.C.C., whose most favourable price, he said, was very little less than the one the Willesden Urban District Council was now getting from the Power Co.—viz., 0·9045d. against 1·889d.—and the Willesden Council could have this latter price revised every seven years. If the Power Co. "went to the wall," as Mr. Hammond had suggested was possible, Willesden would suffer from many disadvantages. The main one was the "permissive" supply possible under the bill. And from this he argued that, as he was eight miles away from Battersea—two miles beyond the limit of economical supply, as stated by Mr. Rider—he would not and could not be supplied at the lowest price. Emphasising his argument against only a "permissive" supply being granted under the bill, Mr. Jones pointed out that the L C.C. itself had protested against this very power being granted to the Kent Power Co., and had lodged a petition against that bill alleging that it was not to the interests of anybody that only a "permissive" supply should be granted.

Evidence was then called to confirm the statements as to the present position of electric supply in Willesden.

Some disinclination was shewn to having the agreement between the Willesden Council and the North Metropolitan Electric Power Co. placed upon the minutes, but the chairman said if it were not handed in for this purpose, the committee could take no notice of the reference to it by Mr. Jones.

Mr. JONES said there was no objection to his opponents seeing the agreements, but he did not wish to expose publicly all the contents of the agreement.

The CHAIRMAN replied that there were things in the agreement that had not been mentioned.

Mr. JONES, after consultation with the officials of the North Metropolitan Electric Power Co., said he agreed to it being handed in.

The Committee adjourned until Tuesday.

A NEW SINGLE-PHASE RAILWAY

London Outer Circle Railway Bill.

A Committee of the House of Commons, presided over by Sir G. Doughty, commenced the consideration of this bill on Tuesday. Mr. C. A. Cripps, K.C., Mr. Hutchinson and Mr. Lynden Macassey appeared for the bill, which is opposed by the Great Eastern, Great Western, North London, Midland and London & North-Western Railway Co.s. Originally some 20 local authorities petitioned against the bill but now only West Ham appeared.

Mr. CRIPPS, in opening the bill, said that it was a proposal to construct a railway on the outskirts of London, making junctions or connections with all the existing railways en route, and linking up the following districts, all of which are north of the River Thames: Feltham, Southall-Norwood, High Wycombe, Greenford, Wembley, Hendon, Finchley, Wood Green, Southgate, Tottenham, Ilford, East Ham and West Ham. The interesting part about this line, which is 32½ miles long, is that it is intended to adopt the single-phase system of traction, but counsel refrained from going into details. The capital of the proposed new company is £4,500,000 in ordinary £10 shares, and £1,500,000 borrowing powers. The total estimates for the construction of the line amounted to £3,320,000 exclusive of equipment, and of this sum £1,000,000 will be required for the purchase of the necessary lands. Mr. Cripps described the financial position of the promoters as unassailable, and in support of this statement gave the following list of promoters—and incidentally mentioned the names of Lord Avebury, Lord Fortescue, Lord Montague of Beaulieu as supporters of the scheme—Mr. R. H. Cox, Mr. E. L. Franklin, Mr. F. S. Franklin, A. H. Keyser and Zonen, Mr. A. Keyser, Kleinwort, Sons & Co., Mr. D. H. Leverson, Mr. H. N. Lubbock, Sir Samuel Montagu, Mr. W. H. Morrison, the National Electric Construction Co. (Ltd.), B. Newgass & Co., Mr. A. Oppenheim, Mr. G. R. Pember, Perry & Co., Price & Reeves, Rodocanachi, Sons & Co., Ruben & Ladenburg, Mr. L. B. Schlesinger, J. & A. Scrimgeour, Stern Bros., Mr. P. H. Wade and Mr. Max Warburg. The terminus of the railway at West Ham will be close to the docks. £500,000 was estimated as the cost of a generating station, but it might possibly turn out that electrical energy will be purchased from some of the large sources of supply which were now being suggested.

Sir JOHN WOLFE BARRY, K.C.B., whose firm are acting as engineers to the line, gave evidence in support of the scheme as outlined by Mr. Cripps, and was cross-examined at great length on behalf of the Great Western and other railway companies as to the probability of there being sufficient traffic along the route to make the undertaking a commercial success in view of the already ample facilities which exist. Sir John Wolfe Barry's opinion was that there would be an enormous traffic in the districts touched by the line, and this was clearly emphasised in the report of the Royal Commission on London Traffic. It would be a cross route traffic, and should greatly assist the existing lines by linking them up.

Mr. J. S. CONACHER, the general manager of the Metropolitan Electric Supply Co., and late general manager of the North British and the Cambrian Railway Cos., gave general evidence in support of the line, and was also cross-examined on the question of competition.

Lord AVEBURY gave evidence in favour of the line on ground of public necessity. There was no doubt as to the capital being raised. He supported all the statements hitherto made in favour of the bill.

Mr. W. FORBES, General Manager of the London Brighton & South Coast Railway, also gave evidence from the point of view of one of the railways that would be linked up by the new line. He dealt with the facilities which would be granted for the carriage of goods which at present greatly disorganised the ordinary traffic.

The Engineering witnesses had not yet been called.

The Committee adjourned.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER BILL.

The consideration of this bill by a Committee of the House of Lords was commenced on Monday. Mr. Wedderburn, K.C., Mr. Hutchinson, Mr. L. Macassey appeared for the bill, and the opponents are the Birmingham Corporation, the Wolverhampton Corporation, the Handsworth Urban District Council, the West Bromwich Corporation, Oswestry Corporation, Shrewsbury Corporation, Walsall Corporation.

Mr. WEDDERBURN, K.C., in opening, said that the object of the bill was to extend the area of the Shropshire, Worcestershire & Staffordshire Electric Power Co., which was originally granted to them in 1901, so as to include an "island" of territory which was located between a number of other electric power companies, and which had been left without an electric power company to supply it. The districts which it was proposed to include were Birmingham, Walsall, West Bromwich, Wolverhampton, Wednesbury, Smethwick, Amblecote, Bilston, Brierley Hill, Coseley, Darlaston, Handsworth, Perry Bar, Quarry Bank, Rowley Regis, Rugeley, Sedgeley, Tettenhall, Tipton, Wednesfield and Heath Town, Short Heath, Willenhall, Kingswinford, Shifnal, and Bushbury. The area includes all that now supplied by the Midland Electric Corpn. for Power Distribution under provisional orders, and this company, although at first opposing, had no one appearing for them. The terms of the bill were that no supply would be given except for railway and tramway purposes in the area of any authorised distributor giving a supply without consent, subject to an appeal to the Board of Trade if it was thought that the consent was unreasonably withheld. Curiously enough, commented counsel, many districts that had been completely out of the original area—*i.e.*, without any appeal to the Board of Trade by the company—had since come to the power company, and negotiations were proceeding with a view to giving a supply. The capital powers of the company originally were £300,000 and £100,000 borrowing powers. The company now asked for a further £600,000 and £200,000 borrowing powers. The company also asked for a four years' extension of the time in which they must complete the first generating station, and a two years' extension of the time within which a substantial commencement must be made. The bill also gives powers for the company to take transfers of provisional orders, and that its generating stations may be exempt from building bye-laws. Most of the opponents to the scheme, said counsel, challenged the financial position of the scheme, but he would satisfy the Committee on this point.

Mr. G. L. ADDENBROOKE said that he had taken up this scheme because he considered that, with the additional area now proposed, it was a very suitable one for an electric power company. He had placed the matter before several of his friends and a syndicate had been formed with a capital of £10,000 to promote this bill. He calculated that in the Worcestershire area there were 10,000 H.P. of machinery available for electric driving, in the Cannock Chase area 30,000 H.P., and in Shropshire 16,000 H.P. Probably throughout the whole of the area 250,000 H.P. were used.

Mr. Faithfull Begg, Mr. G. C. Howard and Mr. A. W. Tate were then called as having backed the bill and as being able to finance the company should the bill pass.

Mr. ADDENBROOKE, recalled, said that it was proposed to erect two additional generating stations, one to the south of Birmingham and another in Hammerwich. All the generating stations would be linked up by a duplicate system of ring mains, so that every large factory, at any rate, could be approached from two directions. Working agreements were now being arranged with the Midland Electric Corporation & Power Distribution, the Birmingham & Midland Tramways Co. and the Kidderminster and District Electric Lighting & Traction Co.

The CHAIRMAN said that the Committee were not satisfied that the capital could be raised, and they wanted something more tangible in the shape of a guarantee than had yet been given. They were not clear that the syndicate might not sell the undertaking after they had got the bill.

After some re-examination of the witness, Mr. WEDDERBURN, K.C., for the promoters, gave a guarantee that the syndicate would not sell the bill, and that it would also undertake to raise a further £10,000 of capital before the other House was reached. With regard to the capital of the parliamentary company, he would give a guarantee that the powers of the bill were not exercised until £300,000 had been raised or secured to the satisfaction of the Board of Trade within, say, 18 months.

The committee adjourned.

NORTH-WEST LONDON RAILWAY BILL.

Mr. Compton Rickett's Committee of the House of Commons further considered this bill last week and again this week.

Mr. W. L. MADGEN, a promoter of the bill, said he did not think there would be any difficulty in raising the necessary capital. The Brush Company had spent £40,000 in promotion fees, and the company would probably be prepared to invest a further £100,000. If the company did not get the contract for the plant, however, he thought it might have to consider its position. The total length of railway was six miles, and it was intended that the trains should cover the distance in 17 minutes. The fares had not yet been fixed, but he thought they would average 2d. per passenger.

In cross-examination, Mr. MADGEN admitted that the Board of Directors at present consisted entirely of nominees of the Brush Company. About 36 million passengers per annum at an average fare of 2d. would be required to pay 5 per cent. dividend.

After hearing financiers in support of the scheme,

The CHAIRMAN announced that, if the bill were passed, a time limit would be imposed within which the railway should be commenced, and a substantial portion of the capital raised. The Committee also desired that the £100,000 which the Brush Company had undertaken to subscribe should be a matter of fixed contract, and that, if the company secured the order for the plant, it should be on terms considered fair and equitable by an independent referee or arbitrator.

Local and railway evidence in support of the proposal was then heard, and, later, evidence as to the proposed exchange stations.

Sir DOUGLAS FOX, one of the joint engineers to the scheme, dealt with the petitions against the bill on the question of vibration, and said that the standard clause dealing with this matter was, in his opinion, quite sufficient to safeguard all interests. He entirely dissented from the proposal which had been made by the promoters of the Hammersmith, City & North-East London Railway to have a physical junction with the line at Marble Arch, and should resist it to the utmost.

Mr. MOON, for the promoters, asked that it should not be put upon the promoters to make agreements with the other railway companies as to interchange of traffic before the line was proceeded with. He would be quite content with a clause that the line should not be opened until the subway communications defined in the bill had been made.

The CHAIRMAN said the Committee would carefully consider the point, which was one that they attached great importance to.

Col. YORKE, chief inspecting officer of railways to the Board of Trade, who was called at the request of the Committee, stated that the Board was substantially satisfied with the provisions made for the safety of the public on tube railways as they were at present.

Sir BENJAMIN BAKER disagreed with the suggestion that the diameter of the tubes should be increased. It would so increase the cost of construction as to make the construction of tube railways impossible from a commercial point of view.

Mr. STEPHEN SELLON gave statistics as to the estimated traffic which the lines would attract. Between 50 and 60 million passengers now travelled by omnibus from Cricklewood to Victoria, but he had estimated that the railway would take 36 millions which at an average fare of 2d. would produce gross receipts to the value of £300,000, from this he deducted 50 per cent. for working expenses.

In the course of cross-examination Mr. SELLON admitted that he had estimated for a passenger traffic of 35 millions a year on the Baker Street & Waterloo Railway, but that so far this anticipation had not been fulfilled. He pointed out, however, that when the line was completed from Paddington to the Elephant and Castle his estimate would be found not to be far out.

Prof. T. E. THORPE was called by the Committee and discussed the memorandum recently issued by the Commissioners of Works with regard to the abatement of the smoke nuisance from generating stations in London. This memorandum was given in full in our issue of May 4. He stated that the suggested clause given at the end of the memorandum had not yet been discussed either by the House of Commons or by a Committee, but he understood that it was to be considered by the Committee now dealing with the London County Council Electric Supply Bill.

Mr. MOON, for the promoters, gave an undertaking that as any clause agreed upon in this connection would be of universal application it should be inserted in this bill.

MISCELLANEOUS.

Newport Corporation Bill.—The chief proposal contained in this bill, which was considered by Earl Lauderdale's Committee of the House of Lords last week, was to carry on the hiring of fittings, motors, &c., in connection with the municipal electric supply undertaking in Newport. Despite the opposition of the Gas Co., the preamble of the bill was found proved.

Twickenham & Teddington Electric Supply Bill.—This bill, which has been passed by the Unopposed Committee of the House of Commons, confirms agreements with the Hampton & Teddington Urban District Councils, and authorises the company to lay mains from its Twickenham power house to supply other districts. Powers are taken to supply energy in any adjoining districts.

Ascot & District Gas (Electric Lighting) Bill was passed by the Unopposed Committee of the House of Commons last week. It authorises the company to supply electricity in its area.

Brixham Gas (Electric Lighting) Bill.—This bill was also passed by the Unopposed Committee of the House of Commons last week. It authorises the company to supply electricity in Brixham.

North-East London Railway Bill.—This bill was passed by the unopposed Committee of the House of Commons last week. The company was authorised by a special act, last year, to construct a tube railway from the City to Waltham Abbey, and it now seeks to raise additional capital to the extent of £333,000 for the acquisition of additional lands and the purchase of additional rolling stock, in order to increase the three minutes service to a two minutes service.

North and South Shields Electric Railway Bill.—The unopposed Committee of the House of Commons passed this measure last week. It gives an extension of time for the construction of a tube railway under the River Tyne between North and South Shields, which was authorised in 1902.

Edinburgh Corporation Tramways.—The Police and Sanitary Committee of the House of Commons considered the Edinburgh Corporation Bill this week. The bill relates to many matters, one of which is to extend the system of cable tramways in Edinburgh and to convert certain lines to electric traction. A horse tramway now running will also be reconstructed for electric traction. Some discussion took place as to the terms of an agreement between the Edinburgh & District Tramways Co. and the Corporation, but this related so much to matters of detail that it need not be gone into. After having heard evidence in favour of electricity as the motive power the chairman announced that the Committee passed the preamble of the bill and stated that they were not responsible for the agreement between the company and the Corporation.

The Crediton Lighting & Power Bill was passed by the Unopposed Committee of the House of Lords on Tuesday. The bill incorporates a new company to acquire the existing gas company and also the Crediton Provisional Electric Lighting Order.

The County of Durham Electric Power Supply Bill was passed by the Unopposed Committee of the House of Lords on Tuesday. The bill exempts the company from certain provisions of the Electric Lighting Acts, and there is a general enlargement of the powers of the company, including authority for a power consumer to use a certain percentage of energy for lighting. Certain agreements have been come to, however, with some of the larger municipalities, in order to do away with their opposition, which will modify certain parts of the bill as applied to them. The bill also authorises working agreements with the Newcastle-on-Tyne Electric Supply Co. and with adjacent undertakers for mutual supply. Railways, canals and Government departments are included as the company's potential consumers. Powers to erect overhead wires are asked for, with an appeal to the B.O.T. should the consent of the local authority be unreasonably withheld. It is also asked that the County of Durham Electric Power Distribution Co. should be exempt from the provisions of the Electric Lighting Acts relating to non-association with other undertakings. A new tariff is scheduled to the bill by which the company shall charge £1 per kilowattt per quarter and ¾d. per unit, including transformation.

London Tube Railways.—Stoke Newington Council are petitioning Parliament to consider the Hammersmith, City & North-East London Railway Bill this Session.

The Preston, Chorley and Horwich Tramways Bill and the South Lancashire Tramways Bill were read a second time in the House of Commons on Monday.

The Macclesfield and District Tramways Bill was read a second time in the House of Lords on Thursday, last week.

The Folkestone, Sandgate and Hythe Tramways (No. 1) Bill will not be proceeded with.

The Nottinghamshire and Derbyshire Tramways Bill and the North Metropolitan Tramways Bill were read a third time in the House of Lords on Monday.

THE NATIONAL PHYSICAL LABORATORY.

In the House of Commons last week Mr. WILLIAM PEARCE asked the Secretary to the Treasury whether commercial tests, chemical or physical, were being undertaken at the National Physical Laboratory, or were included in the circular of charges of the laboratory; and, if so, whether such competition with private practitioners would be stopped, as being contrary to the recommendations of the Treasury Committee in 1898 and to the declared objects of the laboratory.

Mr. M'KENNA, in a printed reply, said that, except for Government work and for some few special cases which came individually before the Committee, chemical analyses were only undertaken at the National Physical Laboratory when required to elucidate some physical or mechanical question under investigation. The average number of chemical tests of all kinds during the past three years had been 39. The number of physical tests made and of instruments tested had averaged nearly 30,000. Physical tests, including tests on instruments, were undertaken in accordance with the recommendation of the Treasury Committee of 1898 establishing the laboratory as a public institution "for standardising and verifying instruments, for testing materials, and for the determination of physical constants." The members of the Treasury Committee, with one exception, became original members of the Executive Committee, and they had been careful to keep their work within the terms of the report. The Committee were fully prepared to consider any complaints which may be made as to the nature of the testing work done and their rates of charges.

MOTOR OMNIBUSES v. TRAMWAYS.

In the House of Commons on Tuesday a discussion took place on the motion of the second reading of the Mersey Railway Bill. Mr. VIVIAN moved the rejection of the bill, special objection being taken to clause 51, which empowered the Mersey Railway Co. to run motor omnibuses in Birkenhead, as this would entail competition with the municipal tramways. He also pointed out that when the railway was first established, the only means of communication between Birkenhead and Liverpool was a ferry owned by the Birkenhead Corporation, and the Corporation was awarded £50,000 compensation for injury to this ferry by the construction of the railway. Only £20,000 had been obtained, however, and the Corporation have been obliged to take the balance in debentures upon which no interest was paid. Apart from this local aspect of the matter he submitted that it was not desirable to confer indiscriminate powers upon existing monopolies. After several speakers had supported the motion on the ground that the passing of the bill would create a dangerous precedent,

Mr. WHITELEY advised the withdrawal of the rejection of the bill and to move an instruction to the Committee to which it was sent to delete clause 51.

This course was agreed to, and after some discussion the House divided, with the result that the instruction to the Committee was carried by a majority of 91.

ELECTRIC RAILWAY ACCIDENTS.

In answer to a question by Mr. Weir in the House of Commons on Tuesday, Mr. LLOYD-GEORGE, the President of the Board of Trade stated that one fatal accident had been reported to the Board of Trade since March 1 as having been caused by electric shock on the Lancashire & Yorkshire Railway. This had happened to a man who was trespassing on the railway about a quarter of a mile from Freshfield station on May 8. There had also been two other fatal accidents to persons crossing the lines at Freshfield within the last two months, but not due to electricity, the unfortunate individuals having been knocked down by trains. The Board of Trade was in communication with the company on the question.

TRUNK TELEPHONE LINE DELAYS.

In answer to a question by Mr. Dunn in the House of Commons on Wednesday as to delay in the trunk telephone service between London and the West of England,

Mr SYDNEY BUXTON in a printed reply, stated that a trunk telephone circuit between London and Exeter was in course of construction, in order to provide a more direct means of communication between London and the Devonshire and Cornish towns than at present exists. The delay was, however, not so much due to the want of this direct line as to the non-completion, owing to the difficulties of obtaining wayleaves, of a trunk circuit between London and Bristol which was commenced two years ago. The work was now, however, being pushed on. The delay did not, as a rule, exceed an hour and, pending the completion of the new circuits, every endeavour was being made to give as good a service as possible.

LEGAL INTELLIGENCE.

Norwich Corporation v. Norwich Electric Tramways Co.

This case came before the Court of Appeal (Lords Justices Vaughan Williams, Stirling and Fletcher Moulton) on Tuesday on the appeal of defendants from the judgment of Mr. Justice Phillimore (reported in *The Electrician* for July 15, 1904). The action was originally brought to recover £53 odd paid by the Corporation for the repair of roads said to have been injured by the company, and both parties sought a declaration as to their respective rights under sec. 57 (5) of the Norwich Tramways Act, 1897. The Norwich Tramways Act, 1897, incorporated the provisions of the Tramways Act, 1870. In some cases the roads were made with macadam, the tramways being laid in granite setts, and which had a line of granite setts next the road. The Corporation had to repair the ridges formed by reason of the macadam becoming worn at certain points. The company's contention was that it became necessary to do this because the surface of the macadam was bad, and that the whole of it was in need of repair. Mr. Justice Phillimore, however, decided that in the greater number of cases the macadam was in sufficiently good repair. With regard to the places where the macadam was worn down below the surface of the setts, the Corporation contended that the company should pay the cost of the repairs in such cases, but the company said that the expense fell on the Corporation. Mr. Justice Phillimore held that it was intended to throw upon tramway companies, as a condition of the privilege given them, the duty of maintaining the even contour of the road by a proper junction of the two surfaces, and he gave judgment for plaintiffs for the amount claimed with 5 per cent. interest. He also made a declaration "that the obligation of the company under sec. 57 (5) of the 1897 Act, to maintain and keep in good condition the junctions therein mentioned, involved the maintenance by the company of a uniform and unbroken contour of such surface immediately adjoining such paving or the lowering of the pavement itself."

Mr. DANCKWERTS, K.C., for appellants, said that the appeal was based on two grounds—first, that the learned judge had no jurisdiction in the matter; and secondly, that the decision on the merits was wrong. Two of their lordships had had the case before them before (see *The Electrician* for Feb. 24, 1905, and Jan. 12, 1906), but they had adjourned it in order to see what the House of Lords did in the case of "Crossfield *v.* Manchester Ship Canal Co." In that case the House of Lords affirmed the decision of the Court of Appeal. The jurisdiction point was not taken at the trial, but it was a point of law which requires no evidence one way or the other.

Lord Justice MOULTON: The House of Lords has held that the omission to plead does not omit jurisdiction.

Mr. DANCKWERTS thought that in the present case the learned judge had gone wrong by treating the surface as the mathematical plan of the street. Where there was a softer material than macadam there was a greater wear and tear, and the result was that certain grooves were formed of greater or less width. The learned judge held that in such cases it was the business of the company to repair some undefined portion of the macadam alongside the granite and the wood.

Mr. MACMORRAN, K.C., for the Corporation, submitted that the want of jurisdiction point had been taken too late, and that jurisdiction was given by sec. 57 of the 1897 act. If the case went before an arbitrator he would be sure to be asked in the end to state a special case.

On the conclusion of the legal arguments, Lord Justice VAUGHAN WILLIAMS, in giving judgment, said the point made by Mr. Macmorran, that it was too late to raise the jurisdiction point, was, in his lordship's opinion, wrong. Want of jurisdiction could be raised at any time, and defendants were not estopped from raising it in that Court. Sec. 33, if it applied at all, did oust the jurisdiction of the High Court, because it appointed a special tribunal to settle these disputes. Speaking for himself, he thought they must read sec. 33 of the Tramways Act, 1870, just as if it had been printed as part and parcel of the special act, and he thought under those circumstances objection could not be made that sec. 33 only applied to disputes which were defined in sec. 33 of the act of 1870. It was contended by Mr. Macmorran that sec. 33 had no application to such disputes, but, having regard to what had been already said, he saw no foundation for that argument, and he thought the special objection failed. That only left him to deal with the application of sec. 33. He could only say that sec. 33 had appointed a special tribunal which was to deal with disputes of that sort, and had to that extent ousted the jurisdiction of the High Court. He thought the decision of the House of Lords affirming the decision of the Court of Appeal in the case of Crossfield *v.* Manchester Ship Canal Co. was really conclusive on the point raised, and that in the present case the jurisdiction of the High Court was ousted. The appeal should therefore be allowed.

Lords Justices STIRLING and MOULTON concurred, and the appeal was accordingly allowed. Their lordships directed that defendants should pay plaintiffs' costs in the Court below and their own costs of the appeal.

F. A. Glover & Co. (Ltd.) v. Delta Metal Co. (Ltd.)

On Tuesday this case came before Mr. Pollock, official referee. Plaintiffs claimed £682. 10s. for materials supplied, work done and labour in connection with an electric light installation for defendants under a contract dated March 7, 1905, and for additions and extras involved. The defence was that one of the conditions of the contract provided that payment should be made on the certificate of the engineer up to 50 per cent. of the value of the completed work, and the balance on the engineer certifying that the whole of the works were completed to his satisfaction, provided always that no certificate should relieve plaintiffs from any liability under the contract. The engineer had never certified that the works were completed to his satisfaction, and defendants contended that plaintiffs were, therefore, not entitled to recover any part of the balance of the £935. 14s. 1d. for work and labour done and materials supplied. With reference to items amounting to £15. 11s. 2d. for changing dynamo pulleys, and men's time running plant and charging accumulators, defendants said the condition was never complied with. Alternatively they pleaded that the items arose in respect of work which was not done at their request and which was not necessary under the contract. Particulars of defects and imperfections in the work had been delivered to plaintiffs, but they refused to complete same. Defendants further said that they would be compelled to complete the contract by other contractors at a cost of £250 to £400, and that they were entitled to deduct that amount from plaintiffs' claim. Defendants paid £250 into court in satisfaction of plaintiffs' claim, and contended that this was sufficient to satisfy it without taking into account their counter-claim. By the contract plaintiffs undertook to complete the installation within six weeks from date of receiving instructions to commence work by defendants' engineer, which was March 14, and on Dec. 8, 1905, their men were withdrawn. By one of the conditions of the contract it was provided that should plaintiffs not complete the works in accordance with the conditions they should pay to defendants by way of liquidated damages £5 per day for every day the work remained uncompleted. Part of the delay was caused by matters for which plaintiffs were not responsible, and defendants were willing to allow plaintiffs five months for the delay so caused. Alternatively defendants pleaded that they had suffered great inconvenience and loss through plaintiffs withdrawing their men on Dec. 8, and had been compelled to lay on a supply of gas in their workshops, the cost of which amounted to between £60 and £70, and they would be put to further expense until the installation was made in accordance with contract. In their particulars defendants alleged that the dynamos provided by plaintiffs were not capable of giving 150 amperes at 100 volts, the specified output at a specified speed not exceeding 850 revs. per min., or a corresponding output at any voltage up to 140. Defendants also said that the dynamos were not suitable for charging the battery. Other faults in the dynamos and various defects on the switchboard were represented by defendants, who further alleged that certain work in connection with the installation which was not executed so as to comply with the rules of the Institution of Electrical Engineers or the requirements of the fire insurance companies.

In reply PLAINTIFFS denied that the terms of the contract were correctly stated by defendants. They alleged that on Dec, 11, 1905, Mr. Jenkinson, defendants' engineer, after inquiring into all the matters alleged in letters written by defendants, decided and allowed plaintiffs' claim at £935. 14s. 1d., and gave a certificate that they had finished their work and were entitled to that sum. Plaintiffs submitted that defendants were not entitled to go behind this certificate and were estopped thereby. Plaintiffs denied that the work was not finished at the time of giving the certificate. Alternatively they said that so far as it was not finished it was occasioned by defendants' own conduct, and that they had always been ready and willing to complete such part of the work as they were bound to complete in accordance with the terms of the contract. Plaintiffs denied that any of the work had been done imperfectly or improperly, or that they had refused to remedy same, or that defendants to complete the contract would have to pay other contractors from £200 to £400. They specifically denied every allegation to the contrary delivered in defendants' particulars. The whole of the work, plaintiffs represented, was submitted to, approved and passed by the defendants' engineer, and was in accordance with the contract.

In a rejoinder DEFENDANTS submitted that their engineers had given no final decision on the matters in dispute, and that the document of Dec. 11, 1905, was neither a certificate nor a final certificate, and was of no legal value.

The case had not concluded at the time of going to press.

Tramway Rating.

In the High Court on Tuesday, Justices Ridley and Darling heard three motions involving questions of rating tramways of the Yorkshire (Woollen District) Tramways Co. in Liversedge, Heckmondwike and Thornhill.

Mr. L. DAVIES, for the company, said that in each case a rule nisi had been granted calling upon the justices to show cause why they should not state cases for the opinion of the Court. No one appeared on the other side, and he asked for the order to be made absolute. The question at issue was whether the company's light railways were, under the Public Health Act, 1875, to be assessed as a railway at one-quarter their full value. The company proposed to all the authorities to pay the rate in full, the ultimate liability to depend upon the decision in the Wakefield Light Railway case (reported in our issue of April 13). Most of the authorities assented to this course, and the company paid the rate in full, being given an undertaking to refund three-fourths of the amount if the decision in the Wakefield case were favourable to the company. Three local authorities would not do this, and the company paid the quarter, and ordinary proceedings were taken with regard to the rest. They appeared before the justices and took the point that they were entitled to exemption, but this was overruled.

Their Lordships made the rule absolute, but refused to order the justices to pay the costs.

London Electrobus Co. (Ltd.)

Mr. EVE, K.C., on Friday, moved before Mr. Justice Swinfen Eady to rectify the register of the above company by removing the names of several applicants who, he said, had been induced to apply for shares on a prospectus which was inaccurate and omitted certain material facts.

Mr. COLEFAX, for the company, said the directors appreciated that some of the statements in the prospectus required qualification and some amplification, and they were getting together the further information, which would be embodied in a circular to be sent to the shareholders, who would be given an opportunity of claiming to withdraw, which would then be acceded to. He thought that should meet the views of the applicants, and if the motion was allowed to stand over for a week he would give an undertaking not to part with the moneys of the company in the meantime. The company had not commenced business and did not propose to acquire the certificate entitling it to do so until these matters were disposed of. The money was all intact.

His LORDSHIP: But would it remain intact if the company went into liquidation? The applicants would then be unsecured creditors.

Mr. EVE said his clients had obtained all the information they wanted without the assistance of the directors and did not require a week to consider the matter.

Mr. COLEFAX said he thought it would be better for the motion to stand over until all the shareholders had been circularised.

His LORDSHIP said that it did not matter to the applicants what the other shareholders did. If they wished to leave the company they were entitled to do so.

Mr. EVE said that one of his clients sent in an application form, and next morning, seeing something in the Press, he wrote withdrawing it. He received in the same envelope the allotment form and a note that it had been sent before his letter of withdrawal had been received (laughter).

Mr. COLEFAX admitted that cases of that kind stood on a different footing.

His LORDSHIP said, unless counsel could agree, he must dispose of the motion.

Mr. COLEFAX said that if Mr. Eve persisted he could not resist the order asked for.

His LORDSHIP: The order must go as regards these applicants. Their money must be returned and the company must pay the costs of the motion.

In Campbell *v.* London Electrobus Co. (Ltd.) an order was also made for the rectification of the register by removing plaintiff's name.

In the case of Byrne and others *v.* the London Electrobus Co. (Ltd.), before Mr. Justice Joyce, the plaintiffs accepted an undertaking by the company not to part with any of the money paid by applicants for shares except to shareholders applying on the form sent with the promised circular. The company also undertook not to take proceedings to forfeit shares for non-payment of instalments.

The case of Obree and others *v.* London Electrobus Co. (Ltd.) was adjourned for a week.

In re Crigglestone Coal Co. (Ltd.)

The hearing of the winding-up petition presented by the British Insulated & Helsby Cables (Ltd.) was resumed before Mr. Justice Buckley on Tuesday, the petitioners being creditors for about £700 for electric cables supplied.

The defence was that the assets of the Coal Co. were all covered by debentures for securing amounts much greater than the value of the assets, and that under the circumstances nothing could be obtained by a winding-up order, whereas such an order would probably seriously injure the debenture holders by causing a forfeiture of the lease of the mines.

His LORDSHIP asked if the receiver for the debenture holders was prepared to return the cables.

COUNSEL replied that this could not be done without the consent of all the debenture holders.

His LORDSHIP said the present state of the law where debentures created a floating charge on the present and future assets of the company caused great injustice to unsecured creditors. He would take time to consider his judgment.

Workmen's Compensation.

On Monday the House of Lords (the Lord Chancellor, Lords Davey, James of Hereford, Robertson and Atkinson) delivered judgment in the case of Back v. Dick, Kerr & Co. (Ltd.), which was an appeal from a judgment of the Court of Appeal (reported in the *The Electrician* for May 12, 1905) reversing an award, under the Workmen's Compensation Act, of Judge Lush Wilson at Exeter County Court.

The appellant was a labourer in respondents' employ, and on Aug. 17, 1904, he was injured whilst unloading and stacking tramrails at the London & South-Western Railway yard, Exeter. The rails were used by respondents in converting the tramway lines to electric traction, and at the time of the accident respondents were engaged in taking up the old horse tramway lines, at a distance of about 700 yds. from the scene of the accident. The County Court Judge found that the site upon which the rails were stacked in the yard was "on or in or about an engineering work," and he made an award in favour of appellant for 7s. 6d. a week, with costs.

This award was, however, upset by the Court of Appeal, and the Lords of Appeal have now confirmed (by three to two) this decision.

Marconi International Marine Communication Co. (Ltd.) and Another v. Lloyds.—On the application of Mr. Eve, K.C., on Friday, Mr. Justice Swinfen Eady consented to hear this action for Mr. Justice Farwell on May 22. It was stated that the action was brought on a compromise which had been effected and involved the construction of an agreement. Expert wireless telegraphists from Ireland and other places would be called.

Underground Telegraph Wires.—The secretary of the Association of Chambers of Commerce of the United Kingdom (Sir Edward Fithian) has received a letter from the Postmaster-General announcing that the underground line between London and Glasgow has been completed.

The line was begun in 1896-7, and reached Birmingham in 1900. In 1902-3 it reached Warrington, and at that point it cut an existing underground line between Manchester and Liverpool. It has been continued to Glasgow through Carlisle. The spur line to Manchester has been continued through Bradford to Leeds. In the south an underground line has been laid from London eastwards as far as Chatham, and westwards as far as Slough, and thence a pipe, but not yet a cable, as far as Reading. During the present year the Postmaster-General hopes to extend this pipe-line to Bristol, and to provide a cable as far as Chippenham. The intention is to carry the line into Cornwall, to the landing places of the important Atlantic and Mediterranean cables which are located there.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Southwark Borough Council require a charge engineer for their electric light station. Commencing salary £2. 5s., rising to £2. 15s. Applications (on forms to be obtained from the Town Hall, Walworth-road, London, S.E.) to the town clerk, Mr. J. A. Johnson, by noon 28th inst. See an advertisement.

The Central Electric Supply Co. require a junior assistant with experience of high-tension alternating current. Commencing salary £100 per annum. Applications to Resident Engineer, 3, Lodge-place, St. John's Wood, London, N.W. See an advertisement.

A laboratory assistant is wanted in the department of electrical engineering of the Glasgow and West of Scotland Technical College. Applications to Prof. Magnus Maclean. See an advertisement.

An assistant chief engineer is required by a large and well-established company engaged in the manufacture of all kinds of electrical apparatus. Candidates must be capable of designing D.C. and A.C. plant of any size and of superintending construction and installation. See an advertisement.

An electrician is required for service on the Gold Coast Government Railway. Salary £300 per annum, with free single furnished quarters, and first-class passages out and home. Application to Messrs. Baker & Shelford, Consulting Engineers, 35A, George-street, London, S.W. See an advertisement.

A fitter is required in the electric light department by the Government of Lagos. Applications will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., on or before May 21.

Paddington (London) Council require an assistant engineer at Paddington Infirmary, accustomed to electric lighting machinery, &c. Wages 38s., rising to 40s.

The governing body of Battersea (London) Polytechnic invite applications for the position of head of the department of electrical engineering from September next. Particulars from the secretary.

Mr. Arthur Blok, A.I.E.E., of East London College, has been appointed chief lecturer in electrical engineering at Croydon Polytechnic.

EDUCATIONAL NOTICES.

East London College.—A course of six lectures on "Extra High-tension Cables," dealing with some of the points in the manufacture and testing of these cables, will be delivered at this college, Mile End-road, London, E., on Mondays, from 8 to 9, commencing 21st inst., by Mr. J. T. Morris, M.I.E.E. The fee for the course is 5s. Syllabus can be obtained from the Registrar, or the director of studies, Mr. J. L. S. Hatton, M.A.

Northampton Institute.—On Tuesday a grant was made by London County Council to the Governors of this Institute for the equipment of an intermediate laboratory for electrical engineering.

Argentina.—During the past year the length of Government telegraph lines was increased by 622 km. (385·6 miles).

The "Review of the River Plate" states that Mr. Gandulfo's concession for electric tramways in Avellaneda has been extended by La Plata legislature to 60 years.

The new mayor of Buenos Ayres disapproves of the contract signed by his predecessor with the Compañia Alemana Transatlantica de Electricidad, as he considers the tariff too high.

Rosario Municipality have received a tender from the A.E.-G. for 857 arcs for public lighting at $12·40 (gold) per month inside the Boulevards and $15·10 outside. The Gas Co. tendered at $11 (m/n) per lamp per month. The Rosario Electric Light Co. did not tender.

A partial stoppage of the electric tramway service of Santiago de Chile recently occurred (says the "Review of the River Plate"), because the owning company had "run out of carbon brushes for the motors."

Australasia.—The "Australian Mining Standard" says the Government have refused to sanction the project of the Waihi Gold Mining Co. (Thames, N.Z.) to employ the water power of the Hora Hora rapids for the generation of electricity as the Government propose to themselves erect works at Huka Falls, Waikato River.

The Government have now practically acquired the horse tramways of Adelaide (S. Australia) and will convert them to electric traction. The directors of the various concerns have agreed to accept sums which will aggregate £280,000, and the agreement now only awaits formal sanction by Parliament and by the shareholders of the companies.

The annual report of the Launceston (Tasmania) city electrical engineer (Mr. Wm. Corin) for the past year states that the revenue of the electricity department was £13,097 (against £12,292 in 1904) and the net profit £1,552 (against £2,179), the decrease being accounted for by the difficulties which had to be overcome during the work of changing the system of generation during the year. When the new three-phase plant is in full working order, it is expected that the profit will be increased by £600 or £800 per annum, and that the cost of future extensions can be met out of profits. The motors connected aggregate 424 B.H.P. (against 218 B.H.P. last year).

Wellington (N.Z.) municipal electric tramways earned a profit of £12,000 during the past year.

Belfast—The annual report of the city electrical engineer (Mr. Victor A. H. M'Cowen) states that for the year ended March 31 the total output was 4,502,049 units.

1,966,955 units were supplied to the tramways and 2,535,094 sold for lighting and power, against 2,290,872 for the previous year, an increase of over 10 per cent., the increase in lighting units being 9 per cent. and in power 13½ per cent. The total revenue was £37,453, and the revenue from lighting and power supply and motor rents amounted to £30,793, an increase of 9 per cent., the average price being 2·857d. The cost of production had been reduced to 0·918d., against 1·18d. per unit. Mr. M'Cowen hopes to further materially reduce this during the present year. when the department settles down into normal running conditions. The equivalent of 235,774 8 c.p. lamps is connected to the mains (an increase of 45,928), including an equivalent of 3,038 H.P. in motors. The department had applications for 7,479 8 c.p. lamps in hand. The gross profit was £20,225. After providing interest and sinking fund the net profit was £6,691, which Mr. M'Cowen recommends should be placed to renewals suspense account. Further reductions in the charges for electrical energy, to take effect from July 1 next, are foreshadowed, and Mr. M'Cowen states that he will submit his suggestions at an early date. The maximum load during the winter occurred on Dec. 22, and amounted to 4,375 kw. (2,615 kw. for lighting and 1,760 kw. for traction). The maximum traction load occurred on Easter Monday. and reached 2,475 kw. The new plant on order should see them safely through the next winter, but Mr. M'Cowen anticipated that it would be necessary to provide further plant for the winter of 1907. The new plant installed under the tramway contract has not yet been taken over. The contractors are making various alterations and adjustments, and they hope to be ready for the official tests shortly. The underground feeder cable section of the contract has been completed and taken over. The contractors are still working on the overhead equipment, but this should be soon completed.

The gross profit on the tramways was £33,226, and after paying interest and sinking fund, &c. (£40,597), the net deficit is £7,371.

An inquiry was held here last week into the application of the Corporation to borrow (among other sums) £10,000 for electric lighting extensions.

The city electrical engineer (Mr. VICTOR A. H. M'COWEN) said the loan was made up as follows: £1,835 for sub-station at Fortwilliam, £2,265 for mains, £1,400 for sub-station plant for supplying Cavehill and Whitewell tramways, £3,000 for small extensions in the city, and £1,500 for meters. They had an agreement with the Cavehill and Whitewell Co. by which the Corporation was to receive a minimum of £1,250 per annum for their supply. The amount apportioned was 150,000 units at 2d., further 25,000 units at 1¾d., and beyond 1½d. They had various inquiries for current from the Fortwilliam district, and the cost of this extension would be about £4,100.

There was no opposition.

Bermondsey (London).—A special meeting of the Council is to be held on July 3 to consider a recommendation from the Electricity committee to apply for a provisional order authorising the Council to supply electricity in the old parishes of St. Olave and St. Thomas and St. John, Horselydown.

Birmingham.—The Tramways committee approved on Tuesday a scheme for providing along the new tramway routes telephone call boxes to enable drivers and conductors to get into immediate communication with the depots. The boxes will be erected about 600 yds. apart. Arrangements have also been made between the Tramways and Watch committees whereby the instruments may also be used for fire brigade and police purposes.

For the year ended March 31 the electricity department sold 5,383,904 units of electric current, realising £75,094, compared with 4,645,027 units and £71,195 in the previous year.

The gross profit was £41,457. 10s. 4d., compared with £39,573. 12s. 7d. Works costs were 1·454d. per unit, against 1·584d. After paying interest and sinking fund charges (£35,359), which showed an increase of £6,575. 13s. 4d. the surplus was £6,097. 11s. 9d., compared with £10,789. 7s. 4d. This reduction is due to increased interest and sinking fund charges on the Sumner-lane works. The surplus has been carried to reserve. During the present year there will be further large capital expenditure, and it is anticipated that there will be a deficiency in the year's accounts to meet which it will be necessary to draw upon reserve. The total length of new mains laid during the past year was 15,703 yds., compared with 11,050 yds. The new lamp and motor connections during the year were equal to 30,808 16 c.p. lamps, against 16,168, including 1,508 H.P. in motors connected, as against 375 H.P.

The Electrical committee think it advisable to secure an extension of the powers obtained in the 1903 act to supply electricity in bulk outside the Corporation's area, so as to permit current to be distributed in the areas of neighbouring local authorities, and generating and transforming stations to be erected there, subject to the consent of such authorities.

Blackpool.—The traffic receipts of the tramways department for the year ended March 31 amounted to £49,803. 16s. and with other revenue the total was £50,875. 2s. 2d.

Working expenditure was £29,515. 14s. 7d., leaving £21,359. 7s. 7d. Interest, sinking fund and income tax required £14,751. 18s. 2d., and the net profit was £6,607. 9s. 5d. The disposable balance is £6,383. 12s. 5d., against £3,398. 10s. 2d. in the previous year. The estimated net credit balance was £7,429, of which £5,000 was to be devoted to relief of rates and the balance (£2,429) to be credited to reserve. Capital outlay for the year was £7,512, making the total £281,363. 10s. 6d. 7,362,132 passengers were carried and 909,746 car-miles were run. 1,215,968 units of electrical energy (1·33 per car-mile) were consumed. The average traffic revenue per car-mile was 13d. and per mile of single track £2,866. The average working expenses per car (excluding total power cost) was 5¼d. and including total power cost 7¾d. The average fair paid per passenger was 1·6d., and the everage number of passengers per car-mile 8.

Boston.—The Board of Trade have granted the application of the National Provincial Electricity Corpn. for a provisional electric lighting order, the Council having right of purchase at end of 21 years.

Brazil.—The "Brazilian Review" states that, in addition to the electrification of the Bahia tramways, works are being initiated for utilising the Tymbora falls (about 120 km. from Bahia). It is estimated that 30,000 kw. of energy can be obtained from this source.

Broughty Ferry.—The Council have received sanction to a further loan of £5,000 for electricity supply, to be redeemed within 30 years.

Cardiff.—The borough electrical engineer and manager (Mr. Arthur Ellis) reported to the Electrical committee on Tuesday that for the year ended March 31 the net profit of the electricity department was £1,588. 5s. 7d.

During the year they had installed a large amount of additional plant, but they would be fairly stationary in regard to capital expenditure for the next two or three years. But for increased loan charges the profit would have been greater. Mr. Ellis considered that the time had arrived when the department must push on; gas had come down in price during the last few weeks, and he suggested that the profit of £1,500 be carried forward in view of any reduction in revenue. At present the charges for electric current were a flat rate of 4½d. per unit, or 7d. for the first hour's use and 2d. per unit after; for power and heating the charge was 4d. per unit for the first hour and 1d. after. Mr. Ellis submitted three alternate proposals as to charging, the third of which he recommended, and this the committee confirmed. The proposal was to retain the maximum demand system at 7d. and 2d., but to reduce the flat rate to 3½d. per unit, which meant a reduction of £2,721. A flat rate of 1½d. per unit for power and heating has also been adopted, and last year's profit is to be carried forward, as suggested by Mr. Ellis.

The Council have granted the National Telephone Co. permission to lay their wires underground on the basis of a payment of 5s. per wire, the scheme agreed upon being subject to the approval of the public works committee, the city engineer, the electrical-engineer, and the waterworks engineer.

Carlisle.—The Council recently authorised the Electricity committee to fit the five boilers at the electricity works with Crosthwaite fire-bars at a cost of £400.

It was stated that the city electrical engineer (Mr. C. D. Burnet) had been carrying out a series of tests by arrangement, and the results were very satisfactory. The fire-bars had been costing about £90 per annum, and Messrs. Crosthwaite had given an undertaking that they would replace any burnt bars during the lifetime of the boilers so fitted.

Cheltenham.—The electricity department is contributing £1,000 out of the year's profits to relief of rates.

China.—In a report by Mr. Consul-General Fraser on the trade of Hankow in 1905, it is stated that a British firm has obtained authority to instal the electric light in the concessions adjoining Hankow, but that the Chinese authorities refuse to allow anything to be done in connection with the installation of the electric light in the native town. The report states also that the Chinese authorities are showing a determined disposition to curtail to the utmost the rights granted to foreigners.

Customs Decisions.—The German Minister of Finance has decided that anodes of Acheson graphite are to be classified as wares of plastic carbon and the import duty has been fixed at 3 marks per 100 kilogs upon such anodes weighing more than 3 kilogs each and 30 marks per 100 kilogs upon anodes under 3 kilogs each. The term "electrodes" in No. 908 of the new tariff is to refer only to electrodes used regularly for accumulators.

The duty on twisted (not insulated) copper wire cable imported into New Zealand is 10 per cent. ad val.

Darwen.—For the past year the net profit on the electricity department was £230, compared with a loss of about £90 in the previous year.

Devizes.—The Council have been in negotiation with a firm of consulting engineers for a transfer of their provisional order, 1904, but an agreement has not yet been arrived at.

Devonport.—The total income of the electricity undertaking for the year ended March was £17,953. 17s. 7d., including £6,816. 2s. 10d. paid by the Devonport & District Tramways Co. for current, £2,399. 4s. by the Plymouth, Stonehouse & Devonport Tramways Co., £5,932. 12s. 1d. received from private consumers in Devonport and £1,803. 7s. 6d. from private consumers in Stonehouse.

The expenses were £7,644. 2s. 1d. and the gross profit was £10,309. 15s. 6d. Interest absorbed £3,426. 18s. 6d. and depreciation £4,260. 5s. 1d., leaving £2,622. 11s. 11d. to be carried to reserve. The capital expended during the year was £6,521. 15s. 10½d., making a total of £110,118, 7s. 3½d. 2,109,095 units were generated, 473,170 units were supplied for private and 26,742 for public lighting, 1,195,988 for traction and 14,621 for power. There are 276 consumers with an equivalent of 30,320 8 c.p. connected for private lighting.

Dewsbury-Ossett Tramways.—Soothill Nether Council have decided to support this tramway scheme.

Dockyard Lighting.—The Admiralty have decided upon the strength of the staff to be employed at the generating station at Sheerness Dockyard as follows :—

Station supervisors, B class (from 42s. to 49s. per week), 2; assistant drivers and dynamo attendants (28s. to 31s. 6d. per week), 3; apprentices or skilled labourers (at one-sixth ordinary week rate per eight hours' shift, or from 28s. to 31s. 6d. per week), 2: leading stokers (31s. 6d. to 35s. per week), 2; stokers (24s. 6d. to 31s. 6d. for six days per week and paid for overtime), 4; jointer (34s. to 42s. per week), 1.

Edinburgh.—Sir Alexander Kennedy's report on the advisability of establishing a depreciation fund in connection with the electricity undertaking will be discussed at the next meeting of the Electric Lighting committee.

Egypt.—H. B. M. Consul-General at Cairo states that there are now 1,036 telephones lines in use in Upper and Lower Egypt (an increase of 457 during 1905) and that 850 additional lines are in course of construction. The telephone system has still to be extended to the provinces of Ghirgeh, Keneh and Assonan, and lists are being prepared of the villages it is proposed to connect.

Electricity in Mining.—The Lake Proprietary Co. (Ltd.) has acquired the entire share capital of a Swedish company owning 77 mining leases and extensive freehold lands and timber properties at Stora Strand and Vingnäs, Sweden, about 90 miles north of Gothenburg. The company reports that it has entered into an agreement for a supply of electric power from a local power station at very low rates (not exceeding £4 per horse-power per annum). The properties are to be developed entirely by electric power.

Exeter.—The first year's working of the Corporation electric tramways shows gross income of £14,448, expenditure £8,048. Interest absorbed £2,619 and sinking fund £1,488. £1,000 is placed to reserve and renewals fund, £519 carried forward and £500 (equal to ½d. rate) devoted to the relief of general rates. Working expenses were 7·648d. per car-mile. Current cost £2,714, and the Tramways committee are asking the Electric Lighting committee to consider the feasibility of reducing the charges they now make for current—viz , 1⅞d. per unit for the first 100,000 units and 1¾d. after.

Fenton.—Hanley Electric Light committee have dropped the negotiations for a supply of electricity in this district.

Finland.—It is announced that the Communications Department of the Senate has presented a report which sets out that the question of the introduction of electric railways is a very important one for Finland, and that it is beyond doubt possible and practicable to work the majority of the Finnish railways by electricity, power being obtained from the rivers Vuoksen and Kymmene, as well as from the Imatra Rapids. At the latter point a power station could be erected. The suggestion is made that a committee be appointed to obtain all information and report.

In 1905 the municipality of Helsingfors decided to establish its own electricity works to supply the entire communal area with electric energy for all requirements. For the purposes of the project a preliminary loan of £100,000 is to be raised, and a committee is elaborating the details and preparing plans for the supply station. The question of buying up the existing private works is under consideration. A large number of isolated installations exist at Helsingfors. There are also two firms established to supply electric light and power and the local electric tramway company has a power station of its own.

Greenock.—The Corporation have decided to extend their area of electricity supply to embrace the whole of the burgh.

Hanley.—In regard to the abstract of the annual report of the borough electrical engineer (Mr. C. H. Yeaman) which appeared in our last issue, we would point out that the works cost for 1905 was 1·35d. per unit, the total cost 1·99d. and the commercial cost (including interest, redemption and other loan charges) was 3·51d., compared with 3·72d. per unit in 1904.

The special sub-committee of the Electricity committee appointed to consider how future surpluses on the electricity undertaking should be appropriated recommend that for the present these should be carried to reserve instead of being applied to relief of rates. The Electricity committee, which has endorsed the views of the sub-committee, have also considered a report of H.M. electrical inspector of factories (Mr. G. Scott Ram) as to the transforming chambers in the borough. It is reported that an expenditure of about £2,000 will be required to make certain alterations and to bring these chambers up to date.

Letters have appeared in a local paper from the chairman of the Electricity committee (Ald. H. Coates) and the borough electrical engineer (Mr. C. H. Yeaman) on the recent report of the latter on the present condition of the electricity works (which was abstracted in our last issue). Mr. Yeaman's letter states that the Hanley works to-day bear evidence of changes which have taken place ; the older machinery, though inefficient compared with the newer, is still capable of doing what is required until means can be found to substitute something better. He advised reconstruction at a steady rate which will involve the undertaking in no financial embarrassments. A municipal electrical undertaking, he urges, cannot be judged by its net profits or surplus revenue only. If it sells cheaply and gives a reliable supply over a large area, it cannot earn many figured profits, but if its costs are low it is well managed. The size of the undertaking and its load-factor are determining features in the costs. Obviously a large works or one supplying a mixed lighting, motive-power and tramway load had an initial advantage over a smaller works or one without a tramway load. The capital expenditure is a further point. The engineering costs in one case may be lower than another, but if its loan charges are higher there is no ultimate benefit given to its owners or consumers. Mr. Yeaman concluded by expressing the view that Hanley has every reason to anticipate a satisfactory development of its electricity undertaking.

Harrogate.—The profit on the electricity undertaking for the past year was over £1,700.

Huddersfield.—For 1905 the revenue of the electricity department from the sale of electricity for public and private lighting, meter rentals, hire of motors, &c., was £24,937. 19s. 1d., being £12,564. 17s 4d. for the June half year, and £12,373. 1s. 9d. for the December half year.

The total expenses were £13,044. 1s. 1d., including cost of generation (£8,125. 14s. 10d.), distribution (£2,173. 16s. 3d.), management expenses and general establishment charges (£1,388. 15s. 10d.), rent, rates and taxes (£1,195. 17s. 4d.), and public lamp maintenance (£159. 16s. 10d.), and after allowing £19. 18s. 2d. for bad debts the balance was £11,873. 19s. 10d. Interest required £5,035. 15s. 8d., redemption of debt £4,857. 1s. 5d., and the balance (£2,052. 17s. 9d.) has been transferred to depreciation and contingencies account, bringing the latter account to £11,834. 14s. 5d. Last year the balance was £3,915. 1s. 11d. The total capital expenditure is £176,239. 10s., an increase of £266. 13s. 4d. during the year. There are 2,245 consumers, with an equivalent of 157,572 8 c.p. connected. 1,685,670 units were sold.

I.E.E. Benevolent Fund.—The eighth annual general meeting of contributors to this Fund will be held at 92, Victoria-street, London, S.W., on Tuesday next at 4 p.m., when the report of the committee of management and statement of accounts and balance-sheet will be submitted. The accounts show that at Dec. 31 the Fund possessed £2,232. 15s. 11d., of which £2,053. 18s. 3d. was invested.

India.—Messrs. Killick, Nixon & Co. and John Fleming & Co., of Bombay, are promoting a scheme for the generation and supply of electricity to the numerous mills and factories on both sides of the River Hooghly for a distance of 25 miles north of the town of Hooghly and 17 miles southward to Budge Budge.

It is proposed to run mains along each bank of the river, and the proposed area of supply embraces practically the whole of the mills and factories of the Calcutta district, which are at present using about 120,000 H.P. and are destined at no distant date to use much more. The scheme also includes supply in bulk to distributors and for electric traction. No lighting powers are requested for direct supply except to persons taking power. At the outset only one generating station will be built, but it is projected ultimately to build two. The mains will cross the river at three points—at Hooghly Railway Bridge, at or near Barrackpore, and at or near Budge Budge ferry. The Port Commissioners have already announced that they will raise no objection, provided precautions are taken not to impede the channel. It is not, however, proposed to seek powers to supply energy within the limits of Calcutta and Howrah, which are already covered by the licence of the Calcutta Electric Supply Corpn. Rights will be sought to lay trunk mains only through these areas. The draft license asks for the adoption of two systems of supply—a two or three wire direct-current supply at a pressure not exceeding 600 volts between the outers, and a single phase or polyphase alternating current supply at a pressure not exceeding 10,000 volts between the phases. The maximum charges allowed will be not exceeding 100 hours at maximum power, 4 annas (4d.) ; 100 to 200 hours, 2d. ; and above 200 hours, 1d. per unit, but the actual working charges will probably be fixed at figures considerably lower than these. The capital of the proposed company has been provisionally fixed at £300,000 (or 45 lakhs of rupees). The company will probably be floated in this country. Messrs. Killick, Nixon & Co. are already organising similar supply schemes for Karachi and for Ahmednagar. The draft license will probably not be dealt with by the Bengal Government before the end of the year.

Italy.—H.B.M. Consul at Rome (Mr. C. C. Morgan) states that a scheme has been submitted to the municipality of Rome for the utilisation of the water power existing in the neighbourhood of Subiaco (about 44 miles from Rome) and the generation of electrical energy for lighting the capital. It is proposed to adopt overhead transmission.

Liquid Barretter Litigation.—The National Electric Signalling Co. have forwarded us the following communication upon this subject :

TO THE EDITOR OF THE ELECTRICIAN.

SIR : As the present status of the litigation on the liquid barretter patent has been greatly misrepresented, we would be obliged if you would kindly give publicity to the following statement of the facts in the case. The following decisions have been rendered :—

(1). Oct. 16, 1905 : National Electric Signaling Co. *v.* De Forest Wireless Telegraph Co., A. White, L. De Forest, et al. Decision in favour of the National Electric Signaling Co., holding that the De Forest Co. infringes patent and ordering an accounting for damages.

(2). Nov. 8, 1905 : National Electric Signaling Co. *v.* De Forest Wireless Telegraph Co., A. White, L. De Forest, et al. A decree of injunction against De Forest Co., A. White, L. De Forest and the officials of the De Forest Co. restraining them from using, manufacturing or selling the liquid barretter.

(3). Jan. 27, 1905: National Electric Signaling Co. *v.* Gesellschaft fur Drahtlose Telegraphie, m.b.H., et al. Decree of injunction against Slaby-Arco or "Telefunken" Co. restraining them from the use of the liquid barretter in any of its forms.

(4). De Forest Wireless Telegraph Co. *v.* National Electric Signaling Co. Charging the National Electric Signaling Co. with infringement of the Neugschwender-Schacfer.De Forest "Goo" receiver. Suit dismissed.

(5). April 7, 1906. National Electric Signaling Co. *v.* De Forest Wireless Telegraph Co., A. White, L. De Forest, et al. Decision in favour of the National Electric Signaling Co. to the effect that the "Spade" electrode used by the De Forest Co. infringed the National Electric Signaling Co.'s liquid barretter patent, enjoining the De Forest Co. against further use of this type of receiver and ordering an accounting for damages.

(6). May 1, 1906: National Electric Signaling Co. *v.* De Forest Wireless Telegraph Co., A. White, L. De Forest, et al. Motion brought for contempt of court. White, De Forest and De Forest Co. adjudged guilty of contempt of court and arrest ordered and bail fixed at $10,000,000.

NATIONAL ELECTRIC SIGNALING Co.
(Reginald A. Fessenden.)

Liverpool.—At the City Council meeting on Wednesday a motion by Mr. B. W. Ellis in favour of charging for all current supplied to hospitals, &c., for surgical purposes at the same rates as energy supplied for power was rejected.

Ald. Smith stated that medical men who use a minimum of 200 hours per quarter are already supplied at power rates.

The Council adopted a recommendation to supply electric motors on the hire-purchase system for periods not exceeding five years. The proposal was opposed by Mr. Rutherford, who objected to the extension of municipal trading beyond reasonable limits, especially as it involved many risks.

Ald. F. SMITH said the committee's proposal was an attempt to enable the smaller trader to take advantage of the municipal supply of electricity.

Ald. W. B. BOWRING thought it was not a business a great Corporation should enter upon. The electric motor supply business was a dangerous one to embark upon.

Mr. MAX MUSPRATT said that in Manchester the number of motors used had almost quadrupled since the introduction of the hire-purchase system, which proved that such facilities were appreciated.

London County Council.—On Tuesday a loan of £2,000 was granted to Woolwich for electrical fittings.

Tramways.—The Highways committee recommended expenditure of £230,000 for the purchase of the rolling stock, plant, machinery, horses, &c., of the North Metropolitan Tramway Co., making the total amount to be paid to the company £341,202, or about £93,000 less than was anticipated when the terms for the acquisition of these were approved by the Council.

Consent was given to an agreement with the County of London Electric Supply Co. for supply of electric current for working the tramways from the "Angel," Islington to Highbury Station at 1d. per unit.

The Highways committee reported that the Board of Trade had approved the construction of tramways in Kingsland-road on the side slot instead of the centre slot system.

London County Council Tramways.—The work of conversion to electric traction on the Moorgate-street end of the tramways running to north-east London via Old-street was commenced on Monday.

Stoke Newington Council have asked London County Council to carry out the work of electrifying the tramways between Stoke Newington railway station and Dalston during August and September, so as to interfere as little as possible with the trade of the main thoroughfare.

London's Decadence as a Manufacturing Centre.—On this subject Messrs. Leopold Farmer & Sons, land and estate agents, 46, Gresham-street, London, E.C., write as follows:—

Owners of manufacturing property in London are sorely perplexed at the present moment as to what is going to happen to their holdings on account of the additional restrictions imposed by London County Council. If an owner of such a holding is dependent upon the rental obtained as his or her sole source of income we very much fear the outlook is somewhat depressing under the existing dictatorial regulations. We are sympathisers with the movement for forming a strong and influential body of property owners to further look into the cause and effect of the present administration on manufacturing property.

Louth.—The Council have asked for a further extension of four months for their electric lighting order, 1902.

Manchester.—The works sub-committee of the Tramways committee are considering the question of the reorganisation of the works department, and it is anticipated that their report will be laid before the full committee on Tuesday.

At the City Council meeting on Wednesday the chairman of the Tramways committee (Ald. Wainwright) stated that the actual loss in connection with the parcels department last year was £5,500. This year the loss would probably be about one-fourth that amount.

Marylebone (London).—The proposal to light Oxford-street, from Marble Arch to Tottenham Court-road, with incandescent gas has been taken back by the Lighting committee, as members of the Council favour electric lighting, current being taken from the Council's electricity works.

The Electricity committee reported to the Council last week that there was a profit on revenue account for the year to March 31 of £1,236, instead of an anticipated deficit of £3,374. At the end of the current year, after a reduction in price of current of ¼d. per unit, a profit of £16,757 is anticipated.

Mitchelstown (Ireland).—The Council have amended their application to the L. G. Board for a loan for electricity supply, and have submitted a revised map of the proposed area of supply. The Board is now asked to sanction a loan of £3,220.

Morley.—The salary of the borough electrical engineer (Mr. J. E. Ellis) has been increased from £200 to £225.

New Cable Steamers.—The latest addition to the submarine cable fleet of the Eastern Telegraph Co. was launched on Saturday from the yards of Messrs. Bow, M'Lachlan & Co. at Paisley. The new vessel, which has been named the "Sentinel," is a single-screw steel steamer, built throughout to Lloyd's highest requirements. The steamer, with her fiddle bow, fine model and graceful stern has quite a yacht-like appearance. The machinery, supplied by the builders, is placed amidships, and is of triple-expansion type, with usual auxiliaries, steam being generated in a large marine return tube boiler. Forward and aft of the machinery space large cable tanks are fitted with all the usual cable gear. The special bow gear for cables is neatly wrought into the fiddle bow, a steam cable winch is fitted forward, and a special steam winch aft. The decks and woodwork throughout are of teak. The accommodation provided for officers, crew, and electrical staff is of an ample character.

A similar steamer will, we understand, be launched in a few days by Messrs. Bow, M'Lachlan & Co. for the Western Telegraph Co.

Newcastle-on-Tyne.—A L.G. Board inquiry was held on Tuesday into the application of the Council for sanction to borrow £4,500 for lighting certain streets by electricity.

The inspector (Mr. R. H. BICKNELL) said the Board had been refusing loans for electric lighting on account of the extra cost. He quoted a case where the comparative cost of gas and electricity was in the ratio of 1 to 1·74, and the Board had desired him togo very carefully into this point.

The town clerk (Mr. HILL MOTUM) said the Council believed that electricity gave a much better light than gas, and they had authority to use electricity for street lighting. At present there were 200 arc lamps in the city, and by arrangement with the tramways department it was proposed to add 180 arc lamps. Owing to the increased number of lamps the the Tramways committee was able to reduce the charge from £15. 10s. to £11 per lamp per annum, this figure to include everything in connection with repairs, maintenance, &c. The Council had considered the question very carefully, and had come to the conclusion that electricity was the best medium for lighting the streets.

The engineer and manager of the Corporation tramways (Mr. E. HATTON) said the electric current would be supplied to the lamps through special feeders. Sufficient spare ducts had been laid when the tramways were constructed to carry the cables, so that it would not be necessary to take up the streets. The proposed capital expenditure was £4,500 for the 180 lamps.

The INSPECTOR said he was not an electrical engineer, but the drop in the charge per lamp per annum from £15. 10s. to £11 seemed a large sum.

Mr. HATTON said that at £15s. 10s. the committee made a fair margin of profit. By reducing the charge to £11 they would make a very small profit. The larger output from the power station would bring down the cost. The annual charge for the 380 lamps would be £4,180.

The INSPECTOR having pointed to the low cost per unit (0·36d.), Mr. HATTON said that they were a traction station, and worked the power station 17 hours a day, and did not "bank up," as they had to do at an electric lighting station. Thus they had a more even load and their charges were much reduced.

The INSPECTOR said the L.G. Board was under the impression that no station yet had been able to supply electricity to give as good a light as the incandescent gas at the same price. The matter had been gone into very carefully by the Board's electrical experts. It would be necessary that applicants should show that they could give as good a light by electricity and at the same price as by gas. He would go into the matter later with the tramways engineer.

Obituary.—The death is announced of Mr. Wm. Craven, chairman of Craven Bros. (Ltd.), Manchester, who expired suddenly at his residence at St. Anne's-on-Sea on the 10th inst.

The death took place on Tuesday of Prof. James Blyth, Professor of Natural Philosophy at the Glasgow and West of Scotland Technical College, Glasgow.

Ozone Generators.—It is stated that an experiment with ozone generators, installed by the Electric Ozone Synd., of London, is being tried at the Liverpool Stipendiary Magistrate's Court. Various methods of ventilating the Court and the passage leading from the cells to the dock have been in use, but the results have been unsatisfactory. The electric ozone generators have been in operation a couple of days with, it is stated, good effect.

Plymouth.—The Council rejected on Monday a proposal of the Tramways committee that they should have control of the repairs of the tramway track.

The net profit on the electricity undertaking for the year ended March was £3,500.

Reading.—For the year ended March 31 the traffic receipts of the municipal tramways undertaking were £32,140. 0s. 7d. (against £32,625. 8s. 5d. for 1904-5), and the total income was £33,126. Traffic expenses were £8,613, generation expenses £3,387, general repairs and maintenance £2,812 and power expenses £3,918, leaving a gross profit of £15,114, compared with £14,130. After paying sinking fund and interest the net profit was £2,761, compared with £2,923. 7,952,070 passengers were carried and 877,646 car-miles were run, the average receipts per car-mile being 8·78d.

Richmond-on-Tees.—The Council have been petitioned to either carry out an electric lighting scheme or to permit a company to do so, and a committee has been appointed to consider the advisability of allowing the local Electric Lighting Co. to deal with the matter.

Russia.—Mr. Consul Groves reports that conversion of the Moscow tramway system to overhead electric traction has, owing to the recent disturbances, made somewhat slow progress. There is a steadily increasing demand for electrical appliances. Mr. Groves' report continues :—

A German syndicate has concessions from the Ministry of Finance, and its representatives are travelling about Russia and inspecting large towns with a view to installing electric lighting plant and starting electric tramways. This shows that our competitors are well on the alert. In local shops nearly all the electrical appliances on show are of German manufacture. There are in Moscow some branch establishments of well-known German electrical firms, hence it is not surprising that I am assured that over three-fourths of all the electric plant used in Russia comes from Germany. The following figures would certainly seem to bear out the same. Unfortunately the customs returns do not show electric plant under a separate heading. However, under the heading "Electric lighting, mathematical and surgical instruments and photographic appliances," we see:—

	1903. Roubles.	1904. Roubles.
Total imports	4,013,000	4,090,000
From Germany	3,036,000	3,156,000
„ United Kingdom	187,000	184,000

As far as I can make out, the electrical appliances form from one-fifth to one-fourth of the total imports mentioned above. That does not include electrical machinery, which is not shown separately, but comes under the general heading of machinery. I am glad to be able to state that part of the contract for the new electric tramcars for Moscow was secured by a British firm, which has supplied up-to-date 19 cars. I am also told that the same firm has secured part of the order for the new electric tramcars for St. Petersburg.

Spain.—The "Bulletin" of the French Chamber of Commerce reports a rumour that the Olot to Gerona Railway has been purchased by the owners of an important Spanish waterfall and others with a view to its conversion to electric traction and its extension to San Juan de las Abadesas.

Sutton Coldfield.—The total revenue of the electricity department for the year ended March 25 was £4,005. Working expenses came to £2,182. Interest came to £957, £871 was devoted to repayment of loans, &c., and £283 was paid for bank interest, and, after taking credit for £590 from the district fund, the net deficiency is £288. The total capital expenditure is £39,259 (increase of £1,815. 9s. 3d. on the year) and £3,883 has been repaid.

Telegraphone at a City Meeting.—On Wednesday, during Mr. Balfour's speech at Cannon-street Hotel in the City of London on the education question, an experiment was made in recording his speech on the telegraphone, and the experiment proved entirely successful. On the table in front of Mr. Balfour was placed a box containing telephone transmitters which were in electrical connection with the telegraphone placed in a corner of the hall. Mr. Balfour and Miss Balfour were both much interested in the experiment.

Tramway Parcel Traffic.—Sunderland District Tramways (Ltd.) will inaugurate on Monday a system of parcels collection and delivery.

The Dundee, Broughty Ferry & District Tramways Co. are also organising (in conjunction with Dundee Corporation) a scheme for the collection and delivery of parcels.

Tynemouth.—The Town Council have made terms with the Newcastle-upon-Tyne Electric Supply Co. regarding their power bill. The company are to have no right to supply electricity to individual consumers within the borough, but the Council have decided to take electricity in bulk from the company. In consequence of this arrangement the Council are advertising for sale, on another page, a new 600 kw. steam generating set, which is still in the makers' hands.

Wednesbury.—The Council have made an agreement with the Midland Electric Corpn. for Power Distribution to supply electric current to King's Hill.

Willesden.—The Council have been notified by the Metropolitan Electric Supply Co. that they propose to lay cables for supplying energy in bulk to various authorities in Middlesex, and permission has been granted to the company to lay a cable along a short portion of Coronation-road.

The North Metropolitan Electric Power Supply Co. have been granted permission to use the Council's distributing main for conveying current to the new tramway depot at Stonebridge, the company paying $\frac{1}{10}$d. for each unit transmitted.

Workhouse Lighting.—Christchurch guardians have referred to the visiting committee an offer by the Bournemouth & Poole Electricity Supply Co. to supply electric current for lighting the workhouse.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Torquay Town Council invite tenders for the supply, delivery and erection, complete, of condensing plant, consisting of one surface condenser and steam-driven air and circulating water pumps, together with the necessary pipework connections and sundry other ironwork. Specifications, &c., from the town clerk (Mr. Frederick S. Hex), and a copy of the specifications, general conditions and drawings may be inspected (but not obtained) at the office of the consulting engineers (Messrs. Kincaid, Waller, Manville and Dawson), 29, Gt. George-street, Westminster, S.W. Tenders to the Town Clerk before noon June 1. See also an advertisement.

Mansfield Corporation invite tenders for a battery of accumulators and reversible booster and switch gear. Specifications, &c., of the consulting engineers (Messrs. Robert Hammond & Son), 64, Victoria-street, London, S.W., and tenders to the town clerk (Mr. J. Harrop White) by noon 30th inst. See also an advertisement.

Dublin Lighting committee invite tenders for sub-station switchboards and accessories and transformer pillars. Specifications from the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders to chairman of Lighting committee, 3, Cork-hill, Dublin, by 28th inst. See also an advertisement.

The Metropolitan Asylums Board invite tenders for supply of builders', engineers', smiths', plumbers', gas fitters' and miscellaneous ironmongery and electrical accessories. Forms of tender from the offices of the Board, Embankment, London, E.C., where tenders must be delivered by 10 a.m. May 30. See also an advertisement.

Colwyn Bay and *Colwyn* District Council invite tenders for supply, delivery and erection of water-tube boiler, steam dynamo and condensing plant. Specifications, &c., from the electrical engineer, Mr. A. R. Tudman. Tenders to the clerk (Mr. James Amphlett), Council Offices, Colwyn Bay, by noon June 1. See also an advertisement.

Bristol Electrical committee invite tenders for (*a*) one 3,000 kw. (6,000 volt) three-phase turbo-alternator, with condensing plant; (*b*) one 500 kw. and (*c*) two 300 kw. motor generators or rotary converters (6,000 volts a.c. to 500 volts d.c.); (*d*, *e* and *f*) extensions to e.h.t., h.t. and l.t. switch gear: (*g*) 30 ton electric travelling crane; (*h*) water-tube boilers, with economisers, mechanical stokers, superheaters, induced-draught plant, &c.; (*j*) boiler feed pumps; (*k*) extension to coal conveyor; (*l*) steam and water pipe work; (*m*) water tanks; (*n*) steel troughing and fixing for protection of cables in subway; (*p*) annual supply of joint and junction boxes. Tenders from manufacturers only. Intending tenderers should communicate with the city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol, who will furnish further particulars.

Coventry Corporation invite tenders for supply and erection of Lancashire boilers, economiser, steam and water pipes, mechanical stoker, two 600 kw. and one 300 kw. alternators and two-phase motors. Tenders to the town clerk (Mr. Geo. Sutton) by 10 a.m. 24th inst.

Accrington Council invite tenders for supply of machinery in connection with (1) Lancashire boiler plant, (2) high-speed generating plant, at their electricity works. Tenders to the borough electrical engineer (Mr. Harold Gray) by noon 22nd inst.

Manchester Electricity committee invite tenders for the supply, delivery and erection of seven 150 kw. single-phase transformers and high and low tension switchboards for sub-stations. Tenders to the Chairman of the Electricity committee by noon 23rd inst.

Manchester Corporation want tenders by noon 22nd inst. for supply of e.h.t. feeder cables, l.t. concentric cable and tail-end boxes. Specifications, &c., from the Secretary, electricity department, Town Hall.

Belfast Tramways and Electricity committee invite tenders for battery boosters, balancers and switch gear. Tenders to Sir Samuel Black, Town Hall, Belfast, by 11 a.m. 21st inst.

St. Pancras (London) Council want tenders by noon, May 21, for coal for the electricity works, &c. Forms of tender from Electricity Department, 57, Pratt-street, N.W

Fulham (London) Council want tenders by noon May 23 for substation equipment. Specifications from the borough electrical engineer.

Rotherham Tramways Committee want tenders by 21st inst. for trolley wire, bracket arms, rails, fish plates, tie bars, bolts and nuts and granite setts. Forms of tender, &c., from the Borough Surveyor.

Worthing Corporation require tenders by noon 28th inst. for gas engine and gas producing plant for their electricity works. Specification, &c., from the Resident Electrical Engineer.

Birkenhead Corporation require tenders (by May 29) for booster balancer and extensions to switchboard and travelling crane.

The Commercial Intelligence Branch of the Board of Trade have received from H.M. Consul at Copenhagen copy of the conditions of tender (in Danish) for the supply of (1) cables and (2) electricity meters to Copenhagen Lighting department. The conditions may be inspected at the offices of the Branch, 73, Basinghall street, London, E.C. Conditions from the Director of Public Lighting, 22, Vestre Boulevard, Copenhagen, to whom tenders by June 7 for cables and June 9 for meters.

TENDERS RECEIVED AND ACCEPTED.

Among recent contracts obtained by Siemens Bros. & Co. are the following:—

One Siemens-Ilgner electric winding engine (Koepe pulley, with direct-coupled motor driven by flywheel motor-generator) for Duffryn Rhondda Collieries Co. (System: 2,200 volts, 25 cycles, three-phase; capacity, 1,500 tons in eight hours from a depth of 520 yds.) One Siemens-Ilgner electric winding engine (cylindrical drum winder with geared motor driven by flywheel motor-generator), through the Corlett Electrical Engineering Co., for Axwell Park. (System: 5,500 volts, three-phase; capacity, 3,500 lb. from 250 ft.) Two Siemens-Ilgner winding engines, each having cylindrical drum and geared motors, and driven by a common flywheel motor generator, for the United Alkali Co. (System: 3,300 volts, 25 cycles, three-phase; capacity, (1) 400 tons in eight hours from 164 yds.; (2) 160 tons in eight hours from 164 yds.) Complete electrical equipment of Pilkington Bros.' glass works (comprising two 660 kw. and one 330 kw. c.c. generators with flexible couplings for direct coupling to gas engines; five 450 B.H.P. and three 180 B.H.P. motors for driving polishing and grinding benches, one 70 kw. motor-generator, two 40 kw. balancers, main switchboard, control apparatus, distribution boards, mains and accessories). Two electric telphers for handling casks of tobacco in the new tobacco warehouses, for the Bristol Docks committee. Two 1,500 kw. c.c. generators direct-coupled to engines (85 revs. per min.), for Royal Arsenal central power station, Woolwich. One 250 kw. and one 500 kw. high-speed alternators for direct coupling to Rateau turbine, for Mr. P. J. Mitchell. One 375 kw. high-speed alternator for direct coupling to Willans turbine (3,000 revs. per min.).

An important order has just been placed with Davey, Paxman & Co., Colchester and London, for ten horizontal compound steam engines on the Paxman-Lentz system, of an aggregate of 7,000 H.P., for an electric light installation. Messrs. Davey, Paxman & Co. are sole licensees for the manufacture of this type of engine, which is well-known for its excellent design and economy in steam consumption.

Messrs. Bruce Peebles & Co. have received from Messrs. Willans & Robinson an order for two 750 kw. 6,000 volt three-phase turbo-alternators for the new electric generating station of the Natal Government Railways at Durban.

Grimsby Council received 17 tenders for the annual supply of incandescent lamps, and the tenders of the General Electric Co. (Robertson lamps) at £27s. 5s. 6d. and Sharples, Hill & Co. (Stearn lamps) at £28. 13s. 3d. were accepted. The tenders of the Sloan Electrical Co. for arc lamp globes at £16. 4s. and carbons at £48. 14s. 9d., Drake & Gorham for Nernst lamps and spares for £2. 19s. 10d., H. C. Brown for lubricating oils for £54. 18s. 4d., and Gowthorpe & Sons, General Electric Co., and Mountford Rubber Co. for sundry stores were also accepted.

The following tenders have been received by London County Council for telephones, fire alarms and tell-tale clocks at Long Grove Asylum:—

Cox-Walkers, Ltd. (*acc'd*)	**£1,715**
Private Wire & Telephone Installation Co.	1,495
Bromley, Batstone & Kirk	£1,760
F. A. Glover & Co........	2,067
Strode & Co.	2,399

After the tenders were opened the Private Wire & Telephone Installation Co. intimated that they had omitted to include £300 for contingencies, and the Asylums committee therefore decided to accept the tender of Cox-Walkers, Ltd.

Westminster City Council have received the following tenders for arc lamps for the Great Smith-street swimming baths:—

Leo. Sunderland & Co., three 10-ampere lamps (£49. 10s.), six 6-ampere lamps (*provisionally accepted*) (**£84. 10s.**); E. L. Berry, Harrison & Co., £67 and £91. 15s.; F. J. Coleby & Co., £67. 10s. and £85. 10s.; Foote & Milne, £66. 10s. and £95; Westminster Engineering Co., £54 (for 6 ampere lamps).

The Metropolitan Asylums Board have accepted the tender of Buchanan & Curwen at £38. 15s. for works in connection with lighting the new boiler house at the Eastern Hospital by electricity. Bromley, Batstone & Kirk, contractors for the South-Eastern Hospital, have received an order to provide (at a cost of £49) additional electric lighting in the boiler house.

Cardiff Telephone committee have accepted the tender of the National Telephone Co. for a telephone installation at the new Town Hall and Law Courts for an unlimited service at £880. 15s. The company also quoted £773. 5s., with an additional message rate. The Post Office quoted £1,212. 6s. for a service which was partly unlimited and partly at a message rate.

West Ham Corporation have accepted the following tenders:—General Electric Co., a.c. motors; British Insulated & Helsby Cables, cable; British Westinghouse Co., meters; Universal Electric Mfg. Co., house cut-out boxes, &c.; British Electric Transformer Co., transformers.

The Postmaster-General's Department, Brisbane, has accepted the tender of Paton & Russell (Sydney) for telephone wall sets, and that of John Slater & Co. (Melbourne) for platinum wire, copper wire and main springs for registers.

Belfast Asylum committee have accepted the tender of W. Coates & Sons for supply of two turbine water wheels, two c.c. dynamos, two pumps, &c., at £1,071, for the electric lighting of Purdysburn Asylum.

Shoreditch (London) Council have accepted the tender of the Klein Engineering Co. (at £200) for an automatic coal-weighing machine for the Whiston-street station.

The North-Eastern Railway Co. have accepted the tender of Veritys Limited for "Aston" interpole motors for their permanent way shops.

Pritchetts & Gold (Ltd.) have received an order for a storage battery of 114 cells (600 ampere-hour) for the Burghill Asylum, Hereford.

London County Council have entered into a revised contract with J. W. Gray & Son for executing repairs, &c., to lightning conductors attached to the Council's schools.

Plymouth Tramways committee have accepted the tender of the Brush Co. for six demi-cars at £501 each.

Willesden Council have accepted the tender of Geipel & Lange for arc lamp carbons at £2. 19s. 1d. per thousand pairs.

Ilford Council have accepted the tender of Norton Bros. for the erection of a steel chimney at the electricity works.

Pontypridd Council have accepted the tender of the Brush Co. for eight electric tramcars.

Islington (London) Lighting committee have provisionally accepted the tender of the Electrical Co. for the annual supply of meters.

BUSINESS NOTICES.

We are informed that Mr. Noel L. Godber, of the Westinghouse Cos.' publishing department, and formerly of the British Thomson-Houston Co.'s publication department, has been appointed acting editor of the "Engineering Times."

The I T E Electric Co. have opened offices at 20, Great Russell-street, London, W.C. Mr. W. Everett Gibson is manager.

Messrs. Siemens Bros. & Co. announce that the list price of the Tantalum lamp is reduced as from to-day (Friday) from 5s. to 2s. 9d.

BANKRUPTCIES, LIQUIDATIONS, &c.

Psychiloid Limited is being wound up voluntarily. Mr. G. S. Greening, 18, Norfolk-row, Sheffield, is liquidator.

The P.M. Electric Mfg. Co. (Ltd.) is being wound up voluntarily. Mr. E. Hill, 79, Mark-lane, London, E.C., is liquidator.

A meeting will be held on June 15 at 9, Parr-street, Liverpool, to receive an account of the winding-up of the Electric Works Co. (Ltd.)

The British Cable Synd. (Ltd.) is being wound up voluntarily. Mr. D. L. Honeyman is liquidator.

A meeting will be held on June 18 at Westminster Palace Hotel, London, S.W., to receive an account of the winding up of the Nernst Electric Light (Ltd.)

Plant for Sale, &c.—Some shop-soiled arc lamps and brackets, telephone instruments, and incandescent lamps are advertised for sale in another column.

Tynemouth Corporation are willing to receive tenders for the purchase of a 600 kw. steam generator (continuous current) which they have for sale owing to their having arranged for a bulk supply. The plant is new, and is still at the respective makers' works, where it can be seen by appointment. Some particulars are given in an advertisement, and full details can be obtained from the borough electrical engineer, Mr. C. Turnbull, electricity works, Tynemouth.

Liverpool Corporation electric supply department have for sale two Lancashire boilers, Worthington feed pump and feed-water heater, two w.-i. tanks, two Browett-Lindley and two Willans engines, direct coupled to Siemens dynamos. The plant may be viewed on application to the resident engineer, Highfield-street, Liverpool. See also an advertisement.

Marylebone (London) Borough Council are prepared to receive tenders for the purchase of some second-hand electrical plant, particulars of which are set out in an advertisement. Conditions, forms of tender, &c., from the resident electrical engineer and manager (Mr. F. A. Wilkinson), 19 and 20, York-place, Baker-street, W. Tenders to the town clerk (Mr. James Wilson), Town Hall, Marylebone-lane, London, W., by 4 p.m. 23rd inst.

Messrs. G. Elliott & Co., 186-188, Long-lane, Bermondsey, London, S.E., have for sale two Holmes and one Ellwell-Parker dynamos, also Johnson & Phillips dynamo and steam engine, some electric motors, &c. See an advertisement.

Messrs. Sabberton Bros., engineers, Norwich, advertise for sale a 63 B.H.P. motor, starting switch, shunt regulator, &c.

Plant Wanted.—Mr. Thomas Johnson, Prescot-street, Wigan, advertises for a compound engine (about 400 H.P.) for driving electric plant.

Business for Sale.—The business of A. J. Harris & Co. (Ltd.), electrical and mechanical engineers, dynamo and motor manufacturers, Bradford, is advertised for sale as a going concern. Particulars from Mr. Geo. Walker (Messrs. Armitage & Norton, C.A.), Halifax Commercial Bank-chambers, Bradford.

Premises to Let.—Messrs. R. D. & J. B. Fraser, Princes-street, Ipswich, advertise a spacious factory to let.

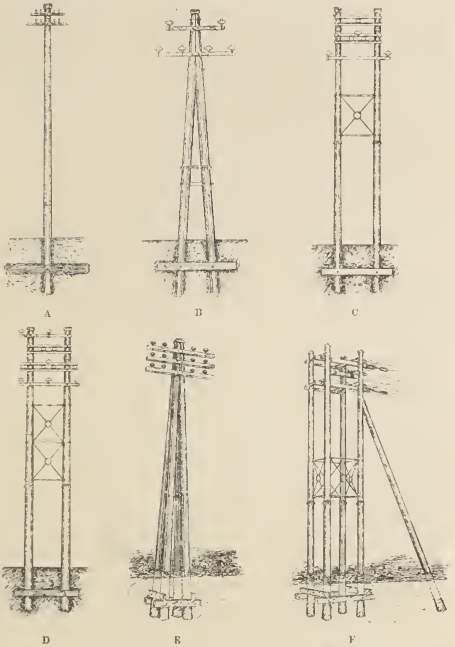
The "Journal."—Part 177 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. Particulars of contents are given in an advertisement.

Screw-cutting made Easy.—A simple circular device, serving as a screw-cutting indicator, has been issued by the "Model Engineer," price 2d.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on May 9 to 15, with the ports of destination :—

Africa—Alexandria, £122 (including £27 telegraph material); Cape Town, £211 (including £75 telegraph material); Delagoa Bay, £44; Durban, £222; East London, £610; Mombasa, £114; Port Elizabeth, £696; Port Said, £15. *Argentina*—Buenos Ayres, £667 (including £235 telegraph material). *Australasia*—Auckland, £369; Lyttelton, £18; Melbourne, £951 (including £727 telegraph material); Otago, £89; Perth, £1,341; Rockhampton, £12; Sydney, £2,645 (including £516 telegraph material); Wellington, £81. *Belgium*—Ghent, £35; Ostend, £35. *Burma*—Rangoon, £14. *Canada*—Halifax, £185 (telegraph material); Hamilton, £546; Montreal, £532; Toronto, £39. *Ceylon*—Colombo, £75. *Channel Islands*, £57. *Chili.*—Valparaiso, £206; *China*—Shanghai, £176 (including £98 telegraph material); Tientsin, £394. *Cuba*, £137. *Denmark*—Copenhagen, £19 (telegraph material). *France*—Bordeaux, £80; Paris, £45. *Germany*—Hamburg, £8. *Gibraltar*, £56 (including £8 telegraph material). *Holland*—Amsterdam, £75 (including £50 telegraph material); Rotterdam, £14 (telegraph material). *Hong Kong*, £232 (including £21 telegraph cable). *India*—Bombay, £1,322; Calcutta, £2,748 (including £55 telegraph material); Karachi, £20; Madras, £151 (including £116 telegraph material). *Japan*—Kobe, £10; Tokio, £124 (telegraph material) Yokohama, £1,987. *Mauritius*, £23 (telegraph material). *Portugal*—Lisbon, £44. *Spain*—Barcelona, £95; Bilbao, £38. *Straits Settlements*—Penang, £308; Singapore, £163. *U.S.A.*—New Plymouth, £140; New York, £153. Total £18,493, against £15,517 in the corresponding week last year (May 10 to 16).

Catalogues, &c.—The largely extended use of creosoted wooden poles for telegraph and telephone work and for overhead power transmission gives additional interest to a catalogue just issued by Richard Wade, Sons & Co., Garrison-side, Hull. In this catalogue particulars are given of the process of creosoting timber to preserve it, and the value of this process in rendering the timber useful and reliable, especially in connection with electrical work for telegraphs, telephones and power transmission. A number of illustrations of an interesting nature are given in the catalogue, showing the poles in course of construction and the result of the creosoting treatment. There are also a number of interesting diagrams of poles made by Messrs. Wade to the design of Callender's Cable & Construction Co. These instructive diagrams we reproduce. Messrs. Wade, Sons & Co. supply timber for all purposes, and at all times carry very heavy stocks, which can be drawn upon at short notice.



A—Single pole with oak arms and brace block. B—Double or A pole with brace block, oak arms and spiked collar, suitable for heavy main line. C—Double or H pole with angle irons and spiked collars. D—Heavy H pole with angle, channels, oak arms and spiked collars, suitable for terminal of heavy line. E—Heavy 4-member pole clamped at top and fitted with oak arms, suitable for a corner strain. F—Heavy 4-member parallel pole with channel irons on two sides and oak braces or arms on the other two, fitted with spiked collars. The illustration shows a fifth or straining pole which is supplied if required. This is suitable for a heavy corner strain.

A new supplementary catalogue of Smith's patent system of electrical fittings has been issued by J. F. Smith & Co., of Birmingham. It is claimed that by this system a more simple design of switch wiring is attained. Examples of these fittings are shown in the accompanying illustration.

Examples of the Smith System of Electric Light Fittings.

J. H. Holmes & Co., Newcastle-upon-Tyne, have issued an illustrated pamphlet giving a list of factories and general stores and trades for which the company have manufactured and installed electric generating and power plant.

Elliott Brothers, Lewisham, London, S.E., have ready a new Wheatstone bridge list (R. 91) describing a re-designed and improved form of this bridge. An "infinity" contact is now provided, and the bridge has an overall range of measurement from 0 001 to 1,110,000 ohms. The instrument is primarily intended for portable and workshop use. A recent addition to the bridge is a "double" or "successive" key, making the bridge self-contained and avoiding the use of separate keys for battery and galvanometer circuits.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

April 2, 1906.

7,889 Tingley. Dynamo-electric machines for rotation at high speeds. (Date applied for, April 10, 1905.)*†
7,891 McMahan. Synchronising apparatus for alternating-current machines. (Date applied for, April 10, 1905.)*†
7,909 Schaefer. Coupling for arc lamps and the like.
7,915 Besser & Cobe. Electrolytic interrupters and method of operating same.*
7,916 Tourtel & Johns. Electric time switches.
7,919 Milch. Dynamo-electric machines. (Date applied for, 3/4/05.)*†
7,920 Johnson. (Felten & Guilleaume Lahmeyerwerke A.G., Germany.) Dynamo-electric machines.*
7,921 Sir W. G. Armstrong, Whitworth & Co., & Sodeau. Time fuses.
7,925 Clift. Switch for electric ignition systems.
7,942 Eisenstein. Wireless telegraphic and telephonic systems.*
7,945 Headley. Switches.
7,947 Blackmore. Electro-magnetic separators.

April 3, 1906.

7,961 Siebert. Dynamo-electric machines.
7,968 Lambert. Folding steps for tramway cars.
7,974 Lawson. Protecting devices for live rails.
7,977 Rhodes & Rhodes. Insulators.
7,998 Fairweather. (Kellogg, U.S.) Telephone exchange system.*
8,002 Burnaby. Electric fittings for lamps, telephones and the like.*
8,009 Haenflein. Electric indicating devices for water level in boiler.
8,017 Lee. Metallic filaments for incandescent lamps.
8,018 Lee. Metallic vapour electric lamps.
8,024 Jefferson. Switches or cut-outs.
8,029 Holmes & Allen. Trolley heads for electrical tramway systems.*
8,038 Orling. Electro-capillary recording apparatus.
8,039 Rambaldini. Continuous electrolysis. (Date applied for, 3/4/05.)*†
8,044 A.-G. Brown, Boveri & Co. Repulsion Electric motors. (Date applied for, April 7, 1905.)*†
8,057 Kuzel. Manufacturing incandescence bodies of difficultly fusible conductive materials with the use of colloidal oxides and hydroxides of difficultly fusible metals. (Date applied for, Aug. 3, 1905.) †
8,078 Arnold. Electrical machines with commutating poles.*

April 4, 1906.

8,084 Valentine & Betts. Electrolytic smelting of lead sulphide ores.
8,139 Godfrey & Watkinson. Adjusting the height of electric lamps.
8,144 Brockie. Raising and lowering of arc lamps.*
8,168 Angelina. Improvements in or relating to microphones.*
8,173, 8,174 and 8,175. Bines. Telephone apparatus.*
8,182 Driver. Holders for incandescent lamps.*

April 5, 1906.

8,211 Whalley. Telephone circuits.
8,219 Plummer & Burks. Electric lighting plant.
8,235 Lowenherz. Automatic switch for portable incandescent lamps.
8,238 Beaver & Claremont. Manufacture of electric cables.
8,243 Guthrie. Auxiliary pole-facings on direct-current motors and dynamos.
8,255 Oliver. Mechanical ears for carrying overhead transmission cables.
8,259 Leighton. Magnetic compasses.

April 6, 1906.

8,324 McCarty. Wireless telephone.*
8,332 Douilhet. Electric sterilising apparatus. (Date applied for, April 10, 1905.)*†
8,340 Siemens Bros. & Co. & Lauckert. Telegraphs for transmitting orders.*
8,343 Cox. (Beckett, Australia.) X-ray tubes.
8,345 De Marçay. Accumulators. (Date applied for, Jan. 24, 1906).*†
8,347 Thompson. (Société Lyonnaise de Mécanique et d'Electricité, France.) Electric capstans.
8,352 Accumulatoren-Fabrik A.-G. Accumulators. (Date applied for, April 7, 1905.)*†
8,359 Banks. Electrical fittings for use with lamp circuits on road vehicles.

April 7, 1906.

8,371 Salmon & Creffield. Electrical apparatus for transmitting signals.
8,392 Lackie. Indicating and recording permanently the maximum demand for energy on any circuit.
8,401 Malan. Railway switch and signal apparatus.
8,402 Cooper. Controlling systems for electric motors. (Date applied for, April 10, 1905.)*†
8,412 Küchenmeister. Portable apparatus for producing alternate current for medical purposes.
8,416 Cumings. Electrical fuses.
8,425 Metz. Tramway rails.*
8,426 Cunningham. Battery terminals for electrical purposes.
8,430 Chitty. Dynamo-electric machines.
8,434 Finzi & Tallero. Brush-holders for electrical machines. (Date applied for, April 8, 1905.)*†
8,443 Phillips. Electrostatic cotton and silk-spinning improver.

COMPANIES' MEETINGS AND REPORTS.

Western Telegraph Co. (Ltd.)

The 65th ordinary general meeting was held on Wednesday under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice calling the meeting.

The CHAIRMAN then said: Gentlemen, I am again in the happy position of being able to congratulate the shareholders upon the satisfactory report which is submitted for their consideration, the message revenue for the six months under review being nearly £47,000 more than in the corresponding half-year of 1904, and a most pleasing feature is that the improvement is general, all the countries of South America having contributed to the increased receipts. I am also glad to say that our receipts are maintained up to the present moment; but as I remarked on the last occasion when we met, we are now sharing in the general prosperity of South America, which in the past had gone through critical periods seriously affecting trade and commerce, and we must not forget that circumstances of less satisfactory nature than those which at present exist may arise, though I do not wish to prophesy that that will be the case. Referring to the other side of the accounts, the general expenses in London were more by £322, due to the ordinary augmentation of the salaries and wages and a small increase in the number of the staff. The expenditure at the stations also shows a somewhat large net increase of £7,575. The most important item is again salaries and wages. The increased traffic, as a matter of course, entailed the engagement of extra staff, but more than half the enhanced expenditure under this head was due to the higher value of the Brazilian currency, the average rate being 16½d. per milrei against 12¼d. in the latter half of 1904. The greater part of the increase in rent, taxes, house allowance, fuel and light was also due to the higher rate of exchange. Furniture for additional staff quarters at one of our large stations had to be supplied, and more stationery and printing was necessitated by the increased traffic. Maintenance of landlines, electrical instruments, &c., repairs to buildings, legal expenses and a few other items, on the other hand, show decreased expenditure. Under abstract C, which details the expenses attending the maintenance of our cables, there is a net increase of £15,502. The repairing vessel "Norseman" has been engaged in effecting some extensive repairs to the older sections, and the cable used for this purpose cost us over £13,000 more than in the corresponding period of 1904. Similar repairs and renewals of weak parts are being continued, but the money is well spent, and a marked improvement has ensued in the condition of several of the cables in shallow water. The net result is that after providing £14,162 for debenture stock and debenture interest and sinking fund, and £4,978 for income tax, there remains a balance of £149,516, to which is to be added the sum of £3,131 brought forward from June 30 last, making a total of £152,648. First and second interim dividends, amounting to £62,379 have been paid, and after transferring £80,000 to the general reserve fund, and £5,000 to the maintenance ships' reserve fund, there remains a balance of £5,269, which is carried forward to the next account. The shareholders are aware that the capital expenditure as shown in the balance sheet exceeds the issued capital by nearly £223,000, and that our reserves and debenture sinking funds are under-invested by over £410,000, the difference being accounted for by balances due to the Company, the value of spare cable and stores, remittances in transit, bills receivable and cash in hand. As we have further capital expenditure in view in the shape of a new cable to St. Vincent, Cape Verd Islands via the Azores, which will enable us to better cope with our increased traffic, the Directors last month offered the share and debenture holders the then unissued balances of 4 per cent. debenture stock amounting to £230,620 with the most gratifying result that the whole amount was taken up. A considerable portion of the sums paid upon application and allotment have already been invested in high-class securities yielding a satisfactory rate of interest. I think these points deal with all that I have to say on the commercial aspect of the Company. At the last general meeting I announced that Mr. Andrews had felt it necessary on account of health to resign his directorship. I now deeply regret to report that he died on the 4th instant, and I am sure the proprietors participate in our sorrow at his loss. I have also to mention to the shareholders that, now that Mr. St. John Brodrick is no longer in the Ministry, the Directors have elected him to resume the seat at the Board which he formerly occupied with such benefit to the Company; and we have the pleasure of seeing him with us here this afternoon (cheers). I now move the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Sir John Denison-Pender, K.C.M.G.) seconded the resolution which was at once carried unanimously.

The Rev. JAMES C. WILSON moved a vote of thanks to the Chairman, Directors and staff for their services in the past half-year. He specially congratulated the Directors for their courage in adding the large amount they had put to the contingencies account.

Mr. JOHN E. CORBEN seconded the motion, which was carried unanimously.

The CHAIRMAN briefly acknowledged the vote on the part of his colleagues and himself and the staff.

The proceedings then terminated.

West Coast of America Telegraph Co. (Ltd)

The ninth ordinary general meeting was held at Electra House, Finsbury-pavement, on Tuesday, under the presidency of Sir JOHN DENISON-PENDER, K.C.M.G.

The SECRETARY (Mr. Fred. L. Robinson) read the notice calling the meeting and the auditors' report.

The CHAIRMAN: Gentlemen, I think that the accounts are so ample and clear that very few words on my part are required in the way of further explanation; but there are one or two items which I may, perhaps, put a little more fully before you. With regard to the traffic, we have had an increase this year of £8,471, as compared with last year, the figures being £50,808 this year and £42,337 for last year. I am glad to say that that increase is not attributable to any special political excitement or anything of that sort, but is owing to good genuine business all along the coast. This is the most satisfactory form of traffic which we have. The prospects for the current year are also good; the increase we had in 1905 is not only maintained, but has so far increased even beyond the figures of 1905. With reference to the stations expenses, you will see that there is a small decrease of £161, the expenses of 1905 having been £17,200, as compared with £17,361 for 1904. But that decrease really arises from a specific cause, and therefore I am afraid we can hardly look upon it as an actual decrease in the ordinary working expenses. In the previous year we had two or three large expenses. Of course, if we are carrying increased traffic no one can expect it to be done with the same staff and the same accommodation as we were able to carry the smaller traffic with. Although, therefore, there is an apparent decrease of £161 in the expenses, yet, as I have shown, the cost of working has really been increased by £714. Then, with regard to the repairs, their cost was £12,338 in 1905, as compared with £9,203 in 1904, showing an increase this year of £3,135. Repairs to cables are matters which, as all shareholders in cable companies know, cannot be governed or controlled by the Board to any great extent. If a cable breaks it must be repaired. We have had one or two letters with regard to the question of the payment of a dividend. It must not be forgotten, as you will see by the accounts, that we have this year put £10,000 to general reserve and £2,000 to the maintenance ship's reserve fund. Your cables are 30 years old and your ship is very nearly the same age—27 years. You cannot expect to go on keeping a ship of that age and cables of that age in thorough working order without a considerable expenditure on them; and if you will follow me for one moment with the capital and our indebtedness, I think you will agree with me that we are right in strengthening our reserves. You have got a share capital of £112,520, you have income bonds to the amount of £20,000 carrying 4 per cent. per annum, and you have a debenture debt of £150,000. For the sake of this argument we will leave the capital alone; but then you have got £170,000 which you have to provide for in 1917. That is to say, the income bonds will have to be paid off and the debenture debt has also to be arranged for in 1917. I do not say that the debenture debt will require paying off altogether at that date, because if we are in a prosperous state we may renew them to a certain extent; but it would be very unwise, even if we were able to do it, to carry on that large debenture debt. Against this you have reserves at the present time of £26,185, including the ship's reserve of £6,000. I have seen it stated in one of the papers that our reserves amount to between 25 and 26 per cent. of our capital. That is very true if you take the share capital only, but surely in estimating your reserves you have to take into account your debenture and your other debt. The reserve fund, therefore, works out at not 10 per cent. of the capital and the debt. Assuming that we put away for the next 11 years, at the end of which this debt will become due, something like £10,000 a year to the reserve fund, you will be in the position then of having a reserve fund of something like £130,000, including what you have to-day, to meet your liabilities of £150,000 of debentures and £20,000 of income bonds, or £170,000 together. That amount would be adequate, because we could deal with a small proportion of the debentures. I put this clearly before you because we have had one or two letters with regard to the question of dividend, and I have seen one or two letters in the financial papers with respect to the matter; but I do not see how the Directors, doing their duty, could think of paying a dividend until they saw the reserve reach an amount which would render the future of the Company practically safe I now move the adoption of the report and accounts.

The motion was carried unanimously, and the retiring director (Sir Albert J. Leppoc Cappel, K.C.I.E.) and the retiring auditors (Messrs. Deloitte, Plender, Griffiths & Co.) having been re-elected, after a vote of thanks to the Chairman and Directors the proceedings terminated.

Submarine Cables Trust.

The thirty-fifth ordinary annual meeting was held on Tuesday, the Most Hon. the MARQUIS OF TWEEDDALE, K.T., presided.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting.

The CHAIRMAN said the revenue for the year, which includes £159 for interest on deposits, amounted to £25,057, against £24,288 in the previous year, an increase of £769. This increase is almost entirely attributable to larger dividends received from two of the companies in which we hold investments. Our expenses remain practically the same—a little over £1,100. There have been no changes in the capital investments of the Trust. You will remember that last year the Anglo-American Telegraph Co. were unable to pay the full 6 per cent. on their preferred stock, but this year they have paid the full 6 per cent., and this accounts for an increase of about £466 in our revenue. Our shares in the Makay Companies were, as you will remember, originally in the Commercial Cable Co., but they were exchanged, with the approval of the certificate holders, for preferred and common shares in the Mackay Companies. This exchange has proved beneficial to the Trust, and yields a somewhat larger return than the shares in the old company did. Those companies have paid dividends of 2 per cent. on their common shares instead of only 1 per cent., as in the previous year. There is also a small amount of increase in our receipts from the Great Northern Telegraph Co. They declared a largely increased dividend, but as our holding is small, the increase to us only amounts to about £10. The receipts from our other investments remain practically the same as last year. The total result is that after paying 6 per cent. net to our certificate holders, we have been enabled to purchase 41 certificates, or seven more than last year, so that we have now acquired and cancelled 1,074 out of the original 4,200, leaving 3,126 certificates outstanding. You will be glad to know that the market values of the securities held by the trust show an appreciation over capital of nearly £200,000. I now move the adoption of the report and accounts.

Sir JOHN DENISON-PENDER, K.C.M.G., seconded the motion, which was carried unanimously.

The auditors, Messrs. Deloitte, Plender, Griffiths & Co., and Messrs. Gane, Jackson, Jefferys, Wells & Co. were afterwards re-elected, and a hearty vote of thanks was accorded the trustees.

Globe Telegraph & Trust Co. (Ltd.)

The thirty-third ordinary general meeting was held on Tuesday, under the presidency of the Marquis of TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, our receipts for the past year, after deducting all expenses, amounted to £205,718, against £199,123 last year, an increase of £6,595. We have paid the usual interim dividends of 2s. per share on the ordinary shares, in addition to the preference dividend, and we now recommend a final dividend of 5s. on the ordinary shares, making 5½ per cent. net for the year on these shares, carrying forward £4,499. Only one change has taken place in our investments during the year—the sale of £600 nominal in 4 per cent. debentures of the West Coast of America Telegraph Co., and the investment of the proceeds in the Mackay Cos.' ordinary shares. By this change we may expect to receive a somewhat larger return than the 3¾ per cent. yielded by the debentures which we have sold. The full 6 per cent. dividend paid on our Anglo-American Telegraph Co.'s shares, in place of 5½ per cent. last year, gives us an increase of over £1,400, and, in like manner, we have received from our holding in the Direct United States Cable Co. £1,200 more than last year. From our holding in the Great Northern Telegraph Co. we have received the same amount as last year, the handsome dividend of 24 per cent. having been paid, the only difference being that 5 per cent. of this was in 1905 in the form of a bonus. In the case of our holding in the Indo-European Telegraph Co., which for years has paid a dividend of 10 per cent., you will remember that I mentiond last year that the directors of that company had declared a special distribution of 3 per cent. on their ordinary shares, which belonged to our current financial year, and this added to our income the substantial sum of £3,500, and the Indo-European Co. have paid a similar amount for the year upon which we have just entered. The Mackay Cos. having paid 2 per cent. on their common shares, as against 1 per cent. in the previous year, has also added somewhat to our receipts. The receipts from our other investments remain practically the same. The only further observation I have to make is that our investments show a surplus over their cost of £639,000. I now move the adoption of the report and accounts and the payment of the dividends set out therein.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

The retiring director (Sir Albert J. Leppoc Cappel, K.C.I.E.) having been re-elected, and the retiring auditors (Messrs. Deloitte, Plender, Griffiths & Co. and Mr. John Newton) being re-appointed, a vote of thanks to the chairman and directors brought the proceedings to a close.

BUENOS AYRES ELECTRIC TRAMWAYS CO. (1901) (LTD.) The gross receipts for 1905 amounted to £64,514, compared with £34,309 in 1904. Working expenses (inclusive of London administration charges and interest on loans for construction) were £51,228, as against £30,367 (exclusive of such interest), showing a net profit of £13,286, compared with £3,942. The traffics have greatly increased during the year, and the ratio of working expenses to receipts has considerably diminished. Out of the balance, profits and debenture interest absorbed £10,000, leaving £696 to be carried forward.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—Col. A. J. Filgate stated at the meeting on Friday that the capital expended during the year was £73,774, making the total £498,277. The net revenue was £33,720, compared with £29,499. A final dividend at the rate of 10½ per cent. was declared, making 8½ per cent. for the year. The position of the corporation was a strong one, and their business continued to increase steadily.

CASTNER-KELLNER ALKALI CO. (LTD.)—Sir Wm. Mather stated at the meeting on Monday that during the year they had made considerable progress. The company had always paid particular attention to necessary developments, both in improving their processes and establishing newer processes. They would see from the director's report that they were erecting on the Tyne a department which would enlarge very much their facilities in regard to a portion of their manufacture. It was a removal, in a sense, from Runcorn of a certain portion of their plant and a large addition to it on the banks of the Tyne. Fortunately the opportunity of acquiring electric power at a very reasonable price on the Tyne came when they were casting about to see how far they should enlarge one of their departments at Runcorn, and they resolved, after investigating very closely the matter, to remove a department from Runcorn and establish it on the Tyne in order that they might have the advantage of power ready for them without any further expenditure. They saw a great advantage in the change, because it liberated a very large amount of power which they could use for other branches of manufacture which promised well for the future. Replying to questions, he said that one-third of their power plant now consisted of gas engines, which had had the effect of reducing cost of fuel satisfactorily. With regard to the acquisition of the business of the Aluminium Co, he thought it was a fortunate thing that they had entered upon that enterprise, because it enabled them to tide over a disastrous time in the chemical trade in this country and to earn a dividend.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—At the meeting last week Mr. Jas. T. Tullis said that, so far as the section of the business connected with electric wires was concerned, they had had great difficulty in fighting a combine. They had kept out of it, and it was possible some move might be made whereby the Company might join and have that competition arrested. The extra cost of raw material had militated against that section of the business, but Mr. Maclean had produced a class of wire that had been accepted by the most critical experts, and had proved to be of a fine class. The troubles of the company seemed to be passing away.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—Mr. A. C. Miles stated at the meeting last week that the directors recommended an increase of 2 per cent. in the dividend. The traffic receipts had increased by over £1,000, the operating expenses had been reduced by £2,000 and the cost of repairs, maintenance and administration was also lower. In regard to the arbitration between the company and Dudley Corporation for the purchase by the latter of the tramways and light railways within the town, the total amount to be received by the company, would not be less than £50,000, and if the sanction of the court was obtained to the purchase of the No. 5 railway under light railway terms a larger sum would be received. Parcels and goods traffic was likely to still further increase with the facilities afforded for inter-communication between the towns.

MEXICO ELECTRIC TRAMWAYS (LTD.)—The result of the company's operations for 1905 is a net profit of $580,964·26, which, at 2s., gives £58,096. 8s. 6d. The net balance is £64,574. 11s., added to £14,625. 3s. 11d. from last year, making £79,199. 14s. 11d. Preference dividend requires £30,000, £35,000 has been transferred to reserve, leaving £14,199. 14s. 11d. to be carried forward. During the year several advantageous extensions have been made to the system in and around Mexico, and a contract has been entered into with the Mexican Light and Power Co. to supply power through their water power installation on most advantageous terms to the company. The installation to carry out the provisions under the contract will entail an expenditure of £50,000, and is expected to come into operation towards the end of the year. Further additions have been made to the equipment in cars, freight cars and funeral cars, involving an outlay of about £11,000. 47,746,001 passengers were carried in 1905, against 42,602,194 in 1904, the gross earnings being $3,642,105·61, against $3,272,306·97.

REUTER'S TELEGRAM CO. (LTD.)—The directors' report for 1905 states that the balance for distribution for the year to Dec. 31 last is £4,817. 1s. 10d., including £179. 13s. 5d. brought forward. An interim dividend of 2½ per cent. was paid in Oct. last, and the directors now declare a dividend of 4s. per share (making 5 per cent. tax free for the year). £81. 9s. 10d. is carried forward.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year to Dec. 31 last states that the amount to credit of revenue is £28,031. 13s. 9d., against £27,135. 19s. 9d. for the corresponding period of 1904. The expenses have been £23,231. 10s. 10d., against £21,421. 19s., leaving £4,800. 2s. 11d., added to £1,734. 18s. 2d. interest on investments and £1,424. 16s. 5d. brought forward, making £7,959. 17s. 6d. It is proposed to pay 4s. per share on the first preference (2s. balance of arrears to June 30, 1905, and 2s. on account of dividend to Dec. 31, 1905), carrying forward £1,047. 5s. 6d. Traffic receipts show an increase of £1,080. Cost of maintenance of cables was £8,721. 13s. 11d., compared with £6,374. 10s. 9d. for the corresponding period of 1904. During a part of that period the "Henry Holmes" was chartered to another company and earned £4,050. The maintenance expenses referred to are exclusive of a further expenditure of £1,173. 10s. 8d., which has been charged to reserve in respect of part of the cable used in renewals during the half-year. In the early part of the year several interruptions of the cables occurred, probably caused by earthquakes. To assist the company's steamer "Henry Holmes" in overtaking the exceptionally heavy work of restoring the broken cables, the directors decided to charter the cable steamer "Cambria," and she was accordingly despatched to the West Indies on March 10. Having almost completed her work she will shortly return to England. The annual subsidy of £400 paid by St. Vincent expired on March 31, and has not been renewed. The subsidy granted by Grenada has been reduced from £1,000 to £600 per annum from April 1. The directors have elected Sir John Cameron Lamb, C.B., C.M.G., to a seat at the board.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—At the meeting last week Mr. S. R. Blundstone said that the salient feature of the year's working was that the profits were somewhat larger than in the previous year, but the dividend was somewhat less, owing to increased interest and depreciation charges. The traffic had been much better, owing to the through running which had recently been arranged.

NEW COMPANIES, STATUTORY RETURNS.

NEW COMPANIES.

AUTOMIXTE (LTD.) (87,816.)—Reg. March 3, capital £1,000 in £1 shares, to carry on the business of motor-car, omnibus and vehicle proprietors and manufacturers, &c.

DORCHESTER ELECTRIC LIGHT & POWER CO. (LTD.) (88,721.)—Reg. May 10, capital £15,000 in £1 shares, to adopt an agreement with W. J. Fryer for the acquisition of a transfer of the Dorchester Electric Lighting Order (1901) and any order amending or extending same, and to carry on at Dorchester or elsewhere the business of an electric lighting company.

PERCIVAL SPENCER (LTD.) (88,742.)—Reg. May 11, capital £3,000 in £1 shares, to take over the business carried on by Spencer & Co. at Manchester, and to carry on the business of electrical, telegraph, telephone, and general engineers, manufacturers, and sellers of dynamos, motors, arc lamps, cables, &c. Secretary and reg. offices, F. M. Smith, 32, King-street West, Manchester.

PHŒNIX ELECTRIC HEATING CO. (LTD.) (88,751.)—Reg. May 12, capital £10,000 in £1 shares, to acquire the business carried on as the Electric Heating Co., and to carry on the business of manufacturers of, dealers in and repairers of electric stoves and apparatus for heating, cooking and other purposes, electricians, &c. The subscribers include Mrs. L. Binko, Mr. George Offor (director of the North Metropolitan Electrical Power Distribution Co., Ltd.), Mr. S. A. Sillem (director of the Birkdale Electric Supply Co.), Mr. F. A. Donnison, A.I.E.E., engineer; Mr. W. Sillem, A.M.Inst. C.E. First directors, F. A. Donnison, W. Sillem, S. A. Sillem and two others to be nominated by Mrs. L. Binko. Reg. office, 3, Holborn-place, London, W.C.

STATUTORY RETURNS.

NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)—In return to April 5 capital is £200,000 in £1 shares, of which 150,000 have been taken up. £1 per share has been called up on 146,000 and £145,968. 15s. has been received, leaving £31. 5s. in arrears. 4,000 shares are considered as fully paid. Mortgages and charges: £100,000.

ST. JAMES'S & PALL MALL ELECTRIC LIGHT CO. (LTD.)—Return to Feb. 27 gives capital as £300,000 in 40,000 ordinary and 20,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 39,650 ordinary and 20,000 preference shares, and £298,250 has been received, £1,750 is considered as paid on 350 ordinary. Mortgages and charges: £150,000 3½ per cent. debenture stock and £168,438 guaranteed debenture stock of Central Electric Supply Co., being half total loan capital.

CITY NOTES.

MEMORANDA (May 17).—Bank rate 4 per cent. (since May 3, 1906). Price of silver $30\frac{7}{8}$d. per oz. Consols $89\frac{9}{16}$—$89\frac{11}{16}$ for money, $89\frac{11}{16}$—$89\frac{13}{16}$ for account; 2½ per cent. annuities 88½—88¾. Consols Pay Day, June 1. Stocks and Shares Continuation Day, May 29; Ticket Day, May 30; Pay Days, May 31 and June 14; Mining Share Carry-over Day, May 28.

FELTEN & GUILLEAUME-LAHMEYERWERKE, A.G.—At the general meeting on the 30th inst., the directors will recommend a dividend of 10 per cent.

GANZ & CO.—The electrical department of this company is uniting with the General Electric Co. of New York, the Allgemeine Elektricitäts-Gesellshaft, Berlin, the Allgemeine Oesterreichische Elektricitäts-Gesellschaft, Vienna, and other companies in the formation of a new company with a capital of 8,000,000 kr. which will acquire machinery, fixtures and orders in hand from Ganz & Co. at 3,500,000 kr. A second company is purchasing patents, &c., from Ganz & Co. at 500,000 kr., and these will be transferred to the first-mentioned new company, which will enter into an arrangement with the A. E.-G. "Union" for the use by them of the new company's patents and inventions, in return all profits of the "Union" Co. in excess of 4 per cent.

HAVANA ELECTRICITY CO. (LTD.)—A resolution in favour of voluntary liquidation has been passed by the shareholders, which is due for confirmation on 24th inst.

MANILA ELECTRIC RAILROAD & LIGHTING CORPN.—The net revenue for 1905 was $354,670.33. The railway department has only been in operation since April 10, 1905.

NORDDEUTSCHE SEEKABELWERKE A.G., NORDENHAM. The net profit for 1905 was 3,992,007m., of which 477,900m. have been placed to reserve, 1,000,000m. was absorbed by interest on and redemption of loans, 4 per cent. preference dividend required 240,000m., and the ordinary dividend was 11 per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchage Committee have appointed May 23 a special settling day in 10,000 £5 (10s. paid) shares of the *Madras Electric Supply Corpn. (Ltd.)*, and have granted quotations to a further issue £37,100 5 per cent. first debentures of the *Costa Rica Electric Light & Traction Co. (Ltd.)*, £1,333,000 4 per cent. perpetual debenture stock of the *Great Northern, Piccadilly & Brompton Railway Co.* (in lieu of scrip certificates now quoted) and a further issue of 10,000 £5, fully paid, 6 per cent. cumulative preference shares of *Bruce Peebles & Co. (Ltd.)*. The committee have been asked to allow 110,000 £1 fully paid ordinary shares of the *Consolidated Electrical Co. (Ltd.)* to be quoted.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The directors announce a final dividend of 4s. per share, making 4 per cent. for the year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 12	1,440	+ 189	50	66,795	− 199
Airdrie	,, 4	218	+ 20	18	3,868	+ 299
Anglo-Argentine	,, 12	16,105	+ 2,196	19	296,387	+ 29,7 5
Ashton-under-Lyne Corp.	,, 5	295	+ 17	6	1,932	+ 164
Ayr Corporation	,, 12	231	− 4	52	14,604	− 113
Baker St. & Waterloo Ry.	,, 12	1,341	− 73	9	18,290	...
Barnsley	,, 4	153	+ 16	18	2,810	+ 34
Barrow	,, 4	221	+ 16	18	3,837	+ 248
Bath Electric Trams, Ltd	,, 9	749	− 2	19	13,015	+ 1,932
Birkenhead Corporation	,, 13	1,036	+ 44	...	...	...
Birmingham Corporation	,, 12	614	+ 258	6	3,309	+ 1,005
*Birmingham & Mid.	,, 4	1,578	− 357	18	24,818	− 6,690
Blackburn Corporation	,, 9	935	− 34	¶16	6,702	+ 526
Blackpool Corporation	,, 10	5′2	− 72	5	4,5 1	+ 293
Blackpool and Fleetwood	,, 12	296	− 31	19	5,205	+ 205
Blackp'l, St. Anne's & Lytham	,, 10	241	− 39	§27	5,425	+ 646
Bolton Corporation	,, 13	2,095	+ 192	6	12,981	+ 615
Bournemouth Corporation.	,, 9	1,512	+ 437	†6	9,224	+ 2,752
Bradford Corporation	,, 12	4,428	+ 168	6	27,244	+ 1,566
Brighton Corporation	,, 13	920	− 17	6	5,644	− 129
Bristol Trams & Carriage	,, 11	4,925	− 57	13	60,699	+ 3,016
Buenos Ayres & Belgrano	,, 13	3,780	+ 228	19	67,936	+ 4,713
Buenos Ayres Elec. Trms	April 14	1,478	+ 308	15	21,269	+ 4,550
Burnley Corporation	May 12	1,143	+ 25	6	7,336	+ 450
Burton Corporation	,, 13	287	− 23	§6	1,811	− 1 6
Bury Corporation	,, 6	896	...	5	5,002	...
Calcutta Tramways Co.	,, 12	R42,950	+ R6,266	19	R830,839	+ R88,128
Camborne-Redruth	,, 12	108	− 3	2	218	+ 61
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 4	51	+ 4	18	1,155	+ 339
Central London Railway	,, 12	6,503	− 256	19	129,324	− 4,347
Chatham & Dist. Lt. Rys.	,, 10	664	+ 6	†18	11,215	− 206
City of Birm'gh'm Tram Co.	,, 4	5,193	− 271	18	83,170	− 4,733
*City & South London Rly.	,, 13	2,493	− 57	19	54,592	+ 10
Colchester Corporation	,, 10	191	+ 4	‡7	7,461	− 1,330
Cork Electric Trams Co.	,, 10	456	− 49	19	7,9 0	− 82
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 4	416	− 21	18	7,499	− 370
Dover Corporation	,, 12	232	+ 31	6	1,391	+ 124
Dublin & Lucan Railway	,, 11	115	− 2	§19	1,856	− 96
Dublin United	,, 11	5,106	+ 205	‡19	87,199	+ 2,000
Dudley—Stourbridge	,, 4	738	− 19	18	13,959	+ 294
Dundee Corporation	,, 9	1,003	+ 179	§51	48,519	+ 5,210
East Ham Council	,, 12	879	+ 13	6	5,586	+ 722
Exeter Corporation	,, 11	259	− 82	6	1,625	+ 52
Gateshead & Dist. Trams	,, 4	897	+ 43	13	16,430	+ 780
Glasgow Corporation	,, 12	16,590	+ 1,369	50	768,861	+ 52,019
Glossop	,, 5 ,, 12	131 146	− 3 − 20	19	2,382	+ 234
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 4	209	+ 4	18	3,717	+ 167
Gt. Northern & City Rly.	,, 12	1,725	+ 133	19	34,190	+ 1,414
Greenock & Port Glasgow.	,, 4	598	+ 5	18	10,626	+ 749
Halifax Corporation	,, 9	1,171	− 4	6	9,153	+ 478
Hartlepool Tramways	,, 4	255	+ 22	13	4,642	+ 289
Hastings Elec. Trams Co.	,, 10	684	...	19	8,810	...
Huddersfield	,, 12	1,479	+ 227	6	8,991	+ 1,091
Hull Corporation	,, 12	2,145	+ 108	6	13,218	− 31
Ilford Dist. Coun.	...	...	...	...	...	...
Ilkeston Dist. Council	,, 9	123	− 3	6	713	− 7
Ipswich Corporation	,, 12	385	− 20	6	2,418	− 14
Isle of Thanet Co.	,, 12	402	− 76	31	9,249	− 808
Keighley Corporation	,, 10	143	+ 1	30	6,288	+ 532
Kidderminster & District	,, 4	91	− 1	18	1,736	+ 21
Kilmarnock Corporation	,, 12	187	− 12	52	8,0 3	...
Kirkcaldy Corporation	,, 9	207	− 11	10	,099	− 80
Lanarkshire Trams Co.	,, 10	847	+ 159	†19	15,8 0	+ 3,572
Leamington	,, 4	136	+ 77	18	2,539	+ 1,191
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	,, 12	2,252	+ 79	19	30,820	+ 3,956
Leith Corporation	,, 1	500	+ 240	51	19,816	+ 13,611
Liverpool Overhead Rly.	,, 3	1,457	− 94	19	26,545	− 1,921
Liverpool Corporation	,, 5	10,763	− 208	18	185,946	+ 5,329
*London County Council	,, 5	25,076	− 901	5	132,776	+ 8,129
London United	,, 11	5,892	− 610	†19	100,220	+ 4,960
Lowestoft	,, 12	122	− 25	33	4,235	− 187
Maidstone Corporation	,, 10	101	− 21	6	629	− 77
Manchester Corporation	,, 12	13,100	+ 720	6	78,141	+ 4,250
Mersey Railway	,, 11	1,836	+ 179	19	32,713	+ 1,341
Merthyr	,, 4	187	− 18	18	3,293	− 48
Metropolitan Dist. Railway	,, 13	8,010	+ 701	19	151,196	+ 8,944
*Metropolitan Elec. Trams	,, 4	3,0 9	+ 918	18	53,731	+ 17,636
Middleton	,, 4	274	− 11	18	5,151	+ 360
Nelson Corporation	,, 12	136	+ 13	7	918	+ 101
Newcastle-on-Tyne Corp.	,, 12	3,848	+ 278	6	23,657	+ 1,110
Newport (Mon.)	,, 12	695	+ 43	6	3,662	+ 210
Northampton Corporation.	,, 11	434	+ 17	6	2,463	+ 58
Oldham, Ashton & Hyde	,, 4	808	+ 19	18	9,440	+ 351
Oldham Corporation	,, 13	1,813	+ 254	7	12,259	+ 709
Perth (N.B.) Corporation	,, 9	137	...	26	3,807	...
Perth (W. A.) Elec Trams	,, 11	1,550	+ 209	‡19	28,983	+ 1,521
Peterborough	,, 4	102	− 17	18	1,892	− 120
Pontypridd District Coun.	,, 12	152	+ 7	6	1,057	− 41
Portsmouth Corporation	,, 12	1,763	− 131	6	11,120	− 247
Potteries	,, 4	1,600	− 3	18	81,031	+ 1,654
Preston Corporation	,, 9	689	+ 84	...	...	...
Reading Corporation	,, 10	594	− 29	...	...	...
Rochdale Corporation	,, 14	1,016	+ 465	6	6,189	+ 2,751
Rotherham Corporation	,, 10	461	+ 85	6	2,751	+ 225
Rothesay	,, 4	116	+ 7	18	1,494	+ 306
Salford Corporation	,, 14	4,407	+ 240	6	27,303	+ 439
Sheerness	,, 2	50	− 11	18	884	− 153
Sheffield Corporation	,, 13	5,212	+ 376	7	85,857	+ 2,292
Southampton Corporation.	,, 9	884	− 33	†6	5,971	+ 99
Southend Corporation	,, 9	825	+ 7	6	1,981	+ 78
Southport Tramways	,, 4	272	− 42	18	4,594	+ 78

(a) These comparisons are with the corresponding period last year. † Minus 6 days. ‡ Minus 2 days. § Plus 2 days ¶ Plus 3 days. * Partly electrical

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	May 4	749	+ 121	18	14,010	+ 2,158
Stalyb'dge, Hyde, &c., Jt. Bd.	..	...	...	...	...	...
Stockport Corporation	,, 11	817	+ 256	6	5,420	+ 2,074
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	,, 9	336	...	...	...	...
Swansea Trams	,, 4	759	+ 6	18	13,359	+ 4,253
Swindon Corporation	,, 9	173	− 10	¶5	1,050	40
Taunton	,, 4	43	− 12	18	748	− 34
Tynemouth and District	,, 4	183	− 20	18	3,968	− 18
Tyneside Trams Co.	,, 9	387	+ 3	19	7,187	+ 438
Wallasey District Council.	,, 12	729	− 7	6	4,536	+ 158
Walsall Corporation	,, 12	501	+ 36	17	9,291	+ 692
Warrington Corporation	,, 10	359	+ 48	11	2,162	+ 223
West Ham Corporation	,, 10	2,168	+ 510	6	13,473	+ 5,071
Weston-super-Mare	,, 2	73	− 22	18	817	+ 33
Wolverhampton Corpn.	,, 9	812	...	6	4,880	...
* Wolverhampton District	,, 4	378	+ 55	18	6,942	+ 650
* Worcester	,, 4	252	− 30	18	4,372	− 397
Wrexham	,, 4	95	+ 4	18	1,707	− 45
Yorksh're W.R. Trams	,, 13	811	+ 159	19	14,093	...
Yorkshire Woollen District	,, 4	817	+ 263	18	14,918	+ 4,655

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., May 16.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to May 16. Highest.	Business, Week to May 16. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-ArgentineOrd.Shs.ex rights	7 —7½	5 10 4	Ap, Oct	8½	7 3/32
5	2/9	Do. 5½% Cum. Pref.	5⅞–6⅛	4 10 0	—	6 1/16	5 15/16
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	⅞–1⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞–4⅛	6 1 4	—	4 3/32	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	93 —96	4 13 9	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	116 —119	5 2 2	—	..	..
St.	5%	Do. Pref. Ord. Stk	109 —112	4 9 3	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	108¾	108½
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	102%—104%	4 6 6	—	103¼	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3 —3¼	5 6 0	—	3 1/16	2 15/16
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5⅝–5⅞	5 2 6	—	5⅝	..
5	8/0	Do. "B"	5 —5½	5 7 0	—	5⅛	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	104¼	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	101 —103	4 17 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	102 —106	5 4 3	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	103 —105	5 14 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	9¼–9¾	4 2 0	—	9⅝	..
5	2/6	Do. Nos. 105,001 to 137,610	8½—9	4 9 0	..	8 15/16	8 13/16
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 3	—	108	..
1	0/6	Cape Electric Tram Shares	⅝–⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 —97%	5 2 6	..	97	96½
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 —91	..	..	..	..
St.	..	Do. 6% "B" Ditto	84 – 88	..	..	86	85
1	..	Lisbon Elec. Trams Ord.	1 9/16—1 11/16	..	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102 —105	4 15 0	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	103¾	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —108	4 12 6	..	—	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	143 —146	..	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	99½	98⅞
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu.Pr.	4¾—5¼	5 14 6	..	..	—
5	5/1	† Calcutta Elec. (1-50,000)	8¾ 9¼	4 11 11	—	..	..
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½–3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	10 —11	–	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	100 —102	4 18 2	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	112 —115	5 4 0	..	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref. ex 7½d. on a/c of arrears	⅞—1	6 0 0	—	29/32	27/32
1	1/0	Rand Electric	1¼—1⅜	—	—	..	..
1	..	River Plate Electricity Co. Ord.	1 7/16 – 1 9/16	..	..	..	..
1	1/2⅖	† Do. 6% Non. Cum. Pref.	⅞ - 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4 17 0	..	..	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅜—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	..	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 - 103	4 17 0	..	..	—

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 16.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to May 16. Highest.	Business, Week to May 16. Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	11$\frac{19}{32}$	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 8 3	..	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	6⅛—6⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾—9¼	5 8 6	—	8¼	..
5	8/6	Do. 7 per Cent. Pref.	8¾—9¼	8 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 —105	3 16 3	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	102	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 —4½	5 0 0	—	..	..
5	2/3	Do. Do. (1903)	4 —4½	5 0 0	—	—	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —109	4 2 6	Jn, Dec ..	..	..
10	7/0	City of London Electric Lighting Ord.	10½—11¼	5 6 6	Feb, Aug	11	10¾
10	6/0	Do. 6 per Cent. Cum. Pref.	13 —14	4 5 6	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	101¾	..
5	4	County of Durham Elec. P. D. Ord. £3 pd.	3 —3$\frac{1}{32}$	4 0 0	April, Oct	..	..
5	5%	† Do. Do. 5% non cum. pref.	5⅛—5⅜	4 15 3	April, Oct	5¼	..
10	6/0	County of London Elec. Supply Ord.	8 —9	5 11 0	—	8$\frac{11}{16}$	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	110¾	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —102	4 8 0	..	100¾	..
5	8/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	—	..
5	5/0	Hove Electric Lighting Ord.	8¼—8¾	5 5 0	—	—	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 —11	4 11 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 2	..	..	—
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
8	2/4½	London Electric Supply Ord.	2 —2½	4 0 0	—	..	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	3 19 2	Mr, Jn, S, D	100	99¼
5	10%	Metropolitan Electric Sup. Ord.	8¼—9¼	5 8 0	April, Oct	8¾	8⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 0 0	Jan, July	5$\frac{17}{32}$	5$\frac{7}{16}$
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 3	—	—	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	101 —103%	4 7 4	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞—11	6 8 11	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 —104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅜—7⅝	5 6 8	Feb, Aug	7⅝	..
5	5%	Do. 5 per Cent. Non Cum. Pref.	5¾—5⅞	4 6 3	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	$\frac{31}{32}$—1	3 0 0	Mar, Aug	1	..
100	4½%	Do. 4½% Deb.	101 —102	4 8 3	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10 —11	5 13 0	Feb, Aug	10⅞	10¾
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	7⅝	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	..	..
1	0/8	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	1$\frac{5}{16}$	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	4 —4½	5 11 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4$\frac{15}{16}$—5$\frac{1}{16}$	4 14 0	—	4$\frac{31}{32}$	..
St.	4½%	Do. 4½% 1 Mort. Deb.	101 —103	4 7 4	..	102	—
5	6/6	Westminster Elec. Sup. Ord.	10 —11	5 18 0	Mar, Sept	10$\frac{3}{16}$	10
5	2/6	Do. 5 per Cent. Cum. Pref.	5$\frac{5}{16}$—5$\frac{9}{16}$	4 10 0	..	..	..
5	..	Do. Issued at 7/6 premium all paid	5$\frac{5}{16}$—5$\frac{9}{16}$	..	..	5$\frac{15}{32}$	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4 Perp. Db. St.	94 —96	4 3 4	..	95	—
1	1/0	Bath Elec. Trams Pref. Ord.	⅞—1	4 17 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	$\frac{15}{16}$—1$\frac{1}{16}$	4 12 3	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 —103	4 7 3	—	102¾	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	102⅞	102¾
10	9%	Bristol Tramways and Carriage Ord.	15½—15¾	5 15 2	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10¼	3 18 0	..	—	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	..	—
10	6/0	British Electric Traction Ord.	6½—7	4 5 8	—	6⅞	6$\frac{23}{32}$
10	6/0	Do. 6 per Cent. Cum. Pref.	9 —9½	6 6 0	Feb, Aug	9⅜	9$\frac{3}{16}$
St.	5%	Do. 5 per Cent. Perpetual Debs	113 —116	4 6 0	..	115	113
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 —95	4 14 9	..	93¼	—
St.	4%	Central London Ordinary Stock	88 —90	4 10 0	June, Dec	90	88
St.	4%	Do. 4 per Cent. Pref. Stock	99 —101	3 19 0	..	100¾	99½
St.	4%	Do. Deferred Stock	77 —80	5 0 0	..	78½	77¼
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	111⅞	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 —95	4 4 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 —5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	39 —41	4 10 0	Feb, Aug	40⅞	39
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼—3¾	10 13 4	..	3¾	3½
10	4/0	Gt. Northern, Piccadilly & Brompton Ord., Speyer Bros. Scrip Certs	8 —9	4 8 11	—	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	106½—107½	4 3 8	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 —2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8½—8⅝	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref	9¼—9¾	5 2 6	—	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	97 —100	4 0 0	—	99½	97½
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	$\frac{3}{32}$	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	$\frac{15}{16}$	..
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	103	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref	½—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	8 —9	5 15 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8 —9	5 11 0	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	101 —104	4 8 6	—	—	—
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	95¼	..
..	5%	Underground Elec. Rys. Co. of London	93 —97	5 3 0	..	96¼	95¾
St.	3½%	Waterloo and City Ord.	99 —102	3 8 8	June, Dec	..	—
St.	4½%	Yorkshire W.R. El. Trs. Co. 4½% 1st Debs.	95 —97	4 13 0	—	95½	..

Shre.	Last Dividend	Name.	Price Wed., May 16.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 16. Highest.	Business Week to May 16. Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	3¾—4	5 0 0	..	3$\frac{31}{32}$	3$\frac{29}{32}$
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	5 19 6	July, Feb	..	—
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 —107	4 4 0	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞—2⅜	..	..	2$\frac{3}{32}$	2
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 —85	4 14 0	..	..	..
2	[illegible]/0	Brush Electrical Engineering	⅝—⅞	..	March ..	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	—	..
5	10/0	Callender's Cable Con. Ord. xd & bonus	10½—11½	4 10 6	Jan, July	11$\frac{5}{16}$	11
5	2/6	Do. 5 per Cent. Cum. Pref	5¾—6	4 3 4	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	..	..
1	4½d.	Castner-Kellner Alkali Co.	1$\frac{1}{16}$—1$\frac{3}{16}$	5 1 6	..	1$\frac{3}{16}$	1⅛
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 —102	4 8 0	—	100	..
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1$\frac{3}{16}$—1$\frac{5}{16}$	7 10 0	—	—	—
1	7½d.	Do 6% Cum. Pref.	1$\frac{1}{16}$—1$\frac{3}{16}$	5 8 0	..	..	—
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2¼	3 6 6	Jan, July	2	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	97%—100%	5 1 0	Jan, July	97¼	97
5	10/0	Dick, Kerr & Co. Ord	1¾—1⅞	5 8 0	Sept	—	..
5	8/0	Do. 6% Cum. Pref.	1$\frac{5}{16}$—1$\frac{7}{16}$	4 6 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	—	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	—	Feb, Aug	1$\frac{9}{16}$	..
5	2/6	Do. (£5 paid)	2½—3	—	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	..	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	4¾—5¼	5 14 0	..	5$\frac{3}{16}$	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	108	—
2	1/7½	Electric Construction Co.	$\frac{9}{16}$—$\frac{13}{16}$	9 6 0	July	—	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅜—9⅞	5 3 0	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	94 —98	4 1 6	—	..	—
5	10/0	Henley's Telegraph Works Ord.	12 —13	5 15 0	Feb, Aug	..	—
5	2/8	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	5½	—
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 —111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½—59½	..	..	58¼	—
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17 —18	2 17 2	Feb, Aug	17$\frac{5}{16}$	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	2½	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	$\frac{29}{32}$—$\frac{31}{32}$	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	⅞—1	6 0 0	..	$\frac{15}{16}$	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 10 0	..	..	..
12	4 0	Telegraph Construction & Maintenance.	32 —34	5 6 0	Mar, July	32¾	32
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	101 —103	3 17 6	Jan, July	..	—
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2$\frac{7}{16}$—2$\frac{9}{16}$	5 15 0	..	2$\frac{9}{16}$	2$\frac{15}{32}$
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1¼	4 0 0	..	1$\frac{7}{32}$	1$\frac{3}{16}$
St.	5%	Do. 5% Non-Cum. Preferred	114 —117	4 5 3	—	116¾	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock Red.	103 —105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 —108	4 3 8	—	107½	107¼
5	—	Willans and Robinson Ord.	1¾—2¼	—	Apr, Oct	1⅞	1½
5	—	Do. 6 per Cent. Cum. Pref.	3 —3½	—	Apr, Oct	3$\frac{7}{16}$	1$\frac{15}{32}$
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 —85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	3¾—4¼	—	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	84	82
St.	15/0	Anglo-American	67 —69	4 14 0	F, My, Ag, N	68¼	68
St.	60/0	Do. Preferred	114 —115	5 4 6	F, My, Ag, N	115	114
St.	10/0	Do. Deferred	25¾—26	..	F, My, Ag, N	26	[illegible]
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	96½—97½	4 1 3	Ja, Ap, Jy, O	98	97
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	..	—
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
100	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 8	Jan, July	..	..
20	4 0	Direct United States Cable.	16¼—16¾	4 1 0	Ja, Ap, Jy, O	16$\frac{15}{32}$	16$\frac{13}{32}$
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	[illegible]/0	Eastern Ordinary	142 —145	4 16 6	Ja, Ap, Jy, O	145	143
St.	17/6	Do. 3½ per Cent. Pref. Stock	89 —91	3 17 6	Ja, Ap, Jy, O	90⅞	90
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —108	3 14 0	May, Nov	107	..
10	6/8	Eastern Extension xd & bonus	14½—15	4 13 6	Ja, Ap, Jy, O	14⅝	14¼
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	107½	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 3	Feb, Aug	..	—
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) with coupon 67	39 —41	5 17 0	Jan, July	39⅛	38½
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 —103	4 7 3	June, Dec	..	..
25	57/6	Indo-European	56 —58	5 12 1	May, Nov	57½	57
100	$1	Mackay Companies Common	73$\frac{13}{16}$—74$\frac{3}{16}$	3 0 6	Jan, July	—	..
100	4%	Do. Preference	76$\frac{13}{16}$—77$\frac{3}{16}$	5 3 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 —103	3 17 6	June, Dec	100¾	..
10	4/0	West African Telegraph Shares	9¾—10¼	4 17 6	..	..	—
[illegible]	—	West Coast of America	¾—⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100 —103	3 17 8	Jan, July	..	..
10	—	West India and Panama	⅞—1⅛	..	May, Nov	$\frac{31}{32}$	[illegible]
10	6/0	Do. 6% 1st Pref.	8 —8½	7 1 0	May, Nov	8$\frac{5}{16}$	8$\frac{1}{16}$
10	—	Do. 6 per Cent. 2nd Pref.	6 —7	..	May, Nov	6⅝	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14 —14½	4 17 6	Mr, Jn, O, D	14$\frac{5}{16}$	14$\frac{3}{16}$
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	10[illegible] —104	3 17 0	..	103	..
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	97½	97
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	7¾—8¼	4 18 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	$\frac{15}{16}$—1$\frac{1}{16}$	3 15 3	—	—	..
1	0/6	Do. 6% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109 —111	5 8 0	—	110¼	109
St.	6%	Do. Def. Stock	108 —110	4 11 0	—	109¾	108
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	13¼	13½
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅜—5⅝	4 9 0	Feb, Aug	5$\frac{15}{32}$	5$\frac{7}{16}$
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	99	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 6	—	105½	105
1	0/9⅗	† Oriental	1⅜—1½	4 0 0	April, Oct	1$\frac{7}{16}$	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	1$\frac{5}{16}$	..
St.	24/7⅗	Do. 4% Red. Deb. Stock	99 —101	3 19 0	..	—	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	..	—
5	3/0	United River Plate	7 —7½	5 6 8	July	7¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —112	3	June, Dec	—	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	—	..	..
10	2/0	Globe Telegraph and Trust	11⅛—11⅜	4 15 0	Ja, Ap, Jy, O	11¼	11
10	3/0	Do. 6 per Cent. Pref	14¾—15	4 0 0	Ja, Ap, Jy, O	15	14¾
10	6%	Submarine Cables Trust (Cert.)	126 —129	4 13 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

◆

It is apparent from the report of the Council of the Institution of Electrical Engineers, which was placed before the annual general meeting last night, that a great deal of the Council's work is done in committee. The members and the Council themselves certainly owe a debt of gratitude to the hardworking men who have devoted their time gratuitously to attend the 110 committee meetings held last session. There is a danger, however, to which we wish to call attention. It is notorious that the Sectional Committees do very little else than propose authors for papers, and therefore the committee work referred to is presumably done chiefly by small committees of three or four members nominated by the Council. When this work is of a detailed nature, it is evident that the confirmation of the Committee's report by the Council will, as often as not, be a mere matter of form, and thus there is a risk of questions of considerable importance being settled without the wide discussion on them from all points of view that can only be afforded by a meeting in which many interests are adequately represented by a number of members.

◆

One such subject is mentioned briefly in the Council's report—viz., the proposal for the international standardisation of the nomenclature and rating of electrical machinery. It appears that a committee has already been appointed to report on the matter and that the first meeting of international delegates will be convened at an early date. We are not told the names of the men to whom the serious task has been allotted of ascertaining the national opinion on what is of the greatest importance to every electrical manufacturer, but we trust that before any delegates are appointed with instructions to support the Committee's findings at the International Conference full publicity will be given to the code of standards arrived at.

◆

We publish on another page the complete programme for the forthcoming meeting of the Incorporated Municipal Electrical Association in London from June 19th to 23rd. London is an excellent centre for this meeting, and we have no doubt that so many members will be attracted to it as to beat previous records. At the first meeting, at Kingston-on-Thames, on Tuesday, June 19th, after Mr. Edgcome has delivered his Presidential Address, Mr. Sydney Baynes—whom we are glad to see once more taking an active part in the proceedings of the Association—will occupy the stage and read a Paper on "Steam Turbines," which should lead to a good discussion and a useful exchange of experiences. On the following day, in London, the subjects are of a more commercial nature, and this will be the "Councillors' Day," although the Papers are by station engineers. At the Business Meeting on the Thursday, some important alterations in the Articles of Association will be proposed, which we set out fully on p. 225 in such a way as to indicate their nature. On Friday, June 22nd, there promises to be a good discussion on station economy: Mr. G. Wilkinson will relate his experience with a boiler arranged on the Druitt Halpin principle; Mr. W. A. Vignoles will doubtless explain how he gets his excellent results with comparatively small steam units; and a debate on the ever-green question of "combined" stations of a small size will be started by Mr. S. J. Watson. The works which are to be visited have been well selected, and the whole programme promises an instructive and enjoyable Convention.

◆

The discussion in London on Messrs. Tweedy and Dudgeon's Birmingham Paper on "Overhead Equipment" brought out a diversity of opinion on several points, which shows that there is neither settled practice nor a clear body of experience tending thereto. No doubt there are many individual engineers who know why they build a trolley line in a particular way; but these men differ materially upon such fundamental points as the size and strength of poles and the gauge of wire that are necessary or advisable. Mr. TWEEDY's criticism of the early work done in this country mainly by Americans was taken by one speaker as a criticism of American practice, which he naturally defended as the outcome of the climatic and other conditions there existing. The actual sense of the criticism was just the reverse—viz., that Americans had done work here without recognising the difference of British conditions.

◆

THE most novel and important points raised in the Paper met with no more elucidation than they did in Birmingham. The peculiar wear of trolley wire mainly at and near ears, and the failure of insulated bolts, especially those of brass, require considerably more investigation. One speaker suggested the abolition of the insulated bolt altogether, and this seems a sensible and practicable improvement. That the localised wear of wire is mainly a dynamic effect, depending upon oscillation of the trolley boom and head, and aided by arcing owing to insufficient contact surface was the most definite suggestion advanced. An ear made of pure copper was shown as offering better contact, and therefore diminishing arcing. But, in fact, the wheel ought not to touch the ear.

◆

THE insulated bolts shown included iron and brass. Several of the latter, stated to have a very low insulation resistance, showed no sign of fault but a darkening of the surface. With a lens, however, it was clear that the darkening extended to a definite thickness, and that this dark skin was changed in character, probably charred. This effect is always caused by a creeping leakage current over organic material, and the more rapid and definite deterioration with brass is doubtless due to the higher solubility and conductivity of the salts produced by electrolytic attack of that alloy as compared with iron salts.

◆

DURING the week an opportunity has been afforded us of examining the wheels on a large number of cars, all with steel tyred wheels. This examination confirms the experience related by Mr. PANTON in the article upon which we commented in this column in our last issue. Practically every pair of wheels showed exactly the kind of wear, and the same difference between the wear on the wheels at the geared and non-geared ends as described by Mr. PANTON, who, we think, has proved his case on that particular point.

◆

AN interesting example of relative prices of gas and electricity for public lighting comes from one of our Australian correspondents. It appears that the local authorities at Collingwood and Fitzroy, near Melbourne, had been deliberating on the most suitable form of illumination for the principal thoroughfare of the two municipalities, and recently the gas and electric companies were invited to quote a price for what they considered the most satisfactory method of lighting the street, and to erect a specimen lamp illustrating what they proposed. The Gas Company's first offer was for 34 lamps, totalling 8,500 c.p., but this was subsequently increased to 42 lamps and 12,400 c.p., made up of seven Lucas lamps of 1,000 c.p., two of 400 c p., thirteen of 200 c.p. and twenty of 100 c.p., the price for which, on a five years' contract, with lamps lit from sunset to midnight was £291 per annum, including the specimen Lucas lamp already erected. The Electric Light Company offered alternatively fifteen 3,000 c.p. or twenty-two 2,000 c.p. flame arc lamps at figures differing but little from the Gas Company's, although over three times the amount of illumination was to be provided.

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The Wireless Telegraph Conference.—It is announced that, on the proposal of the British Government, the International Wireless Telegraph Conference, which is to take place in Berlin this year, has been postponed from June 28th to October 10th.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Tangier—Cadiz	Feb. 17, 1906
Paramaribo—Cayenne	April 20, 1906
Sydney—Nelson	April 26, 1906
Cape Haitien—Puerto Plata	May 15, 1906

National Physical Laboratory.—Mr. R. B. Haldane, the Secretary of State for War, will open on June 25th the buildings which have been added to the National Physical Laboratory for electrotechnical and photometric work. This is the first day of the tour of the members of foreign societies received by the Institution of Electrical Engineers, and they will be invited to attend the ceremony.

Personal.—Prof. W. Ostwald has resigned the professorship which he has held in the University of Leipzig for nearly 20 years. According to *Nature* he has decided to retire to his country house at Grossbothen, where a small private laboratory has been arranged, and to devote himself to literary and experimental work.

Major P. A. MacMahon, F.R.S., has been appointed Deputy Warden of the Standards by the President of the Board of Trade in succession to the late superintendent of weights and measures, Mr. H. J. Chaney.

Royal Institution.—On Friday evening last Prof. Schuster devoted an hour to the discussion of "International Science." He described the organisations in existence already for carrying out such work as cataloguing scientific Papers, star-cataloguing, geodesy and meteorology, and outlined the main results in these directions. His main point was that some central authority should be established to direct the work of those already in being, in the sense of confining their efforts to proper subjects and preventing overlapping. Throughout the discourse Prof. Schuster made numerous opportunities of charging the English Government with parsimony.

The Milan Exhibition.—The following are amongst the International Congresses which will be held at the Milan exhibition during the season: May 28th to 30th, Firemens' Congress; May 24th to 29th, Congress on Automobiles; September 5th to 9th, Electro-biology and Radiology; September 24th to 28th, Chambers of Commerce; September 23rd to 30th, Engineers and Architects; September 17th to 22nd, International Union of Tramways and Railways; and September 17th to 21st, Commercial Training. Among the congresses for which the dates are not yet fixed is one devoted to meteorology and a congress of tramway associations.

Obituary.—We regret to announce the death of Mr. F. C. Danvers on the 17th inst. Mr. Danvers has been one of the honorary auditors of the Institution of Electrical Engineers for many years. For thirteen years he was Registrar and Superintendent of Records at the India Office. He had considerable engineering ability, and after joining the clerical establishment of the East India House, he was deputed to make a report on traction engines for use in India, where railway communication at the time was very scarce. Later he prepared plans for the construction of a railway under the Hoogli.

The death took place on Tuesday of Sir Thomas Richardson, engineer and a director of Richardsons, Westgarth & Co. (Ltd.).

Protection of Overhead Lines from Lightning.—A few months ago we described the equipment of the high-tension overhead line used in the Tame and Rea Sewage Disposal Scheme (see *The Electrician*, Vol. LVI., page 212), and it is interesting to learn that during the extremely severe thunderstorm which passed over that portion of the Birmingham district on Wednesday, May 16, the B.T.-H. lightning arresters with which the line is equipped worked most satisfactorily and effectively protected the installation. All the arresters on the line discharged after practically every flash with no resultant damage. It will be remembered that the overhead transmission line in question is about five miles long, and works at 2,200 volts 50 cycles three-phase.

Temporary Interruption of Supply at Portsmouth.—A somewhat serious disturbance of the Portsmouth lighting system occurred on Friday evening last at about 8.30, when the whole town was for a few minutes plunged in darkness. A short circuit developed in a junction box, which blew a fuse at the station. It appears that in replacing it further trouble was caused and one of the sets began to pull up; the other machine fuses then blew, causing a total interruption of supply. New fuses were inserted as quickly as possible, and in a few minutes' time supply to the undamaged sections was resumed. The fault was eventually located and a spare piece of cable put in, enabling the section to be switched on again at about 2.45 a.m. The fault, it is stated, was originally caused by the failure of an arc lighting cable, which burnt through the ordinary lighting feeder.

A New High-speed Electric Lift.—Through the courtesy of Messrs. A. W. Gamage (Ltd.) we inspected yesterday afternoon in their Holborn office block a new electric express lift which has been installed by Messrs. A. W. Penrose & Co., who claim that it is the fastest electric lift in Europe. The control is so arranged that the lift can be driven at any one of six speeds, ranging from 170 ft. to 450 ft. per minute, while at the same time the starting and stopping is particularly smooth. A semi-enclosed shunt-wound motor drives the drum through a worm gear, the worm itself being cut on an extension of the armature shaft, which also carries a brake drum. The main controller is compactly arranged, and is constructed entirely without slate, as only micanite insulation is used. A double solenoid reversing switch is used, fitted with overload and no voltage release gear, and a separate solenoid, provided with a dash-pot, progressively cuts out the starting resistances by means of a row of carbon plunger contacts. The small master controller on the car is of the drum type, and besides closing the control circuits actuating the starting and reversing contractors, inserts resistances into the shunt circuit of the motor in six steps. It is thus possible by suitably handling the car controller to raise the speed as quickly or slowly as desired, or to run at any one of the six speeds by remaining on a particular step. These shunt resistances are carried on the car. Before stopping, the resistances are progressively cut out again, causing a braking action, and on the last step but one the armature circuit is short circuited on to the starting resistances forming a still more powerful brake, and finally when the circuit is completely broken the mechanical brake on the motor shaft comes into action in the usual way.

Tynemouth Electricity Undertaking.—We recently announced that an agreement had been come to between the Newcastle-upon-Tyne Electric Supply Co. and the Corporation of Tynemouth, under which the Corporation were to receive a supply in bulk from the Company. It is now stated that the arrangements have been satisfactorily concluded and that the agreement has been drawn up and sealed. According to the *Shields Daily Gazette* the result will be that the municipal electricity works in Tynemouth will become the centre for the distribution of current rather than a generating station. The article from which we quote continues: To some of the places where electricity will shortly be supplied the Corporation have no mains laid. Among such consumers is Smith's Dock Co., in which a large amount of power will be required for short spaces of time. To meet such a demand it would have been necessary for the Corporation to instal new plant which would lie idle for many hours of the day. The Newcastle Electric Supply Co. will be able to supply at much cheaper rates than the municipal authority and to meet the largest demand for power at any moment. Electrical energy will be delivered at the Tynemouth electricity station in the form of three-phase current, and it will be transformed to continuous current by plant which the company will supply and fix at their own cost. Extremely low rates are mentioned at which the Corporation will be supplied with energy by the company, but we have been unable to obtain confirmation of these. The steam generating plant now used at the Corporation power station will be retained for uses on emergency and to assist during the winter peak load—*i.e.*, between 2 p.m. and 10 p.m. from November to February inclusive, with the exception of Saturdays, Sundays and holidays.

Electric Power Supply.—A Paper by Mr. J. N. Shoolbred, bearing the title "The General Supply of Electricity for Power and Other Purposes; its Commercial Character and Controlling Management," was read at the Society of Arts on Wednesday. Mr. Shoolbred, owing to the sudden death of his wife, was unable to be present, and the Secretary read the Paper:—

The main object of the Paper was to ascertain the cause of the backwardness of Great Britain in the facilities for the supply of electric power for all purposes. The author complained that the attitude which had been adopted by Parliament was as if it were simply a private trading question, and consequently the numerous and varied interests of the public community had been entirely overlooked. The small amount of progress made by the Lancashire and Yorkshire Electric Power Companies was cited as illustrating this point, although it is doubtful whether either of these companies will agree that "little or nothing" has been done to carry out their powers. This result, in the author's opinion, was due to the fact that the interests involved were too important to be dealt with satisfactorily for the public weal by private traders, no matter how distinguished the individuals might be. Mr. Shoolbred suggested, to obviate an extension of this condition of things, the formation of public boards which would end in the extinction of the power companies, and he could conceive that this could be done with due regard to the interests of the power companies. It had been done, he said, in the case of the Mersey Docks and Harbour Board. The author then gave details of a number of other public boards upon the lines of which electric power boards of control could be established. He mentioned the Clyde Conservancy, Tyne Improvement Commissioners, the Thames Conservancy, the Metropolitan Water Board, and the Derwent Valley Board.

Mr. Graham Harris, who was in the Chair, said that the pioneers of electric power companies had been handicapped from the beginning by the want of enthusiasm shown by the Stock Exchange and investors generally with regard to the electrical industry. Three-quarters of the money now invested in the electrical industry here came from the Continent or America, and this money was the profit that had been made from the electrical industry in those countries, due to the absence of that grandmotherly legislation which had so much hampered Great Britain. By the Act of 1882 the electrical industry had been damned for 10 years—he was not sure whether this word was strong enough. He would express no opinion as to the merit of the suggestion made by the author, as to whether it was best to create boards of control or leave things as they were. All he could say with regard to the electric power companies was that the difficulty was in obtaining the necessary financial support; the demand was waiting to be met.

Col. Allan Cunningham suggested that one of the chief causes of the belated progress of the electrical industry here was that there was an excellent supply of illuminating gas, an industry which had a large sum of money invested in it, and which was an English invention. In most of the Continental countries and in America this was not so, and, consequently, electricity had a free field.

Mr. A. J. Martin and Mr. Leon Gaster also spoke in the same strain.

The Chairman in a few final remarks referred to the methods employed in developing the electrical industry on the Continent as compared with Great Britain. He knew of two Continental power stations, both containing several hundred thousand kilowatts of plant, which had been erected before a single consumer had been secured. The very opposite obtained in England.

A vote of thanks to Mr. Shoolbred for his Paper was passed at the close, with an expression of sympathy in the unfortunate domestic bereavement which he had sustained.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, May 25th.**

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Colour Phenomena in Photometry," by J. S. Dow; (2) "Exhibition of an Automatic Arc Lamp," by H. Tomlinson and the Rev. G. T. Johnston; (3) "The Theory of Moving Coil and other kinds of Ballistic Galvanometers," by Prof. H. A. Wilson; (4) "Exhibition of a Bifilar Galvanometer free from Zero Creep," by A. Campbell.

FRIDAY, June 1st.

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. H. Moissan on "L'Ébullition des Metaux."

THE CLASSIFICATION OF ALTERNATE-CURRENT MOTORS.

BY V. A. FYNN.

The technical press of all countries is nowadays replete with contributions, discussions and patent descriptions all concerning alternate-current motors mostly of the single-phase commutator type. It will be generally admitted that this subject is not without a certain amount of intrinsic difficulty, and that the appearance in quick succession of new or improved types of motors does not make it the easier to keep up-to-date. The author ventures to think that the lack of uniformity in the classification increases the difficulty quite unnecessarily, and often gives rise to misunderstandings and time-wasting discussions. These alternate-current commutator machines are now most certainly coming into general use, and it would be to the interest of all concerned to agree to and abide by one uniform classification. The object of this contribution is to propose, for general acceptance, a classification which the author believes to have a rational basis. If such a result cannot be achieved, it is at least hoped that this contribution will induce someone who can do so, to put forward a better proposal and thus benefit the community. There are, undoubtedly, a number of difficulties to be overcome, partly due to the extreme pliability of the single-phase commutator motors and the consequent multiplicity of possible variations; there ought, however, to be no particular difficulty about agreeing as to the proper nomenclature of the main types.

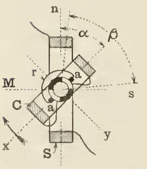


Fig. 1.

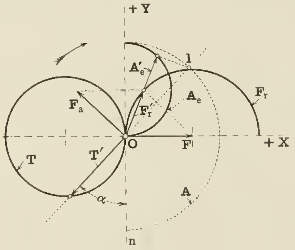


Fig. 1A.

The author believes that the term "repulsion motor" has done a good deal to bring about the confusion which now prevails, and he thinks that it will be advisable in the first instance to examine into its origin and into how far its use is justified. To the best of his knowledge it is in Thomson's American Specification No. 363185 of 1887 that the term in its present acceptance is used for the first time.

The fundamental form of Elihu Thomson's motor as described and illustrated in that specification is shown in Fig. 1. Concentrically with the stationary coil S is mounted a pivoted coil C, the two ends of which are each connected to a segment of a commutator. These segments are diametrically disposed, and are insulated from each other, brushes (*aa*) short-circuited by the short conductor (*r*) bear on these segments. Each segment extends for this two-pole motor over a little less than one quarter of the periphery as indicated by the angle β. When the two coils are concentric—*i.e.*, when the axes y and s coincide, and S is connected to an alternate-current supply, then there will be no torque even if C is short-circuited, and although a heavy current will under such conditions be induced in that coil. When C is at right angles to S—*i.e.*, when the axes y and s are perpendicular to each other, there will also be no torque and also no current in C even if short-circuited. In the intermediate positions—*i.e.*, for any values of α between 0 and 90 degrees, a torque will be exerted, and in the direction shown by the arrow.

Amongst the experiments described in the specification referred to as having led up to the motor shown in Fig. 1, is that illustrated in Fig. 2, where a coil S, connected to an alternating supply and having a laminated core or not, is said to exert a "repelling" effect on a closed coil C disposed in a plane parallel to the convolutions of the coil S. This last statement is, of course, perfectly correct, and it is evident that the term "repulsion motor" owes its origin to the effect illustrated in Fig. 2. It is to be noted that coil C, if placed as indicated in the figure, will tend to move away from coil S whilst keeping parallel to it, for the "repelling" effect will be in the same direction and of the same magnitude all along the circumference of the coil as indicated by the small arrows 1 and 2. If coil C were pivoted on an axis passing through O, and parallel to the convolutions of S, there would be absolutely no tendency for that coil to rotate, but the "repulsion" effect would tend to bend the shaft. Indeed, when in Fig. 1 coil C is placed concentrically with S (y and s coinciding) there is no rotation, and if the coils are exactly concentric also no bending strain on the shaft. Coil S simply tends to expand whilst coil C tends to contract, but rotation does not result. There is, therefore, no reason for referring to the motor in Fig. 1 as a "repulsion motor."

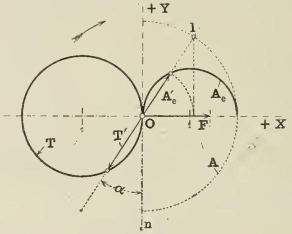


Fig. 1B.

As a matter of fact the effect illustrated in Fig. 2 is nothing else, but the effect discovered in 1820 by Ampère, and which he summed up somewhat as follows: parallel circuits "attract" each other if traversed by currents flowing in the same direction, and "repel" each other if traversed by currents flowing in opposite directions. This rule is nothing, but a special case of that electrodynamic action which is illustrated in Fig. 5 and which forms the basis of every dynamo or motor whether of the continuous or of the alternating type. A conductor C through which a current flows, for instance, upwards through the paper, as indicated by dot, when immersed in a field F, directed from top to bottom of the paper, will tend to move to the right. Ampère's rule is illustrated in Figs. 2*a* and 2*b*, which show respectively the "attraction" and the "repulsion" of parallel circuits. The rule illustrated in Fig. 5, when applied to Figs. 2A and 2B, explains this behaviour, and it is only necessary to remember that if in Fig. 5 the direction of the current through C or the direction of the field F be changed, then the direction of the torque exerted on C will be reversed. Taking Fig. 2B we have the current in conductor A producing a field of the direction indicated by the full concentric lines, these lines cut conductor B, and according to Fig. 5 this conductor B will move to the right; similarly the field produced by B (dotted lines) acting on A will cause the latter to move to the left, hence the "repulsion." Ampère very correctly restricted his rule to parallel circuits, and the author can see no reason for altering this now, by describing as "repulsion" the effect responsible for the operation of a particular type of single-phase motor in which there are no interacting parallel circuits.

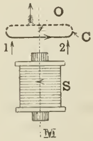


Fig. 2.

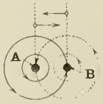


Fig. 2A.

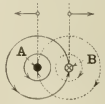


Fig. 2B.

Of course Ampère's rule holds good for alternating currents as well as for continuous currents; in the former case, however, the magnitude of the "repulsion" or "attraction" also depends on the relative phase of the currents in the two conductors, just as the torque exerted on C in the more general case of Fig. 5 also depends on the relative phase relation between the field F and the current in C. One true example of the application of Ampère's "repulsion" effect in alternate-current practice is to be found in the constant-current transformer with moveable secondary coil. In Fig. 2 one component of the current in coil S goes to excite the field M which conveys the secondary current into coil C by induction; the other component is equal and opposed to that secondary current. The secondary current in C and the component in S neutralising that secondary current are of opposite phase, which is equivalent to same phase but opposite direction, and are responsible for the "repulsion" effect.

The operation of the motor in Fig. 1 is due to the electrodynamic action illustrated in Fig. 5, but not to the special case of it discovered and characterised by Ampère. Let us connect the coils S and C of Fig. 1 in series and to a source of continuous current, and let these coils be placed exactly concentrically. There will be no movement whether the current in the two coils circulates in the same or in the opposite direction. It will be recognised that this combination simply constitutes the fundamental form of an ordinary continuous-current series motor. Assume, for instance, that the direction of the current through the two coils is opposite, and let C be the armature and S the field winding, hold S fast, and displace C from its original position through an angle α. Counting this angle α from n, the normal to the direction of the field produced by S, it is well known that the torque exerted on C will be proportional to sin α, to the magnitude of the field due to S and to the strength of the current in C. Now in Fig. 1A the coil S is supposed to be fixed in the axis Y and the coil C to be pivoted about O. Assuming that the field due to C (armature field) is not neutralised, and keeping the current through both coils constant and equal to A, we require to ascertain the torque on coil C for various values of α. For the particular position O1 of the coil C shown in Fig. 1A the value of this torque is ascertained as shown by the construction lines. The fields F and F_a yield the resultant field F'_r, and, in order to find what proportion of the total current A flowing through C is "effective" as far as torque is concerned, we project O1 on to OF',, obtaining A'_e, and we know that the torque T′ for that position is proportional to the product of F'_r and A'_e. Repeating this construction for all positions of C between + Y and − Y, we find the variation of the torque on C for these various positions represented by the circle T, the resultant field being represented by the half-circle F_r and the effective amperes by the half-circle A_e. If the coil is moved further the direction of the torque reverses, unless the current through C is reversed. Nothing will be changed if we substitute alternating for continuous current, but a phase difference will be introduced between current and E.M.F. The field F_a produced by the armature current is detrimental to the commutation in the continuous-current machine, but it is absolutely fatal in any workable alternate-current motor, and for this reason it is always neutralised. In Fig. 1B it has been assumed that F_a has been completely neutralised, and it will be seen that the torque for the same assumptions has remained absolutely unchanged. A continuous-current series motor, whether with neutralised armature reaction or not, therefore operates in virture of the same principles as an alternate-current series motor in which the current is conveyed to the armature and to the field by conduction.

Let us now examine into the operation of the motor in Fig. 1 with shorted coil C and when S is supplied with alternating current. In Fig. 3 is a clearer diagrammatic representation of the same machine. Coil S (stator winding) produces the transformer field M, and what we require to know is how will a torque be exerted on C (the short-circuited rotor winding) and what magnitude will it assume for different values of α_1, that angle being measured from n, the normal to M.

Disregarding leakage for the moment, it can be said that for $\alpha_1 = 0$ deg. or = 180 deg. the ampere turns in C (due to the E.M.F. in C induced by M) can be fully neutralised by equal and opposed ampere turns in S, but for any other value of α_1 only part of the ampere turns in C can be neutralised by those in S. In order to study the operation of such motors it is simplest to resolve the coil C into two coils, the one C_1 parallel to S and the other C_2 perpendicular to it as shown in Fig. 4. The ampere turns in C_1 must be proportional to cos α_1 and will be neutralised by equal and opposed ampere turns in S, those in C_2 must be proportional to sin α_1, and will produce the motor field F_0, whereas the current in C_1 will represent the armature current; the transformer field M simply acting as a means for conveying the current into C. The ampere turns in C_1 and C_2 will be cophasal with those of C, and consequently the motor field F_0 due to C_2 will be cophasal with the armature current in C_1. The direction of the torque will be found at once by reference to Fig. 5, and is indicated in every case. The E.M.F. induced in C by the transformer field will be proportional to cos α_1 and, leaving self-induction out of the question for the moment, the current in C will also be proportional to cos α_1. If A_c is the current in C, its maximum value will be reached in Fig. 3A, for $\alpha_1 = 0$ for values of α_1 between 0 and 90 deg. its value will be limited by the half-circle A_c. It now becomes easy to find the two components of A_c for each position of coil C. The current in coil C_1 is A_{c1} that in coil C_2 is A_{c2}, both have been plotted for all the positions of coil C and yield the curves distinguished by the corresponding letters. Since the motor field due to A_{c2} is in phase with that current, and since the latter is in phase with A_{c1}, the armature current, the torque will be proportional to the product of A_{c1} and A_{c2}, the curve thus obtained is designated by T. For the one value of α_1, indicated in Fig. 3A, the values of the determining factors are A'_{c2} for the motor field, A'_{c1} for the effective armature current, and T′ for the torque, which is proportional to the product of these two.

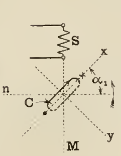


FIG. 3.

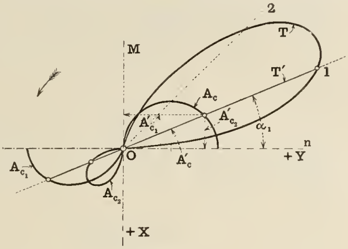


FIG. 3A.

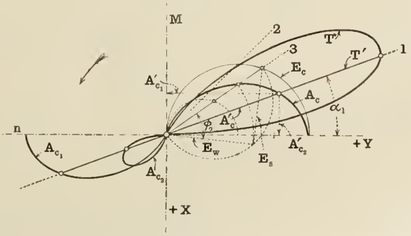


FIG. 3B.

The curve of the torque is of some interest, as it shows incidentally that the maximum torque is not obtained for $\alpha_1 = 45$ (dotted line 02), as has been so often suggested in text books and elsewhere, but for a value of $\alpha_1 \simeq 30$ deg. The effect of self-induction is to reduce the current in C, to remove the maximum torque to another value of α_1 and to cause the rotor current (and consequently also the stator current) to lag behind its E.M.F. Dealing with the two components of coil C, it is an easy matter to determine the influence and the magnitude of this self-induction. If the stator coil S could completely neutralise the ampere-turns in coil C_1 that coil would have no self-induction, part of the flux set up by C_1 does not, however, link with S and is responsible for an E.M.F. of self-induction in C_1 which is proportional to this leakage flux. The ampere-turns in C_2 are not neutralised in any way, and the whole of the flux generated by them is responsible for an E.M.F. of self-induction, the latter is consequently proportional to A_{c2}.

In Fig. 3B the effect of this self-induction which was not taken into account in Fig. 3A has been included, it being assumed that the secondary leakage flux is 10 per cent. of the total flux which C_1 could set up if it were not neutralised. The E.M.F. induced in coil C will be as before proportional to cos α_1 and is represented by half circle E_c. For any position of coil C the current A_c flowing through it, can be ascertained as shown for the position 03 where E_s stands for the sum of the E.M.F.s of self-induction set up by the whole flux due to the corresponding value of A_{c2} and that set up by 10 per cent. of the corresponding value of A_{c1}. E_w is then proportional to the rotor current, the actual value of the latter when E_w is known only depending on the rotor resistance. The angle ϕ_2 between E_c and E_w is the angle of lag of the rotor current behind the E.M F. induced in C. Repeating this construction for all values of α_1 and taking the rotor resistance as 1 we get the curve A_c representing the current in coil C for all values of α_1 between 0 and 90 deg. From this corrected current curve we obtain, as in Fig. 3A, the curves A_{c1} and A_{c2}, and, finally, the curve T as proportional to the product of the two former. The scale in the two figures has not been kept the same, so as not to impair their clearness, but it is easily seen that the torque in Fig. 3B must be smaller; the maximum torque now occurs for a value of $\alpha_1 \simeq 23$ deg. Line 02, again, indicates the 45 deg. position, and it is seen that the value of the torque may vary very greatly with a very small movement of coil C.

It is further to be noted that however far the rotor current lags behind its E.M.F.—in other words, however bad the power factor—the starting torque will always be good, since the field is bound to be of the same phase as the armature, seeing that a current of the same phase passes the armature winding C_1 and the field winding C_2. The variations of the current in C_1 and C_2 are proportional for a given value of α_1, so that this machine must have a series characteristic for the same reasons as the machines analysed in Figs. 1A and 1B.

There are, however, some striking differences between the two, and any name given to the motor in Fig. 3B should be such as to characterise the nature of or the reason for these differences. The armature reaction in Fig. 3B, due to C_1, is, as has been explained, neutralised by the ampere-turns in S; it is, therefore, best to compare this motor with that in Fig. 1B, where the armature reaction (field F_a) has also been taken as neutralised. The main differences are as follows: The direction of rotation is different, but then that is simply due to the fact that coil C has in Fig. 3 been displaced as regards n in an opposite direction to that in Fig. 1; to call attention to this fact the angle of displacement is given as α_1 and α respectively. If in Fig. 1 coil C were displaced by α_1 (in the opposite direction to α), everything else remaining as before, then the direction of rotation for that motor would also be reversed. In the series-conduction motor, Fig. 1B, the torque goes from zero for $\alpha = 0$ to a maximum for $\alpha = 90$ deg. and falls again to zero for $\alpha = 180$ deg. In Fig. 3A the torque is zero for $\alpha_1 = 0$, reaches a maximum, and is again zero for $\alpha_1 = 90$ deg., for in that position S cannot possibly act inductively on C. Now, as α_1 further increases the torque again increases, but in the opposite direction, owing to the change thus brought about in the relative position of the coils C and S, which determines a change in the direction of the field component C_2 relatively to the armature component C_1. All these differences are only due to the fact that the current is not conveyed to the armature by "conduction," but by "induction." The difference in the shape of the torque curve is also due to the same fact, so that the only manner in which the two motors can be rationally distinguished is by referring to the first as a "series conduction" and to the second as a "series induction" motor.

It is seen that the torque conditions thus arrived at for the motor shown in Fig. 3 coincide exactly with those outlined at the beginning with reference to the motor shown in Fig. 1. It has also been shown that this torque is the result of the same electrodynamic action as that which determines the torque in the ordinary continuous-current motor; when in movement the operation of the two machines is also identical in principle. The main difference is that the working E.M.F. in the case of the continuous-current motor is conveyed to the armature by "conduction," whereas for the motor shown in Figs. 1 or 3 it is conveyed by "induction," the back E.M.F. is in both cases generated by rotation of the armature conductors in the motor field, and in addition the continuous-current motor is separately excited, whereas the motor in Figs. 1 or 3 provides its own excitation. The object of this contribution is not to give a complete theory of the operation of the single-phase series induction motor, and it is thought that the outline of this theory, which has just been given, will answer the present purpose.

So far we have dealt with the simplest forms only of the types of motors which have been considered, we can now pass to the consideration of their practical realisations. As far as the "conduction" type is concerned, nothing will be changed when a complete armature with commutator is substituted for the single coil C. Such a machine is shown diagrammatically in Fig. 6. The rotor or armature is supposed to be of the grammering type, and the brushes a_1 and a_2 are supposed to bear directly on the armature winding. This assumption is made throughout the following figures, and in order to still further simplify these diagrams, the form shown in Fig. 7 will be adopted and is to be taken as identical in every respect to that shown in Fig. 6.

The practical form of the series-induction motor shown in Fig. 3 is diagrammatically illustrated in Fig. 8. We observe that the whole of the rotor is short-circuited by the interconnected brushes a_1 and a_2; this produces a current distribution such as indicated by the dots and crosses. This armature could obviously be replaced by one single coil such as C of Fig. 9 and inclined by α degrees with respect to n; the resulting direction of the torque ascertained in the manner already set forth will be found to be clockwise as shown by arrows. But there are other and independent short-circuits in this rotor—namely, the coils bridged or short-circuited by each of the brushes a_1 and a_2 independently of the conductor joining these brushes and short-circuiting the rest of the armature. These coils are inclined by α_1 degrees with respect to n, and their effect can be replaced by a single coil C such as shown in Fig. 3. These coils will also exert a torque, and it is easily seen from Fig. 3 that this torque will be *opposed* to the torque exerted by the rest of the rotor. A closer inspection of Fig. 8 will show that the assumption made in Fig. 4 was thoroughly justified. Out of all the conductors conveying current and distributed around the rotor, only those comprised between brush a_1 and point 2 on one side, and brush a_2 and point 1 on the other (in fact, the conductors within the angle $2\alpha_1$) can produce a flux which will link with S, and it is, therefore, only that portion of the rotor winding which can be neutralised by S; it corresponds to coil C_1 in Fig. 4, is distinguished by heavier lines and represents the armature winding of the motor. The rest of the conductors on the rotor, those comprised between brush a_1 and point 1 on the one side and brush a_2 and point 2 on the other (the conductors within the angle $2(90 - \alpha_1)$) produce a flux, the direction of which is given by arrow F_0; it is at right angles to S and therefore has no inductive effect on the stator winding. This flux does duty as motor field, and the conductors producing it correspond to the ordinary field winding and to coil C_2 in Fig. 4. It will be noted that the armature winding C_1 is con-

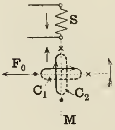


FIG. 4.

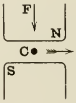


FIG. 5.

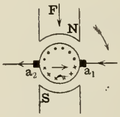


FIG. 6.

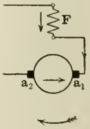


FIG. 7.

nected in series with the field winding C_2 the same current flowing through both, for they form part of one and the same rotor winding, also that the field is excited by a current generated in the rotor by induction from the stator. Such a motor must therefore be classified as a "self-excited single-phase series-induction motor."

But this designation would not fully characterise this motor, for when the machine is running there is produced along the axis n, by rotation in the transformer field due to S, an E.M.F. (E) which partly compensates the motor. This E M.F. is in phase with the transformer field, its magnitude depends on the magnitude of that field and on the speed of revolution, its periodicity will always be that of the field to which it is due. It is fairly evident that not the total E_r generated can be effective as far as the rotor axis $a_1 a_2$ is concerned. The effect of the conductors within the angle $2\alpha_1$ cancels out, as can be easily seen by reference to Fig. 8, and the effective E_r is only proportional to those conductors which represent the field winding and are comprised within the angle $2\ (90-\alpha_1)$. We have seen (Fig. 3B) that these very turns provide by far the greater part of the rotor self-induction E_s. This E.M.F. of self-induction lags 90 deg. behind the rotor current, and is on the whole of opposite phase to the transformer field, consequently also of opposite phase to E_r; the latter therefore tends to oppose E_s and as the speed increases E_r and the power factor also increases. Supposing that at synchronous speed the motor field equals the transformer field in magnitude, then E_r will equal that part of E_s which is due to the field winding, but the power factor cannot be unity yet, because the self-induction of the armature winding and that of the stator winding S has not been compensated for. At a speed *above* the synchronous the power factor *ought* to become unity, but other effects, mainly the reaction of the coils short circuited under the individual brushes, obviate this possibility. The back E.M.F. (E_b) is nearly opposed to the working E.M.F. (E_r) due to S and opposite in phase to the motor field. It is to be noted that in this motor the transformer field remains practically constant as long as the E.M.F. impressed on the stator is constant, and that there are no means for adjusting the compensating E.M.F. In order to differentiate such a motor from one in which phase compensation is under control, the author proposes to refer to it as a "self-excited *partly* compensated single-phase series induction motor."

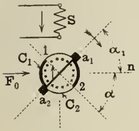


FIG. 8.

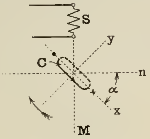


FIG. 9.

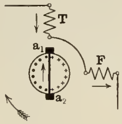


FIG. 10.

Turning now to Fig. 10, no long explanation is required to show that in this case all the conductors on the rotor help to produce a field which will link with S (although those in the immediate neighbourhood of the brushes are not very effective). The whole of the rotor winding can therefore now be neutralised by equal and opposed ampere turns in S. It is obvious that the rotor currents cannot in this case produce a field which could do duty as motor field, and it becomes necessary to provide this field by other means. In Fig. 10 a winding F is disposed on the stator at right angles to T and is connected in series with the latter. The field produced by F can have no inductive effect on T, but in conjunction with the rotor current it produces the torque. It is only necessary to turn Fig. 10 through 90 deg. in a clockwise direction to recognise its practical identity with Fig. 6. The winding T will carry a current which is the resultant of the magnetising current of the transformer in the axis a_1 a_2, and of the neutralising current in the same axis, and which is equal to in magnitude (assuming a transformation ratio of 1 : 1) but opposed in phase to the rotor current. The resultant current in T will be very nearly in phase with its neutralising component, therefore nearly of opposite phase with the rotor or armature current. Since the same current flows through T and F, and since the field due to F is practically cophasal with the current through F, that field must be nearly of opposite phase with the rotor current, but this is equivalent to being of the same phase and opposite direction to it, consequently a torque will result. The magnitude of the transformer field is not constant in this case. Here, again, armature and field current will vary proportionately, so that the motor will have a series characteristic, but in this instance the rotor carries armature current only, and the motor field is directly produced by the stator current. No true compensating effect takes place and this machine must therefore be classified as a "separately excited single-phase series induction motor."

(*To be continued.*)

MECHANICAL DESIGN OF COMMUTATORS FOR DIRECT-CURRENT GENERATORS.

BY R. LIVINGSTONE.

(*Continued from page 172.*)

Stresses in Commutators (continued).

Stress at f_5 (see Fig. 1).—To obtain the stress at this point we must obtain the total volume of copper in the commutator. Let this volume = V, then the load on end ring will be PVl_3/L_1.

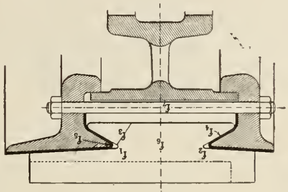


FIG. 1.

In Fig. 7 we will consider the stress with regard to the axis Y – Y. Then $(B)M=\frac{PVl_3l_5}{L_1}$, now the moment of inertia of this portion of the "V" is $I_1+2\pi I_2$, where I_1 = moment of inertia of section Y – Y about the axis ⊙ and I_2 = moment of inertia of "V" about axis Y – Y.

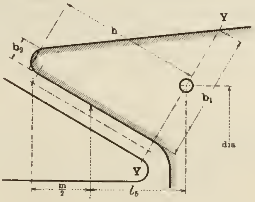


FIG. 7.

Now
$$I_1=\frac{b_1^3\pi\ \text{dia.}}{12},$$

and
$$I_2=\frac{h^3(b_1+3b_2)}{12}.$$

Then the moment of inertia of whole "V" when in the form of a continuous ring is

$$\frac{\pi\{b_1^3\ \text{dia.}+2h^3(b_1+3b_2)\}}{12}.$$

Then
$$Z=\frac{b_1^3\ \text{dia.}+2h^3(b_1+3b_2)}{3{\cdot}82h},$$

and
$$f_5=\frac{3{\cdot}82h(PVl_3l_5)}{L_1\{b_1^3\ \text{dia.}+2h(b_1+3b_2)\}}. \quad . \quad . \quad . \quad . \quad (11)$$

To this must be added the stress due to the horizontal component of the centrifugal forces tending to bend the end ring as a whole. The treatment is the same as for a continuous beam on a large number of supports spaced the pitch of the bolts, and can be found in any text-book on mechanics.

Stress at f_6.—This, again, is treated as a beam supported as in Fig. 6 and loaded directly as the area of the bar. This method of treatment can also be found in any text-book on mechanics. In addition to the B.M. due to the outward pull of the copper, there is a horizontal component due to this force, and this must be added. The value of the B.M. due to the horizontal component is

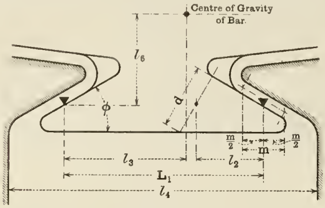


FIG. 6.

$$\frac{PBl_6}{2\cot\phi}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

In short commutators the tension on the section between the "V's" might be high, and this also should be computed, keeping in mind the eccentric loading of the section.

Bolt Stress f_7.—Here we must again take the whole volume of copper.

$$\text{Load on bolts} = \frac{PV}{2\cot\phi}.$$

Let the total area of bolts at the bottom of the thread = A, then

$$f_7 = \frac{PV}{2\cot\phi A} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

This completes the equations for stresses due to centrifugal force, and before going into the stresses due to initial tension and expansion I would point out that, as all the stresses are directly proportional to the bolt stress, it will not be necessary to go through every portion of the commutator again.

Stresses due to Initial Tension.—Earlier in this Paper I mentioned that, to ensure that the commutator will be sufficiently rigid, the pressure on the mica between the bars should be 25 D lb. per square inch with an initial tension in the bolts of 12,000 lb. per square inch. Then $B \times 25D \times 2\pi = 12{,}000A \times 2\cot\phi$,

$$\therefore \quad A = \frac{DB}{153\cot\phi} \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

Stresses due to Expansion.—It is unnecessary to point out that, when dealing with such a piece of apparatus as a commutator, absolutely exact mathematical expressions for the stresses due to expansion are not necessary and are very inconvenient for practical use; so in the following investigations I shall obtain simple formulæ by making assumptions which will not involve serious errors. In dealing with expansion it will make matters simpler to resolve the commutator into the diagrammatic form shown in Fig. 8, taking care that our units of length and area are corrected for the change of leverage which this necessitates. Thus

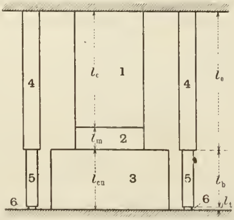


FIG. 8.

l_c = Length of copper in the circumference
= Number of bars × mean thickness.
l_m = Length of mica in the circumference
= Number of mica strips × thickness of each.
l_{cu} = Corrected length of copper between "V's"
= $L_1 \times \pi\tan\phi$ (Fig. 6).
l_e = Length of end ring
= π × diameter of end ring.
l_b = Corrected length of bolts
= $l_4 \times \pi\tan\phi$ (Fig. 6).
l_t = Corrected length of bolt at bottom of thread
= Length at bottom of thread × $\pi\tan\phi$.
B = Area of bar and area of mica.
B_{cu} = Corrected area of copper annulus
= Area of annulus ÷ $\pi\tan\phi$.
B_e = Corrected area of end ring = the area of a ring of solid iron which, if placed round the outside of the commutator and the end rings taken away, would have the same stress as f_5.
B_b = Corrected area of bolts
= Total area of bolts ÷ $\pi\tan\phi$.
B_t = Corrected area of bolts at bottom of thread
= Total area at thread ÷ $\pi\tan\phi$.

If linear coefficient of expansion of copper = 0·0000103
" " iron = 0·0000073
and T° = rise in temperature of copper,
t° = " " iron,
η = difference of expansion in Fig. 8,

then $\eta = 0{\cdot}0000103T^\circ(l_c + l_{cu}) - 0{\cdot}0000073t^\circ(l_e + l_b + l_t)$.

Assuming a rise of temperature of 60 deg. in copper and 25 deg. in iron, then

$$\eta = 0{\cdot}00062(l_c + l_{cu}) - 0{\cdot}000182(l_e + l_b + l_t). \quad . \quad . \quad (15)$$

Now, if in Fig. 8

f_c = Stress in and E_c = Young's modulus of (1)
f_m = " " E_m = " " (2)
f_{cu} = " " E_{cu} = " " (3)
f_e = " " E_e = " " (4)
f_b = " " E_b = " " (5)
f_t = " " E_t = " " (6),

then $f_cB_c = f_mB_m = f_{cu}B_{cu} = f_eB_e = f_bB_b = f_tB_t$, and the difference of expansion must equal compression of 1, 2, and 3 + extension of 4, 5, and 6. That is

$$\eta = \frac{l_cf_c}{E_c} + \frac{l_mf_m}{E_m} + \frac{l_{cu}f_{cu}}{E_{cu}} + \frac{l_ef_e}{E_e} + \frac{l_bf_b}{E_b} + \frac{l_tf_t}{E_t},$$

$$\therefore \quad \eta = f_t\left(\frac{l_cB_t}{E_cB_c} + \frac{l_mB_t}{E_mB_m} + \frac{l_{cu}B_t}{E_{cu}B_{cu}} + \frac{l_eB_t}{E_eB_e} + \frac{l_bB_t}{E_bB_b} + \frac{l_t}{E_t}\right).$$

As the length of bolt at bottom of thread is so short $\frac{l_t}{E_t}$ may be neglected and

$$f_t = \frac{\eta}{B_t\left(\frac{l_c}{E_cB_c} + \frac{l_m}{E_mB_m} + \frac{l_{cu}}{E_{cu}B_{cu}} + \frac{l_e}{E_eB_e} + \frac{l_b}{E_bB_b}\right)}. \quad . \quad (16)$$

As all the other stresses are in proportion to the bolt stress, we need go no further into the expansion stresses, but simply multiply the initial stresses by $\frac{\text{expansion stress}}{\text{initial bolt stress}}$.

Combined Stresses.—To combine the initial stress with the expansion stress, we simply have to add them together, but we cannot add the centrifugal stress to the sum so obtained. The action of centrifugal force is to *reduce* the stresses due to initial tension and expansion, so we must look for some other method of combining the stresses. If the centrifugal force was so great as to cause an elongation in the end rings and bolts equal to η, then the expansion stresses would vanish, and if so great as to cause an elongation = $\frac{\eta\,(\text{initial} + \text{expansion})}{\text{expansion}}$ then both initial and expansion stresses would vanish. Let this ultimate expansion = η_1. The stress in the bolts to cause an elongation in bolts and end rings = η will be $\frac{30 \times 10^6\eta}{B_t\left(\frac{l_e}{B_e} + \frac{l_b}{B_b}\right)}$ and the stress in the bolts to produce an elongation $= \eta_1$ will be the stress given by above $\times \frac{\eta_1}{\eta}$. Let this stress $= f_f$, and let stress due to initial + expansion $= f_{i+e}$. Then, by means of the diagram in Fig. 9, we can easily obtain the combined stresses. To construct this diagram, mark off on the horizontal line, to any convenient scale, a length equal to η_1 and erect a perpendicular at this point. Join the origin to where this perpendicular cuts the stress line f_f. Where this "combined" line cut the stress line f_{i+e}, drop a perpendicular and draw the lines marked "centrifugal" and "initial + expansion." Now, for any centrifugal stress the corresponding combined stress may be read by taking the corresponding point in a vertical direction on the line marked "combined."

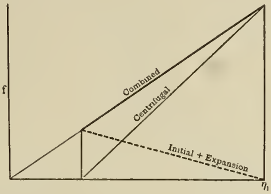


FIG. 9.

Of course, this supposes the combined stresses to be within the elastic limits of the materials. All the stresses, with the exception of the pressure on the mica between bars, will be directly proportional to the bolt stress. The pressure on the mica between the bars will be in proportion to the stress obtained from the line marked "initial + compression." The formula for combined stress is

$$Cf = \frac{f_f - f_{i+e}}{f_f} f_c + f_{i+e},$$

where Cf = combined stress,

f_c = centrifugal stress.

Buckling of the Bars.—There is certainly a load at which the bars will buckle, but in ordinary cases this load is quite outside the power of the bolts, so we may leave this question entirely out of consideration. I have frequently seen it stated that the bars should not be less than 0·2 in. thick for *mechanical reasons*, but in no case have the reasons been given. There may be particular cases where 0·2 in. really is the minimum thickness which can be employed, but that does not justify the sweeping statement that bars should not be less than 0·2 in. thick. The only mechanical considerations which really limit the thickness of the bar are: first, the method of manufacturing bars, and second, the method of connecting the armature winding to the commutator. For instance, I have known the following sizes of bar to be used:—

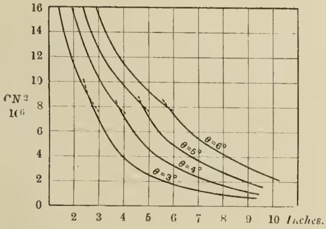


FIG. 10.

0·14in. mean thickness in a commutator 30in. diam. × 9in. long
0·125in. „ „ „ „ 19in. „ × $10\frac{1}{4}$in. „
0·105in. „ „ „ „ 15in. „ × $5\frac{1}{2}$in. „
0·098in. „ „ „ „ 8in. „ × 3 in. „

all without the slightest trouble.

In getting out a new design for a commutator, it is very aggravating to go through the stresses due to centrifugal force, initial tension and expansion to find that some are too high and require some modification in design, so causing a repetition of all the work with the new dimensions. I find, however, that if the commutator is designed primarily with suitably high factors of safety, such as are given in the example taken later, for centrifugal force, little alteration will be necessary to the dimensions. A factor of safety of $2\frac{1}{2}$ to 3 may be allowed for combined stresses at maximum speed.

The curve shown in Fig. 10 will be found useful for obtaining a trial length for the front cut (l).

It is not always convenient to draw out a section of a commutator two or three times full size to obtain dimensions such as m in Fig. 6. A more convenient and accurate method is to obtain the general trigonometrical expressions, and then substitute the ratios for the standard angles, so obtaining the necessary dimensions in terms of R, R_1, and t (Fig. 11). Fig. 11 shows the dimensions usually required. Their values are

$$\beta = \frac{\cos\theta}{\tan\frac{\theta+\phi}{2}} R, \quad \gamma = \frac{\sin\theta}{\tan\frac{\theta+\phi}{2}} R,$$

$$\epsilon = \frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} R, \quad \iota = \frac{\sin\phi}{\tan\frac{\theta+\phi}{2}} R,$$

$$\kappa = \frac{\sin\phi}{\tan\frac{\theta+\phi}{2}} R_1 + \left(\frac{\sin\phi}{\tan\frac{\theta+\phi}{2}} - \frac{\cos\phi}{2} \right) t,$$

$$\lambda = \frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} R_1 + \left(\frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} + \frac{\sin\phi}{2} \right) t,$$

$$\mu = \left(\frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} - 1 + \sin\phi \right) R,$$

$$\nu = \frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} R_1 - \left(\frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} - 1 + \sin\phi \right) R + \left(\frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} + \frac{\sin\phi}{2} \right) t$$

$$\chi = \left(\frac{\cos\phi}{\tan\frac{\theta+\phi}{2}} - 1 + \sin\phi \right) (R_1 - R + t).$$

It is also convenient to know the approximate dimensions of l_1 and the depth of copper below the **V**'s. l_1 may be assumed at $0{\cdot}5l$ and from the actual depth of copper in a large number of commutators I find that the depth below "**V**" $= 0{\cdot}09L_2 + 0{\cdot}2'' = k$, when L_2 = length of bar in inches.

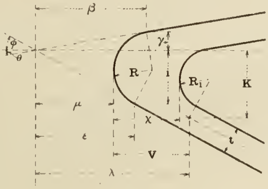


FIG. 11.

The angles θ and δ used by different manufacturing firms vary to some extent especially θ. ϕ is usually made about 30 deg. and certainly this angle gives the best ratio of mica pressure to stress in copper, in most cases. The *best* angle θ is more difficult to determine, as it involves the question of economy of material. If, however, we assume that the most economical commutator is one having a minimum weight of copper and that the weight of copper is proportional to the area of the bar, then expressing the area in terms of tan θ and allowable stress we have

$$B = \frac{8\tan^2\theta f L_2}{9P} + kL_2 - \frac{12\tan\theta f k}{9P} - \frac{40\tan^3\theta f^2}{81P^2} + C,$$

D

$$\frac{d\mathrm{B}}{d\tan\theta}=\frac{16\tan\theta f\mathrm{L}_2}{9\mathrm{P}}-\frac{12fk}{9\mathrm{P}}-\frac{120\tan^2\theta f^2}{81\mathrm{P}^2}$$, then for minimum area $\frac{d\mathrm{B}}{d\tan\theta}=0$, and

$$\theta=\tan^{-1}\frac{3\mathrm{L}_2\mathrm{P}}{5f}-\sqrt{\left(\frac{3\mathrm{L}_2\mathrm{P}}{5f}\right)^2-\frac{9k\mathrm{P}}{10f}}.$$

For example, in a commutator 18 in. diam. 22 in. long at 600 revs. per min.,

$$\mathrm{P}=29{\cdot}5\ f4{,}500 \text{ and } k=1{\cdot}25,$$

$$\theta=\tan^{-1}\frac{66\times 29{\cdot}5}{22{,}500}\sqrt{0{\cdot}0075-0{\cdot}00735},$$

$$=0{\cdot}0865-0{\cdot}0122=0{\cdot}0743$$

$$\therefore\quad \theta=4^\circ\ 15'.$$

A small change in the angle, however, makes very little difference in weight and any angle from 3 to 6 deg. is quite suitable for θ. An angle of 4 deg. giving about the best average results.

(To be concluded.)

NOTES ON OVERHEAD EQUIPMENT OF TRAMWAYS.

The following is an abstract of the discussion held at the Institution of Electrical Engineers on Thursday, May 17th, on Messrs. R. N. Tweedy and H. Dudgeon's Paper on the above subject read before the Birmingham Local Section of the Institution on February 14th. An abstract of the Paper itself and of the discussion at Birmingham was given in *The Electrician*, Vol. LVI., pp. 711, 764 and 892.

Before the commencement of the discussion, Mr. R. N. TWEEDY made a few remarks referring to examples of overhead equipment which had come to his notice since the reading of the Paper in Birmingham, emphasising the great variations of weight of poles used in different places under apparently the same circumstances and bringing forward cases of the corrosion of tramway poles with and without bases. Illustrations were also given of the deterioration of the insulation of hangers due to various causes and some results of experience with figure 8 trolley wire. A collection of ears, insulation and trolley wheels in various conditions of wear were exhibited.

Mr. H. M. SAYERS thought that the most valuable feature of the Paper was that it gathered together the results of experience as to the causes and nature of the wear in the different parts of overhead equipment, and allowed deductions to be made, by comparing notes, as to the way in which overhead work might be preserved for a greater length of time by modifications in materials and methods of construction which would make the repair and depreciation bills less important in amount than they were at present. Reference had been made to his own Paper before the Tramways and Light Railways Association about a year ago. That Paper, however, dealt very little with methods of construction or with the adaptation of particular materials to particular circumstances. The most important and novel point brought out in the Paper was the way in which wear on a trolley wire was localised, at the point of support or at the ears. The suggestions made as to the cause of that wear, however, excited a certain amount of criticism. There was no doubt that sparking played a considerable part, the difference between the wear on an uphill and a downhill wire certainly went to show that, but what caused the sparking? It was suggested that it was caused by insufficient area of contact. But he took leave to doubt that. As long as there was contact with the trolley wheel—which was usually pressed upwards with a force of about 20 lb.—and the bright surface of the trolley wire, he did not think there would be any perceptible sparking with the ordinary tramway currents. They all knew what a very large current density could be borne, for a short time at least, between clean metal surfaces pressed together with a considerable pressure, and he thought most people would agree with him that if 60 or 80 amperes were being taken through a contact that had an area of not more than $\frac{1}{200}$ or $\frac{1}{300}$ sq. in. between clean surfaces with 20 lb. pressure between them there would not be any appreciable sparking or spluttering. Of course, if the current went up to 200 or 300 amperes, as it might on a slippery road with a heavy grade and a heavy car, there might be a good deal of spluttering. That sparking did take place at the ears could be easily proved by watching the majority of lines at night, but he suggested that the sparking was caused by breach of contact between the trolley wheel and the wire. The trolley wheel danced, and then, of course, sparking followed, so that the effect was due to mechanical causes. A further mechanical effect was that if the wheel danced, it hit the wire a blow, and again sparking followed, which, however, did not come at the same point. He thought that this action largely accounted for the somewhat peculiar shapes of the worn wire which the authors had exhibited. He was consequently disposed to say that the cause of wearing at the ears was not due to the use of round wire or insufficient contact, but that it was due to the dancing of the trolley wheel brought about by mechanical causes. To some extent it might be due to running with worn trolley wheels, for there was a great tendency to keep the trolley wheels and heads in use longer than was desirable, as shown by the noise on some lines. This was bad economy, for a trolley wheel did not cost a great deal, and was worth its weight of metal even when scrapped. It was better to scrap the wheel at the end of 3,000 or 4,000 miles than to keep it on for another 2,000 and make dents in the trolley wire. Again, the tension on the trolley pole had something to do with this, and so had the length of the trolley arm. The method of suspension was really an essential point. It had been remarked by the authors that rigid or elastic suspension made comparatively little difference. He preferred to take the view that it was not a question on either one or the other, but a question of uniformity—*i.e.*, uniform rigidity or uniform elasticity of suspension. On the Buffalo & Lockport Electric Railway, where five years ago he had seen cars running at from 50 to 60 miles an hour, the trolley wire was carried by a parallel galvanised iron wire, so that the suspension was not at the poles but directly on to the iron wire, about 15 ft. apart, forming a sort of catenary suspension. This gave a practically level trolley wire and one that was not more flexible at one point than another. He suggested that the difference of rigidity or flexibility at different points of the trolley wire sets up a wave motion in the trolley boom, which accounted for the jumping at the ears, and was thus the cause of the sparking at the ears. A badly-made ear which caused the flanges of the wheels to be caught would also cause the trouble, but he took it that no engineer with a conscience would put up such ears, whether mechanical or soldered. His faith in soldered ears remained very strong, but he had never seen a trolley line work better than the one on the Great North Road, where flexible ears and grooved wire was used. The trolley wheel could not be heard when passing over the ear and there was no spark. The equipment was in excellent order after nine months' wear. The question of insulated bolts had been raised by the authors. These, he considered, were the weakest points in the whole of the overhead equipment, and the more modern ones were no better than the older ones in this respect. In fact, among the samples exhibited by the authors was a Dickinson insulator that had lasted a good many years on 300 volts. It had a much longer creepage passage across the insulated material than the modern ones, and this might account for the longer life. The principal agent in the destruction was electrolysis. The iron or brass, as the case might be, was positive to the hood, and whatever current leaked across it resulted in the corrosion of the metal. With iron, the salts formed were mainly oxide and carbonate of iron. If there was a considerable amount of sulphurous acid in the atmosphere, as was the case in some manufacturing districts, then they got a mixture of sulphates and sulphites of iron. Most of the salts were insoluble and increased very greatly in bulk. This accounted for the splitting up of the insulating material. With brass, the products of electrolysis were mainly soluble salts and they did not split up the insulating material in the same way. He had not been able to follow the suggestion in the Paper that one of the effects with brass bolts was the deposition of a metallic skin on the insulating material. He did not see how that could occur. If any deposition took place under varying voltage and current density that would obtain, this must take the character of a tree effect and would not form anything like a conducting film. He had tried to get gun-metal bolts for a long time, but had not been able, hitherto, to obtain satisfactory ones. The makers either seemed to be reluctant to use the right material or there were manufacturing difficulties which the makers did not explain. The cure for the whole thing was to do away with the present form of hanger, clipping the trolley wire by means of suitable ears, on to the suspending wire, and insulating the length of the suspending wire at a sufficient distance from the trolley wire. Thus there would be no blow, the primary insulation would be a few feet away from the trolley wire on the suspension wire and the secondary insulation in the usual place. If this were done, there would be no difficulty in using porcelain insulators, which had been proved to be far the most suitable and permanent and economical insulator ever used in any climate.

Mr. T. H. SCHOEPF did not agree with the authors that the construction work of overhead tramways should be made lighter. Whilst it was true that the construction put up in many cases was excessively strong, yet he did not think it advisable to go to the other extreme in order to reduce the cost. The authors had criticised American poles and their weights, but from a long experience in America he thought he might say that these remarks on the part of the authors were due to want of experience of American conditions. Considering, for instance, the climate, he remembered an instance where there had been variations in temperature from 10 deg. below zero to 105 deg. above. There must be several means of taking up the change in the length of the span wire, and this must be allowed for in the weight of the poles. Again, when the authors stated that the Americans would practically take any old tree for a pole they were not comparing similar conditions. No city tramway in America ever did that kind of thing, but there were many places where the service was such that they could not afford to put up first class constructions, and therefore wooden poles were resorted to. He quite agreed with the authors that the bases that were put around poles were a source of weakness. He would like to call to mind in this connection that the conditions in America were a great deal more adverse than in England. For instance, in New Orleans they had had a great deal of trouble with the poles through the sea water being within 2 ft. of the level of the street. They used wooden poles, and got over the difficulty by making the template just a trifle larger than the pole they proposed to use. The space between the template and the pole was filled in with sand. In some northern cities, however, where there was a great deal of frost, they had considerable trouble even with concrete bases. When the frost gave in the spring he had seen a pole which was 6 ft. in the ground and concrete all round it pulled completely over. Such things as these should be taken into account when instituting comparisons. He agreed with the authors as to the unsuitability of collars, and did not think that they were by any means a solution to the problem, but would have to be considerably improved. With regard to hangers and the shape of the wire, the authors had now qualified the statement originally made that figure 8 wire was used extensively in

America. He had never seen figure 8 wire, and there was only one place where grooved wire was used to his knowledge. His own opinion was that a wire, not exactly a grooved wire, and yet a modification of the figure 8 wire, with the bulk of the metal in the lower lobe so that the centre of gravity was low, would overcome the tendency of the wire to turn as the wheel came along. He believed that with a proper kind of hanger this would be a solution of a great deal of the difficulty. His experience verified that of Mr. Sayers as to the dancing of the trolley wheel. The Paper made a plea for a smaller trolley wire, but he thought that in working out any particular scheme the construction should be made such that the cost would be as low as possible consistent with good engineering practice, but where the money could be spent there was no better investment than copper, and he was not so sure that it was good to cut the wire too fine because the probabilities were that traffic would increase, and if the traffic increased in 10 years they would have to put in new trolley wire. This period would be far too short in the ordinary course. In the suburbs of Washington, on one particular line, the trolley wire had had to be renewed very frequently, due to the numerous severe curves, and the wear on these curves was intensified by the fact that the trolley wheels in America were not swivelled but rigid. He thought the porcelain insulator had many points in its favour.

Mr. F. GILL, on the question of guard wires, said that so far as the telephone company was concerned, he saw no reason why a tramway engineer should not have notice when certain telephone wires were being removed, so that he might take down the guard wires. It seemed to him to be worth while for tramway authorities to consider whether it would not pay them to get rid of the crossing in some places by paying the cost of the removal of the telephone wires rather than incur an annual expenditure in guard wires. He would like the opinions of tramway engineers with regard to bonding the poles to the track. He had known of at least three cases of cables being damaged through tramway poles becoming alive. In one of these cases a lead cable was put into an iron pipe; shortly afterwards the tramway came along and a pole was put up touching the pipe. Later there was a breakage on one of the bracket arms, and the pole became alive. The current got into the pipe and along the cable, and finally it broke out in about five places on to some lead water pipes. With regard to secondary insulators, he suggested that these should be put further out from the pole. He knew of one case where a man, who was working up a pole, and depending, foolishly possibly, on the primary insulator, took hold of one of the span wires, when he got a shock and fell and was killed. Such a difficulty might be avoided by putting the secondary insulator further out. Telephone people, he said, had had a good deal of experience of porcelain insulators, and they found that the corrugations collected dirt and created a condition of things which resulted in very bad insulation. He would like to ask if the authors were quite certain that the diameter of the wires was exactly 0·324 in. as stated in their tables. A great deal depended upon this, as he had often found that the actual size of wire delivered differed considerably from that specified. One point made by the authors as to economy he thought was entirely wrong. Poles were said to be more economical because they cost less in the first place, but the question of the life was not taken into account. This seemed to be quite a wrong method of dealing with economy, unless the annual expenditure for the life that they were dealing with were considered. For instance, it might pay a tramway company to put in a heavier pole, which, by its longer life, would justify the extra expenditure.

Mr. F. S. GROGAN agreed with Mr. Schoepf that it was a very serious thing to recommend engineers generally to take such light poles for the construction of overhead tramways. The authors stated that 18 in. sag on the light British standard pole would work out all right in ordinary practice. But this came almost as a shock to men who had been used to putting up tramways. They might call it rule of thumb if they liked, but there was a certain amount of theoretical reasoning in the heavy poles which were now being used. He had had a discussion the other day with an engineer on this very point, and the point had been debated as to the strain that should be put upon span poles. If they worked out the span of an ordinary length, say 30 ft., the common practice was to put up a rake of about 5 in. and pull that rake into the perpendicular, or nearly so, with the span wire, and when the trolley wire was erected there was a sag of about 10 in. That put a strain on the pole of about 820 lb., and he thought it was very wrong to put up a light British standard pole for this work. There was another question which entered into this. The authors' argument was that a cheaper cost could be obtained by having a bigger sag in the span wires and so reduce the strain on the poles. This was altogether contrary to general practice and was introducing new ideas, and they hardly knew how they were going to work out. There would be a whole system of "sloppy" overhead lines and this would lead to a good deal more vibration, both sideways and vertically, trolleys coming off, catching, &c. Therefore there would be an enormous force brought on to the poles at certain points, which would probably snap them. In present practice we get none of this, and it was a very serious thing for it to go forth that engineers should use light poles. No thought, either, seemed to be given for the future life of these poles. Another point was that one could not always rely upon the joints of the three-section poles that were used at the present day. Although engineers specified that a certain percentage should be tested, there might be many that got through and were erected that really would not stand the proper test. He had often had to send poles back to the manufacturer, although passed by the engineer, on account of this.

Mr. H. M SAYERS said that the British standard pole had no definite weight, as seemed to be assumed by the last speaker. The British standard specification for the light pole gave the outside diameter of each section and the minimum thickness and the minimum tests. The thickness of the tubes making up the pole could easily be altered by any engineer who required a specially stiff pole. The idea of the committee was that the minimum tests of the light pole would answer for straightaway work, but that anything requiring heavier work would only involve the use of either the larger poles or a stiffer pole made by using thicker tubes.

Mr. GROGAN said it seemed to him that the general acceptation of the term British standard light pole was that it would not be necessary to get more than 500 lb. pull for a 6 in. temporary deflection.

Mr. SAYERS: That is the minimum. If you want a stiffer pole you can make it so.

Mr. GROGAN said that when they spoke of the light pole it was not expected to be a special pole. It was a pole which stood 500 lb. pull for a 6 in. temporary deflection.

Mr. SAYERS: As a member of the standards sub-committee that dealt with this matter, I can say that we thought that this was the weakest and smallest pole that should be used.

Mr. GROGAN replied that the whole point was that, if anyone spoke of a light pole, this was regarded as taking a strain of 500 lb. for a 6 in. temporary deflection. If a stiffer pole were required which would take a greater number of pounds, it was not the light pole of the British standard specification.

Mr. B. BELL asked if there had been any experience of cup and collar insulators, in place of the ordinary bolt straight line insulators, and how these would stand when compared with porcelain insulators. With the cup and collar hanger one had the whole of the top surface, which acted as a watershed and was kept clean by the rain.

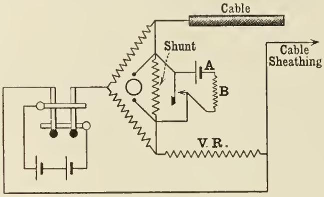
Mr. R. N. TWEEDY, in replying to the discussion, expressed his regret that there had not been more of it. Dealing with Mr. Sayers' remarks as to wear on the up wires, he said he thought his theory was rendered rather doubtful by the wear on the down line. Why was it that there were signs of corrugation or waves on the down line, where there was no tendency to arc the corrugations flat? That there were corrugations, due evidently to the vibration of the trolley wheel, was well seen at ears which were situated on down hills or anywhere where the speeds were high and the current was not used. That the wear on the wire was a function of the tension of the pole was also open to question. It seemed very doubtful whether wide variations in tension caused any considerable difference in the wear. With regard to the wear on the up and down lines, he had samples of ears which showed this very plainly. The ear that was on the up line was worn flat on the bottom, whilst on the down line where there was no current used at all, the ear was hardly damaged or worn. The surface was quite bright. If a catenary suspension, such as was used on the Buffalo–Lockport Railway and all high-tension single-phase railways, was good—and he believed it must be good for high speeds—then the objection raised by Mr. Grogan as to "sloppy" spans had very little weight. The catenary suspension provided a span which was infinitely sloppy, yet the horrors that had been conjured up did not take place. He was much obliged to Mr. Sayers for his explanation of the chemical action of electrolysis that took place and with regard to the deposit on the brass bolts. He really could not say whether it was metallic or what it was, but he did know that the reduction in resistance between the wire and the hanger was very marked indeed after a brass bolt had been up for a year or two. Further than this, the comparative insulation resistance of a brass and iron bolt put up at the same time showed very badly for the brass bolt. It was very difficult to see with the naked eye what the deposit was, and he had not had an opportunity of getting it analysed. Mr. Schoepf had suggested that the authors had overlooked the different conditions between England and America, but they had not exactly done that, because they quite admitted that the conditions were very different, especially with regard to the range of temperature. What they did maintain, however, was that Americans had come over here with their American experience in their minds and had reproduced it in England. They had not considered first of all what the English conditions were. With regard to a heavy trolley wire being a good investment, he did not know whether that would carry much weight at the present time when tramway undertakings were not exactly gilt-edged undertakings. The authors still stuck to their point that trolley wires which were being put up, such as 3/0 and 4/0 were heavier than the conditions required. Such heavy wire was not required mechanically and it was not required electrically. Until the traffic exceeded a five minutes' service, he did not think such heavy wires were necessary, and in very few places was such a service exceeded. In reply to Mr. Gill's question as to the 0·324 in. wire, he said he could not guarantee this at all, but he did not think that the variation was more than $\frac{1}{1000}$ in. either way. On the question of economy, he still maintained that in many cases the construction was too heavy, and that a lighter construction would last as long if properly cared for. As to Mr. Grogan's criticism of the remarks in the Paper about the size of poles, he quite agreed that they were open to criticism, but they had not attacked the question from the technical point of view at all. They simply took the facts as they were, and suggested that for a particular installation the poles were too heavy. There were many inconsistencies that were unnecessary. For instance, it was frequently seen that the same size pole was used for span-wire construction, bracket arms and centre construction. Again, two adjoining systems, working under precisely the same conditions, where the construction was much heavier in the one than in the other. He did not admit that sloppy spans were necessary with lighter construction. One point which was new since the Paper was read in Birmingham was as to the use of pure copper trolley wheels. These were now available and he had some samples on the table. One of them was not absolutely solid, but only had copper around the running surface. It seemed probable that the life of these wheels would be very much longer than the life of brass or bronze wheels, and also the life of the trolley wire, in consequence of the softer nature of the copper wheel, and would compare favourably with the others. The ratio of the life was found to be as 6 to 1, and this was probably due to the better conductivity of the copper.

A MODIFICATION OF THE CABLE ZERO CONDUCTOR RESISTANCE TEST FOR SUBMARINE CABLES.

BY G. B. WINKFIELD.

The earth current on a laid cable varies incessantly in an extremely irregular manner. When a battery is applied to a long cable with its distant end earth, a considerable number of seconds elapse before the resulting current becomes steady. For instance, it has been found that on a long section of cable having a K R. of 9 2 seconds, at least 30 seconds elapse before the testing current reaches a moderately steady value. In the meantime the E.C. is varying irregularly. The most that can be done under these circumstances, is to observe the cable zero, apply the battery for the minimum time admissible, observe the balance deflection, earth the cable for the same minimum time and observe the cable zero again. The mean between the two cable zeros may be assumed to equal the cable zero at the moment of balance. If the full sensibility of the galvanometer is preserved during these readings, everything possible has been done to eliminate the E.C. effect from the C.R. readings.

The following is the actual routine suggested for testing a laid section of cable for C.R. ·—Usual bridge connections, with the addition of a circuit across the short-circuit key, consisting of a battery, A, and a resistance, B (the value of this resistance should never be less than five times that of the galvanometer). The number of cells and direction must be adjusted to suit the E.C. Three cells is usually the maximum ever required. For B use a duplexing resistance of about 200,000 ohms adjustable to 1,000 ohms. Place in the variable arm of the bridge a resistance equal (as nearly as can be estimated) to the cable under test; open the short-circuit key, and with the galvanometer at its greatest sensibility adjust the battery A and resistance B, until the E.C. is compensated and the spot returns approximately to zero. Take a series of readings with battery "off" and battery "on" alternately, allowing the proper charging interval between each.



Example Test.

		Battery "off."	Battery "on."	
1st		+ 10	+ 32	
2nd		+ 15	+ 37	
3rd		+ 20	+ 55	
4th		+ 50	+ 82	
5th		+ 70	+ 70	
6th		+ 40	+ 40	
7th		+ 20	+ 20	
8th		− 10	+ 5	
9th		− 20	+ 0	
10th		− 30	− 20	
11th	− 50	+ 155	+ 321	sum total
	2) − 40	− 20	+ 135	
	− 20	+ 135	10) + 186	difference
			+ 18·6	mean diff.

Resistance in Bridge V.R. 7,020 ohms.

On increasing the V.R. by 10 ohms the spot moved 50 divisions to the left, so + 10 ohms = − 50 divisions; ∴ + 1 ohm = − 5 divisions.

The difference of + 18·6 divisions between the battery "off" and the battery "on" readings observed during the test would be reduced to 0 if $\frac{18\cdot6}{5} = 3\cdot72$ ohms were added to the V.R. of the bridge. Because these 3·72 ohms would, by calculation, make the spot move − 18·6 divisions, and thus exactly neutralise the existing movement of + 18·6 divisions.

The resistance of the cable, therefore, is equal to 7,020 ohms (the resistance in the bridge V.R.) + 3·72 ohms = 7,023·72 ohms.

Call the deflections to the left of zero − and to the right of zero +. Start and finish with an "off" reading. Halve the first and last "off" readings, then add these to the remaining "off" readings, and obtain the sum total. Obtain the algebraic difference between this diminished sum total, and the sum total of "on" readings. To do this, always subtract "off" from "on," never vice versa. Divide this difference by the number of "on" readings.

This gives the true mean difference between "off" and "on." Find out how many ohms + or − this represents by observing (while battery is on) how many divisions + or − an alteration of 10 ohms in the variable arm makes.

If the E.C. is too variable to do this with accuracy, disconnect the cable and substitute in its place a resistance equal to that of the cable; remove the battery A, leaving the resistance B joined up across the short-circuit key; then with battery "on" see how many divisions an alteration of 10 ohms in the variable arm makes.

It will be noticed that the method adopted for meaning is equivalent to taking each set of three readings (two "off" readings and the "on" reading in between them) separately, meaning the two "off" readings, subtracting this mean from the "on" reading, and then meaning all these differences.

In the example test quoted, examining the differences in each set of three readings, one finds that the maximum difference is + 25 divisions or 5 ohms, and the minimum difference is + 10 divisions or 2 ohms. The difference between these maximum and minimum differences is a measure of the reliability of the test. The less the difference the greater the reliability.

The following advantages are claimed for this method :—

1. Testing time used to a maximum advantage, because every reading is made use of and contributes to the final result.
2. The maximum sensibility of the galvanometer is always available, whether the earth current be strong or weak.
3. Small experience is necessary, exact time keeping and scale reading are the only essentials.
4. The results obtained are more consistent and accurate than by any other method.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign book.)

Modern Milling Machines. By JOSEPH HORNER. (London: Crosby Lockwood & Son.) 12s. 6d. net.

The present work is one of the best ever published in England dealing with modern milling machines and cutters. Practically every well-known milling tool is described in considerable detail, including such special forms as gear-cutters, Reinecker's worm-wheel cutters and heavy-face millers or rotary planers.

The author discusses the question of milling machines versus planing machines but without giving any very definite conclusions. It is, however, generally agreed that for plain surface facing and for ordinary jobbing work the planing machine is as economical as a miller and more universal. For manufacturing and for forming profiles, the milling machine is without a rival. It is an agreeable thing to see so many excellent illustrations of English machines, and as pioneers of this work the firm of A. Herbert, Ltd., Coventry, deserve considerable credit. To obtain the maximum advantage of milling in "manufacturing" as against "making" very careful jigging of work is necessary, and to that particular subject, unfortunately, the author has devoted less space than on the descriptions of individual machines of various makers.

The method of holding steps (Fig. 208) is particularly poor; the magnetic chucking table is described, but is much more serviceable for surface grinding than for milling.

More space might be given to formed cutters, the only rational way of making figured tools. The work, however, as it stands is a most excellent one, and will supplement the well-known treatises issued by Messrs. Brown and Sharp, of Providence, which up to the present practically had the field to themselves.

The Ventilation, Heating and Lighting of Dwellings. By J. W. Thomas, F.I.C. (London: Longmans, Green & Co.) 1906. 6s.

Ventilation, heating and lighting through the agency of electricity occupies comparatively small space in this book. In the chapters on ventilation there are a few hints as to the application of electrically-driven fans and punkahs, but practically nothing as to their erection or the arrangement of the circuits. The few pages devoted to electric heating are chiefly occupied with generalities and an oft-repeated complaint that electric heating at 2d. per unit is too costly, except for occasional use in bedrooms. The remarks on electric lighting apply chiefly to the disposition of the lamps in the rooms of a small private house. In such cases it is advisable to use "frosted" globes, not merely, as the author thinks, in order to shield the eye from the bright filament, but chiefly in order to diffuse the light. The following information must be taken *cum grano salis*:—

> A pure carbon filament gives a white glare which, like the incandescent mantle of the gas burner, is very trying to the eye. By adding a trace of common salt to the carbon filament or the material from which it is made, the white glare is removed from the lamp, and the eye can stand the slightly yellow light without injury.

In Appendix I. the theory is put forward—with some indistinctness it is true—that the peculiar oppressive effects experienced just before a thunderstorm are due to the ionisation of the air, and that therefore means should be taken to prevent any of the heating or ventilating processess from altering in any way the electrical condition of the air.

La Théorie Moderne des Phénomènes Physiques: Radio-activité, Ions, Électrons. By Augusto Righi. Translated from the Italian, with additional notes, by Eugène Néculcéa. (Paris: "L'Éclairage Electrique.")

We have here a short and popularly written account of the electron theory covering those parts of electrical science where its application has been most successful and complete. These comprise electrolysis, the Zeeman effect, gas discharges and radio-activity. They are all dealt with in a clear and lucid manner. Besides this, several other matters are touched upon which might well have been more fully dealt with. The theory of conduction in metals, so admirably worked out by Thomson, Schuster, Riecke and Drude, is dismissed in 28 lines, and Drude's successful attempt to formulate an electron theory of contact potential, thermo-electricity and the various galvano-magnetic and thermo-magnetic effects is not even mentioned. The theory of magnetism had not been brought into line with modern conceptions at the time the Italian original was written, but the translator might well have referred to it. An interesting reference to previous work is made in mentioning Fusinieri's theories published at Padua between 1844 and 1847. The leading idea was that a refined gas, "la materia attenuata," was contained in all bodies, and gave rise to electrical phenomena. In a preface, Prof. Lippmann refers hopefully to the attempt to reduce mechanical to electrical conceptions, but points out that while inertia may be purely electro-magnetic, the electron theory retains a large number of mechanical conceptions, such as velocity, acceleration and force. It is, therefore, simply a system of generalised mechanics.

E. E. F.

THE WILLANS-PARSONS STEAM TURBINE.

We have received a well-illustrated pamphlet from Messrs. Willans & Robinson describing the latest forms of steam turbine which they manufacture, and special condensing plant for use with the same. As will be remembered from the description published in *The Electrician*, Vol. LV., p. 221, these turbines, which are manufactured under licence from the Hon. C. A. Parsons, follow the general lines of the Parsons parallel flow turbine, although there are some important differences in methods of construction. The chief feature distinguishing this type of turbine from some of its competitors is the great number of expansion stages involving the use of very numerous blades, but these are of a pattern easily produced and easily fixed. The large number of stages results in a in a very small pressure-drop across each line of blades, which is the surest way to minimise leakage. Where a few stages are substituted for many, higher steam velocities have to be dealt with, and difficulties arise in regard to leakage and otherwise which, in Messrs. Willans & Robinsons' opinion, outweigh any possible gain from merely reducing the number of blades and rings.

The system of blading is covered by the patents of Messrs. Willans & Robinson and Capt. H. Riall Sankey. The blades for both casing and rotor are made up in half rings (or in smaller segments of a circle if the turbine is very large), which are subsequently held by caulking strips in dove-tail grooves in the shaft and casing. Each blade is pressed or stamped at the lower end, so as to form a dove-tail root or "tang," and at the upper or outer end is a short tongue for riveting into the channel shrouding. The foundation ring is slotted out with slots of a dove-tail form to receive the roots of the blades. The shrouding ring is of channel section and is punched to receive the tongues at the end of the blades. Both foundation ring and shrouding are slotted and punched on automatic dividing machines, so that both the pitch and angle of the blades are accurately determined. Blades to the proper number are assembled into a complete half ring by lightly riveting the tongue of each blade into the channel shrouding, and pushing the wider part of the "tang" of the blade into one of the slots in the foundation ring. The riveting is lightly done so as to leave the blades a certain freedom of movement in the shrouding, to enable them to be easily entered into their places in the foundation ring. The half ring is then placed in the groove provided for it in shaft or casing, and is fixed by means of the caulking strip, which gives rigidity and strength to the whole. The riveting of the outer ends of the blades into the channel is completed after the ring is finally secured in the grooves.

It will thus be seen that the blades are held in the foundation ring by the dove-tail form of the root or tang—that is, by mechanical construction, and not merely by being gripped by the adjoining material through the effect of the spreading of the caulking strip. It is true the foundation ring is held in position in the groove by the caulking strip, but, as in the case of the blades themselves, it is the dove-tail form which enables the ring to resist the action of centrifugal force. The groove is dove-tailed or under cut on both sides. The foundation ring has one side at the same angle as the side of the groove. The caulking strip lies against its other side, and by very moderate caulking is so expanded that it, and the foundation ring together, completely fill the groove.

The method of balancing the steam thrust on the revolving blades has been materially simplified and improved. The usual method of balancing is by a dummy "piston" or disc, divided into three steps or diameters. The smallest step is exposed to the high-pressure steam acting on the blades at the high-pressure end of the turbine. Its diameter is the mean diameter of those blades, and the pressure upon it balances the collective end-wise pressure upon all the high-pressure blades. The next "step," or annular piston, is in steam communication with the middle part of the turbine, and similarly balances the blades in that portion. The outermost and largest section of the "piston," which balances the low-pressure blades, is of a diameter equal to the mean diameter of those blades, and is, therefore, very large. In the Willans turbine this section of the piston is omitted, in consequence of which the rotor or shaft is considerably less cumbersome, while a still more important result is that the high-pressure end of the casing is much reduced in diameter. The pressure on the low-pressure blades is balanced by steam acting against the low-pressure end of the rotor, which itself becomes a balancing piston, without adding any part to the machine.

The governor gear is of a simple design. The main regulating valve controlling the turbine is connected by means of a single lever to a powerful governor, driven by worm gearing from an extension of the main turbine shaft. Ball bearings are fitted to all the working parts. A regulating apparatus is fitted by means of which the speed can be varied within specified limits. A secondary governor is fitted for safety purposes only, and is arranged to automatically close the throttle valve should the speed of the turbine exceed a pre-determined limit. An overload by pass valve can be fitted, by means of which any overload up to the overload capacity of the generator can be obtained.

The bearings, the governor working parts, &c., are supplied with a continuous flow of oil under pressure, suitable drains being provided to return the oil to a tank which forms the steam-end baseplate. The oil is here cooled by a special system of water circulation before being again delivered to the bearings, and continuous circulation is maintained by a positive action rotary pump, driven direct from the turbine. A hand pump is also fitted which delivers oil into the main supply pipe, so that the bearings can be flushed before starting the turbine.

Accessibility is a special feature of the design. Hinges are fitted to enable the top of the casing to be quickly opened and closed again, without any danger of fouling between the blades of the rotor and the casing as the parts come together. No fittings are attached to any part of the casing; hence, access is obtained to the working parts without breaking any joints beyond the main casing joint.

These turbines are listed in sizes from 250 kw. to 7,500 kw., and run at speeds ranging from 3,000 to 6,100 revs. per min. Turbines representing an aggregate output of over 26,000 kw have been supplied by the company or are on order, and it is interesting to note that Messrs. Willans & Robinson are making a speciality of turbines for the utilisation of exhaust steam.

A PORTABLE WIRELESS TELEGRAPH OUTFIT.

A great field exists, especially for military purposes, for temporary wireless telegraph stations which can be quickly erected, and which do not require the transport of heavy or clumsy apparatus, so that the whole equipment can easily follow the movements of troops in the field, and can, if necessary, be carried by men only.

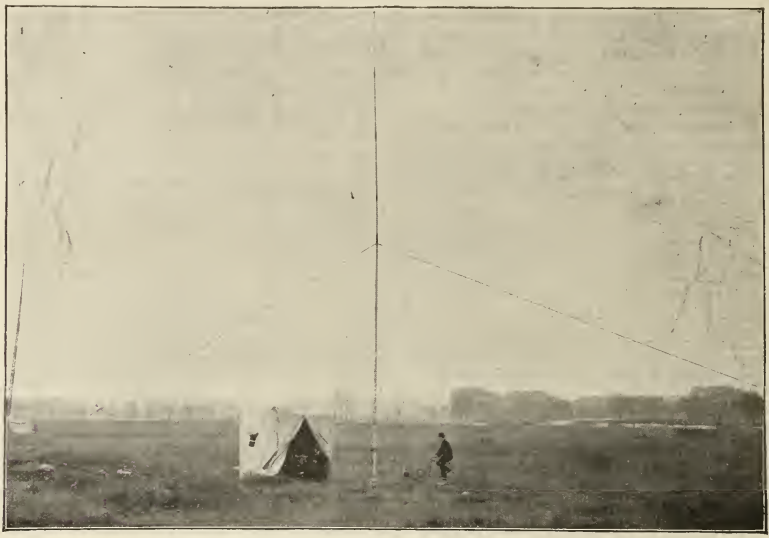


Fig. 1.—Portable Station Erected.

In the construction of apparatus for these requirements, the following points are of great importance: Lightness of the apparatus and convenience of transport, reliability in working, high efficiency considering the size of the plant, suitability for war purposes and durability and simplicity of all parts of the apparatus An equipment of this nature on the "Telefunken" system has been recently brought out by the Gesellschaft für drahtlose Telegraphie, and is specially intended for employment in scouting service either by cavalry or infantry.

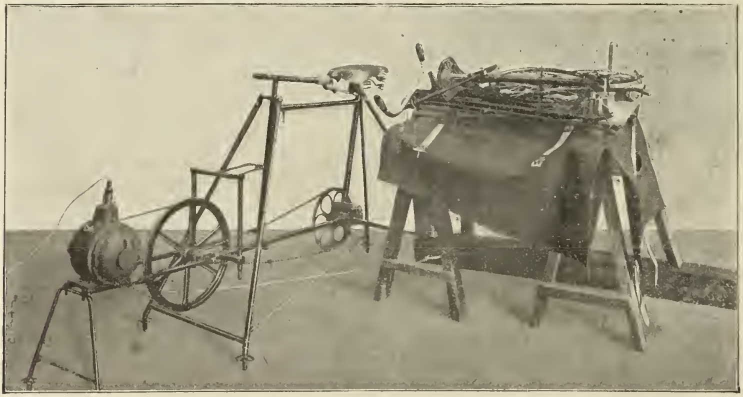


Fig. 2. Pedal-driven Dynamo. Erected and Packed Up.

The portable station is shown complete and erected in Fig. 1.

The aerial network is supported by a magnalium mast 15 metres high, consisting of eight sections each 1·85 metres in length. This carries an umbrella net, consisting of six bronze stranded wires of 25 metres in length. Below the aerial wires are six radiating wires 40 metres in length forming the lower capacity or "counterpoise" fastened to a ring attached to the mast 1 metre from the ground, but insulated from it. The mast itself is insulated from the earth and forms theconductor to the aerial wires.

As a source of current a small continuous shunt dynamo with an output of 1 ampere 45 volts at 1,300 revs. per min. is used. This is driven by a pedal gear after the manner of a bicycle, and can easily be worked by one man. The arrangement is shown in Fig. 2. It is so constructed that it can be taken apart into 10 pieces and put together in five minutes.

Fig. 3 shows the apparatus constituting the transmitter, which can be all packed away in a metal-bound wooden box, provided with a leather case with a rain-proof cover. The arrangement of connections is shown in Fig. 6. The open oscillation circuit is formed by the aerial net, the extension coil, the counterpoise net and the counterpoise coil; and the closed oscillation circuit consists of the spark gap, condenser, exciter, self-induction and correcting coil. The primary circuit consists of the dynamo, which is also provided with a pilot lamp, a plug switch, a Morse key, the primary of the induction coil and its trembler, which, of course, has a condenser, connected in parallel with the break. The length of wave sent is about 364 metres with an unvariable coupling of 8 per cent.

All the receiving apparatus is also collected in a wooden frame, which is enclosed in a leather case. The receiving system is composed of an aerial and lower capacity net with an extension coil and an inductively connected telephonic receiver.

The high-frequency oscillation circuit of the receiver consists of the plug, the receiving transformer, the variable series condenser, and the electrolytic detector, with constant parallel condenser. The local battery circuit contains three choking coils, the head telephone receiver, an adjustable resistance and the working battery. The conductors leading to the high frequency circuit are insulated with especial care. They are silver-plated in order to reduce the losses by damping to the greatest possible extent. With this apparatus it is possible to exclude waves of only 5 per cent. variation in length.

The weights of the various parts of the equipment are as follows: Mast, 30 kg.; aerial net and accessories, 50 kg.; transmitting apparatus, 20 kg.; primary interrupter condenser, 10 kg.; receiving apparatus, 10 kg.; driving

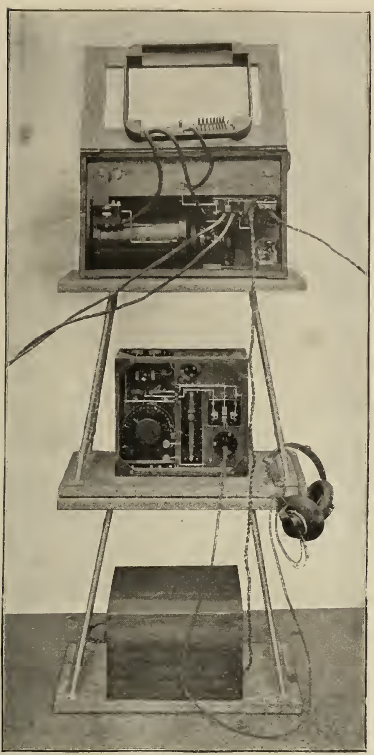


Fig. 3.—Transmitting Apparatus.

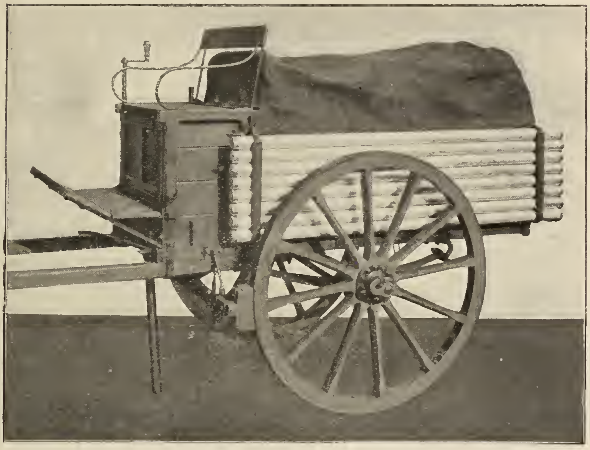


Fig. 4.—Apparatus for the Two Stations Packed together for Transport.

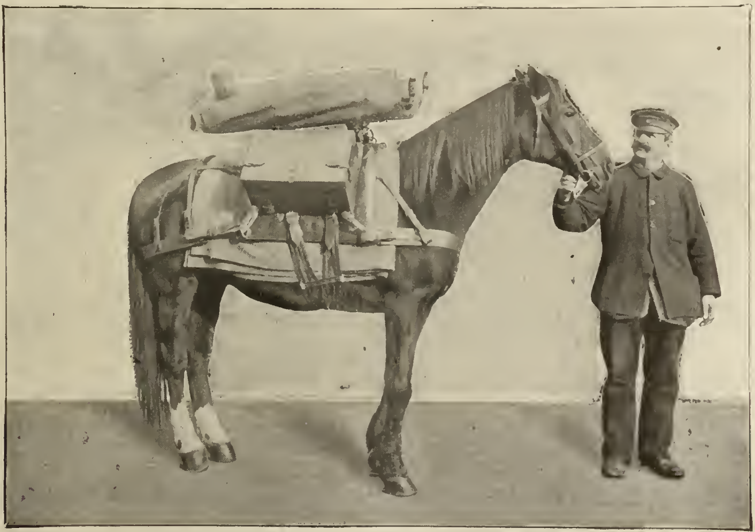
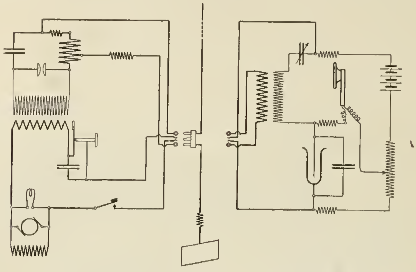


Fig. 5. Part of Apparatus arranged for Transport by Horses.

gear for dynamo, 15 kg.; dynamo, 30 kg.; two stools, 10 kg.; tools, accessories and spare parts, 25 kg.; giving a total of 200 kg.

The portable station has a range of about 50 km. on the level, or about 30 km. in mountainous country. The apparatus for the transmitting and receiving station can, when not required for actual use, be packed together in a two-wheeled transport cart, as shown in Fig. 4. The weight of the cart when loaded is about 850 kg. This cart is intended to transport the apparatus for the two stations up to the point where the officers in command have taken up their position and where telegraphic communication is desired. Here the first station is built up, whilst the apparatus for the second advances with the troops.



Sending Station. Receiving Station.

Fig. 6.

If the equipment is to be used by cavalry it is loaded on to four horses, with pack saddles, as shown in Fig. 5. The weight carried by each horse does not exceed 50 kg. A staff of one officer, one non-commissioned officer and seven men is required, one non-commissioned officer and five men for erecting the mast, and two men to hold the horses. As soon as the station is completely erected (which can be done in 20 minutes) one man is sufficient to look after the transmitter and receiver and two are required to drive the pedal dynamo, working alternately. When the apparatus is used by infantry, or when, in consequence of the nature of the ground, the further transport of the equipment on the cart is not possible, the portable station can be arranged to be carried by eight men. For this purpose two carrying frames formed out of two bamboo parts, tied together with cords, are used, upon which the heavier parts are fastened.

THE REGULATION OF THE PRESSURE OF DISCHARGE OF LIGHTING BATTERIES.*

BY E. P. HOLLIS AND E. R. ALEXANDER.

In a battery under discharge the pressure does not remain constant, but diminishes with the length of the discharge, and, therefore, it is necessary to provide some means of regulating the pressure of the supply to the system. There are two methods of doing this.

1. *The Booster Method.*—In this method the apparatus required consists of (*a*) a battery whose cells have such a capacity that they will give throughout the time of discharge a current greater than that required to be delivered to the system by an amount equal to the current required to drive the booster motor and supply the required boost to the discharge; (*b*) a booster capable of taking the maximum required discharge of the battery and giving to it a correspondingly sufficient boost right up to the end of such time as the battery is designed to give the discharge.

2. *The Regulating Cell Method.*—In this method the following apparatus is required: (*a*) a battery with a number of cells to give the required voltage at no load + a number of extra cells for regulating purposes; (*b*) a booster capable of charging the battery at its maximum charging rate; (*c*) a battery-regulating switch suitable for the discharge of the battery.

When the question is being discussed of whether it is better to use regulating cells or booster control, the invariable argument advanced against the former method is, "Yes, but look at the great cost of the extra regulating cells against which you have nothing to balance in the booster-controlled battery." Mr. Patchell, in the discussion on Mr. Highfield's Paper on his reversible booster before the Institution of Electrical Engineers, May 9, 1901, said: "Supposing 60 cells are required to work a 100 volt circuit, 50 will do just as well if you have a booster, and in big cells you will find that the saving of the cost of the extra 10 cells very far outweighs the cost of the booster and the small switchboard required to work it, so that it is a far cheaper method in prime cost. If you are discussing battery maintenance, you have only to discuss maintenance on 50 cells instead of 60, and there you get another score, so that the saving is a cumulative one." One of the chief reasons for writing this Paper is to combat these statements. There *is* something to balance against the extra cost of the regulating cells, and if a booster control is used, the cost of the extra cells is not saved. We propose to show that whichever method is used the cost of the battery is practically the same.

Let us consider a battery whose normal no-load voltage is E, and at any period during its discharge let its voltage be V. Let C = the current taken by the system and C_0 = the current given out by the battery. Then the current taken by the motor = $C_0 - C$, the boost in volts given by the booster = E − V, and the watts given out by the booster = C_0 (E − V).

Let η = the efficiency of the booster set over all. Then the watts taken in by the motor = $\frac{C_0(E-V)}{\eta}$ and the current taken by the booster motor = $\frac{C_0(E-V)}{\eta E}$

$$= C_0 - C.$$

Thus $$C_0 = C + \frac{C_0(E-V)}{\eta E} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and $$\frac{C}{C_0} = 1 - \frac{E-V}{\eta E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

These results will help us to determine accurately the true net capacity of the battery and booster.

It is obvious that in order to secure a constant voltage discharge to the system for a given time, we must have a battery which will give a number of ampere hours over and above those required to be delivered to the system, or we must supply a number of additional cells for regulating purposes. The former method requires the size of each individual cell to be increased, and the latter the number of cells to be increased. The question now arises, which will be the cheaper, the increased capacity of each cell or the increased number of cells.

The above two equations provide a means of determining what the capacity of the battery should be to give a required discharge to a system through a booster. All that is required to do this is the efficiency curve of the booster and a discharge curve of a cell. By plotting out a curve, determining the values from the equations we have given, we can easily determine the size of the cell necessary.

Let us take a 2,000 ampere hour battery 500 volts, which will give 1,000 amperes for two hours, and let this battery be discharged through a booster at a constant rate of 1,000 amperes. The table given below has been calculated out for this battery. The volts per cell at various times have been taken from an actual discharge curve. The boost per cell required is, of course, the difference between the no-load volts (which are taken as 2·15) and the voltages at these times. The maximum boost per cell will be required at the end of discharge, and then the booster will be working at full load, so that the percentage of full load on the booster can be calculated on this basis. We have given this percentage of full load on the booster merely as a criterion of the efficiency, and the efficiencies of both motor and booster have been given to show the method of estimating the over-all efficiency. These efficiencies have been taken from the curves of 150 kw. machines. The motor currents have been calculated from the equations given above, and the system current is the battery current, 1,000 amperes, minus the motor current.

Time of dis-charge.	Volts per cell.	Boost required per cell.	Percent-age of full load on booster.	Efficiencies.			Currents.	
				Motor.	Booster.	Over-all.	Motor	Sys-tem.
..	1·935	0·215	64	0·850	0·870	0·739	135	865
15 min. .	1·930	0·220	66	0·853	0·873	0·745	138	862
30 min. .	1·915	0·235	70	0·859	0·879	0·755	144	856
45 min. .	1·900	0·250	74	0·865	0·885	0·766	152	848
1 hour. .	1·890	0·260	78	0·869	0·889	0·773	157	843
15 min. .	1·875	0·275	82	0·875	0·893	0·781	164	836
30 min. .	1·860	0·290	86	0·878	0·895	0·785	172	828
45 min. .	1·840	0·310	92	0·880	0·898	0·790	183	817
2 hours .	1·815	0·335	100	0·882	0·900	0·794	195	805

By taking the averages of the last two columns we obtain the following results:—

Average current discharge from battery = 1,000 amperes.
Average current taken by the system = 840 amperes.
Average current taken by the motor = 160 amperes.
Rated capacity of the battery = 2,000 ampere-hours.
Rated capacity of the battery + booster = 1,680 ampere-hours.
Availability coefficient of battery $= \frac{1,680}{2,000} = 0·84.$

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* Abstract of a Paper read on May 14 before the Newcastle Local Section of the Institution of Electrical Engineers.

Therefore, if we require a 1,680 ampere-hour supply to the system we shall require, with a regulating-cell method, a number of cells, each of 1,680 ampere-hours' capacity, but if we use a booster-control method we shall require a less number of cells, but of a 2,000 ampere-hour capacity, or an increase of about 19·1 per cent.

Having obtained the sizes of the cells to be used in each case, we can now determine how many cells will be required. If the booster-control method be used, the number of cells required will be equal to the 'bus-bar voltage divided by the voltage of the cell at no load, or 233 cells. If the regulating-cell method be used, the number of cells in the main battery will be the same as in the previous case—*i.e.*, 233 cells. We have now to calculate the number of regulators.

At the end of discharge the main battery will be down to 1·815 volts per cell, or a total voltage of 422·9. The number of regulators must, therefore, be such as to give at the end of discharge a voltage of 77·1. Now, as the battery is being discharged a number of regulators are cut in immediately to compensate for the drop of pressure across the battery, and the others are cut in a few at a time as the discharge proceeds, and shortly before the end of discharge the last regulator is cut in. It follows that all the regulators will not be right down to the pressure of the main battery, but some of them will be less discharged than the others, and will therefore have a higher voltage. If you refer to the table given, you will see that at the commencement of discharge there is a drop per cell of 0·215 volts, or a total of 50·1 volts, and to compensate for this we must switch in immediately 26 cells, which gives us with the main battery 500 volts. Now, the rest of the regulators will be cut in one after the other, and at the end of the discharge will have a slightly higher voltage than the rest of the cells. We will take the voltage of the rest of the regulators as 1·875 volts. By supplying the previous 26 regulators we have accounted for 50·1 volts, which leaves us 77·1 − 50·1 = 27 volts. The number of regulators required other than those switched in immediately the discharge is put on to the battery will be 14·4. The total number of regulators required will therefore be 26 + 14·4 = 40·4, say 42. This makes the total number of cells in the battery 275.

We can now sum up the batteries in the two cases. With the booster control we shall require 233 cells, each of 2,000 ampere-hours capacity, and with the regulating cells, 275 cells, each of 1,680 ampere-hours capacity.

The relative costs of these two methods can now be obtained. With the regulator method we have to increase the number of cells from 233 to 275, or an increase of 15·3 per cent. In the case of the booster-controlled battery we have to increase the capacity of each cell from 1,680 to 2,000 ampere-hours, or an increase in capacity of 16 per cent. Both these percentages are calculated on the final values. This shows a difference in the increases of 0·7 per cent. in favour of the regulating cell method, and as for small increases in the capacity of the cell the capital cost will, roughly speaking, go up in the same proportion, it will be seen that the capital costs will not differ much. The actual costs are for the 2,000 ampere-hour cell £23. 17s. 6d., giving a total cost for the 233 cells of about £5,563; and for the 1,680 ampere-hour cell £20. 5s., giving a total cost for the 275 cells of £5,569. This difference is so small that it is quite negligible.

When a battery is controlled by a booster this is used for charge and discharge, and is always motor-driven, and, therefore, a special booster is necessary. But with regulating cells it is by no means necessary to have a special booster. The booster is only needed on charge, and this can easily be done by two 500-volt machines in series, one being used as a booster. Batteries are never, except under very exceptional circumstances, charged near the peak of the load, so that there should be plant to spare for this purpose. The only alterations necessary will be a small switchboard for the purpose of putting two machines in series, and possibly a small alteration in the field rheostat of the booster machine to get the voltage necessary. Thus nearly the total cost of a booster set would be saved. It may be urged that if two machines be run in series to charge the battery serious sparking might occur. This has not been so in our experience with modern machines, the only slight trouble being that the voltage on the boosting machines is unsteady and needs readjustment every three or four minutes.

The efficiency of each method is practically the same. The losses in discharge in the booster control method are $E\ (c_0 - c)\ (1 - \eta)$, and work out to about 4 per cent. of the total output of the battery. The losses in the regulating method are nearly zero on discharge. In all probability this saving on discharge would be completely lost on charge by running the two generators in series below their rated capacity.

When regulating cells are used a regulating switch is necessary. To reduce the cost of the leads it is necessary to put this switch as near as possible to the battery house. The ordinary hand-regulated type of battery switch is well known, but it is in most cases far better practice to instal an automatic switch. The largest switch in operation in this country is that installed at the Pandon Dene sub-station of the Newcastle-upon-Tyne Electric Supply Co. This switch controls a 4,000 ampere-hour, 530 volt Tudor battery, installed solely for the purpose of preventing any stoppage of supply to the Newcastle lighting system.

To go back to the cases we have been considering, the cost of a Trumpy switch suitable for 860 amperes would be about £113, including the indicator, and the cost of the copper roding about £97, or a total of £210. This has to be balanced against the cost of the booster in the booster-controlled battery.

When it is desired to charge a battery having regulating cells, the procedure is as follows: After the booster and charging machine are put in circuit and everything got ready for charging, with no load on the battery either charging or discharging, the small control switch for working the Trumpy switch is thrown over in such a direction that the regulating cells are put in circuit. The Trumpy switch will run round to the end, and will then cut itself off automatically. Whilst it is doing this the operator increases the booster voltage so that the battery ammeter always reads zero. The charge can then be commenced. Whenever the battery is charged the regulators should always all be thrown in

In conclusion, we wish to suggest a point which appears to us to be well worthy of consideration. That is, the graduation of the regulators. It is the general practice to make all the regulators the same capacity as the main battery. Though the regulators carry the same current as the main battery, yet a good many of them are only in circuit for part of the time. For instance, on a two-hour discharge the twenty-eighth regulator to be switched in would only be in for about an hour. That is to say, a 2,000 ampere-hour cell would have only 1,000 ampere-hours taken out of it, which is a most uneconomical state of affairs. The last regulator would probably be in for about five minutes. Therefore, we think that it would be more economical to graduate the regulators downwards in capacity from the last group of regulators, which is switched in to compensate for the drop in pressure of the battery when full load is first thrown on. A very high discharge type of plate would be necessary for this.

DISCUSSION.

Mr. TURNBULL said that in the greater number of cases regulating cells were used and not boosters, the latter were only used in power stations, whereas numerous private plants always used regulating cells. The rate of discharge taken by the authors as two hours was rather short, batteries were usually used at night on light loads and were left on the bars until the load came on in the morning, this would mean that the battery was discharging for about five or six hours; this would very much alter the calculations in the Paper. With a booster, the cells could be charged to a higher voltage than the 'bus bars, and at first, when discharging, there is a period when the booster must be reversed, a second period when the booster is not needed, and a third period when the booster is required to boost the discharge. Charging with two machines he thought rather dangerous. The great disadvantage of regulating cells was in their different state of charge at the commencement of the charge, and constant attention is needed to see that they got properly charged and not overcharged as is frequently the case. An automatic booster could be even more easily regulated than a Trumpy switch.

Mr. FRANKLIN thought that the capital expenditure and maintenance cost of the cell regulating system was the cheaper.

Mr. LONGMAN said that one thing not taken into consideration in the Paper was floor space. Batteries were often put in out-of-the-way corners and floor-space was a consideration. The Paper appears to deal with an emergency battery with a high rate of discharge for a short time. Most batteries were not usually run under these conditions. Great trouble was often experienced with the regulating cells, and if these were graded capacity trouble would be experienced when renewing the end cell plates, which usually had to be done before the other cells in the battery needed renewing. He was in favour of the booster system, as it was always ready for immediate use.

Mr. VESEY BROWN thought that a great source of trouble of batteries was due to manufacturers not leaving enough space at the bottom of the plates for the accumulation of sludge; but in the more modern types this fault was being remedied. Automatic switches for batteries were a great trouble, and one of these usually was enough for one man to see after and kept him fully occupied.

Mr. STONEY thought that for country house and private plants regulating cells were preferable. In these plants no booster was required for charging. The machines were slightly over-wound for voltage, and if the engines were speeded up the required voltage for charging was obtained.

Mr. RISELEY said that the Paper dealt with a special battery, the uses of which were to flatten out the peak load and for emergencies.

Mr. HOLLIS, in reply, said that they had thought that a two-hour rate quite suitable for a lighting battery for discharge on the peak of the load. They did not think it wise to have a battery of a higher voltage than the 'bus bars, because, although this gave a more economical running during the time the battery was being discharged, yet the booster had to run during all the time the battery was not being discharged, which is most uneconomical, and if anything happened to the booster the battery was useless. In reply to Mr. Vesey Brown, the Tudor Company now left about a 6 in. space between the bottom of the plates and the cell, this giving ample room for any sludge falling from the plates. The Trumpy switch regulated fairly accurately, and could be left on all night with good results.

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on May 11th, Dr. C. Chree, F.R.S., vice-president, in the chair, a Paper on

"The Dead Points of a Galvanometer Needle for Transient Currents"

was read by Mr. A. Russell. When many types of needle galvanometer are connected with a condenser and a battery in the ordinary manner by a charge and discharge key the following phenomena can easily be observed. When the needle is initially at right angles to the axis of the galvanometer coil, and the spot of light is in the centre, X, of the scale, the throws on charge and discharge are equal. If the controlling magnet be turned through a small angle, or if the suspending fibre be twisted slightly so that the spot of light is not in the centre of the scale initially, the throws on charge and discharge are not equal. The algebraic difference between them, however, is constant. Hence, for an initial position P_1 of the spot of light there is no throw on charge, and similarly for another initial position P_2 there is no throw on discharge. These points the author calls the dead points. If the resistance of the charging and discharging circuits are the same, $XP_1 = XP_2$. In this case the distance P_1P_2 varies directly as the resistance of the charging circuit, and inversely as the applied voltage. If the initial position of the spot of light be outside of P_1P_2, the throws on charge and discharge are in the same direction. The author shows that these effects can be explained with considerable accuracy by supposing that the magnetism of the needle consists of two parts, one permanent and the other proportional to the magnetising force. As far back as 1868 Lord Rayleigh showed that this supposition is sufficient to explain the permanent deflection produced by an alternating current passing through the galvanometer coil. In a Paper also, in 1883, he pointed out that a galvanometer is a very imperfect instrument for indicating whether the integral sum of the transient currents through it is zero or not, and he also mentioned the limitations this imposes on Maxwell's method of comparing mutual inductances. The author finds that it is easy to arrange with a low-resistance galvanometer so that a, relatively speaking, gigantic charge can be passed through the coil without producing any throw at all. He also finds that all the galvanometers he has tested, whether needle or moving coil, will produce throws when certain transient currents pass through them, even although the integral value of these currents is zero. It also appears that the effective internal resistance of ordinary condensers is appreciable in certain cases. These results are of importance in connection with several of the customary methods of testing.

Mr. W. DUDDELL expressed his interest in the Paper, and remarked that the phenomena described were of importance in the measurement of capacity. He suggested that since the R term in the Paper included all the C^2R losses, part of it might arise from eddy currents in the condenser. The condenser shown by the author was constructed by winding together very long strips of tinfoil, and the resistance should therefore appear high if it was true resistance ; perhaps Mr. Russell could tell him the value of the resistance of the condenser shown.

Prof. H. A. WILSON, referring to the effective internal resistance of a condenser, pointed out that if there was dielectric hysteresis there must be a loss of energy, which no doubt amounted to a resistance as determined by the author.

Mr. ROLLO APPLEYARD asked if it was necessary to assume that R was a resistance. It might be a physical constant of the condenser of another kind.

Mr. A. CAMPBELL said that the effects mentioned by Mr. Russell often gave trouble in actual testing work. Some years ago he found that in testing standard air condensers by Maxwell's method, an ordinary needle galvanometer gave erroneous results unless its needle was exactly in the symmetrical position. A moving coil galvanometer, however, gave satisfactory results.

The AUTHOR, in reply to Prof. Wilson, stated that dielectric hysteresis had probably some connection with the internal resistance of the condenser, but the effect was small. The energy radiated into space was also small. Mr. Duddell's suggestion of eddy currents might clear up any lack of uniformity in results obtained with very rapid oscillatory discharges. The author also showed how the resistance of a condenser could be measured in a minute or two by his method. The resistance of the actual condenser used in the experiments was found to be about 9 ohms.

Prof H. A. Wilson exhibited a Lippmann capillary dynamo and electromotor from the George the Third Museum of King's College.

Mr. W. Duddell exhibited some mechanical and electrical phenomena occurring in the telephonic transmission of speech. The apparatus is intended to demonstrate as curves on a screen the simultaneous movement of the microphone transmitter-diaphragm, the current flowing into the telephone line, the current received at the far end of the line, and the movement of the receiver-diaphragm when sounds or speech are being transmitted. The similarity of and the difference between these four curves can be examined by the aid of the apparatus, and the distortion and attenuation produced by the resistance, capacity and self-induction of the line can be demonstrated, as well as the distortions produced by the diaphragms of transmitter and receiver. The characteristic shapes of the curves corresponding to the different vowel sounds and their dependence on the pitch on which they are sung can also be exhibited.

NATIONAL TELEPHONE CO.'S STAFF DINNER.

The thirteenth annual dinner of the staff of the National Telephone Co. was held at the Trocadero Restaurant, Piccadilly, London, on Friday evening last, and was attended by all the principal officers of the Company from all parts of the country, representing a staff numbering nearly 16,000.

The chair was occupied by Mr. W. E. L. Gaine, General Manager of the Company, who was supported on his immediate right by Mr. George Franklin, President, and on his left by Mr. S. H. Sands, Vice-President, and the Directors present included Sir James Fergusson, Bart., G.C.S.I., Sir James T. Woodhouse, M.P., Sir A. K. Rollit and Mr. G. H. Robertson. A large number of guests responded to the invitation to be present, and these included the Right Hon. Lord Kelvin, O.M., G.C.V.O., Major Shepherd, Dr. Grosvenor, Mr. Dane Sinclair, Mr. H. Laws Webb, Mr. H. H. Gaine, Mr. T. A. Welton, Mr. H. Fedden, Mr. J. F. Bond and many others. The officials of the Company present included Mr. Albert Anns, secretary ; Mr. Frank Gill, engineer-in-chief ; Mr. S. J. Goddard, Mr. C. B. Clay, Mr. C. J. Phillips, Mr. A. Coleman, Mr. J. C. Chambers, Mr. R. Shepherd and Mr. F. Cowley. About 250 in all sat down to an excellent dinner, which being concluded,

The Chairman, after proposing the usual loyal toasts, which were drunk with enthusiasm, submitted the toast of the evening, "The National Telephone Co. and the Board of Directors." He said a good deal had happened since they met in that room only 10 short months ago, when he was able to briefly discuss an agreement just then entered into for the transfer of the Company's great undertaking to the State. The Directors had at that time done all that men could do to induce the Government to make a fair and just arrangement as regarded the staff of the Company, but without any marked success at the time. Fortunately, however, by judicious combination the members of the staff were able to obtain the ear of Parliament, and in the evidence which was laid before the Select Committee of the House of the Commons by members of the staff of the National Company a strong and extremely good case was made out, and the report which was presented by the Select Committee was in their favour, and reasonably fair terms to the bulk of the staff were granted. He might say that, with the exception of a limited few, all were fairly treated, and those few were now engaged in selecting the most picturesque and salubrious workhouses in the country where they might hope to spend their declining years (laughter). He desired to make a few remarks upon the progress of the Company during the past 10 months. They had now 1,228 exchanges working in Great Britain and Ireland, an increase during the 10 months of 73. They had increased their subscribers' stations by nearly 50,000, and this would become 60,000 unless he was much mistaken when the period of 12 months had been reached. This was a record increase, and represented something like 15 per cent. They now numbered 378,000 subscribers' stations in Great Britain, and the number of messages was getting so astounding that he was afraid almost to mention them : 1,052,000,000 messages had been handled, an increase of nearly 60,000,000 messages in the 10 months. He had on former occasions made whatever comparison was possible between their messages and those which passed over the telegraph service of the country. But the telegraph service was now so hopelessly in arrear that he had given that kind of comparison up. Of course, they were aware of the reflections that were cast by the newspapers, before Parliamentary Committees, and in the debates of municipal councils on the backwardness of this country in regard to its telephone service. But he had some figures relating to the development of telephones in other European countries up to January 1st last which might be interesting. Taking 10 countries—Austria-Hungary, Belgium, Denmark, Holland, Italy, Norway, Portugal, Russia, Sweden and Switzerland—these countries had a combined population of 288,000,000 souls, against 42,000,000 in this country. But in the United Kingdom he found they had 30,551 more telephone stations than existed in all the countries he had enumerated combined. In other words, their development was 7·2 per cent. greater than had been the development of all these countries put together. To get the nearest number of telephones to compare with Great Britain, he must take eight countries—France, Austria-Hungary, Belgium, Holland, Denmark, Norway, Portugal and Switzerland—and even then we were over 7,000 telephones a-head. They had heard in the past a good deal of Stockholm and the Scandinavian countries, and how advanced these countries were in matters of the kind. These Scandinavian countries were Sweden, Norway and Denmark, but he would throw in Belgium, Holland and Switzerland, and when he had done this, Great Britain alone has 105,000 telephones more than all these countries put together. The only country, in fact, that can stand on the same platform with them was Germany, and Germany, with a population of 58,000,000, had telephones to the extent of 10·2 per 1,000 of the population compared with 10·15 for Great Britain and Ireland. If they left out of account France, Germany and Switzerland, there was no European country that had as many telephones working as London. London, with its 6,000,000 of people, had nearly as many telephones as the whole of France with 39,000,000, as the whole of Sweden with about the same population, as the whole of Austria-Hungary, Belgium and Holland combined with a population of 60,000,000, or the whole of Switzerland, Norway and Denmark combined with 10,000,000. He did not suggest that this development of the telephone in this country had been what it might have been if the National Company had had a fair chance. But these figures were not so conclusive against their enterprise as they were often led to believe was the case (cheers). There was, however, another side to the picture. He had been in America a short time ago, and in that country they did not use the telephone, they breathe it ; not the telephones of the cheap and nasty sort which a good many enthusiastically advocated for this country, but the highly-arranged and scientifically-developed service which really fulfils the public requirements in that great country, and which is adequately paid for, and is worth paying for. They could not here claim to have developed the telephone service to anything like the same extent as they had done in America. Why? Because, owing to the early decision of the Courts of Law in this country which said that the telephone, then newly invented, was a telegraph, which had been invented years before, they had been under the heel of Government control; because for years they had never had any powers for the purpose of putting down their plant; and because until the agreement of last year there had never been any settled policy by any Government which had ruled this country (hear, hear). Now that the telephone policy of the country was a settled policy he hoped they would see what the National Company and what they, the staff of the Company, could do to develop the service in the United Kingdom (cheers). With regard to the Directors, since the staff last met together great changes had taken place. They had lost Sir Henry Fowler, their Chairman, who had accepted high office in His Majesty's Government, and he was sure they all regretted his loss, as he regretted the necessity for leaving them. To the office of President Mr. Franklin had been elected, and the Board had in this way secured a worthy successor. If he was spared he had before him, in connection with the ultimate transfer of their undertaking to the State, a work of no ordinary character and one requiring no ordinary qualities (hear, hear). That he possesses these qualities and that he would rise to the height of his responsibilies he (Mr. Gaine) had not the least doubt; and what he had said of Mr. Franklin, he might equally say of Mr. Sands, their Vice-President, who was one of the oldest Directors of the Company. Of the Board generally, he could say that the Company was exceptionally fortunate in having its affairs controlled by men who were able and capable to do the work. They had with them their old friends Sir James Fergusson, Sir James Woodhouse, and Sir Albert Rollit. Sir Cuthbert Quilter would have been there but for ill-health, and Lord Harris was compelled to be absent as he was out training with his Yeomanry. Other Directors were absent from causes outside their control. He would ask them to drink the toast of "The National Telephone Co. and the Board of Directors," coupled with the names of Mr. Franklin and Mr. Sands.

The toast was drunk with enthusiasm.

Mr. Franklin, in replying, referred to the many pleasant evenings he had spent among the staff of the National Company. By what he might term the accident of the General Election they had the misfortune to lose their President, Sir Henry Fowler, and it devolved upon him (Mr. Franklin) to respond to the toast of "The Company." That Company was perhaps the most abused and the most threatened of all public companies, and he thought the most undeservedly abused and the most undeservedly threatened. Since the telephone was declared a telegraph and since the State had created the Company by licence there had been, as the Chairman had said, no settled policy with regard to the telephone service in this country. It was, in fact, not until last year that what they might consider a definite and final policy had been resolved upon, a policy which eventuated in the agreement which was approved by Parliament last August. By this agreement none could tell what the future of the Company would ultimately be, but as in the past they had been hampered by uncertainty, now that this uncertainty no longer existed, the Directors saw no reason why the Company should not greatly develop. He knew of no organisation with a staff so well organised or so devoted to the carrying out of that destiny, and when 1912 came, and when the Government acquired the staff of the National Telephone Co., not the least of the assets taken over would be the valuable staff which the Company had created (cheers). It was not in the interest of the Government, or their shareholders, that they should mark time or stand still. On the contrary, it was vital to their shareholders, the Government and the public that they should do all they could to develop the telephone service.

Mr. Sands, who also responded, said he was an old servant of the Company, and had done in the past his best for the interest of the staff and for the interest of the public. He thought that was a fair way of putting the matter to them, because he regarded the people who found the money to back up the enterprise as being entitled with the Directors to the first consideration. Next in order came the staff, who had developed the enterprise, and without whose assistance they could never have gained the satisfaction to the shareholders that had been gained in the past, and he felt strongly that if under the altered conditions they could be allowed another 20 years' existence they would have been able to develop the enterprise to a practically unlimited extent; but as they could not hope for that extension they must make the best of the few years at their disposal.

Mr. T. A. Trout proposed "Our Guests," coupled with the names of Lord Kelvin and Sir Albert Rollit. They all knew of Lord Kelvin's wonderful discoveries and inventions, and it might be that some day they might be fortunate enough to build a telephone exchange round his birthplace at Belfast and so perpetuate his memory, as had recently been done in the case of Faraday. Sir Albert Rollit, too, was a distinguished man and a prominent figure in commerce and law, and it was one of the delights of the provincial participants in the staff dinner to have a speech from him.

The toast was drunk very cordially.

Lord Kelvin said he appeared before them in a threefold capacity—as a retired member of the staff of the National Telephone Co., as a non-retired shareholder, and as a happy guest. He desired to thank them for the great pleasure he had had in being with them. He had listened with intense interest to Mr. Gaine's brilliant speech and to that of their President and the Vice-President describing the history of the National Telephone Co. If through those old days of struggle they had brought the Company to its present position in the next five years he believed the progress of the enterprise would be very great. The staff of the Company now approximately numbered 15,000 persons—what would it be when they all entered the service of the Goverment under the Postmaster-General? He had been all along interested in this Company. He was a member of its predecessor, the United Telephone Co., which existed before the formation of the National Telephone Co., and he had a clear recollection of the chequered history of the undertaking. All, however, was well that ended well, and they were looking forward to a brighter future. He personally regarded that future with confidence, and wished perpetual success to the National Telephone Co. and desired that its name should be continued after its business had been transferred to the Government.

Sir Albert Rollit said it was a great honour to any man to be coupled in a toast with Lord Kelvin, one of the greatest modern masters both in pure and applied science. Wherever Lord Kelvin's name was known, whether to the scientist, the manufacturer or the student, it bore with it the highest regard. He wanted that night to impress upon them, as they were engaged in their daily occupation, the necessity of cultivating, not only their art, but the science which underlaid their art, and by that means to gain those receptive, sensitive minds which would take the impression of the hints of Nature and apply them for the benefit of the industries of the world. When he asked them to study he asked himself whether the State was giving every possible facility for scientific, technical and industrial training which they ought to possess, and he was bound to answer that, comparatively speaking, it was not. Sir Albert subsequently amused the company with some excellent humorous stories, which were highly appreciated. He concluded by thanking the staff for their kindness in inviting him to the entertainment and for coupling his name with the toast.

Mr. J. Stirling then proposed the toast of "The Chairman," and said that he had heard the General Manager at many of their annual dinners tell of the pride which he felt in the staff. He thought that he could assure Mr. Gaine, on behalf of the staff, that they also felt a pride in him, in the conspicuous ability and success with which he carried on the great business of the Company, and in the perfect organisation and achievement which had resulted from his labours.

The toast was drunk very heartily.

Mr. Gaine, in reply, thanked them most sincerely for the toast which they had honoured so cordially, and Mr. Stirling for the kind words which he had used in proposing the toast. The post he had to fill was not a very easy one, and not the least of its difficulties was the fear that he might, perhaps, not always be acting justly. If he did not always succeed he trusted they would take the endeavour for the deed. According to his lights he tried to do justice in the position he was called upon to fill (cheers).

The evening's entertainment included an excellent programme of music, both vocal and instrumental, and the proceedings throughout were of a very convivial character.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Steam Turbine Engineering." By T. Stevens and H. M. Hobart. (London: Whittaker & Co.) 21s.

"Practical Motor Car Repairing." By Eric W. Walford. (London: Percival Marshall & Co. 1s.

"Proceedings of the Royal Society." Series A. Vol. LXXVII. No. A519. "Mathematical and Physical Sciences." (London: Harrison & Sons.) 2s. 6d.

"Proceedings of the Royal Society." Series B. Vol. LXXVII. No. B520. "Biological Sciences." (London: Harrison & Sons.) 2s. 6d.

"Die Vorgänge in Ein- und Mehrphasengeneratoren." By J. Rezelman. (Stuttgart: Ferdinand Enke.) 1·20m.

Electricity and Tank Experiments.—At Übigau, near Dresden, there is an institute for carrying out various kinds of hydraulic experiments, including the measurement of the resistance of models of ships to propulsion. This institute, which is in connection with the Technical High School of Dresden, has recently been provided with a new experimental tank, about 260 ft. long and 23 ft. wide. The ship models are drawn through the water by means of a travelling bridge which runs on rails fixed at the edges of the two long sides of the tank. In order to obtain rapid acceleration and retardation, the traveller was built as light as possible, and the bridge, complete with its electric driving equipment, is stated by *Elektrische Bahnen & Betriebe* to weigh only 4½ tons. It is driven by a 20 H.P. 440 volt shunt motor, and the general electrical and mechanical arrangement is analogous to that adopted in crane practice. Current is conveyed to the motor on the traveller by a third rail and contact shoes, and returns through the rails. The speed is regulated by varying the supply voltage on the Ward Leonard system. The operator controls the traveller from a small switch desk at one end of the tank.

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From the earliest days of electric wave telegraphy, even its most enthusiastic advocates have lamented the scattering broadcast of its tidings which seems its inalienable characteristic; and most sedulously have they sought a remedy. Two main lines of search have from the beginning been visible. The one, the method of syntony, has been ardently pursued and has been rapidly pushed into a condition of satisfactory efficacy. The other and more direct method of mitigating the defect in question consists in confining the waves to an assigned path, and has only lately risen to the stage of practical utility. By the introduction of syntonic methods into wireless or, as we would rather say, lineless telegraphy, the nightmare like dread that increase in power and range of transmitters would involve increase of interference and would multiply confusion has already been almost dissolved. Moreover, the fear that malicious interference would be easy and always successful has been considerably diminished; and at the same time, the signalling distance has been enormously extended. Yet, with all its virtues, the best syntonic apparatus has in no degree reduced the wastage that necessarily accompanies impartial distribution of the energy leaving the sender. In other words, efficiency in the mechanical sense, that is, the proportion of the whole output of energy from the sender utilised at the receiver, remains a very small fraction however perfectly the principle of syntonisation be applied.

The second line of attack is of much greater promise in this very matter of efficiency. To pour into the receiver an appreciable proportion of the energy of the sender by transmitting in the direct line, or, perhaps, by making the energy converge ultimately on the objective, is the great, though

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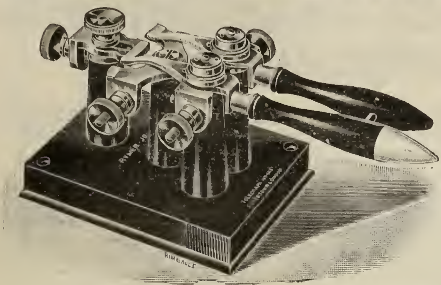

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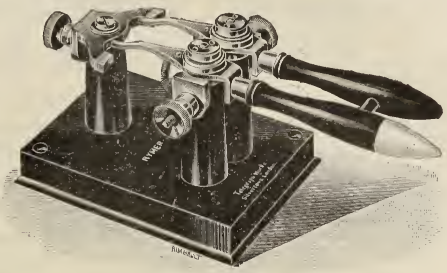

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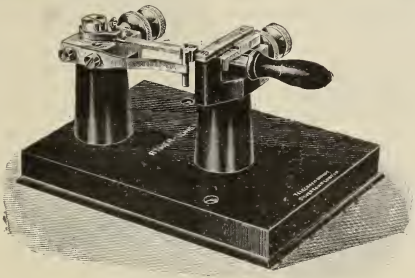

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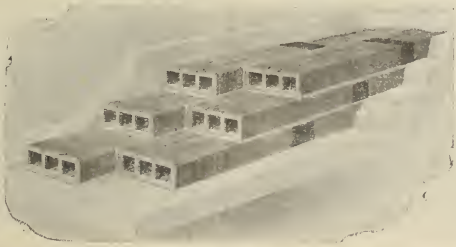

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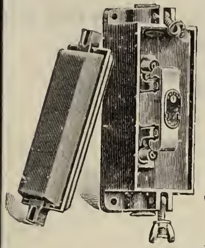

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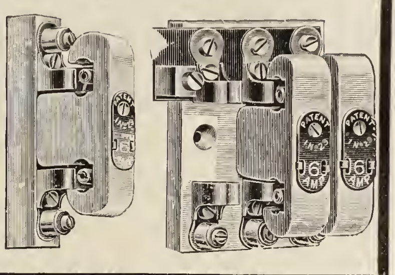

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Cooper—PRIMARY BATTERIES: THEIR CONSTRUCTION AND USE.

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Author's Preface—Extract.—Primary Batteries form a subject from which much has been hoped, and but little realised. But even so, it cannot be said that the advance has been small; and consequently no apology is offered for the present volume, in which the somewhat scattered literature of the subject has been brought together. Recent years have seen important additions to the theory of the voltaic cell, and therefore a considerable number of pages have been devoted to this part of the subject, although it is impossible to do more than give a superficial sketch of the theory in a volume like the present. With regard to the practical part of the subject, this volume is not intended to be encyclopædic in character; the object has been rather to describe those batteries which are in general use, or of particular theoretical interest. As far as possible, the Author has drawn on his personal experience, in giving practical results, which, it is hoped, will add to the usefulness of the book. Owing to the importance of the subject, Standard Cells have been dealt with at some length. Those cells, however, which are no longer in general use are not described; but recent work is summarised in some detail so as to give a fair idea of our knowledge up to the present time. It has also been thought well to devote a chapter to Carbon-Consuming Cells. Very little has been written upon this subject, but it is of great interest, and possibly of great importance in the future.

Cooper—*See* "THE ELECTRICIAN" PRIMERS, page xxviii.

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Heaviside—ELECTROMAGNETIC THEORY. By Oliver Heaviside. Vol. I. Second issue. 466 pages. Price 12s. 6d., post free 13s. Vol. II. 568 pages. Price 12s. 6d. post free; abroad, 13s.

Extract from Preface to Vol. I.—This work is something approaching a connected treatise on electrical theory, though without the strict formality usually associated with a treatise. The following are some of the leading points in this volume. The first chapter is introductory. The second consists of an outline scheme of the fundamentals of electromagnetic theory from the Faraday-Maxwell point of view, with some small modifications and extensions upon Maxwell's equations. The third chapter is devoted to vector algebra and analysis, in the form used by me in former papers. The fourth chapter is devoted to the theory of plane electromagnetic waves, and, being mainly descriptive, may perhaps be read with profit by many who are unable to tackle the mathematical theory comprehensively. I have included in the present volume the application of the theory (in duplex form) to straight wires, and also an account of the effects of self-nduction and leakage, which are of some significance in present practice as well as in possible future developments.

Extract from Preface to Vol. II.—From one point of view this volume consists essentially of a detailed development of the mathematical theory of the propagation of plane electromagnetic waves in conducting dielectrics, according to Maxwell's theory, somewhat extended. From another point of view, it is the development of the theory of the propagation of waves along wires. But on account of the important applications, ranging from Atlantic telegraphy, through ordinary telegraphy and telephony, to Hertzian waves along wires, the Author has usually preferred to express results in terms of the concrete voltage and current, rather than the specific electric and magnetic forces belonging to a single tube of flux of energy. . . . The theory of the latest kind of so-called wireless telegraphy (Lodge, Marconi, &c.) has been somewhat anticipated, since the waves sent up the vertical wire are hemispherical, with their equatorial bases on the ground or sea, which they run along in expanding. (*See* § 60, Vol. I.; *also* § 393 in his volume.) The author's old predictions relating to skin conduction, and to the possibilities of ong-distance telephony have been abundantly verified in advancing practice; and his old predictions relating to the behaviour of approximately distortionless circuits have also received air support in the quantitative observation of Hertzian waves along wires.

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In general, the Author's aim has been to give a sound digest of the theory and practice of the electrical transmission of power, which will be of real use to the practical engineer, and to avoid controversial points which lie in the province of the specialist, and elementary proofs which properly belong to text-books on electricity and magnetism.

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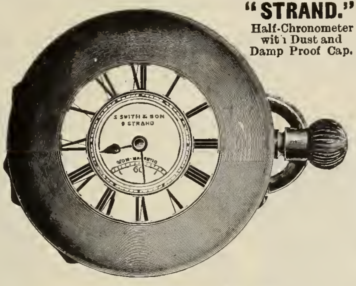

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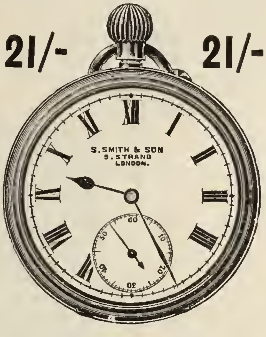

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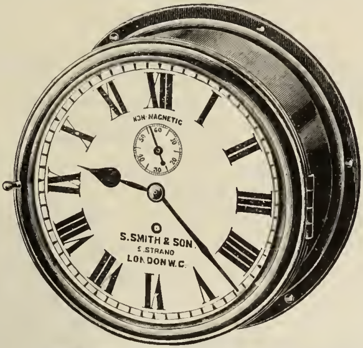

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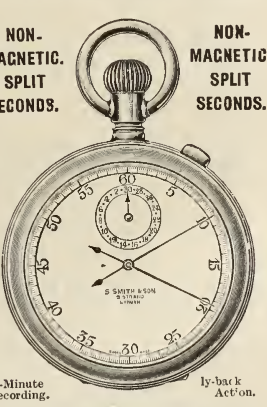

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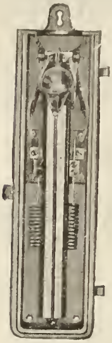

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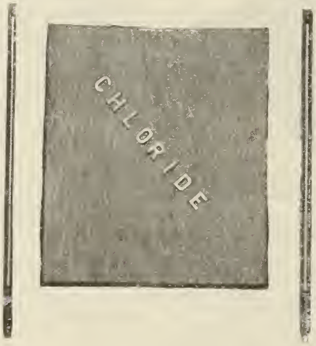

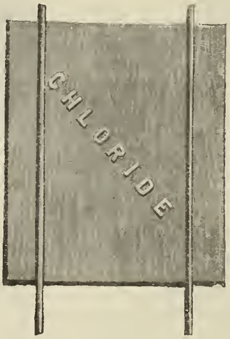

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somewhat ideal, consummation wished by the seekers after efficiency—which, after all, should not in this case be measured in the strict mechanical way, but rather by comparing broadly the value of what is accomplished with the cost of doing it. But not efficiency merely—privacy and immunity from unintentional disturbance of stations not addressed, are also at once attained. Further, the solution of this problem of hailing the right auditor may be expected to serve as or to suggest the solution of the companion problem of listening to a single speaker: a faculty that would facilitate identification and confer a convenient deafness towards unwelcome addresses. But we have neither space nor time to tell off seriatim the host of practical applications that can easily be imagined.

One of the earliest attempts to direct the trains of long waves generated by oscillations on air-wires was that of ZENNECK, who, in some experiments at Cuxhaven in 1899, used an insulated wire parallel to and some metres distant from the vertical antenna. He found that signals were best in the plane of the two wires. Later, HAUPTMANN VON SIGSFELD, among others, used air-wire systems having horizontal parts pointing in the desired direction of transmission, and similar air-wire systems to receive messages from selected directions. For example, SIGSFELD, who seems to have worked most with the receiver, erected an air-wire having a horizontal part equal to the half wave-length connected at each end to vertical wires each the length of the quarter wave. The detector was a coherer inserted at the mid-point of the horizontal wire. With this receiver SIGSFELD showed that the position of the distant transmitter could be gauged to within 10 deg. of arc. And he stated that when the receiver was in the broadside-on position he could detect not a trace of signals. It is of interest to recall, in connection with some remarks in MARCONI'S recent Royal Society Paper, that SIGSFELD recognised the new power his apparatus gave him of investigating atmospheric electrical disturbances, and, in fact, proceeded so far as to establish a connection between these atmospheric effects and the magnetic storm records of the Potsdam Observatory. We may pass over STRECKER'S and SLABY'S 1898 and 1899 experiments with horizontal antennæ, as neither of these observers recognised clearly the directive properties of the non-vertical air-wire; but we may not ignore the experiments and conclusions of BRAUN and of DE FOREST round and about the year 1902. BRAUN worked mainly with receiving antennæ; DE FOREST has recorded his experiences with both senders and receivers. BRAUN'S air-wire was stretched at a height of 5 metres over sloping ground; and sometimes it included, what proved to be unimportant, a condenser shunted by inductance with a view to encourage resonance. What was of importance—and for this he gave reasons—was the actual length of the antenna, and in this matter precision was of greater moment than in the case of the vertical air-wire. His published observations show that a rotation of the receiver air-wire through 10 deg. from the vertical plane through the distant sender was sufficient to extinguish signals. We do not know if BRAUN at this time used the non-vertical air-wire for directed transmitting, but it is well known that about this time DE FOREST reached some success in his handling of both the sending and receiving problems. His sender was very similar to SIGSFELD'S, but his receiver was a comparatively small rotating grid, which enabled him to locate a sender six miles away with an accuracy of about 10 deg. Results quite similar to these have been obtained by a number of inventors in various countries, but, leaving them unmentioned, we now come to MARCONI'S recent work on non-vertical air-wires. It appears to be only within the last year or two that he has wakened to the possibilities of non-vertical antennæ. His principal achievements are detailed in his Royal Society Paper of January, reprinted in our columns recently. He has designed a number of simple combinations of practical utility, and he has advanced our knowledge considerably by making and publishing accurate measurements. Such measurements as these have become possible through the development of the radiomicrometer of BOYS and of the bolometer of LANGLEY at the hands of DUDDELL and TISSOT respectively. By aid of the Duddell instrument, MARCONI has discovered that the horizontal part of the air-wire should be great compared with its vertical portion. Although this is the only novelty he has brought to light, it is one of some significance. If reference is made to the very useful Paper by DUDDELL and TAYLOR on wireless telegraph measurements, read at the Institution of Electrical Engineers last year,* it will be found that a disposition of the transmitter air-wire precisely similar to MARCONI'S, but with 22 ft. vertical and 20 ft. horizontal, was tried end-on and broadside-on to the receiver, with the result that the signals were, if anything, stronger in the broadside-on position. Unfortunately DUDDELL and TAYLOR do not appear to have tried a similar air-wire at the receiver end; but our reference suffices to emphasise the importance of MARCONI'S observation that the horizontal part should be much greater than the vertical part of the air-wire. It is a little surprising that this fact has not been recorded before, for, as a letter in the correspondence columns of our last issue shows, the horizontal air-wire system is an old device.

We have referred above to BRAUN'S 1902 experiments on directive dispositions of air-wires, and have now to follow him when he put aside that mode of tackling the problem and turned his face toward the realising of a more subtle and far more promising method of his. This most ingenious conception, whose beauty and felicity will appeal strongly to the mathematical physicist, is the soul of the noteworthy Paper we print in this issue. Here we may best sketch its outlines by citing an experiment of DE FOREST'S. This inventor, in one of his attempts at directing waves, erected a number of equal vertical wires on the arc of a parabola, at whose focus was the equal vertical sender. By this means a proportion of the radiation was reflected along the axis of the parabola. Thus far the arrangement is merely a copy of a well-known optical experiment. Now this process of electrical reflection involves, first, the setting in electrical oscillation of each vertical wire on the parabolic arc, and, secondly, the despatch of radiation from it. Of course since these wires are at different distances from the focal sender the oscillations on different wires differ in both amplitude and phase. BRAUN'S great conception and ambition is to set up on each of the air-wires on the arc, independently and directly, oscillations of proper frequency, amplitude and phase. Thus will be generated plane-waves of multiplied vigour travelling along the axis of the parabola. In short, BRAUN has borrowed HUYGHEN'S principle from the wave theory of light and worked it out electrically on a gigantic scale with wires. What has actually been accomplished in this manner is described in another column. The present success and the evident potentialities of the method are both very striking, and show that these Strasburg researches will mark an epoch in the development of wireless telegraphy. Of course Prof. BRAUN has met with numerous and formidable obstacles. Some of these are described in the present Paper. One, the fundamental sub-problem, is that of supplying to an air-wire oscillations of desired amplitude and phase. Here the great difficulty, one of wide generality, lies in the fact that usually when the phase of an oscillation is altered its amplitude also changes; these two magnitudes can not, as yet, be separately adjusted. Another and distinct check arises from the circumstance that in any system of neighbouring parallel wires oscillating electrically with different phases mutual interference is inevitable—so very inevitable that it cannot be combated, but must rather be adroitly turned, and, perhaps, even utilised. We trust that in attacking all these perplexities Prof. BRAUN will command success as thoroughly as his sagacity and energy undoubtedly deserve it.

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* See *The Electrician*, Vol. LV., p. 258.

ON DIRECTED WIRELESS TELEGRAPHY.*

BY PROF. DR. F. BRAUN.

(Translation.)

§ 1. Hitherto, as is well known, it has not been found possible to produce interference of the light waves emitted from two independent sources, because one cannot control the phase of a luminous point, much less the phases of the various points which constitute a source of light of appreciable dimensions. But it seems probable that this may be done with electric oscillations emanating from different sources, because it appears possible to control the phase differences between electric waves. Some ways of solving this problem were discussed by me in a former article (*The Electrician*, Vol. LVI., p. 546). Other means were discovered at the Physical Institute here in Strassburg by Dr. Papalexi and Dr. Mandelstam.

Assuming the above problem to have found a solution, it is obviously possible, by adopting electric waves of different phase in conjunction with differences in distance (these are obtained by a geometrical disposition of the various sources of electrical energy), to create around the sending station electric fields having different intensities in different directions. Hence it would be possible to produce a direction of maximum intensity. Some of the possible combinations, which are infinite in number, are apparent without calculation. The combination described in my German patent of July 13, 1901, for instance, follows from the following reasoning:—

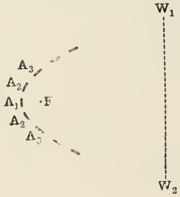

FIG. 1.

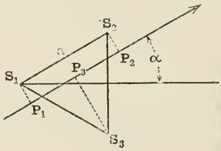

FIG. 2.

A number of vertical transmitting wires $A_1, A_2, A_3 \dots A_n$ are arranged in a parabola as shown in Fig. 1. Let the distances of these wires from the focus of the parabola be denoted by $a_1, a_2 \dots a_n$. Assuming the transmitting wires to commence oscillating at the times $\tau_1, \tau_2 \dots \tau_n$, so that $(\tau_n - \tau_{n-1}) = (a_n - a_{n-1})/V$ (V being the velocity of light), then a wave, $W_1 W_2$, will be produced in a plane at right angles to the axis of the parabola and will proceed in the direction of this axis.

This is obvious, for the oscillations in the plane $W_1 W_2$ must be identical with the oscillations which would be obtained if the waves, emitted from a single transmitter at the focus of the parabola were reflected by the wires $A_1 \dots A_n$. If this reflection does not lead to a phase-displacement, or if the phase-displacement is the same for all points of the parabola, then all oscillations arrive at a distant point (if the direct radiation from the transmitter at the focus be neglected) without any phase-displacement.

In this example use has been made of Huyghen's principle, inasmuch as each point is regarded as an independent source of radiation, whose phase, however, is connected with the phase of the source of light by a law which is given by the geometrical conditions. This phase is produced directly and at will. Viewed in this light, it is easy to judge in which way arrangements of known optical effect may be replaced by electrical arrangements.

§ 2. The advantages which accrue from the introduction of independent sources of radiation are obvious:—

(*a*) One is not bound to the parabola form, as in the case of the experiment with electric images. In that case the focal distance must be nearly equal to one-quarter the wave-length, because in the cases which are possible in practice the direct radiation is not negligible compared with the reflected radiation. If one were to work with wave-lengths such as are customary in wireless telegraphy (say, waves of 160 metres length), the aperture of the mirror, measured at the focus, would have to be of the same magnitude. But even a structure of a length of one whole wave would not act in accordance with the laws of geometrical optics.* Hence one arrives at dimensions which are unpractically large. On the other hand, the experiments with wave-lengths of 120 metres, which are described below, were carried out with three transmitting wires arranged in a parabola of a total length of 3 metres only.

(*b*) Obviously, the total radiation from several wires is larger than that from a single transmitter.

The disadvantages are: (*α*) Generally speaking, energy is also radiated at the back and the sides of the mirror. (*β*) The geometrical disposition leads to certain inconveniences in practice and conduces to energy losses.

§ 3. Many questions arise which cannot be answered *a priori* but can only be determined by experiment. Among them are: (*a*) If the distance from a source of radiation is only a fraction of a wave-length, one cannot make calculations with the velocity of propagation that the wave assumes at a greater distance. But as this applies to each of the several transmitters, it is to be expected that the effect on the field strength at a very distant point is neutralised just as it is eliminated from the calculations which are based on a constant velocity of propagation at longer distances. (*b*) A wave, due to the action of the other transmitters, is generally superposed on the wave impressed directly on the wire. This superposed wave is out of phase with the wave proper, because the phases in the other wires differ from the phase of the wave in the wire we are considering, and also because of the different intervening distances. These two waves produce a resultant which differs both in amplitude and phase from the impressed wave. Since the waves do not start simultaneously, there must be a complicated oscillation during the starting period, and the stationary condition will only be established gradually.

The oscillations are given by the following equations: Let E_1 and E_2 be the E.M.F.s acting in the two wires, at frequencies n_1 and n_2. Assume E_1 to start at the time $t=o$, and E_2 at the time τ_1, a little later. Let τ_2 denote the time which it takes for the induction effect to reach the other wire through the intervening space. Then, approximately,

$$E_1 = a \sin n_1 t \text{ } (E_1 \text{ remains } 0 \text{ until } t = o),$$

$$E_2 = b \sin n_2 (t - \tau_1) \text{ } (E_2 \text{ remains } 0 \text{ until } t = \tau_1),$$

$$p_1 \frac{di_1}{dt} + w_1 i_1 + \frac{Q_1}{c_1} = a \sin n_1 t + \rho \left(\frac{di_2}{dt} \right)_{t-\tau_2} \quad \dots \quad (i_1 = 0 \text{ until } t = o),$$

$$p_2 \frac{di_2}{dt} + w_2 i_2 + \frac{Q_2}{c_2} = b \sin n_2 (t - \tau_1) + \rho \left(\frac{di_1}{dt} \right)_{t-\tau_2} \quad (i_2 = o \text{ until } t = \tau_1),$$

in which ρ denotes a coupling coefficient, while the other symbols have the usual significance.

The equations can be written in the following form:

$$\frac{d^2 i_1}{dt^2} + \delta_1 \frac{di_1}{dt} + n_1^2 i_1 = a n_1 \cos n_1 t + \rho \left(\frac{d^2 i_2}{dt^2} \right)_{t-\tau_2},$$

$$\frac{d^2 i_2}{dt^2} + \delta_2 \frac{di_2}{dt} + n_2^2 i_1 = b n_2 \cos n_2 (t - \tau_1) + \rho \left(\frac{d^2 i_1}{dt^2} \right)_{t-\tau_2},$$

in which δ and n denote the damping factor and the frequency of the wires respectively. n is assumed to be equal to the frequency of the exciting circuit. We can also assume that $n_1 = n_2$. For great accuracy $\tau_2 > \tau_1$. The exciting circuits are considered above as being undamped.

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* This article was received from Prof. Braun at the end of January, but at his request the translation was postponed several weeks, as, owing to his ill-health, Prof. Braun was unable to correct proofs. A further delay was unfortunately caused by press of work in our translating department and drawing office last month.—ED. *E.*

* Undoubtedly, the mirror experiment of Hertz is to be dealt with by the principles of diffraction rather than by the laws of catoptrics. It is somewhat surprising, however, that the latter leads to a fair agreement with the actual facts.

The following is evident, however, without going into the problem mathematically: In coupled systems—which alone are used in practice—the currents in the wires start with small values and increase but gradually. For this reason, the complex initial oscillations in a wire, to which attention was directed above, take place at a time when the action at the far end has not yet attained an appreciable value. Their influence is hardly observed at the phase-measuring apparatus (see the former *Electrician* article to which reference was made above), and the inconvenience can, therefore, be circumvented by measuring and regulating the phase differences after the transmitting wires have been connected up.[*]

(*c*) So far it has been assumed that there is only one oscillation in each transmitting wire. This, however, only holds good if the coupling is of the loosest. In the actual experiments, there were two oscillations in each wire. The stronger of the two had a wave-length of 120 metres and existed in every wire. It was accompanied by a weaker wave of greater wave-length. But even if each system, oscillating independently, possessed a single oscillation only, the mutual influence of the transmitting wires would introduce a further coupling.[†] This was actually observed when the wires were near one another. For this reason the distances between the wires were kept large.

(*d*) Such mutual effects are also caused by the leads to the transmitting wires and by the connecting wires—with end capacities—which were relatively near to each other.

§ 4. The experiments were made on the following lines:—

(*a*) To determine, by integrating instruments, the mean field strength at various positions relatively to the air wires.

(*b*) Assuming these observations to confirm the calculations, to investigate whether the methods are of practical use in connection with the detectors employed in wireless telegraphy. This was necessary because it was thought conceivable that irregularities in the action of the air wires might cause the usual detectors to respond, even if the mean field at the point of observation were nil or very weak.

In view of the complicated nature of the problem, it was thought best to commence with the simple case of three transmitting wires arranged at the corners of an equilateral triangle. With symmetrical excitation, this also represented the simplest case of the parabola arrangement. A further advantage of this arrangement relates to the possibility of rotating the parabola axis in two steps of 120 deg. each, by interchanging the electric conditions of the air wires. Besides, intermediate directions of the maximum field may be obtained by altering the amplitudes and the phase relations. This arrangement also made it possible to verify the theoretical conclusions as to the distribution of the field in space with a *stationary* receiver station. Further, it enabled one to form an opinion as to asymmetries at the transmitting wires, which are not due to the geometrical disposition of the wires, but presumably to local asymmetries in the vicinity of the transmitting wires, especially groups of trees. Fig. 3 represents the transmitting system.

§ 5. *Theory.*—An element, dz, of the periodic current i produces at the time t at a point in space at a considerable distance, r, an electric field, E, or a magnetic field, H, of the value

$$E = H = -\frac{d}{dr}\frac{i_{(t-r/v)}}{r}\sin\xi\,dz \quad . \quad . \quad . \quad . \quad (1)$$

ξ is the angle between r and dz and v the velocity of the wave. Let h be the height of the vertical transmitting wire, and consider the distribution in the equatorial plane, for which $\xi = \pi/2$. Assume that the current in the transmitting wire varies according to the following equation:

$$i = A \sin 2\pi\frac{z-h}{\lambda} \sin\left(2\pi\frac{t}{T} + \delta\right), \quad . \quad . \quad . \quad (2)$$

in which $o < z < h$, λ = length of the wave in air (respectively along the wire), T = oscillation period, δ = the phase and A = current amplitude.

Integrating (2) and taking account of (1), we get

$$E = H = -\frac{A}{r}\left(1 - \cos\frac{2\pi h}{\lambda}\right)\cos\left[2\pi\left(\frac{t}{T} - \frac{r}{\lambda}\right) + \delta\right]. \quad (3)$$

If it be assumed, in accordance with Abraham's method,[*] that the image of the transmitter oscillation reflected by the earth gives rise to the same field as the direct wave itself, then the value of E is double that of equation (3). The field is a maximum for $h = \lambda/4$. This condition could not be conveniently fulfilled in our experiments, but it will be satisfied in experiments later on. To this end it will be necessary to produce a whole wave in each of the transmitting wires. (In the present case the wires were not earthed, but terminated in capacities, so that only half-waves were produced.)

Equation (3) can be written in the form:

$$E = C\cos\left[2\pi\left(\frac{t}{T} - \frac{r}{\lambda}\right) + \delta\right]. \quad . \quad . \quad . \quad (4)$$

It is seen from this equation that the rules which experience has always confirmed in connection with luminous points also hold good for the fields produced at a great distance by linear sources of electric radiation. The amplitude and phase of the resultant of the various superposed fields at a distant point are obtained by Fresnel's parallelogram (vector diagram). In our case we have the three fields E_1, E_2 and E_3, whose amplitudes may be denoted by C_1, C_2 and C_3. Let δ_1, δ_2 and δ_3 be the phase constants of the three transmitting wires. The resultant field E, for large distances r, is then given by

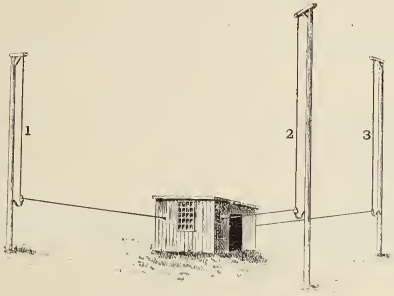

FIG. 3.

$$E^2 = C_1^2 + C_2^2 + C_3^2 + 2C_1C_2\cos\left[2\pi\frac{r_1 - r_2}{\lambda} + \delta_2 - \delta_1\right]$$
$$+ 2C_1C_3\cos\left[2\pi\frac{r_1 - r_3}{\lambda} + \delta_3 - \delta_1\right] + 2C_2C_3\cos\left[2\pi\frac{r_2 - r_3}{\lambda} + \delta_3 - \delta_2\right] \quad . \quad . \quad . \quad (5)$$

in which r_1, r_2 and r_3 denote the distances of the point of observation from the three wires. The above equation assumes that the frequency is the same in all three wires. In the experiments

$$A_1 : A_2 : A_3 = C_1 : C_2 : C_3 = 1 : 0{\cdot}5 : 0{\cdot}5. \quad . \quad . \quad (6)$$

Hence the absolute maximum of E^2 is

$$E^2 = (C_1 + C_2 + C_3)^2 = 4, \quad . \quad . \quad . \quad . \quad (7)$$

and the absolute minimum is

$$E^2 = 0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

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[*] No such disturbances are known in the theory of reflection. This theory assumes stationary conditions throughout, for the incident wave as well as for the reflected wave.

[†] Since the phenomena of fluorescence (and phosphoresence) are, as far as is known at present, without analogy in other branches, the following questions arise: (*a*) Are these phenomena caused by effects which differ in principle from those already known, or (*b*) can they be traced to other known phenomena? If it is permissible to consider them as caused by the coupling effects alluded to above, then much of what is known of them becomes at once comprehensible. If this be true, however, the Stokes law would have to be broadened by assuming that the fluorescent light which has a smaller refractibility than the exciting light and has hitherto almost alone been considered, is supplemented by light which has a greater refractibility than the exciting light.

[*] *Physikalische Zeitschrift* II., 1901, p. 331.

The conditions for the maximum are expressed by the following equations:

$$\left.\begin{aligned}\cos\left(2\pi\frac{r_1-r_2}{\lambda}+\delta_2-\delta_1\right)&=1\\ \cos\left(2\pi\frac{r_1-r_3}{\lambda}+\delta_3-\delta_1\right)&=1\\ \cos\left(2\pi\frac{r_2-r_3}{\lambda}+\delta_3-\delta_2\right)&=1\end{aligned}\right\}, \quad . \quad . \quad . \quad (9)$$

in which only two equations are independent. The conditions for the minimum demand that the equations of (9) assume the value -1.

In the arrangement of Fig. 2 the three transmitting wires, S_1, S_2 and S_3 are placed at the corners of an equilateral triangle, whose sides may have a length a. We make $\delta_1=0$; $\delta_2=\delta_3=\delta$. Let α denote the azimuth of the point of observation P (measured from the line which bisects the angle at S_1 as shown in Fig. 2), then $PP_1=r_1$, $PP_2=r_2$, $PP_3=r_3$ and

$$r_1-r_2=a\cos(30^\circ-\alpha)$$

$$r_1-r_3=a\cos(30^\circ+\alpha).$$

Let us examine a few special cases:—

(A) The condition for an absolute minimum in the direction given by $\alpha=0$ is

$$\frac{2\pi a\cos 30^\circ}{\lambda}+\delta=\pi,\ 3\pi,\ \ldots$$

(B) The condition for an absolute minimum in the direction given by $\alpha=180^\circ$ is

$$-\frac{2\pi a\cos 30^\circ}{\lambda}+\delta=\pi,\ 3\pi,\ \ldots$$

(C) The condition for an absolute maximum in the direction given by $\alpha=0$ is

$$\frac{2\pi a\cos 30^\circ}{\lambda}+\delta=0,\ 2\pi,\ \ldots$$

(D) The condition for an absolute maximum in the direction given by $\alpha=180^\circ$ is

$$-\frac{2\pi a\cos 30^\circ}{\lambda}+\delta=0,\ 2\pi,\ \ldots$$

(E) For the *simultaneous* occurrence of an absolute maximum in the direction $\alpha=0$ and an absolute minimum in the opposite direction ($\alpha=180^\circ$), the conditions (B) and (C) must both be satisfied—*i.e.*,

$$-2\pi\frac{a\cos 30^\circ}{\lambda}+\delta=\pi,\quad 2\pi\frac{a\cos 30^\circ}{\lambda}+\delta=2\pi.$$

Hence $\delta=3\pi/2=270^\circ$ and $a\cos 30^\circ=\lambda/4$.

These conditions are obvious.

If it is desired to interchange the directions of maximum ($\alpha=0$) and minimum ($\alpha=180^\circ$), the conditions to be satisfied are $\delta=\pi/2=90^\circ$ and $a\cos 30^\circ=\lambda/4$, *i.e*, the directions of current in the wires 2 and 3 are simply to be exchanged.

In order to secure the best conditions possible, it is necessary to have control over a/λ, δ, and the current amplitudes.

§6. Table I. contains the values of E^2 (for various values of the azimuth α) as a function of the phase-differences δ. This table is calculated for $4a=\lambda$, in accordance with the conditions prevailing in the experiments. The amplitudes at the wires were $S_3=S_2=\frac{1}{2}S_1$.

Table I.

α	E^2.	E^2.	E^2.	E^2.	E^2.	E^2.	E^2.	E^2.	E^2.	E^2.
0°	2·418	1·384	0·306	0·146	0·006	1·582	2·616	3·694	3·854	3·994
30°	2 560	1·612	0·490	0·294	0·066	1·146	2·094	3·216	3·412	3·640
60°	2·813	2·162	1·099	0·851	0·475	0·395	1·046	2·109	2·357	2·736
90°	2·914	2·725	1·983	1·745	1·309	0·086	0·275	1·017	1·255	1·691
120°	2·813	3·140	2·936	2·777	2·410	0·395	0·068	0·272	0·431	0·798
150°	2·560	3·685	3·699	3·657	3·451	1·146	0·021	0·007	0·049	0·255
180°	2·418	3·340	3·980	3·998	3·882	1·582	0·640	0·020	0·002	0·118
δ	0°	30°	70	80°	97° 45′	180°	210°	250°	260°	277° 45′

Although better results would have been obtained for $4a\cos 30^\circ=\lambda$, certain reasons rendered it necessary to make $4a=\lambda$ in the actual experiments. The following table gives the values for δ for an absolute maximum $=4$ and an absolute minimum $=0$ in the directions given by $\alpha=0$ and $\alpha=180^\circ$.

α.	δ.	
0° 180°	281·7° 78 3°	102·3° 258·7°
..	Maximum.	Minimum.

The calculations above are based on the following assumptions: (*a*) Each of the three wires has only a *single* oscillation which is undamped. (*b*) The space around the transmitting system is devoid of obstacles, excepting, of course, the air wires themselves and the surface of the earth which is considered as a conductive plane. An important assumption is that perfectly symmetrical conditions prevail around the transmitting system. Neither of these assumptions was strictly correct. For this reason the simple theory developed above was primarily used as guidance in the choice of the various dimensions under consideration. But experiments were also carried out to test as to how far the simple theory represented the observed facts.

(*To be continued.*)

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The programme of the Eleventh Annual Convention of the Incorporated Municipal Electrical Association, which will be held in London from June 18th to 23rd, has just been issued. The headquarters of the Association during the Convention will be the Hotel Great Central, Marylebone, N.W.

Tuesday, June 19th.—The Association meets at 10:30 a.m. at the Royal County Theatre, Kingston-on-Thames. A special train will leave Waterloo, platform No. 1, at 9:47 a.m., due at Kingston at 10:10 a.m., returning at 9:35 p.m., due at Waterloo 10 p.m. Return tickets, 2s. 6d. first class, must be obtained from the secretary before June 11th.

The Mayor, Councillor H. C. Minnitt, J.P., has kindly consented to be present and welcome the Association.

Mr. J. E. Edgcome, chief electrical engineer to the Kingston-upon-Thames Corporation, will deliver his Presidential Address.

The following Paper will then be read: "Steam Turbines" (illustrated by lantern slides), by Sydney Baynes (St. Pancras).

At 2 p.m. a trip will be made up the River Thames taking in Teddington, Twickenham, Richmond and Hampton Court.

Wednesday, June 20th.—10 a.m. Meeting in the Wharncliffe Rooms, Hotel Great Central, N.W. The following Papers will be read and discussed: (1) "The Commercial Development of Electricity Undertakings" by S. E. Fedden (Sheffield) and H. Collings Bishop (Newport, Mon.); (2) "Relative Economies of Electric Supply from Small Local Stations and from Power Companies," by J. F. C. Snell (Sunderland).

2 p.m. Visits will be made to the Lot's-road (Chelsea), generating station and the power station of the London United Tramways Co. at Chiswick.

Thursday, June 21st.—The Annual General Meeting will be held at 10 a.m. in the Wharncliffe Rooms, Hotel Great Central, N.W. This will be followed by a Special General Meeting to amend the Articles of Association.

2 p.m. A visit will be paid to the Bow generating station of the Charing Cross, West End & City Electric Supply Co.

7:30 p.m. for 7:45 p.m. Annual General Meeting at the Great Central Hotel.

Friday, June 22nd.—Meeting at 10 a.m. at the Wharncliffe Rooms, Hotel Great Central, N.W. The following Papers will be read: (1) "Live Steam Heat Feed Water; its Effect on the Output and Efficiency of Steam Boilers," by G. Wilkinson (Harrogate); (2) "The Efficiency of Steam Plant," by W. H. Vignoles (Grimsby); (3) "The Supply of Power to Tramways from Small Stations," by S. J. Watson (Bury).

2 p.m. Visit to the London County Council generating station at Greenwich.

Saturday, June 23rd.—The National Physical Laboratory will be open for inspection between 11 a.m. and 1 p.m.

In the afternoon the Kingston, Surbiton and District Lifeboat Saturday Fund and Water Sports will be held, to which all members will be invited.

All applications for railway certificates (permitting special fares), tickets for visits, annual dinner, &c., should be made to the secretary, C. McArthur Butler, Staple Inn Buildings, Holborn, not later than June 11th.

At the close of the Annual General Meeting on Thursday, June 21st, the Special Meeting will consider the fol lowing alterations in the Articles of Association which have been suggested by the Council :—

Article 9.

Original.	*Amendment.*
Honorary members shall be distinguished persons who are intimately connected with municipal electrical undertakings and whom the Association especially desires to honour for exceptionally important services in connection therewith.	That Article 9 shall be altered by adding after the word “ are ” in the second line the words “ or have been.”

Article 23.

The annual subscription shall be payable in advance on the 1st day of January in each year.	That Article 23 shall be altered by substituting in the second line the words “ 1st day of April ” for the words “ 1st day of January.”

Article 27.

In case the expulsion of any individual shall be judged expedient by 10 or more members, associate members, or associates, and they think fit to draw up and sign a proposal requiring such expulsion, the same being delivered to the secretary, shall be by him laid before the council for consideration. If the council after due inquiry do not find reason to concur in the proposal no entry thereof shall be made in the minutes, nor shall any public discussion thereon be permitted, but if the council do find good reason for the proposed expulsion they shall direct the secretary to address a letter according to Form D in the schedule to the person proposed to be expelled, advising him to withdraw from the Association, if that advice be followed no entry on the minutes or any public discussion on the subject shall be permitted, but if that advice be not followed or a satisfactory explanation given the council shall call a special general meeting of members, associate members, and associates for the purpose of deciding on the question of expulsion, of which notice shall be given to the member whose expulsion is in question, and if a majority of the persons present, being not less than 20, vote that such individual be expelled, the chairman of that meeting shall declare the same accordingly, and the secretary shall communicate the same to the individual, according to Form E in the schedule.	That Article 27 shall be altered by adding after the word “ if ” in the 21st line the words “ at a meeting at which not less than 20 members are present,” and by deleting the words “ of the persons present being not less than 20 ” from the 18th line.

Article 28.

The officers of the Association shall be a president, two vice-presidents, three past presidents, an honorary treasurer, an honorary solicitor, an honorary secretary and other members of the council to be elected or nominated under these Articles, who shall constitute the council to direct and manage the concerns of tho Association, and one or more auditors of accounts. Such officers shall be elected or appointed in a manner hereinafter directed.	That Article 28 as originally registered shall be wholly cancelled, and in lieu thereof the following Article shall be substituted : “ The officers of the Association shall be a president, a senior and a junior vice-president, three immediate past presidents, an honorary treasurer, an honorary solicitor, an honorary secretary, and fourteen ordinary members of council, eight being engineer members of the Association, and six representatives of municipalities being members of the Association elected under these articles, and such officers shall constitute the council to direct and manage the concerns of the Association, and a secretary and one or more auditors of accounts. Such officers of the Association shall be elected or appointed in a manner hereinafter provided.”

Article 29.

The number of the council shall be such as the council in any year may fix for the ensuing year, provided that such number shall not be less than 15 or more than 21, inclusive in both cases of the president, vice-presidents, honorary treasurer, honorary solicitor and honorary secretary, but exclusive of the past presidents. The president, two vice-presidents, honorary treasurer, honorary solicitor and honorary secretary shall be elected annually by ballot at the annual general meeting. The other members of the council shall consist of engineers, being members or associate members of the Association and representatives of municipalities being members of the Association. The engineers elected shall retain office for three years and the representatives of municipalities for one year. The council may itself fill any casual vacancies on the council, but the member appointed to fill the vacancy shall retain office so long only as the vacating member of council would in ordinary course have retained the same. All members of the council shall be elected by ballot at the annual general meeting, and shall take office upon January 1st following.	That Article 29 as originally registered shall be wholly cancelled, and in lieu thereof the following article shall be substituted : “ Election of council : The president, vice-presidents, honorary treasurer, honorary solicitor, honorary secretary, four engineer members of the council and three municipal representative members of the council shall retire annually. “ No member of the association shall be eligible for election as president, other than an engineer member who has previously served as a member of the council for two years, and no member of the Association shall be eligible for election as a vice-president other than an engineer member who has previously served as an ordinary member of the council. “ The council may itself fill any casual vacancy on the council, but the member appointed to fill the vacancy shall retain office so long only as the vacating member of the council would in the ordinary way have retained the same. “ The secretary shall be appointed or dismissed by the council. “ The members of the council and all other officers shall be elected by ballot at the annual general meeting, and shall take office immediately after the convention at which they are elected. “ The annual meeting of the Association shall be held during the convention and nominations of members of the council, and other officers shall be made at such annual meeting. “ The financial year of the Association shall end on March 31st in each year.

Article 31.

In the absence of the president it shall be the duty of the vice-presidents to preside in rotation at the meetings of the Association and to regulate and keep order in the proceedings. But in the case of the absence of the president and of the vice-presidents the meeting may elect any member of the council or in the case of their absence any member present can take the chair at the meeting.	That Article 31 shall be altered by deleting the words “ vice-president ” and “ in rotation ” in lines 2 and 3, substituting the words “ senior vice-president, and in the absence of the president and senior vice-president, of the junior vice-president.”

Article 37.

The treasurer shall be a member of the Association, with whom all uninvested money belonging to the Association shall be deposited by the council on acconnt and for the use of the Association.	That Article 37 be altered by adding between the words “ the ” and “ treasurer ” in the heading, and also the first line thereof, the word “ honorary.”

Article 40.

It shall be the duty of the secretary, under the direction of the council, to conduct the correspondence of the Association, to attend all meetings of the Association and of the council and of committees, to take minutes of the proceedings of each meeting, to read the minutes of the preceding meeting and all communications that may be ordered to be read, to superintend the publication of such papers as the council may direct, to have charge of the library, to direct the collection of the subscriptions and the preparation of the account of the expenditure of the funds, and to present all accounts to the council for inspection and approval. He shall also be responsible for all persons employed under him, and shall generally conduct the ordinary business of the Association.	That Article 40 shall be altered by inserting the words “ the honorary secretary and ” before the word “ secretary ” in the heading of the article, and by inserting before the commencement of such article the words : “ The honorary secretary shall perform such duties as the council may from time to time direct and ”—

Article 53.

The first general meeting of the Association shall be held within three months after the registration of the memorandum of association. The annual convention of the Association for the discussions of Papers, the election of officers and members of the council and the transaction of other business shall be held during tho months of May, June or July in each year, at such places as may be selected by the members present at the annual general meeting and on such dates as may be determined by the council.	That Article 53 shall be altered by deleting the words “ officers and members ” in the seventh line and by adding after the word “ council ” in the eighth line the words “ and other officers.”

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is an abstract of the report of the Council presented at the annual general meeting last night. :—

Since the last annual general meeting up to May 17th inclusive, 505 proposals for election have been considered, and there have been elected 10 members, 159 associate members, 13 associates and 251 students. The names of two members have been restored to the register. To the class of members there have been transferred 32 associate members and 4 associates; to the class of associate members there have been transferred 55 associates and 31 students.

The change in the roll during the last 12 months is shown in the accompanying table :—

	1905.		1906.
Honorary members	6	....	6
Members	994	....	1,024
Associate members	1,610	....	1,820
Associates	1,609	....	1,509
Students	1,321	....	1,487
Foreign members	131	....	127
Total	5,671	....	5,973

Members.—W. S. Andrews (recently resigned), J. T. Conolly, A. C. le Neve Foster, G. A. Grindle, A. P. Head, Geo. Hill, W. E. Langdon, E. Macrory, K.C., P. J. Nelson, H. M. Peickert, Carl Von Siemens, J. T. Sprague and R. F. Yorke.

Associate Members.—J. R. Craddock, J. H. Hamilton, W. A. Kenneth, L. J. Langridge, C. Laszlo and G. Swetenham.

Associates.—E. F. Blatchford, G. C. Bompas, Sir H. C. Fischer, G. Jacomb-Hood, J. Kingston, H. Marsh, D. E. Moore, G. Musket, C. J. Page, S. W. G. Tamplin and A. Anstruther Thomson.

Foreign Members.—J. Frayssinier, Carl Mulvad and J. S. Rasmussen.

Students.—A. D. Melville and C. P. Nuttall.

Thirteen members, 8 associate members, 51 associates, 3 foreign members, and 55 students have resigned since the date of the last report.

During the past year there have been 18 committees at work; 15 general meetings, 19 council meetings, and 110 committee meetings have been held.

Local Sections.—The several local sections of the institution continue to carry on their work with energy and success. During the session 43 meetings have been held, as follows:—At Birmingham 7, at Dublin 7, at Glasgow 7, at Leeds 6, at Manchester 10, and at Newcastle 6. The Cape Town Local Section, during the year ending March 31, 1906, has held seven general meetings for the discussion of Papers. Although that Local Section cannot point to any original communications by its members, certain of the home Papers have been selected by the committee, upon which organised discussions have been raised, and by this means much useful and interesting material has been brought before the members of the South African Section of the Institution.

Scholarships.—The Council has awarded one Salomons scholarship, value £50, to Mr. R. G. Jakeman, of University College, London.

Two David Hughes scholarships value, £50 each, have also been awarded to Mr. A. Kinnes, of the Central Technical College, and Mr. G. F. O'Dell, of King's College.

Annual Premiums.—The Council have awarded the following premiums for papers and ommunications:—

The *Institution Premium*, value £25, to Mr. V. A. Fynn, for his Paper "A New Single-phase Commutator Motor."

The *Paris Electrical Exhibition Premium*, value for this year £20, to Prof. A. Schwartz and Mr. W. H. N. James, for their Paper "Low-Tension Thermal Cut-Outs."

An *Extra Premium*, value £10, to Mr. H. T. Harrison, for his Paper on "Street Lighting."

An *Extra Premium*, value £10, to Mr. W. J. A. London, for his Paper on "The Mechanical Construction of Steam Turbines."

An *Extra Premium*, value £10, to Dr. D. K. Morris and Mr. G. A. Lister, for their Paper on "The Eddy Current Brake for Testing Motors."

An *Extra Premium*, value £10, to Mr. R. N. Tweedy and Mr. H. Dudgeon, for their Paper on "Notes on Overhead Equipment of Tramways."

An *Original Communication Premium*, value £10, to Dr. W. E. Sumpner, for his communication "New Iron Cored Instruments for Alternating-Current Working."

The *Fahie Premium*, not awarded this year.

The First Students' Premium, value £10, to Mr. A. G. Ellis, for his Paper "Steam Turbine Dynamos."

The Second Students' Premium, value £8, to Mr. H. W. Taylor, for his Paper "Some Notes of Single-phase Railways."

The Third Students' Premium, value £5, to Messrs. F. C. Prentice and J. S. Westerdale, for their Paper "The Efficiency of Lamp Globes."

An Extra Premium, value £5, to Mr. W. Browning, for his Paper "Notes on Electrical Conductivity."

Papers which were received too late for consideration in making the awards of premiums in 1905 have been taken into account this year. Papers other than those of the students' section, which were not in type up to the end of April, 1906, have been reserved for consideration in 1907. In accordance with precedent the council, in awarding premiums, have not taken into account papers contributed by present members of Council.

Students' Section.—Meetings of the Students' Section have been held in London, at which papers have been read and discussed. By the kind permission of the authorities concerned, visits to a number of works and other places of electrical interest were made during the session. At Easter time the students' committee successfully organised an excursion to Manchester, where many of the leading electrical firms also granted facilities for the inspection of their works. The Manchester branch of the students' section has also held meetings throughout the session for the reading and discussion of papers, and took part with their colleagues from London in the visits paid to works in Manchester during the Easter holidays. The Glasgow local section announces that a students' section has been formed in connection with that local section. Arrangements were only matured at the latter part of the session, and a preliminary meeting for the election of office-bearers has been held. The committee elected Professor Magnus McLean as chairman, and are making arrangements for papers and visits during the coming session.

Other Work of the Session.—In addition to the routine work of the session, the important work of revising the wiring rules of the Institution has been almost completed by the committee appointed for that purpose, and it is hoped to publish the new edition before the end of the current year.

The council have also directed their attention to the terms of the London Building Acts Amendment Bill, 1905, and, in consideration of the probability that the restrictions in the bill would prejudicially affect buildings of electrical companies and undertakings, a petition against the bill was drawn up and presented to Parliament.

The Workmen's Compensation Bill, 1906, also received attention. It was thought that the terms of the bill were detrimental to the interests of certain branches of the electrical industry, and accordingly a letter was addressed to the Home Secretary petitioning that the objectionable clause might be altered.

In pursuance of a resolution passed by the Chamber of Delegates at the Electrical Congress at St. Louis, the council have to report that steps have been taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardising of the nomenclature and ratings of electrical apparatus and machinery. An executive committee has been formed by the council, with instructions to consider and report upon a scheme for the constitution of such an International Commission, and a draft scheme has now been submitted for approval to the leading Electrical Associations of all countries. The first meeting of delegates of these associations will be convened at an early date.

It will also be remembered that at the same Congress it was also resolved that an endeavour should be made to summon an International Conference to consider and determine the question of electrical standards, units, and nomenclature. The question has been considered by H.M. Government, and it is hoped that the conference will assemble within a reasonable period of time.

Appointment of Representatives.—In 1903 a general committee was appointed by the Institution of Civil Engineers for the consideration of the best method for the proper education and training of engineers. In response to an invitation to appoint a representative to act on that committee, the council of the Institution of Electrical Engineers nominated Mr. R. Kaye Gray, the president of that year.

The council further appointed an Advisory committee on the education of electrical engineers to assist them in formulating proposals to submit through their representative to the General committee. This Advisory committee consisted of the following members: Robert Kaye Gray (*Chairman*), Prof. W. E. Ayrton, W. A. Chamen, Prof. J. D. Cormack (*Reporter*), E. W. Cowan, Col. R. E. Crompton, C.B., H. Dickinson, W. H. Patchell, A. Siemens, G. Stoney, J. Swinburne, Prof. S. P. Thompson, Prof. W. E. Thrift, J. C. Vaudrey, Major-Gen. C. E. Webber, C.B. (the late).

The General committee have now completed their work, and their report has been presented to and adopted by the council of the Institution of Civil Engineers, and copies have also been presented to the council of this institution, who have reprinted it as an addendum to the present report.

An invitation was received in January from the American Philosophical Society of Philadelphia to send a representative to attend the celebrations in Philadelphia in April, 1906, upon the occasion of the bicentenary of the birth of Benjamin Franklin. Sir William H. Preece, K.C.B., past president, was appointed to represent the Institution on the occasion, but was unfortunately prevented from undertaking the journey. An illuminated address of greeting which had been prepared was sent to Prof. Elihu Thomson, hon. member, and was presented by him to the American Philosophical Society in honour of the event.

The council was invited in the early part of the year by the Home Office to nominate a representative to advise the Department in preparing a code of regulations for the generation and use of electricity in factories and workshops. In this matter Mr. W. H. Patchell, vice-president, was appointed to assist the Home Office as requested.

Mr. W. H. Patchell was also appointed to serve on the Organising committee of the International Mining Conference to be held in London in June, 1906.

Building Fund.—The building fund, which at the commencement of the year 1904 stood at £19,398. 12s. 4d., amounted on December 31, 1905, to £19,856. 17s. 8d. The property on the site is fully let on advantageous terms, and an increased revenue may confidently be anticipated during the current financial year. The term of five years during which many of the members agreed to contribute a regular yearly amount has now expired, but it is hoped that they will renew their subscriptions and continue to contribute annually as hitherto.

Benevolent Fund.—With regard to this fund, the council have the pleasure to report that the Organising committee of the Electrical Exhibition at Olympia allocated a portion of the profits of that enterprise to the Benevolent Fund of the Institution, and in due course the committee handed to the council a donation to the fund of £350. The Electrical Engineers' Ball committee have given a donation of £25 to the fund from the surplus at their disposal after meeting the expenses of this year's ball. The regular contributors to the fund amongst the members of the Institution have somewhat increased in number, but it is still a matter of regret that the number of these is comparatively small. The capital account of the fund on December 31, 1905, stood at £2,021, as compared with £1,849 at the end of 1904. This amount does not include the two donations above referred to, which have since been added to the fund. Two grants in aid were made during the year under the rules of the committee.

Wilde Benevolent Fund.—No grant has been made from this fund during the past year.

Annual Accounts.—The annual statement of accounts for 1905, duly audited, is appenped to the report. The income and expenditure compare with 1904 as follows:—

	Income.	Expenditure.	Carried to general fund.
1904 ..	£10,075 17 4 ..	£7,950 1 5 ..	£2,125 15 11
1905 ..	£10,369 0 8 ..	£7,066 5 6 ..	£3,302 15 2

The entrance fees for the year, which are not treated as income, amounted to £569. 3s., and this sum has been carried to capital account.

Library.—The work of re-organising the library is steadily progressing and special grants have been made by the council in aid of the work. A sum of money has also been voted to be expended on the acquirement of writing tables and other articles of furniture which will greatly add to the comfort and convenience of the members and visitors who desire to consult the books and periodicals. A small committee, consisting of

Dr. S. P. Thompson, F.R.S., past-president, Mr. W. Duddell, and Mr. T. Mather, F.R.S., is devoting much time and labour to the work of compiling lists of the works which are required to bring the library up to date. An arc lantern and a special circuit for lecture experiments has been installed in the library for use at meetings of the Students' Section and of other societies who avail themselves of the room for purposes of reading and discussion of Papers. The accessions to the library during the period from May 31, 1905, to the date of this annual general meeting numbered 405, nearly all of which have been prescuted by the authors or publishers. The supply of specifications of electrical patents and of abridgments of specifications relating to electricity and magnetism is continued by the kindness of H.M. Commissioners of Patents, and the arrangement is still in force whereby the specifications of all electrical patents published during any week are placed on the library table on the following Monday morning.

PARLIAMENTARY INTELLIGENCE.

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LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

(Continued from page 185.)

Tuesday, May 22.

The CHAIRMAN said the Committee thought it desirable that the case for the promoters of the Administrative County of London and District Electric Power Bill should be taken at this stage.

The Hon. J. D. FITZGERALD, K.C., on behalf of the promoters of this bill, said he had prepared himself for such a request by the Committee and was prepared to go on. He said he regretted that the ordinary procedure had not been followed in connection with competing bills—viz., that they should all be referred to the same Committee, so that the Committee might hear evidence from all of them and give their decision as to which, if any, should go forward. However, by the terms of its reference, this Committee was entitled to hear the case that he had to put forward against the London County Council Bill. The question to be considered here was not whether the L.C.C. scheme would pay or not, but whether it was the best scheme and on the right lines for dealing with the problem. It was conceivable that it might pay if they could get a sufficient number of authorised distributors to take such an amount of electrical energy at such a price as would pay the working expenses and interest and sinking fund charges. This would make a paying concern, but it would not make an undertaking which provided for the electrical requirements of London. Such a scheme must take into account the following three heads of supply: (1) Supply to manufacturers; (2) to tramways, railways, canals, &c.; (3) bulk supply. The bill of the L.C.C. was in substance a bulk supply scheme tacked on to the tramway generating station which they happened to possess, and was totally inadequate for suburban railway supply. No such scheme as this could pay. The Lancashire Power Bill had been a striking object lesson in this respect. One of the main essentials of a successful power scheme was the entering into contracts for the hiring out of machinery for the purpose of assisting the manufacturer, and this was emphasised when he stated that it had been calculated that if all the machinery in London could be worked electrically it would mean a saving of £2,000,000 per annum to the manufacturers. The L.C.C. could not undertake such a form of business, which was the only way to properly develop the supply of electricity. No powers were taken in the bill to get at the manufacturer at all. It had been suggested that clause 35 (the right to ask the Board of Trade to inquire into the prices charged by authorised distributors) would have this effect, but this was absolutely impossible. The only thing that the Board of Trade could do was to prescribe a new maximum charge, but any such charge, even if on a sliding scale, must deal with the most disadvantageous case. Then, again, how could the L.C.C., with any grace at all, put this clause into effect when they themselves were refusing to have a maximum price put into the bill as regards themselves; and, further, that they refused to be compelled to give a supply to anybody. He maintained that the L.C.C. could do no better under this bill than the existing authorised distributors. No manufacturer or railway company had been called in favour of the bill, and this was not surprising. By the bill it was shown that the scheme of the L.C.C. would only have 60,000 kw. available by 1915.

The CHAIRMAN pointed out that all the Committee were agreed that the L.C.C. scheme was only an instalment.

Mr. FITZGERALD said he quite agreed, but whilst with proper precautions as to buildings and land it was possible to build on instalments, it was impossible to do this with the transmission system. The transmission system of the L.C.C. scheme was only capable of dealing with 80,000 kw., or a little over one-seventh of the estimated requirements by 1915. The voltage to be adopted by the L.C C. had an important bearing on this question. The weight of copper necessary for the same loss of energy in the transmission cables varied inversely as the square of the voltage, and the extra cost of laying the necessary transmission system at 6,600 volts, as compared with 20,000 volts would be, he had been informed, £20,000. In pointing out the various disadvantages of the L.C.C. scheme, Mr. Fitzgerald referred to the absence of duplicate routes for the mains, and urged the importance of this from the railway point of view. Mr. Fitzgerald then went on to compare the prices charged by the Newcastle-on-Tyne Co., who paid a good dividend, and those charged by local authorities.

The CHAIRMAN: Does not your argument show what large profits there are in the electric supply business.

Mr. FITZGERALD said his argument was meant to prove that in the only large town outside London—viz., Newcastle, where the whole of the supply was in the hands of a company, the price was lower than elsewhere.

Continuing, Mr. FITZGERALD said that the Greenwich generating station was already out of date and should be scrapped, and that Battersea was too far up the river.

Coming to the Administrative Co.'s scheme Mr. FITZGERALD said that there were now three generating stations—viz., Barking, Greenwich and West Ham.

The CHAIRMAN here stopped Mr. Fitzgerald going too much into detail, but to confine himself to showing that this scheme was a better one than the L.C.C.'s scheme.

Mr. FITZGERALD said he would do this, but it would be necessary to quote certain clauses. For instance, clause 48. This gave the company the right to go to the Board of Trade if any manufacturer wished for a supply, and the authorised distributor refused his consent to the company to give a supply.

The CHAIRMAN: Indirectly, does not clause 35 of the London County Council Bill have the same effect?

Mr. FITZGERALD said this was hardly the case, for the L.C.C. could not fix the price to any individual manufacturer. In addition to this, there were clauses providing for the revision of the maximum prices in the company's bill either at the instigation of the authorised distributors or the L.C.C. The purchase clause was also put in to meet objections, and the period was 42 years at the value of the undertaking, without any allowance for goodwill. Certain agreements had been made with the electric supply companies in London by the Administrative Co. last year, which showed that it was possible for the authorised distributors to work with the power company and to reduce their prices. In dealing with the question of municipal *v.* private trading in the question of electric power supply, Mr. Fitzgerald dwelt upon the want of success of the majority of electric power companies. He said that the debenture holders of the South Wales Electrical Power Distribution Co. had applied for the appointment of a receiver, and, in addition, he pointed to the largely speculative nature of the undertaking, as well as the capital commitments of the Council. The consequences of a mistake in the granting of the powers were of such enormous importance that he would ask for a careful hearing of his evidence and the views that would be placed before the Committee.

Mr. C. H. MERZ, the engineer to the promoters of the Administrative Co.'s bill, said he considered the proposal of the County Council to deal with only one portion of the demand—viz., the bulk supply—in a direct manner, and only in an auxiliary manner with the other portions of the demand, was quite wrong in principle. In addition to this, he considered the site of the Battersea generating station was a bad one, for it meant that coal would be 1s. per ton dearer than at Greenwich. If anything, the station should be further down the river than Greenwich. Further, he did not think that proper provision had been made for writing off the generating plant. The Council had only allowed this at the rate of 2·7 per cent., whereas he considered the generating plant should be written off at the rate of 5 per cent. per annum. During the course of his comparison of the Administrative Co.'s scheme and the L.C.C. scheme, Mr. Merz handed in a book of tables similar to those which we gave at great length in connection with our report of the proceedings of this bill last year. They had been modified to meet the new condition of things arising out of the promotion of the L.C.C. scheme, but the figures in the main are identical. The railway service alone, said Mr. Merz, would require 220,000 kw., and, in the scheme of the Administrative Co., provision had been made for laying ducts for dealing with this output. Great stress was again laid upon the establishment of a commercial department to "push" the sale of electricity, work which the L.C.C. could not undertake. On the question of the distributing system, Mr. Merz stated that the 20,000 volt system adopted by this company would result in a saving of £20,000 in copper alone, as compared with the L.C.C. scheme. Specimens of cable were shown to the Committee to illustrate this. A table was also handed in giving the various prices, and as an example it was mentioned that a ten-hour user would get his energy for ¾d. per unit, 20 per cent. lower than the price under the London County Council Bill. Attention was also drawn to the sliding scale of dividend which was discussed so much last year. In fact, the general features of the scheme were just briefly touched upon, at the request of the chairman, who remarked that if the Administrative Co.'s Bill were ever read a second time, the details could all be gone into by a Select Committee. Mr. Merz consequently confined himself, for the most part, to a discussion of the general essentials to the success of a power scheme as outlined by Mr. Fitzgerald in his opening speech. Incidentally he mentioned that he had carefully gone into the relative merits of a scheme involving long-distance transmission, such as that proposed by the Additional Co., but he had come to the conclusion that it would not be a desirable one, from many points of view, not the least of which was the element of unreliability which would be introduced.

Wednesday, May 23.

Mr. MERZ was cross-examined by Mr. FREEMAN on the question of the value of a tramway load as a nucleus of a good power scheme. Witness said that it all depended upon the price charged to the tramway department. He did not know of any municipality that charged its tramway department a low enough price. In answer to questions as to why the existing companies could not do all the "pushing" for business that the Administrative Co. could do, Mr. Merz answered that all he knew was that it was not done. With regard to the life of plant, Mr. Merz agreed that it was possible for the Council to scrap its plant at an earlier period than the period of the loan. It might be a wise policy, taking into consideration the state of the undertaking, to scrap the plant in this way, but to have to continue the capital charges on unremunerative plant was bad finance.

Mr. FREEMAN: Never mind the finance, so long as the policy is good.

In answer to further questions, Mr. MERZ said that he knew of no installation in which 20,000 volts was used, but he had cable of this nature to the value of £100,000 on order, and four miles was laid.

At the close of Mr. Freeman's cross-examination, the CHAIRMAN asked if any other counsel wished to ask questions.

Mr. LLOYD, K.C., for the Administrative Co., pointed out that this was hardly possible, as all the other Counsel were opponents to the L.C.C. scheme with himself.

The CHAIRMAN said that the Committee not only had this bill before them as an opposing scheme, but also as an alternative scheme, and if anyone wished to ask questions he must allow them to do so.

Mr. LLOYD said he had no objection whatever; but no other counsel asked any question.

In answer to the Committee, Mr. MERZ said that he anticipated that whereas the individual manufacturer in London now burned 10,000,000 tons of coal per annum, if the whole of his scheme were to be put into operation, and the whole of the supply came into his hands, the consumption of coal would be reduced by 6,000,000 because he could give the same power for the burning of 4,000,000. The main difference between what a company could do as compared with a municipality was the methods which the former could adopt to get consumers. He was prepared to go to a consumer and supply his works with any quantity of electricity at a fixed price per annum. He would, in fact, have a small army of skilled engineers who would interview the power user, and show him how cheaply he could get electricity. He considered in fact that a desperate effort should be made to prevent railway companies putting up their own generating stations. If his bill passed, he hoped to be able to show the County Council that he could supply their tramways cheaper than they could themselves do it. In fact, he was willing to make it a condition of the bill that within 12 months of its passing they would supply the L.C.C. and save them £20,000 per annum. The reason why the existing authorities did not have a large supply for power purposes was that, in his opinion, the right current for this purpose should be three-phase. He was willing to supply power consumers by agreement with the authorised distributor and to allow the latter a percentage of the profits. It was the best thing for London that the supply of electrical energy to London should be in one hand provided that control gave all commercial advantages. He hoped that in one of his proposed generating stations, at Barking, some new method of generation would be available, under which coal would not have to be burned. To carry out the larger scheme proposed by his Company, the County Council would have to spend a further £2,000,000 on their transmission system. He was of the opinion that the area outside London, whether in the case of his bill or that of the County Council was necessary to the scheme as a whole. Without actually saying that the Greenwich generating station was uneconomical, Mr. Merz said he should be sorry to have to start a power scheme with the station.

Mr. S. Z. de FERRANTI agreed with the views expressed by Mr. Merz. With regrard to the use of 20,000 volt cable he said that the British Insulated and Helsby Cable Co. was manufacturing a large quantity of such cable, and 30,000 volts under ground had been successfully tried in the South of France. As a personal view, and not in any way binding the Administrative Co., Mr. Ferranti suggested the following solution of the difficulties which now appeared to bar the way to the supply of electric power on a large scale in London. The County Council should buy and lay the transmission system and also the land for the generating and sub-stations, and whilst the Administrative Co. should erect the building and instal the generating plant. There could then be a profit-sharing system. This was a bare outline, but he had deeply thought over the proposition as one who had endeavoured to give a similar supply several years ago. He had some reason to believe that the company would be prepared to enter into such an arrangement.

Mr. A. H. SEABROOK, the electrical engineer to the West Ham Corporation, was then called by Mr. Balfour Browne in support of the case of the Corporation against the London County Council Bill. He gave the general details of the electrical undertaking there, and claimed exemption from the bill on the usual grounds.

Mr. BALFOUR BROWNE, K.C., then addressed the Committee.

A NEW SURFACE CONTACT TRAMWAY SYSTEM.

Folkestone, Sandgate & Hythe Tramways (No. 2) Bill.

A Committee of the House of Lords considered this bill on Wednesday. Mr. Lewis Coward, K.C., Mr. H. Lloyd, K.C., and Mr. Rostron appeared for the promoters. Mr. COWARD, in giving details of the bill, said that the only opposition was from frontagers, the most important of whom was Lord Radnor, who was an important property owner in the district traversed by the proposed tramways. The National Electric Construction Co. are promoting the bill, and Mr. Coward said he thought their financial position would not be challenged. It was proposed to construct a new system of tramways connecting up Hythe, Sandgate and Folkestone, the total distance being 11 miles 2 furlongs. The gauge was 3 ft. 6 in. and the system of traction proposed was the Dolter surface-contact system, which had been very successful in Paris and was now being installed on 10 miles of track in connection with the Mexborough, Rawmarsh and Swinton tramways, and also on a very extensive system of tramways in Torquay. Some lines which were granted to the Folkestone Corporation were to be taken over, and an agreement had also been come to with the South-Eastern Railway Co. for the acquisition of some horse tramways in Sandgate and Hythe. Originally there were two competing bills for these tramways, but the other bill had been withdrawn, and the one now before the Committee had the support of all three local authorities. The capital of the company which it was proposed to incorporate was £280,000, and it had been agreed to spend £60,000 on road widenings.

SHROPSHIRE, WORCESTERSHIRE & STAFFORDSHIRE ELECTRIC POWER BILL.

The consideration of this bill by a committee of the House of Lords Committee was concluded on Monday. The previous proceedings were given in our last issue. Birmingham and Wolverhampton were eventually cut out of the bill. These authorities, however, have the right to ask for a supply in bulk, whilst the company may lay mains through these cities to supply towns on the other side.

The CHAIRMAN announced that the preamble of the bill was found proved subject to the condition that £300,000 of the capital must be subscribed and paid up within 18 months.

On the discussion of clauses, the Committee imposed the further condition that £100,000 must be raised within 12 months prior to a commencement being made upon the Harborne (King's Norton) generating station.

Mr. WEDDERBURN, K.C., for the promoters, suggested that, as this extra condition was to be imposed, the period of 18 months in which the £300,000 had to be raised should be increased to two years.

The CHAIRMAN said the Committee could not go back on its previous decision.

With these amendments, the bill was ordered to be reported for third reading.

NORTH WEST LONDON RAILWAY BILL.

Mr. Compton Ricketts' Committee of the House of Commons has continued its consideration of the North West London Railway Bill since our last issue.

Mr. STEPHEN SELLON, who has given estimates of the probable traffic, was further cross-examined, and this closed the case for the promoters.

Mr. H. LLOYD, K.C., for the London County Council, who is opposing the bill, argued that the scheme was an incomplete one, and that the estimates of traffic were unduly optimistic, judged by the results on other tube railways. Such a route as that proposed would be better served by tramways, with a subway in the central portion of London.

Mr. VESEY KNOX, on behalf of the promoters of the Hammersmith, City and North East London Railway Bill, argued that this bill should not be passed pending some decision being come to by Parliament regarding the recommendations of the Royal Commission on London traffic.

Mr. FREEMAN, K.C., on behalf of several property owners, urged the rejection of the bill, as the proximity of such a railway as this would depreciate the value of property in the vicinity.

On Tuesday Mr. MOON, K.C., addressed the Committee on behalf of the promoters of the bill. The Committee then deliberated in private, and

The CHAIRMAN announced that the preamble of the bill was found proved, with a time limit of four years for the completion of the works, and two years for the acquisition of lands. The Marble Arch station should be so constructed as to lend itself to a physical junction with the Hammersmith, City & North East London Railway, if such a condition were imposed. In that bill, which was now pending, exchange stations must be constructed at all the points where other lines were touched, except with the Metropolitan Railway at Edgware-road, where there seemed some doubt as to its practicability.

LIGHTING OF "BIG BEN."

During the course of the discussion on the Civil Service estimates in the House of Commons on Thursday last week,

Mr. A. S. WILSON asked if there was any intention of reverting to the "greenish" lighting of Big Ben which was adopted for a short period last year.

Mr. HARCOURT said that the lighting of Big Ben cost about £240 per annum. The green light was about £80 a year cheaper than the white light, but he was not prepared to go back to the green unless the hon. members thought the public would become accustomed to it in the interests of economy.

[The "greenish" light referred to was produced by mercury-vapour lamps.—Ed. *E.*]

TELEPHONIC COMMUNICATION IN IRELAND.

In answer to questions in the House of Commons last week as to telephonic communication with the principal towns of south and west Cork, the POSTMASTER-GENERAL said that instructions have been given for a canvass to be made in these districts to ascertain how many persons are willing to subscribe to telephone exchanges, and no time would be lost in coming to a decision.

MISCELLANEOUS.

Derbyshire & Nottinghamshire Electric Power Bill.—The Unopposed Committee of the House of Commons considered this bill on Thursday last week. The bill contains some financial provisions, and authority is sought to erect overhead mains, the consent of the local authority to be subject to appeal to the Board of Trade if unreasonably withheld. Power to give a supply in bulk to adjoining areas, and also to railways, tramways, &c., is taken in the bill. It further seeks to exempt the company's generating stations from building bye-laws, and authorises agreements to purchase the Derbyshire & Nottinghamshire Tramways and also the transfer of the Newark & District Light Railway. After some discussion it was decided to postpone the bill sine die in order that the House of Lords might be communicated with as to the arrangements proposed concerning the other companies mentioned.

Baker Street & Waterloo Railway Bill.—This bill was passed by the Unopposed Committee of the House of Commons on Thursday last week. It asks for power to make certain deviations of the route already authorised, but not yet constructed, to take some additional lands in the boroughs of Paddington and St. Marylebone, and to abandon certain works.

Municipal Electric Tramways v. Motor 'Buses.—A proposal by the Glasgow & South-Western Railway Co. to run motor omnibuses in connection with their stations, which was considered by a Commission under the Private Bill Procedure (Scotland) Act last week, was strongly opposed by the Glasgow Corporation and other municipalities. Evidence was given on behalf of the railway company that there would be no competition with any tramway service in the country districts, the object of the clause being to bring passengers who lived away from the line to the stations of the company. Mr. James Dalrymple, the general manager of the Glasgow Corporation Tramways, gave evidence against the proposal, first, on account of the extra congestion in the streets which the motor 'buses would create, and, secondly, because of the competition with the municipal tramway service. The Commissioners ultimately deleted the clause.

Folkestone & District Electric Supply Bill.—This bill was passed by the Unopposed Committee of the House of Lords on Tuesday. It seeks to confer further powers upon the Folkestone & District Electric Supply Co., and to legalise agreements as to electric supply with the Sandgate and Hythe Corporations. The bill also provides for the transfer of the provisional orders held by the two corporations in question.

Lancashire Electric Power Bill.—This bill came before a Committee of the House of Commons on Tuesday, and the preamble was found proved. Originally 64 petitions had been lodged against the bill, but the promoters had come to terms with all of them, and there was no opposition. The bill asks for an extension of its powers to enable it to supply energy to lighting authorities, to persons requiring a supply for power purposes, and to railways, tramways, &c. In the bill as deposited no supply was to be given to a consumer in the area of an authorised distributor without consent, but in the case of that consent being unreasonably withheld an appeal was to be made to the Board of Trade. In order to get rid of all the opposition, however, the company has now deleted the reference to the Board of Trade.

Dumbartonshire Tramways.—A Commission appointed under the Private Bill Procedure (Scotland) Act considered last week a provisional order proposing the construction of tramways in Dumbartonshire. It is the intention to incorporate a company. There was very little opposition and the preamble of the order was found proved. The Commissioners struck out a proposal to supply electricity for lighting purposes, preferring to leave it to the promoters to make application to the Board of Trade under the Electric Lighting Acts.

Newcastle-upon-Tyne Electric Supply (Additional Powers) Bill.—This bill was passed by the Unopposed Committee of the House of Lords on Tuesday. It provides for the transfer to the company of the Whitley & Monkseaton Electric Lighting Order, 1901, and the Seghill & Tynemouth (Rural) Order of 1902 from the Northern Counties Electricity Supply Co. Working agreements with the County of Durham Electric Power Supply Co. and the County of Durham Electric Power Distribution Co. are also provided for, and agreements for mutual supply with the Newcastle & District Electric Lighting Co. General powers are also taken to enter into agreements for supply to authorised distributors, to properties situate partly within and partly without the area of supply, to lay the necessary connecting mains and to erect overhead mains under the conditions already mentioned in connection with other bills. Exemption from the non-association clause of the Electric Lighting Acts is also sought, and the stand-by supply clause is included in the bill.

Kent Electric Power Bill.—This bill was considered by a Committee of the House of Lords on Monday. The object of the bill is to give certain new powers to the Kent Electric Power Co., which was authorised in 1902 with a capital of £750,000 with borrowing powers equal to one-third of that amount. The promoters sought, among other things, to supply electrical energy in bulk in contiguous areas, and to this the only opponent was the L.C.C, as this power would enable the promoters to supply within the area of the London County Council Electric Supply Bill, now being considered by a House of Commons Committee. Mr. Freeman, for the L C.C., urged that the company should be restricted to the area granted to the company in 1902. Evidence was called to show the progress of the company, and the Committee passed the preamble of the bill, in order that the House of Commons might deal with it in conjunction with all the other power bills, which had originated in the Lower House.

The North and South Shields Electric Railway Bill and the Twickenham and Teddington Electric Supply Bill were read a third time and passed in the House of Commons on Tuesday.

The Ascot & District Gas (Electric Lighting) Bill and the Brixham Gas (Electric Lighting) Bill were read a third time in the House of Commons on Monday. The Oldham & Saddleworth Tramways (Abandonment) Bill the Hackney Electricity Bill and the Wallasey Tramway Improvements Bill were read a second time.

Electro-Harmonic Society.—The annual meeting will be held at the Institution of Electrical Engineers on Wednesday next, May 30, at 4·30 P.M. During the past season 72 new members were elected, 39 members resigned, six were struck off the register, and three members died. There are now 551 names on the membership roll.

LEGAL INTELLIGENCE.

Marconi International Marine Communication Co. (Ltd.) and Another v. Lloyds.

In the Chancery Division on Tuesday Mr. Justice Swinfen Eady had an action brought to determine the true construction of an agreement between the parties as to the working of plaintiffs' system of wireless telegraphy at certain of the defendants' stations.

Mr. WARMINGTON, K.C., said the question at issue was as to the relations between Lloyds and plaintiffs which commenced in 1901. The course of business at Lloyds required that they should have early intimation of the arrival and also anything that happened to a ship in the course of a voyage, and Lloyds, prior to 1901, had evidently made considerable inquiries and investigations as to other systems of wireless telegraphy, but those systems were not considered practicable and indeed there were none in actual operation. In 1901 Lloyds made an agreement with plaintiffs to adopt plaintiffs' system. Three or four years afterwards it was said by Lloyds that plaintiffs had not fulfilled their obligations under that agreement, while plaintiffs said that Lloyds had broken certain terms of the agreement. That led to litigation, and the litigation was terminated by an agreement in which there were three clauses which now came up for special consideration. The original agreement, dated Sept. 26, 1901, recited that the Marconi International Marine Communication Co. (Ltd.) had acquired from Marconi's Wireless Telegraph Co. (Ltd.) the sole exclusive licence to use for all maritime purposes in all parts of the world, except the United States of America, Hawaii, the Republic of Chili, and any Colonies or dependencies thereof respectively, certain patent rights and inventions for wireless telegraphy collectively known as the Marconi system, and also of other patent rights which Marconi's Wireless Telegraph Co. (Ltd.) or might thereafter acquire or have the power to use. Lloyds thought it desirable that one system of wireless telegraphy should be in general use. Under this agreement Marconi's system was to be installed at certain of Lloyds' signal stations, Lloyds to have the benefit of all maritime communications and plaintiff companies the benefit of all sea telegrams received—*i.e.*, all private messages were to be received for the benefit of plaintiffs and all communications with regard to ships and their cargoes for the benefit of defendants. The system was to be worked by Lloyds. Clause 9 of the agreement provided that (1) "If at any time during the currency of this agreement the company shall desire to establish a system of sea telegraphy at any of Lloyds' signal stations in any part of the world, and shall give notice in writing to Lloyds of such desire, it shall have the right to instal and maintain such system at such station at its own expense, and Lloyds shall work such system for the company and all revenue from sea telegraphy at any such station shall be accounted for by Lloyds to the company, less only all reasonable out-of-pocket expenses incurred by Lloyds in complying with the company's request. On the termination of this agreement the expense of removing the installation shall be paid by the company. For the purpose of this agreement the expression sea telegraphy shall mean only the receipt and transmission of messages to and from passengers to vessels, messages of public news transmitted to or from vessels, and generally any messages transmitted to or from vessels which could not reasonably be described by the expression maratime signalling as defined in this agreement." On June 7, 1904, Lloyds commenced their action against the Marconi International Co., but a compromise was come to at the trial. This order was dated Nov. 25, 1905, and the terms of the compromise included the following: "Defendants will concur with Lloyds in arranging for the British Admiralty, if willing to work the wireless telegraphy for both maritime signalling and sea telegraphy at all stations in the United Kingdom or abroad, whether defendants' or Lloyds', at which now or hereafter Marconi's system for maritime purposes is used. This clause not to apply to Poldhu and similar stations primarily used for shore-to-shore or overland telegraphy. The defendants are to be at liberty to arrange with the British Admiralty the payments to be paid for the expense of working the stations for the purpose of sea telegraphy, and the plaintiffs are to be at liberty to arrange with the British Admiralty the payments to be made for the expense of working the stations for maritime signalling." (2) "At all such stations in the United Kingdom or abroad (subject to the exceptions stated in the principal agreement of September 26, 1901), at which the British Admiralty are unwilling to work the wireless telegraphy and at which sea telegraphy shall for the time being be practised, the working of wireless telegraphy to be under the control of defendants or either of them, if and so long as they so desire, and if not, then to be done by Lloyds on reasonable notice. In case of any complaint by defendants as to alleged insufficiency of work at any station at which wireless telegraphy is worked by Lloyds the sole remedy of defendants is to be to take over the working of wireless telegraphy themselves at such station and not to sue for damages or otherwise. This clause not to include stations in the Suez Canal, in Egypt, or in the Soudan, unless the Egyptian Government consents; but plaintiffs will use their best endeavours to procure such consent. Lloyds shall not be compelled to work under this clause the telegraphy at any station at which they would not have been bound to work it under the principal agreement. As regards stations at which the wireless telegraphy shall not be worked by the Admiralty, the cost of maritime signalling to be borne by Lloyds and the cost of sea telegraphy by defendants. Any question of apportionment to be settled by arbitration in case of difference. Lloyds not to pay any portion of the expenses of the Poldhu or any similar station primarily used for shore-to-shore or overland telegraphy. Lloyds and defendants to do their best to persuade the British Government not to grant a licence for use of wireless telegraphy during the continuance of the agreement to any but plaintiffs and defendants. Lloyds to be exclusively entitled to the benefits of all maritime signalling worked by the Marconi system in all countries (except those mentioned in the first paragraph of the principal agreement), the benefits and profits of all sea telegraphy to belong as between the plaintiffs and the defendants to the defendants."

COUNSEL said the stations with regard to which complaint was particularly directed by his clients were Malin Head, Lizard, North Foreland, Crookhaven, Rosslare and Niton, the contention of his clients being that the British Admiralty were not now and had not since the date of the agreement been working wireless telegraphy and they further submitted that the British Admiralty were not willing to work the wireless telegraphy. Defendants now said that the Admiralty were willing to work wireless telegraphy if what defendants called certain reasonable stipulations were accepted by plaintiffs. But the present position was (he continued) that the Admiralty were not working any station, and that being so, the working of the wireless telegraphy had to be, as they submitted, under the control of plaintiffs.

Mr. EVE, K.C., for defendants, said the difficulty was that a good deal of correspondence the Admiralty insisted upon as being confidential.

Mr. WARMINGTON : I ask you lordship to help us both in this matter. As evidence of the willingness or unwillingness of the Admiralty it seems to me to rest on the correspondence.

His LORDSHIP : Are you agreed that the British Admiralty are willing to do it on certain terms ?

Mr. WARMINGTON : No. We do not go as far as that. We say that no definite terms had been agreed to by either side. They had never got as far as discussing positive terms.

Mr. EVE said he thought so far as maritime signalling was concerned the Admiralty agreed that they would not get the electricians employed to take over the signalling alone, but they would have to take over the telegraphy too. The Admiralty said that as long as that position was insisted upon by Marconi's the Government would not go any further.

Mr. WARMINGTON : The point communicated to us was that the Admiralty declined to work sea telegraphy.

Mr. EVE : That is quite inconsistent with the communication made to us that it would not pay them to keep their electricians employed to take maritime signalling alone. They go further and say that the two services cannot be separated.

Mr. WARMINGTON : Our correspondence shows that the Admiralty were unwilling, and they give us their reason. His argument on clause 2 was that from the moment the Admiralty stated they were unwilling to take over the stations, and until such time as they were willing to take them over, plaintiffs were entitled to work them themselves.

The plaintiffs' case closed here.

Mr. EVE, K.C., said that in 1904 Lloyds commenced the action which had been already referred to, and in which they alleged they had performed the agreement, and had been willing to undertake and carry out the working, but that defendants had refused to allow them so to do. Marconi's, by way of defence to that action, alleged incompetency by the operators of Lloyds, and, by way of counterclaim, claimed a declaration that that they were entitled to retain possession, and an injunction to restrain any attempted handing over of the work to the Admiralty. On March 11, 1905, Lloyds commenced the second action. By way of defence it was denied that the two agreements upon which that action was based were really one transaction, and it was also denied that the station at Poldhu had been established wrongfully within the meaning of the said agreement. The question was as to whether the station at Poldhu was under the control of the International Company, and whether the agreements referred to must be read as one transaction. Both parties were asserting their right to work wireless telegraphy, and each party seemed to have been suspicious of the ability of the other to work that portion of it in which the other was interested. He asked his lordship, on the construction of the agreement, and on the matters in issue, to hold that it was not competent for plaintiffs merely to adopt the position of interposing, but to say that they were bound actively to take steps with Lloyds in inducing the Admiralty to undertake the working of the particular stations set out in the pleadings.

Evidence was then tendered by Capt. A. E. BETHELL, assistant director of naval ordnance at the Admiralty of the negotiations between the parties at a conference. They had not (he said) been able to come to terms with the Marconi Company as that company wished to impose a condition which the Admiralty could not accept, that if the working, in the opinion of the company, was unsatisfactory the company was to have the right to work it themselves. The Admiralty never intended to maintain the commercial part for Marconi's system. All they undertook to do was to manage the Instruments. The commercial part was to be conducted by a representative of Lloyds. The point was as to who was to be the judge of the efficient working.

Mr. THOS. DEVEREUX, head of the signal department at Lloyds, said that at the date of the compromise they were actually in possession and working the five stations, and remained so ever since. In cross-examination he said he was not personally a skilled electrician.

Other evidence having been given, Mr. JAMES and Mr. WARMINGTON addressed the Court on behalf of their respective clients.

In giving judgment his LORDSHIP said that it appeared that on Sept. 26, 1901, an agreement was entered into between one of the Marconi Co's. (the International) and Lloyds, and that for certain considerations that company granted to Lloyds the right or licence to use and work for the sole purpose of maritime signalling at all or any of Lloyds signal stations already established or thereafter to be established during the currency of the agreement the Marconi system of wireless telegraphy and any patents or inventions in connection therewith, and there were provisions as to the supply and installation of apparatus and as to payment of royalty. One clause (9) provided for the establishment by the company of a system of sea telegraphy at any of Lloyds' signal stations in any part of the world and for Lloyds to work the system for the company, all revenue derived from sea telegraphy at any station to be accounted for by Lloyds to the company, less all reasonable out-of-pocket expenses. The expression sea telegraphy was to mean only the receipt and transmission of messages to and from passengers to vessels, messages of public news transmitted to or from vessels and generally any messages transmitted to or from vessels which could not reasonably be described by the expression maritime signalling. Maritime signalling is defined to mean "the collection, publication and diffusion of all such intelligence and information with respect to shipping, cargoes, freight and insurance as is at present collected or diffused by Lloyds." Therefore, the result of the agreement was that the stations were to be worked by Lloyds, the profit from the sea telegraphy going to the Marconi companies, and the benefit of the maritime signalling to Lloyds. That agreement and another agreement of even date entered into between Lloyds and the other Marconi company led to litigation, with the results known. The terms agreed upon as the result of those actions formed the ground of the present action, and the real question was what is the proper construction of the terms so agreed upon. His Lordship then exhaustively reviewed the correspondence which had passed between the parties, the proceedings at the conference spoken of by Capt. Bethell, and the proceedings at law, and said from a careful study of all these matters, that if there was any question between Lloyds and the Marconi companies as to the time on which the Admiralty should be asked to take over certain stations and work them they could have gone to arbitration. At present he was confronted with the fact that there had been an informal conference and a simple announcement that the Admiralty was unwilling to take over the stations. He therefore made the declaration in the terms asked for by the plaintiffs, and the costs must follow the event.

Fourteen days stay was granted to enable the defendants to consider whether they would appeal.

Metallic Seamless Tube Co. (Ltd.) v. Simplex Steel Conduit Co. (Ltd.)

The Court of Appeal (the Master of the Rolls and Lords Justices Romer and Cozens-Hardy) on Tuesday delivered judgment in this appeal of the Simplex Steel Conduit Co. from the decision of Mr. Justice Buckley revoking the letters patent on the ground of want of subject matter. (The arguments were reported in *The Electrician* of the 11th inst.)

Lord Justice ROMER, in delivering the judgment of the Court, said it was difficult to decide whether there was or was not sufficient invention to support a patent. On the one hand, where a substantial advance on prior knowledge was made, it ought not to be held that there was no subject matter for a patent merely because the way in which the advance was made was simple, and even though it might be a matter of surprise that its discovery was not made earlier. But it should be borne in mind that it would have a prejudicial effect upon trade if patents were taken out for unsubstantial alterations in machinery, and in his opinion a patent should not be applied for where the invention only affected a small result of trifling or dubious utility. The patent in this case appeared to fall within the last class. Mr. Justice Buckley had come to the conclusion that there was no proper subject matter for invention, and he did not see his way to differ from Mr. Justice Buckley. The patent concerned the use of metallic conduits for electrical conductors. In using such conduits it was necessary that there should be complete electrical metallic circuit throughout, and to effect that a tight grip must exist between the successive parts of the conduit. That grip was at first obtained by making the conduits screwed at the ends, so as to be capable of being screwed into each other and into the fittings which had to be employed. But these screw conduits were heavy and expensive, and accordingly there was undoubtedly room for an invention which would enable plain conduits to be used. By Lake's patent it was shown how plain conduits could be fastened together and to fittings by a tight grip by means of a simple contrivance known as a split bush. That solved the problem that had previously existed. All that the present patent purported to do was to slightly increase the size of the conduits and to make a corresponding alteration in the split bush, though with a sacrifice of some of the tightness of grip afforded by the bush in Lake's patent. It was said on behalf of the present appellants that this increase of the size of the conduits was useful, and to make the necessary alteration in the split bush required invention sufficient to support their patent. In the first place he found it very difficult to believe that any advantage was obtained by increasing the size of the conduit, especially when by doing so the grip was weakened. In Lake's patent all the conduits could be of a uniform size and all the fittings could be of a uniform size, though slightly larger in size than the conduits. It was said by appellants' Counsel that by their patent use could be made, if desired, of the screw conduits which would be of the same size as the fittings, but it was difficult to see why anyone should want to use screw conduits when he could use the cheaper plain conduits. Moreover, the specification of appellants' patent showed that the object of it was the use of plain conduits, and there was no suggestion of any advantage to be obtained by the use of screw conduits. But assuming that there was a small advantage to be obtained by having Lake's conduits the same size as the fittings, was there any real difficulty in altering Lake's split bush so as to make it fit and grip the increased size pipes? He could not think there was. Lake's invention was part of the public knowledge, and if a workman of ordinary intelligence, knowing of the invention, had wished, for any reason or fancy in using that invention, to have the size of the pipes increased so as to be of the same size as the fittings, he thought he would have had no difficulty in doing so by making an alteration in the bush. And in altering the bush he thought the most natural thing for him to do would have been to alter it in the same way in substance in which the appellants had altered it. Seeing that some grip must be obtained and the mouth of the bush must be enlarged to fit the correspondingly increased size of the conduit, it could not, in his opinion, be fairly said that there was anything peculiar or original in having a shoulder sloping. Taking into consideration all the circumstances of the case, it appeared to him that to support the appellants would be to unfairly take away from the public the full use to which they were entitled of the benefit of public knowledge, and in particular that given by Lake's patent. The result was that, in his opinion, the appeal failed and should be dismissed with costs.

Mr. WALTER: Will your lordships, pending the consideration of appealing, stay the lodging of the order for revocation at the Patent Office for one month?

The MASTER OF THE ROLLS: Yes.

Traction Corporation (Ltd.) v. Bennett.

In the Chancery Division on Friday, before Mr. Justice Buckley, Mr. BUCKMASTER, K.C., moved for an injunction to restrain defendant from dealing with, disclosing or offering for sale an invention relating to a system of electric traction until after the hearing of proceedings that were pending before the Comptroller opposing a complete grant to defendant in respect of the invention. Defendant's affidavit stated that he was willing to give an undertaking in the terms of the notice of motion, plaintiff giving the usual undertaking in damages.

Mr. BUCKMASTER agreed to this, and his Lordship allowed the motion to stand over, the costs to be costs in the cause.

London Electrobus Co. (Ltd.)

Mr. Justice Buckley on Friday heard two motions to rectify the register of this company by removing the names of certain applicants for shares on the ground that they had been induced to enter into their contracts to take shares by a misstatement in the prospectus. There was also a motion to restrain the company from dealing with the money of the applicants paid in respect of shares until after the hearing of the dispute with regard to the rectification of the register.

Mr. BUCKMASTER, K.C., in support of the motion, said a letter had been received from the Company consenting to an order in favour of applicants. It was also set out that any person requiring the return of his money could obtain it.

His LORDSHIP: That means that they are going to pay everybody?

Mr. BUCKMASTER agreed. He said the prospectus stated 17 advantages of the electric omnibus over the petrol omnibus. Applicants did not complain of that, but of a paragraph stating that the electrically-driven omnibus of the type of which the company had secured a monopoly for a certain time and within a certain district was protected by letters patent, whereas what was protected was only an axle or bearing or some part of the machinery. A circular issued by the directors on May 16, stated that the improvements referred to in the prospectus "had no reference to the accumulator or motor but are concerned with the driving and gearing mechanism made use of in the construction of omnibuses of the type which the company proposes to run."

His LORDSHIP thought that the statement in the prospectus meant that the company had obtained a monopoly of a particular type of electrically-driven motor.

Mr. BUCKMASTER said that the statements in the prospectus could not be substantiated. He asked for an order for rectification in both cases, and the return of the moneys paid, the company to pay costs.

His LORDSHIP made an order accordingly.

In "Obree and Others *v.* the Company" an order was also taken by consent.

Mr. EVE, K.C., also moved, before Mr. Justice Swinfen Eady, on behalf of a number of applicants, to have the register of the company rectified by the removal of their names as shareholders, and for the return of the moneys they had paid, with interest. The company consented to an order in these terms. Counsel said that one of the applicants had made an affidavit, and his lordship said counsel could have an order subject to a consent brief. If this was not agreed to, he could have an order for the applicant who had made an affidavit, and the rest of the motion would stand for a week.

"Byron and Others *v.* the Company" was again mentioned to Mr. Justice Joyce by Mr. HUGHES, K.C., who asked for an immediate order of rectification of the register by the removal of the names of the applicants. An originating summons, he said, had been taken out by 250 persons under Sec. 36 of the Companies' Act, and under that summons they asked for relief.

His lordship made the order, the company to pay the costs.

Compensation for Tramcar Collision.

At Leeds on Monday, the Under Sheriff of Yorkshire (Mr. E. Gray) and a jury sat to assess the damages to be paid to John North in respect to injuries received in a tramcar accident at Buttershaw in November, 1905.

Mr. WAUGH, K.C., explained that North was a plasterer and steeplejack, and on Nov. 4 he got on to a Bradford Corporation tramcar going to Shelf. Upon the journey a collision occurred. Claimant was thrown off his seat on the top of the car, his head came in contact with the standard and his skull was fractured. He still suffered from the shock. The Corporation offered him £40 as compensation, but the claim was for £1,000.

After hearing medical evidence and legal addresses, the jury awarded £750, and the Corporation were ordered to pay the costs.

F. A. Glover & Co. v. Delta Metal Co.—Mr. Pollock, official referee, resumed on Friday last the hearing of evidence in this case, which was reported in our last issue. The further hearing has been adjourned until after the Whitsuntide vacation.

In re Crigglestone Coal Co. (Ltd.), petition of British Insulated & Helsby Cables (Ltd).—Mr. Justice Buckley on Tuesday made a compulsory order for the winding up of the Coal Co., the petitioners being judgment creditors for about £750 for electric cables supplied. The facts were reported in our last issue.

DEPRECIATION, &c., ON ELECTRICITY SUPPLY UNDERTAKINGS.

An exhaustive report upon the present condition of the electric lighting machinery and plant, its probable life and the provision which ought to be made for renewals of plant and machinery, has been prepared for Edinburgh Corporation by the consulting engineer (Sir Alex. B. W. Kennedy) and the resident electrical engineer (Mr. F. A. Newington), who state that they believe that provision for payment of interest and sinking fund on municipal undertakings should not be considered as in any way superseding the necessity for the establishment of a reserve or depreciation fund, which could be used for the same purpose as a depreciation fund in any ordinary commercial undertaking. Judged also as an ordinary commercial undertaking, they believe that no balance in the net revenue account can be properly considered profit until the reserve fund has been built up to such an extent as to make the undertaking perfectly safe against all possible emergency demands, whether due to rise in prices or in working costs, to special maintenance or renewals, or to the necessity for adopting new methods or more modern machinery to replace those at present existing. For a total expended capital of about £900,000 Edinburgh Corporation has an invested reserve at May 15 last of nearly £59,000, which has since been increased to about £76,000. This reserve, the report states, is still £14,000 short of the amount allowed by the terms of the provisional order, and there was no doubt that in several past years the Corporation had preferred to take money from the gross surplus of the electric lighting accounts and place it to the credit of the City rather than to make up the reserve from year to year to the full amount allowed, although this amount in itself bears so small a ratio to the total capital expended. The actual amount taken from the electricity account and placed to credit of City funds has been £25,539. The point on which most anxiety might naturally be felt by the Electricity committee was whether the reserve fund, even when built up to its statutory value, would really be sufficient to meet such eventualities as might reasonably be expected to arise in the future. There was no doubt that, if any very wholesale renewals of plant had to be anticipated within the next 10 or 12 years, the fund would be too small—that is to say, it might very soon be greatly reduced, if not entirely extinguished by the amounts which would have to be taken from it.

After carefully examining into the state of the plant and mains, &c., however, the Corporation's engineers hope that there is no real ground for alarm on this particular head, so far as regards the machinery itself. At the date of a previous report in 1899 very much trouble had been found in connection with some of the rubber-insulated mains, the durability of which had not proved as great as was expected and on their renewal a considerable sum had been expended. Later on considerable sums were expended on the renewal of rubber mains, but that expenditure, fortunately, did not prove to be as heavy as was feared, and was met out of the revenues of each year. For some years past the expenditure in the maintenance of mains had not been in any way abnormal, and they believe they may anticipate that a large portion of the mains now laid will work for some years without more than ordinary maintenance. It could not, however, be forgotten that although at present to all appearance the paper insulation used on modern cables was satisfactory, and had not shown signs of serious breaking down yet there had been no lengthened experience with it such as could enable them to make sure that a serious or sudden breakdown, however unexpected, might not take place later on. The bituminous insulation, which had also been used to a considerable extent, was by no means so satisfactory, and might certainly lead to serious renewals before long. The plant (boilers, engines, dynamos, &c.) had been kept in good order, renewed and fully maintained out of revenue, and the whole plant was working in every way as economically now as it did when it was first put down. There was no doubt that, if work were being started in Edinburgh to-day instead of 11 years ago, with a certainty of the enormous demand of to-day, instead of the quite uncertain and extremely small demand of 1895, and with the enlarged capacity of the dynamo makers of to-day, it would be natural to start with larger units of plant, which would have a certain advantage in economy of steam and also in economy of space. It was equally certain, however, that such economical advantages as could be gained would be small, so small that their possible attainment would in no way whatever justify the scrapping of any of the existing plant for displacement by larger or different machinery. That conclusion was emphasised by a comparison of the station costs in Edinburgh with those anywhere else throughout the whole of the United Kingdom, even in the most modern stations, so far as they were working under anything like similar conditions.

A large portion of the City which was originally supplied with alternating current was now being supplied with continuous current, but the alternating-current plant remained as useful as before, being used always to supply current to outlying suburbs further and further away from the stations themselves as the general (continuous-current) system of electric lighting all over the City extended, which was precisely the intention with which the plant was originally put down. As yet, it had not been necessary to reduce the original working pressure in any of the boilers. Such a reduction of pressure, when it took place, might very speedily compel them to renew such boilers, even although they would not be worn out, and these would probably form the first item of plant on which serious expense in renewals would have to be incurred. The total amount expended on boilers in both stations had been about £50,000, but some of that had been expenditure on boilers which were still quite new. The engines and dynamos are working economically, and the number of years for which they could still be run would depend on the way in which the cost of their maintenance increased as they grew older. They were not likely to become much less economical, but a time must come when they became so expensive in up-keep that it would be cheaper to renew them than to go on using them. The reserve fund had therefore to provide in the first instance for the renewal of boilers, which might quite possibly begin about five years hence. It had next to provide for renewals of the other station plant, for which a time could hardly be given. The report of 1899 took 20 years as a round figure which might represent the average time at which renewals of plant generally might have to commence, but it was quite possible that the oldest engines and dynamos might run more than 20 years from the time of their purchase (or nine years from now) before they had to be disused. The fund had also to serve as a stand-by in case of any serious failure in the insulation of the mains. While they had no reason to anticipate such a failure, it would be foolish to ignore the fact that the insulating materials used were modern in their application, and had not yet had the chance anywhere of showing their duration, so that their behaviour after 15 or 20 years was a matter of inference only, and not of experience, and that as to certain portions the insulation had already become a serious matter. The reserve fund had further to provide for the contingencies included generally under the word antiquation. By that was meant that, at some time, which could not, of course, be fixed beforehand, or even guessed at, new inventions, new methods of generating electricity, improved methods of raising steam, &c., might be brought forward, and might prove themselves to be such great improvements on the methods or machinery in use as practically to render the latter antiquated, and to compel the Corporation to do away with them before they have been worn out, and replace them by other machinery. If any such change occurred suddenly and on a large scale, it would be necessary for the Corporation, in terms of their provisional order, to make up any deficit by a contribution from the rates, and that was no doubt a contingency which it was most desirable to avoid. They did not anticipate the occurrences of such improvements, but in spite of that it would be unwise to take up any dogmatic attitude as to the impossibility of such improvements. Over and over again it had happened in every industry that when production had seemed to be as perfect and as cheap as means could make it, a new and quite unexpected invention or alteration had shown improvements to be possible which had not hitherto been dreamt of. It was, of course, impossible to provide by reserve any such sum as should correspond to a wholesale renewal of the undertaking, but it appeared right to consider that the fund should provide for the renewal of any particular section of the undertaking without drawing unduly on the income of any particular year. It was proposed by the Electricity committee in 1900 that application should be made to Parliament for powers to increase the reserve fund under the provisional order beyond 10 per cent. of the total capital. That proposal, however, did not pass. Any such increase, if thought desirable by the Council, would unquestionably be on the side of security, and in the existing prosperous condition of the undertaking as to revenue it would be easy to raise the reserve without an increase in price of current, or even concurrently with a reduction of price, so long as the annual surplus was appropriated to reserve. Later on, when the price of current had been still further reduced (as it no doubt must be), and when possibly the price of coal was higher and the cost of maintenance increased, it might no longer be possible at all so easily to set aside any considerable sums for increase of reserve. For the last two or three years coal had been very low in price, but an increase of only 1s. per ton would mean over £2,000 per annum on the quantity used at present, and that quantity was, of course, becoming greater every year.

Therefore, Sir Alex. Kennedy and Mr. Newington express a hope that the Council might, out of revenue, increase as soon as possible the reserve to its statutory limit, and thereafter keep it up to that limit, and in view of the uncertainty as to the life of certain portions of the machinery and plant, and particularly as to the durability of the insulation of the mains, they had to express the very strong opinion that it would only be a reasonable measure of precaution for the Corporation to form a depreciation fund up to, say, 5 per cent. of the total capital expenditure as soon as possible after the reserve has reached its statutory limit. How far it might be possible to increase the reserve from 5 to 10 years hence it was impossible to say. It could not but be sound policy to treat the undertaking as it would be treated if it were being run as a private concern, and to take advantage of the present good years to make provision for years later on, when possibly the works might not be so prosperous—or at, any rate, the gross surplus not so large as at present—and when the cost of fuel and also the cost of renewals and maintenance might be unavoidably greater. If it should turn out, fortunately, that they had not to draw largely on reserves before the bulk of the borrowed capital was repaid, the Corporation and the public generally would still obtain the full advantage of their policy in that the ultimate renewals could be largely carried out, as they became inevitable, from reserve and without becoming a charge upon the rates or the necessity of further borrowing, and therefore with a corresponding reduction of capital charges against revenue during the further continued working of the undertaking.

Galveston, U.S.A.—This city, which may be said to have been created by the Atlantic cable companies, is now the centre of much industrial activity, and is especially notable as the chief railway and shipping port of Texas. Huge piers and docks have recently been erected, and vast numbers of railway cars loaded with imported merchandise for the interior or with merchandise for export are constantly going and coming. The Southern Pacific Railway Co. have recently erected, or have in course of erection, seven large piers, and have installed a number of electric conveyors to transfer merchandise between the railway cars and vessels loading at pier sides.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A vacancy occurs for a pupil in a company's central station (direct current) in the south-west area of London. Applications to "County," Moorgate-court, London, E.C. See an advertisement.

An electrical draughtsman is wanted, with experience in plotting mains and with a fair knowledge of engineering drawing. Applications by May 28 to the Engineer and Manager of Stepney electricity works, 27, Osborn-street, Whitechapel, London, E. See an advertisement.

Southwark Borough Council require a charge engineer for their electric light station. Commencing salary £2. 5s., rising to £2 15s. Applications (on forms to be obtained from the Town Hall, Walworth-road, London, S.E.) by noon 28th inst.

A supervisor is required at the Royal Arsenal, Woolwich. Salary £160, rising to £230 per annum. Candidates must have a degree or diploma obtained after a full three years' course at an approved engineering college, as well as a good practical workshop training. Applications to the Chief Superintendent of Ordnance Factories, Royal Arsenal, Woolwich, from whom further particulars. See an advertisement.

Mr. H. G. McHaffie, resident electrical engineer at Hoylake and West Kirby, has been appointed electrical engineer to the Para Electric Railways & Lighting Co. Mr. McHaffie leaves England on June 19.

On Wednesday Battersea (London) Council appointed Mr. F. A. Bond (chief engineer of Heston and Isleworth District Council's electricity works) as chief engineer at a commencing salary of £500 per annum.

Mr. W. F. Duncan has also been appointed shift engineer at Battersea electricity works.

Argentina.—The "Review of the River Plate" says an electric tramway is to be constructed to connect the Port of Buenos Ayres, Flores and Banfield.

The Anglo-Argentine Tramway Co. are appealing to the Finance Minister for the rescission of the decrees declaring as lapsed the concession granted to Mr. G. Moore for a tramway in the Port of Buenos Ayres and granting a concession for same district to Gandulfo & Co.

On 25th ult. an extension of La Capital Tramway Co.'s system (about 2½ miles) between Parque Patricios and Puente Alsina, Buenos Ayres, was opened for traffic.

Australasia.—Our Australian correspondent informs us that Sydney Council have decided to put down electrical plant instead of the present engine and boiler used for working the refrigerators at the Eastern Fish Markets at a cost of £500.

Barton (Lancs.)—An electric lighting order, which is to be transferred to the Lancashire Electric Power Co., has been granted to Barton Rural Council for Flixton, Clifton, Davyhulme and Barton Moss districts.

Beverley.—In 1901 the Corporation obtained a provisional electric lighting order "in order to keep out a company and to obviate competition with the municipal gas works." Nothing has been done, but an offer of £200 for the transfer of the order has now been made by a company, and the Parliamentary committee has been requested to report thereon.

Birmingham.—For the year ended March 31, the gross profit on the Aston municipal tramway line was £9,968. 12s. 5d., and after paying interest and sinking fund on the line and on the tramways under lease and new routes in hand, and a portion of the expenses of obtaining the Corporation Act, 1905, the net profit is £4,353. 11s. which has been placed to reserve.

The accounts of the electricity department were submitted to the Council on Tuesday, and the chairman of the Electric Supply committee (Mr. Ellaway) gave a résumé of the chief features of the past year's working.

The output had increased by nearly 16 per cent. and the receipts showed an advance, notwithstanding the reduction in charges which came into operation at Christmas. The cost of production had been reduced and worked out at less than 1d. per unit, and the total cost of generation and distribution was 1·45d. against 1·58d. The net profit was £6,097, which is to be carried to reserve. They could hardly expect to avoid a deficit this year as interest and sinking fund would be due on nearly the whole of their capital expenditure, and they would not have full distribution of current to the tramway company until January.

Brighton.—The Corporation have resolved to take no further steps towards obtaining powers to wire consumers' premises on the ground that such powers have been found to be practically useless elsewhere.

Burton-on-Trent.—The receipts of the electricity department for the year to March were £10,377.

Working expenses were £4,809 (1·192d. against 1·31d. per unit), and after meeting interest and sinking fund charges there was a surplus of £1,393, of which £320 has been used to meet expenditure in connection with the change of voltage, and the remainder has been put to a reserve. 416,354 units were sold for lighting power, heating, &c. (against 367,407), and 553,512 were supplied to tramways (against 619,525). There are 28,775 equivalent 8 c.p. lamps connected (increase 1,701) and 65 motors of 311·5 H.P. (increase 107·25 H.P.) The plant capacity is 1,710 kw. (increase 100 kw.), and the maximum loads were for lighting and power 492 kw., and for traction 250 kw. (against 427 kw. and 250 kw. respectively), the load factors being for lighting 9·67 (against 9·84), and for traction 25·3 (against 28·3).

The borough electrical engineer (Mr. P. J. Pringle) reports that the reduction of 1·73 per cent. in the number of units sold for traction was due to the reduced car-miles run, which he attributes to depression in local trade. The plant capacity has been increased to meet a demand for current by the new Burton and Ashby light railway, but the supply has not yet been required.

The energetic manager and engineer of the municipal gas works (Mr. F. L. Ramsden) has issued to present and prospective users of power in the town a folding card pointing out the merits of gas for heating and other purposes. There are about 140 gas-engines of various sizes up to about 50 B.H.P. at present supplied from the Corporation gas mains, and these are used for many purposes, including the driving of dynamos for electric lighting.

Cardiff.—The Corporation on Tuesday decided to reduce the charges for electric current (as set out in our last issue).

Chile.—The acting British Consul-General at Valparaiso (Mr. A. L. Rowley) reports that a concession granted to Señor Ambraoio Olivos for an electric railway between Valparaiso and Santiago, via Placilla, Casa Blanca and Curacavi, has been sold to the Cia. Chilena de Invenciones. A copy of the concession and a plan of the projected railway may be seen at the Commercial Branch, Board of Trade, 73, Basinghall-street, London, E.C.

Clitheroe.—The Council, having received an offer for the transfer of their provisional order, 1904, have decided to obtain information as to the success of electricity undertakings in towns similar in size to Clitheroe before deciding.

Croydon.—The tramways from Croydon to Mitcham were officially inspected on Friday, and it is expected that the West Croydon tramways will be opened in a few days.

Customs Decision.—Telephone disinfectors, for attachment to instruments, imported into the Australian Commonwealth, are liable, as "machinery and appliances, n.e.i., electrical," to import duty of 12½ per cent. ad val.

Dundee.—A special meeting of the Electricity committee will be held on Monday, to consider the alternative schemes prepared by the city electrical engineer (Mr. H. Richardson) for the extension of the electricity undertaking.

Mr. Richardson recommends the erection of a new generating station at Stannergate, but the alternative is to rearrange and extend the plant at the existing station. The cost of the two schemes is put as follows:—No. 1 Main station, £51,160. Sub-stations: Maryfield, £3,750; Dudhope, £3,550; West, £3,750; Lochee, £5,300; cables, £23,490—total £91,000, or without Lochee, £78,640. The estimated cost of the new station on two alternative sites is put at £82,090 and £82,010 respectively. The costs of the extensions at the present station at Dudhope are as follows: (*a*) £55,930, without Lochee £47,930; (*b*) £41,460, without Lochee £33,460.

East Ham.—The purchase of the North Metropolitan Tramway Co.'s line in the Romford-road is under consideration by the Council. The borough engineer is preparing plans and estimates for connecting up the Plashet-lane terminus to the West Ham tramway lines in Green-street.

Edinburgh.—A full abstract of the joint report of Sir Alexander Kennedy and Mr. F. A. Newington on the condition of plant, &c., at Edinburgh electricity works will be found on another page of this issue.

The Traction Corpn. (Ltd.) have submitted another offer to Edinburgh Corporation for constructing the proposed Polwarth-Mound route on the Kingsland mechanical surface contact system.

Exeter.—The income of the electricity department for the year ended March 31 was £14,586. After paying all expenses, including interest and sinking fund charges, the profit was £993.

Glasgow.—Last week the Bazaar committee recommended that the Corporation proceed at once to establish a complete public time service, combined with the supplying and lending of clocks, &c., to offices, shops and warehouses, as has been done by the Normal Zeit Co. in Berlin and Antwerp, or alternatively that an arrangement be made with Messrs. Barr & Stroud or the Magneta Co. for an extension of their respective systems. The report gave a list of 43 sites of proposed electric public clocks.

The convener (Mr. Miller), in moving the adoption of the report, urged the importance of a reliable time service for the public. An examination of 43 clocks in the city during ths past week showed that 14 were correct, 18 were fast and 11 were slow, the incorrectness varying from a quarter of a minute to three minutes. He understood that one objection to the proposed scheme was that it involved a large expenditure. But if the clocks were leased, as was done in Berlin, Antwerp and other Continental cities, there would be no large expenditure at the outset, but only a yearly charge. In that way the annual cost would not be much more than was paid at present for a time service which was not reliable.

After discussion, Mr. Miller agreed to take the matter back for further consideration.

Great Grimsby.—The capital expenditure on the electricity undertaking to March was £83,051, an increase of £2,113 during the past year.

Revenue was £11,996, and working expenses £5,699 (against £1,239), and after paying capital charges the net profit was £1,004. Private consumers' lamps and motors connected are equivalent to 52,282 8 c.p. lamps (against 42,863 at March, 1905), and 513 H.P. of motors are connected (against 345 H.P.) 105,746 units were supplied for public lighting (102,986), 556,111 to private consumers (458,224), and 460,200 for traction (463,772). The plant capacity is 900 kw., and the maximum supply demanded was 702 kw. (647 kw.). Working expenses were 1·24d. (1·084d.)

The report of the borough electrical engineer (Mr. W. A. Vignoles) states that the destructor supplied sufficient steam during the year to generate 137,577 units (against 75,019), for which £143 (¼d. per unit) has been paid. This has been included in cost of fuel. Capital charges were 6⅜ per cent., and the net profit 1·13 per cent. on capital expended. Mr. Vignoles anticipates a marked improvement in the position of the undertaking as a result of the supply which the Great Central Railway Co. are about to take.

Hackney (London).—The president of the Institution of Electrical Engineers is to be asked to appoint an arbitrator to deal with matters in dispute between the contractors for condensing plant and pipework (Ashton, Frost & Co.) and the Council.

Hanley.—The Council have decided to allocate half the surplus on the past year's working of the Electricity department to relief of rates and the other half to depreciation and contingency account. The Electric Lighting committee recommended, as stated in our last issue, that the whole of the profit (£1,266) be transferred to depreciation and contingency fund.

Hastings.—The accounts of the electricity department for the 15 months ended March 31 have been issued and show a very considerable improvement over the previous year.

At Hastings current is supplied at (*a*) a flat rate of 6d. per unit, or (*b*) on the summer and winter system, under which a charge of 6d. per unit is made for the maximum number of units consumed during one hour's burning per day (including Sunday) in each of the two summer quarters, and during three hours' burning per day in each of the two winter quarters, and in addition a charge of 2½d. per unit for all current consumed in any quarter over and above the maximum number of units. Where a consumer takes an aggregate exceeding 12,000 units per annum, supply is given at prices ranging from 4¼d. per unit for first 2,000 units per quarter to 3d. per unit for all over 7,000 units per quarter. Until Dec. 31, 1905, consumers had also an option to pay a rental of 10s. per 8 c.p. lamp per annum and to take current at 1½d. per annum.

The income from the sale of current by meter, plus £3,127. 3s. 3d. for lamp charge, was £19,536. 19s. 1d.; from public lighting £5,058. 2s. 4d. (including £1,575 lamp charge); and meter rental, &c., brought the total to £25,726. 4s. The working expenses came to £10,924. 8s. 11d. (against £9,870. 10s. 7d. in the previous year), leaving a gross profit of £14,801. 15s. 1d., against £9,597. 7s. 10d. After paying interest, redeemable stock dividends and sinking funds, and allowing £166. 18s. 2d. for bad debts, the net profit was £2,309. 9s. 8d. (compared with £116. 12s. 7d.). The total capital expended is £150,994. 3s. 3d., an increase of £14,174. 13s. 10d, during the 15 months. 1,435,122 units were generated. 934,870 units were sold to private consumers and 299,216 were supplied to the 104 public lamps. The total maximum supply demanded was 680 kw.

The borough electrical engineer (Mr. Russell F. Ferguson) and his staff are to be heartily congratulated upon their success in bringing the Hastings electricity undertaking into such a sound financial condition, and the Council, recognising this good work, have increased Mr. Ferguson's salary from £375 to £450, with increments of £25 a year, to £600, provided Mr. Ferguson remains with the Council until March 25, 1912.

Hearts of Oak Benefit Society's Building.—The new head offices of the Hearts of Oak Benefit Society, in Euston-road, London, W.C., which are to be opened to-morrow (Saturday) by the King, are lighted electrically throughout, current being supplied from the mains of the St. Pancras Borough Council. There are about 1,000 incandescents, about 270 of which are carried by bronze electroliers specially designed by the architects and made by Veritys Limited. The contractors for the installation are Messrs. Donnison, Sillem & Co. There are five Waygood electric lifts (two of them passenger lifts). The contracts for the electric lighting and for the electric lifts were executed in accordance with plants and specifications prepared by Mr. W. H. Thornbery, consulting engineer, Birmingham, and under his supervision.

Hendon.—Steps are about to be taken to lay cables in the central part of this district by the Electric Supply Corpn.

Kirkintilloch.—The Council's provisional order (1903) has been extended for another year.

Leeds.—The capital expenditure on the electricity undertaking at March last was £827,855, an increase of £10,551 during the year.

Revenue was £94,256 (against £84,417). Working expenses (including £3,494 net cost of replacing a 200 kw. set) were £31,800 (against £28,364). After meeting capital charges (£59,211, against £55,770) the net profit (£3,245, against £283) has been carried to reserve. 9,197,259 units were sold (against 7,030,681), 682,404 were supplied for street lighting (217,997), 5,102,979 for private lighting (4,871,731) and 3,411,876 for power and heating (1,940,953. For lighting the equivalent of 297,139 35 watt lamps is connected (264,628) and the aggregate horse-power of motors installed is 5,471 (3,904). The average price per unit was 2·46d. (2·88d.) and the cost per unit, including capital charges, 2·38d. (2·87d.)

The tramway accounts for the past year show receipts of £312,166, against £298,233 in previous year. Working expenses were £156,399 (against £161,713). 7,211,866 car-miles were run (against 7,121,038) and the earnings per car-mile were 10·51d. (10·15d.)

London County Council.—At Tuesday's meeting £1,776 was loaned to Islington for electric lighting.

Lighting the L.C.C. School of Building.—On Feb. 20 the Council decided to spend £2,250 in electric lighting plant for the L.C.C. school of building at Brixton. Since then the Education committee have negotiated with the South London Electric Supply Corpn , and now recommend that £2,050 be spent in fixing motor generators, switchboards, wiring, &c., and that the offer of the company be accepted to supply current to the school at 1¼d. per unit for five years. Agreed.

Islington and Highbury Tramways.—The Highways committee reported having arranged in connection with the reconstruction of the tramways from the Angel to Highbury for Reid Bros. to lay the cable ducts as an extension of their present contract at an estimated cost of £1,400, while the necessary switch gear and feeder pillars will be obtained from Eckstein, Heap & Co. and W. T. Glover & Co. at schedule rates under their existing contracts.

Edgware-road Tramways.—It was agreed to authorise the Highways committee to again confer with Middlesex County Council with a view to reviving the scheme for a tramway from the Marble Arch to Cricklewood, which, it will be remembered, was rejected recently by a Select Committee of the House of Commons.

Manchester.—An inquiry was held on Friday into the application of the Corporation to borrow £63,000 for extensions of the electricity undertaking—viz., £8,656 for plant at nine sub-stations, £14,000 for supply of current to six consumers, £12,450 for prospective requirements in supply of motive power, and £27,394 for distributing mains, service cables, &c.

The deputy town clerk (Mr. Hudson) said the loan would not involve any charge on the rates. On the contrary, it was hoped that in a few years the department would be able to relieve the rates. It was calculated that the six large firms proposing to take the current for power would need at least 10,000,000 units per annum. That would be remunerative work from the Corporation standpoint, and would have the advantage of providing a day load for the plant. The firms included the Fine Cotton Spinning Co. which would be the first instance in the city of electricity being used for power in a cotton mill.

The city electrical engineer (Mr. S. L. Pearce) gave technical details. Agreements had been entered into with Armstrong, Whitworth & Co., Beyer, Peacock & Co., Hans Renold and Mather & Platt, which would entail an expenditure on this heading of about £5,000. Two new lighting feeders were required for the supply to the northern portion of the city area; also distributing mains in various parts of the city and in Levenshulme and to the works of Johnson & Nephew and the Shaw Jardine cotton mill, and for two new traction feeders in the city and one in Levenshulme. £12,000 was included for additional mains to supply prospective consumers. An expenditure of £500 was estimated for instruments and testing apparatus for the laboratory.

The chairman of the electricity committee (Councillor Howarth) said that since 1902 the consumers had increased from 4,013 to 6,339, the equivalent 8 c.p. connections for lighting and power from 414,115 to 847,534, while the units sold for traction increased from 10,502,299 to 40,620,514, and the revenue from £134,463 to £330,370. During the past few years the increase in the sales of electricity, more particularly for tramways and power, had been exceptional. During the year ended March, 1902, 10,502,000 units were sold, against 40,615,000 units during the year ended March, 1906, an increase of 286 per cent. Since the establishment of the department in 1893 £300,768 had been set apart as sinking fund, £108,515 stood to the credit of reserve and renewals suspense accounts, and £52,964 had been passed over to the city fund. He asked that the loan might be for a period of 25 years.

On Tuesday the Tramways committee received and accepted the resignations of Mr. J. Eades, tramway rolling-stock superintendent, and the foreman mechanic, and the committee adopted suggestions of the general manager (Mr. J. M. M'Elroy) for filling the vacancies thus created. The rolling-stock department is to be re-arranged by the appointment of a superintendent with electrical and mechanical knowledge, who will have control of the entire works, with a works manager or foreman as assistant.

Municipal Telephony.—The second balance-sheet of Swansea Corporation telephone system shows a net profit of between £700 and £800.

Provisional Orders Revocation.—The Board of Trade have revoked the North Worcestershire (Bromsgrove Urban) (1904) and the Bromsgrove (1901) Electric Lighting Orders.

Seattle-Alaska Telegraph Cable.—The submarine telegraph cable between Seattle and Alaska, which was opened for traffic in Sept., 1904, is reported to have shown gratifying financial results, the receipts for 1905 being £25,971, a general increase going on throughout each month of the year.

Spain.—In the district of Bilbao there is now hardly a town or a village, especially when situated in the vicinity of running water, where electric light is not employed as an illuminant. The use of electric motors in small industrial operations is becoming universal in the Bilbao district, where recently some 4,000 further horse-power of electric energy was introduced from Guipuzcoa, and where during the current year about 8,000 H.P. is to be added to the present large use of electric power.

In 1905 101,194 incandescent lamps were imported into Bilbao, of which only 1,133 came from the United Kingdom, the Netherlands, Belgium and Germany being the chief sources of supply.

The manufacture of incandescent lamps has recently been taken in hand in Spain, and in both Madrid and Pampeluna works have been erected for the manufacture of these articles. At Barcelona the manufacture of dynamos and motors is being undertaken on a considerable scale.

Sunderland.—The profit on the municipal electric tramways for the year ended March was about £3,500.

Taunton.—Subject to the approval of the Board of Trade the undertaking of the Taunton & West Somerset Electric Railway & Tramway Co. is to be transferred to the Taunton Electric Traction Co. for £26,346. 11s. 4d.

Walthamstow.—The Council have received sanction to borrow £13,382 for the purchase of additional plant for the electricity department. The electrical engineer is to report as to the cost of obtaining the necessary apparatus to enable the Council's men to re-wind armatures.

West Ham.—The electrical engineer (Mr. A. Hugh Seabrook) reported to the Corporation on Tuesday that the electrical adviser to the Board of Trade (Mr. A. P. Trotter) recently paid an unofficial visit to the power station, and expressed himself perfectly satisfied with the manner in which the overhead arc lighting wires had been erected by the tramways department, and stated that West Ham had established a precedent. The Board of Trade have had many applications from other towns for sanction to the same system, and Mr. Trotter therefore came down to see for himself the appearance and safety of the overhead wires.

Mr. Seabrook has also reported to the Council that the agreement with the Dock Co. in regard to the supply of current to Silvertown is now practically settled. To provide for all future requirements of the electricity department it will be necessary to lay 18 further lengths of conduit, the total estimated cost being £17,239, made up of two 6,600-volt 0·2 cables, £6,741; transformers, switch gear and connections, £6,835. This will increase the capacity of the works by 8,000 kw., and already orders are in hand for 2,000 H.P. One inquiry was from a large flour mill over 5,000,000 units per annum. The average revenue anticipated at an average price of 1d. per unit is £17,000 (for 4,000,000 units per annum). Mr. Seabrook's report was approved, and authority was given to proceed with the work.

Wigan.—The Tramways committee have abandoned the proposed tramway extension to Abram.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Portsmouth Corporation invite tenders for supply of tramway feeder cables. Specifications, &c., from the tramways engineer (Mr. V. G. Lironi), Vivash-road, Fratton. Tenders to the town clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, by 10 a.m. June 5. See also an advertisement.

Portsmouth Corporation also invite tenders for 18 double deck tramway electric motor cars. Specifications, &c., from the tramways engineer (Mr. V. G. Lironi) and tenders to the town clerk (Mr. Alex. Hellard), Town Hall, Portsmouth, by 10 a.m. June 5. See an advertisement.

Torquay Town Council invite tenders for the supply, delivery and erection complete of condensing plant, consisting of one surface condenser and steam-driven air and circulating water pumps, together with the necessary pipework connections and sundry other ironwork. Tenders to the town clerk (Mr. Frederick S. Hex) before noon June 1.

The Metropolitan Asylums Board invite tenders for supply of builders', engineers', smiths', plumbers', gas fitters' and miscellaneous ironmongery and electrical accessories. Tenders to offices of the Board, Embankment, London, E.C., by 10 a.m. May 30.

Colwyn Bay and Colwyn District Council invite tenders for supply, delivery and erection of water-tube boiler, steam dynamo and condensing plant. Tenders to the clerk (Mr. James Amphlett), by noon June 1.

Handsworth (Staffs.) Education committee invite tenders by June 5 for wiring education offices and schools at Perry Barr and Handsworth. Specifications from Mr. F. A. Nixon, Generating Station, Soho-road, Handsworth.

Handsworth (Staffs.) Council want tenders by noon May 30 for a borehole pump, electric motor, &c., for Grove-lane baths.

Mansfield Corporation invite tenders for a battery of accumulators and reversible booster and switch gear. Tenders to the town clerk (Mr. J. Harrop White) by noon 30th inst.

Glasgow Corporation want tenders by 10 a.m. 28th inst. for wiring the new St. Paul's parish church. Forms of tender from Mr. Colin Young, 124, St. Vincent-street, Glasgow.

Dublin Lighting committee invite tenders for sub-station switchboards and accessories and transformer pillars. Tenders to chairman of Lighting committee, 3, Cork-hill, Dublin, by 28th inst.

Bradford Corporation want tenders by 26th inst. for tramrails, fishplates and joint pieces.

Hull Corporation want tenders by noon June 1 for two Lancashire boilers for the tramway power station.

Radcliffe Council want tenders by June 16 for granite setts tramrails, fishplates, &c., and for special track work.

Nuneaton and Chilvers Coton Electric Light Committee require tenders for a 200kw. steam dynamo. Tenders by noon of June 12th.

Bradford Electricity Committee require tenders by 10 a.m., June 1st, for 12 months' supply of steam coal.

The "Gaceta de Madrid" of May 15 contains a notice inviting tenders for the electric lighting of the town of *Trigueros*, Spain, for 20 years.

TENDERS RECEIVED AND ACCEPTED.

Southampton Corporation have received the following tenders:—

	Storage Battery.		
Tudor Accumulator Co. (*acc.*)	£1,250	Chloride Elec. Storage Co	£1,418
Hart Accumulator Co.	1,672	British Accumulator Co.	1,371
D. P. Battery Co.	1,550	Accumulator Industries	1,370
Premier Accumulator Co.	1,465	Elec. Power Storage Co.	1,178
Pritchetts & Gold	1,442		
	Chain Grate Stoker.		
Babcock & Wilcox (*accepted*)	£230	Edward Bennis & Co.	£247
Stirling Boiler Co.	276		

Bruce Peebles & Co. have secured an important contract for the erection and equipment of the Delhi electricity supply station and the construction of the local tramways (about 10 miles of track). The amount of the contract is £103,000.

West Ham Corporation have accepted the following tenders: British Insulated and Helsby Cables, tramway cables from Canning Town power station to Stratford (at £1,956 per mile), total £3,650; General Electric Co., changing a 600 kw. alternator, £815; Babcock & Wilcock, pipework for turbo-generator, £95.

Battersea (London) committee have accepted the tender of the Electric Construction Co. for an additional switchboard panel; of E. F. Moy (Ltd.) for a reverse-current circuit-breaker; of Nalder Bros. & Thompson for alteration to switchboard; and of the General Electric Co. for a switchboard meter.

Greenock Corporation have accepted the following tenders:— Belliss & Morcom, two quick-revolution engines to drive two 750 kw. dynamos; British Westinghouse Co., two 750 kw. dynamos, and one 750 kw. motor-generator; Mirrlees Watson Co., surface condenser, to condense 30,000 lb. of steam per hour.

Marylebone (London) Council have received the following tenders for pipe work for the extension of the condensing system at the generating station: Babcock & Wilcox (*provisionally accepted*), £1,375; Jas. Simpson, & Co., £1,493; John Cochrane & Sons, £1,391. 10s.

Hackney (London) Council received nine tenders (varying from £3,285 to £4,784) for work in connection with the condensing plant scheme of the electricity department, and the lowest (that of T. W. Pedrette) was accepted.

The tender of the Lancashire Dynamo & Motor Co. (Ltd.) has been accepted by Govan Corporation for supply of electric motors for all sizes over 3 H.P. for the ensuing year, this being the third consecutive year that the company has obtained the contract.

Fulham (London) Council have accepted the tender of A. C. Potter & Co. at £300 for providing and fixing new pumping plant for the artesian well at the electricity works.

Govan Corporation have accepted the tender of Electromotors Limited, Openshaw, Manchester, for C.C. motors from ½ H.P. to 3 H.P. (both medium and slow speeds) for the forthcoming year.

The contract for the switchboard required at the Shanghai-Nankin Railway workshops has been placed with Kelvin & James White (Ltd.)

Stepney (London) Council have accepted the tender of E. & F. Wright for 25 large and 25 small cast-iron chambers for street disconnecting boxes at 31s. 6d. and 23s. 6d. each chamber respectively.

Wigan Electric Light and Tramways committee have accepted the tender of W. T. Glover & Co. for cables.

Walsall Corporation have accepted the tender of the Stirling Boiler Co. for a boiler.

Coventry Electric Light committee have conditionally accepted the tender of J. & H. McLaren for two engines at £8,512.

Hackney (London) Council have placed an order with Nalder Bros. & Thompson for repairs to the battery regulating switches.

The Adams Mfg. Co. have secured the contract for the year's supply of motor-starting rheostats at Govan.

Guildford Council have accepted the tender of Carling, Gill & Carling for wiring the castle grounds bandstand.

Doncaster Corporation have placed an order with Pritchetts & Gold for 133 450 ampere-hour standard lighting cells.

Walthamstow Council have placed an order with White. Jacoby & Co. for repairing three armatures at £130.

BUSINESS NOTICES.

Wm. Sierwald and Hy. Atkinson, electricians, &c., 73, Corporation-road, Middlesbrough, have dissolved partnership. Debts by Mr. Sierwald, who continues in his own name.

Fred. Howard Walker has retired from the firm of Walker & Hutton, electrical engineers, Scarborough. Debts by the remaining partners, who continue under same name.

As from May 17 the business carried on by the Simplex Steel Conduit Co. (Ltd.) will be continued under the name of Simplex Conduits (Ltd.)

W. T. Henley's Co.'s Works.—Statements having appeared in some of the papers that W. T. Henley's Telegraph Works Co. were removing their works from North Woolwich to Gravesend owing to the high rates prevalent in the London area, Mr. George Sutton, managing director, writes on behalf of the company to say that although the rates form a heavy charge on their business they have no intention of removing from their works at North Woolwich, but they have erected the additional works at Gravesend to meet the great expansion of the business in the manufacture of electric lighting and power cables, which had outgrown the capacity of their Woolwich factory.

BANKRUPTCIES, LIQUIDATIONS, &c.

Albert Dickinson, electrical engineer, 19, Upper Mill-hill, and the Electrical Works, Dixon-lane, Wortley, Leeds, has been adjudicated bankrupt. First meeting of creditors May 28 at 22, Park-row, Leeds, and public examination on June 26 at County Court, Leeds.

A receiving order has been made against Theodore Ferdinand Rene, electrical engineer, 9, Plum Tree-court (formerly of 6, Snow-hill), London, E.C. The first meeting of creditors June 1 at Bankruptcy-buildings, London, W.C.

The Catania Electric Lighting & Tramways Co. (Ltd.) is being wound up voluntarily. Mr. A. J. Lawson, 4, Adelphi-terrace, London, W.C., is liquidator.

The Tramways Extension Synd. (Ltd.) is being wound up voluntarily. Mr. E. Davies, 5, London Wall-buildings, E.C., is liquidator.

Sale by Auction.—Mr. John Sulley will sell by auction on the works, 2 and 4, Dodd-street, 17-23, Farrance-street, Limehouse, London, E., at noon on June 12, some specially-constructed machinery for rubber manufacturers, waterproofers, &c., including six indiarubber proofing machines, polishing and pumicing machines, washing mills, dough mixers, masticators, strainers, mixing mills, calenderers, g.p. digesters, semi-curer, two vulcanisers with rollers and trays, tubing machines and wire spinner, dry curing room or stove with gear complete, a 400 light dynamo, steam engine, boiler, shafting, pulleys, &c. The machinery, which may be viewed by appointment, will be on view on day prior to and on morning of sale. Catalogues and further particulars from the receiver (Mr. Edward C. Moore), 3, Crosby-square, E.C.; Crosse & Sons, 7, Lancaster-place, Strand, W.C.; and from the auctioneer, 46, Cannon-street, E.C., London.

Plant for Sale, &c.—Messrs. Sabberton Bros., engineers, Norwich, advertise for sale a 63 B.H.P. motor, starting switch, shunt regulator, &c.

Tynemouth Corporation are willing to receive tenders for the purchase of a 600 kw. steam generator (continuous current) which they have for sale owing to their having arranged for a bulk supply. The plant is new, and is still at the respective makers' works, where it can be seen by appointment. Some particulars are given in an advertisement, and full details can be obtained from the borough electrical engineer, Mr. C. Turnbull, electricity works, Tynemouth.

Liverpool Corporation electric supply department have for sale two Lancashire boilers, Worthington feed pump and feed-water heater, two w.-i. tanks, two Browett-Lindley and two Willans engines, direct coupled to Siemens dynamos. The plant may be viewed on application to the resident engineer, Highfield-street, Liverpool. See also an advertisement.

Messrs. G. Elliott & Co., 186-188, Long-lane, Bermondsey, London, S.E., have for sale two Holmes and one Ellwell-Parker dynamos, also Johnson & Phillips dynamo and steam engine, some electric motors, &c. See an advertisement.

The Efandem Co., 67A, Shaftesbury avenue, London, W., have for sale a rotary transformer. See advertisement.

Mr. John Vincent, jeweller, Weymouth, advertises for sale some private electric lighting plant.

Business for Sale.—The business of A. J. Harris & Co. (Ltd), electrical and mechanical engineers, dynamo and motor manufacturers, Bradford, is advertised for sale as a going concern. Particulars from Mr. Geo. Walker (Messrs. Armitage & Norton, C.A.), Halifax Commercial Bank-chambers, Bradford.

Electrostatic Voltmeter and Multiplier.—Lord Kelvin's multicellular electrostatic voltmeter is a well-known type of instrument supplied by Messrs. Kelvin & James White in either portable or horizontal scale pattern. A new pamphlet has been issued fully describing the latest type of this instrument. In the past the shortness of the useful scale and inequality of the divisions at either end of the scale have been objections, but in the form described in the new circular these difficulties have been overcome. It will be seen by reference to the accompanying Fig. A, which is a reproduction of an actual scale, that the divisions are practically equal throughout and the length of the scale is 6 in. Another objection to these instruments was that the case was connected to one of the two terminals, and as the instrument was supported on insulated legs there was always a possibility of the operator getting a shock from the case. This objection has also now been entirely overcome, and the case of the instrument can be connected to earth with perfect safety. Other improvements have also been made in the latest types of this instrument. A multiplier for use with elotrostatic voltmeters has been provided, consisting of a series of non-inductive resistances and a switch suitably arranged so as to give even values for the constants. This multiplier and switch can be fitted to the instrument in the space below the scale at the front, as shown in Fig. B.

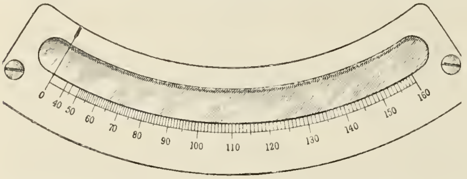


Fig. A.

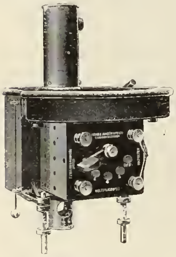
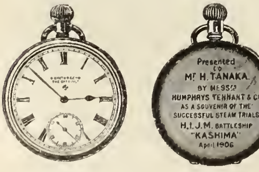


Fig. B.

High Grade Watches. – Messrs. S. Smith & Son, of 9, Strand, London, W.C., have acquired a world-wide fame for their watches and other time and speed-recording instruments. Certainly amongst members of the electrical profession and industry the manufactures of this firm are favourably known. It is not, therefore, surprising that, looking out for a suitable and serviceable souvenir for presentation to the Japanese sailors who recently visited this country to take over the battleships built here for the Japanese Government, an English watch of Messrs. Smith & Son's make was the favoured object, and a large order for these watches was accordingly placed, for presentation to the entire crew of the "Kashima," to celebrate her successful steam trials. The "Charing ✠" watch, which we illustrate herewith, was selected for the purpose, and it will be seen that each man is identified by having his name engraved upon the back of the watch.



The "Charing ✠" Watch.

Electric Shipwork.—An illustrated catalogue relating to electric light installations and electrically-driven ships' auxiliary machinery on warships, merchant vessels, &c., has been prepared and issued by Clarke, Chapman & Co., Gateshead, makers of all classes of machinery and apparatus for lighting, power, steering, &c., on board ship. The accompanying Fig. 1 shows a ship lighting generating set with enclosed high-speed forced-lubrication engine, and Fig. 2 an electric capstan windlass fitted with two lifters, suitable for working a $1\frac{9}{16}$ in. stud link cable, this being loose on the shaft and provided with patent direct grip action, preventing the movement of the lifters along the shaft in either direction unless the handwheel be turned. Other illustrations in the list show various pieces of machinery for use on board ship, including windlasses, baggage winches, anchor and warping capstans, vertical motors for use on floating docks for driving pumps, &c. An excellent idea of the large amount of work of this class which has been executed may be gathered from the long list of warships, troopships floating docks, merchant vessels, trawlers, yachts, &c., which have been provided with machinery and apparatus by Messrs. Clarke, Chapman & Co.

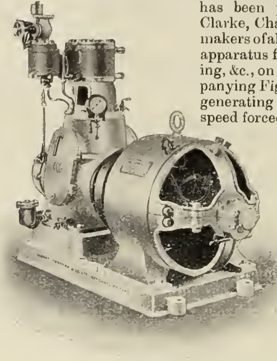


Fig. 1.—Ship Lighting Generating Set, by Clarke, Chapman & Co.

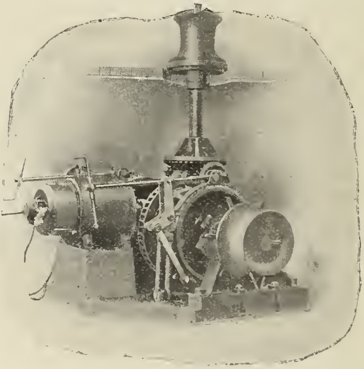


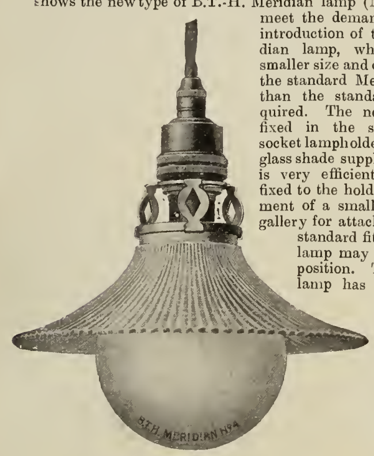
Fig. 2.—Electric Capstan Windlass, with Two Lifters, by Clarke, Chapman & Co.

Tantalum Lamps.—There is now ready a new price sheet (150) describing a novelty in the shape of the Tantalum "Sun" lamp. This is illustrated in the accompanying figure. The Tantalum "Sun" lamp is made on the same principle as the standard lamp, but is provided with a filament rated for 45 British c.p., and enclosed in a bulb 4 in. in diameter. The lamp proper consists of bulb, lampholder, gallery and holophane glass shade. It is claimed that the useful life and the total life of this lamp are appreciably longer than the standard Tantalum lamp owing to the larger bulb. Messrs. Siemens Bros. & Co. state that the efficiency of the filament is, as with the standard lamp, about 1·7 watts per rated c p., but owing to the special disposition of the filament relatively to the holophane shade a downward illumination is obtained of 180 c.p., giving the remarkable efficiency of 0·45 watts per c p.

Tantalum "Sun" Lamp, complete.

Flame Arc Lamps.—A new list of "Excello" flame arc lamps (replacing former list 5,003) is issued by the Union Electric Co., 151, Queen Victoria-street, London, E.C. The new list contains much more additional information regarding the "Excello" lamps than was formerly available, both with regard to their construction and erection. Reference is made to the newer apparatus now sent out with the "Excello" lamp; a comparative table showing the running cost of "Excello" lamps is given; and a report from the Westminster Testing Laboratories with curves showing the results and tests made with these lamps is also included. The "Snowball Excello" arc lamp which burns with pure carbons is fully described. This lamp has been designed to meet the demand for a light with the superabundant violet rays eliminated, for interior and exterior illumination where the effect upon the red colours exhibited has been found to be a disadvantage. The "Snowball Excello" lamp produces no chemical vapour, gives a perfectly steady, reliable and very clear true illumination, and has a high terminal voltage (90 v. across terminals), so that one lamp can be used singly on 100 to 110 volts circuits, and two lamps in series on 200—230 volts. To distinguish this lamp from other "Excello" lamps a pine shape globe is supplied and the lamp is particularly recommended for shop lighting, where true rendering of colours by artificial light is of great importance; and for picture galleries and similar places.

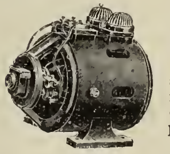
New B.T.-H. Meridian Lamp.—The accompanying illustration shows the new type of B.T.-H. Meridian lamp (No. 4), designed to meet the demand created by the introduction of the B.T.-H. Meridian lamp, where a lamp of smaller size and candle power than the standard Meridian, but larger than the standard 16 c.p., is required. The new lamp can be fixed in the standard bayonet socket lampholder. The "Prisms" glass shade supplied with the lamp is very efficient, and is readily fixed to the holder by the employment of a small shade carrier or gallery for attaching the shade to standard fittings, so that the lamp may be burned in any position. The new type of lamp has a rating of from 32 c.p. to 35 c.p., with an energy consumption of 60 watts. 4 in. frosted or obscured spherical bulbs are supplied with the lamp, which is made for voltages of 100/125 and 200/250.



New Type B.T.-H. Meridian Lamp.

Catalogues, &c.—Alternating-current instruments (ammeters and wattmeters) for laboratory use, of the shunted pattern, are listed and described in a new circular issued by Elliott Bros., Century Works, Lewisham, London, S.E., who also have ready a new circular list of Partridge's sparklet fuses. The illustrations of this circular show the fuse open and closed.

A new type of alternating to continuous current transformers of small size is described in a circular issued by the Crypto Electrical Co., London. The machine is shown in the accompanying illustration. It will be seen that the base plate, coupling and one pair of bearings have been dispensed with, and the rotor of the motor is built on the same shaft as the armature of the dynamo, making the machine more compact, its dimensions being only 15 by 13 by 11. The machine is at present being made in one size only for an output of 100 watts on the secondary. The primary can be wound for single, two or three-phase, and for any voltage and periodicity. The weight is 72 lb.



Crypto Transformer.

A. Reyrolle & Co., of Hebburn-on-Tyne, have ready two new pamphlets (Nos. 28 and 29) dealing respectively with house service fuse boxes and iron-clad distributing boxes. The former is a very concise list, showing the various sizes and designs of house-service boxes manufactured by Messrs. Reyrolle as standard articles. The company have a section of their Hebburn works specially equipped for the manufacture of these boxes. The distributing boxes are a special line of this firm's manufactures, the boxes being made specially for use in factories, shipyards, on board ship, &c., where a damp-proof and fire-proof apparatus adds to the safety and convenience in working the installation. In this pamphlet there is a type of stamped fuse illustrated, these fuses being made for the more convenient working capacities, and stamped clearly with the current at which the fuse will blow. The use of these stamped fuses tends to eliminate the risks which accrue owing to thoughtless attendants using the wrong size fuse.

A new list of desk and ventilating fans is issued by Veritys Limited, who notify that large stocks of these fans are kept at this season of the year.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on May 16 to 22, with the ports of destination :—

Aden, £203. *Africa*—Alexandria, £387 (including £38 telegraph material); Beira, £183 (telegraph material); Cape Town, £1,036 (including £786 telegraph material); Delagoa Bay, £170; Durban, £2,002 (including £398 telegraph material); East London, £101; Larache £8; Port Elizabeth, £21; Port Said, £60. *Argentina*—Rosario, £122 (telegraph material). *Australasia*—Adelaide, £31; Auckland, £61; Brisbane, £77; Fremantle, £70; Lyttelton, £50; Melbourne, £744; Napier, £60; Otago, £409; Perth, £7; Sydney, £1,386 (including £121 telegraph material); Wellington, £129 (including £25 telegraph material), *Azores*, £26 (telegraph material). *Belgium*—Ghent, £15. *Brazil*—Rio Janeiro, £1,814 (telegraph apparatus). *British Guiana*—Demerara, £50. *Burma*—Rangoon, £13. *Canada*—Halifax, £115 (telegraph material); Montreal, £701. *Ceylon*—Colombo, £176. *China*—Shanghai, £100; Tientsin, £95 *Cochin China*—Saigon, £16. *Denmark*—Copenhagen, £7. *France*—Paris, £110. *Gibraltar*, £285 (including £79 telegraph cable). *Holland*—Amsterdam, £233 (including £38 telegraph material). *India*—Bombay, £949; Calcutta, £970. *Italy*—Genoa, £200, *Japan*—Kobe, £399. Tokyo, £365 (telegraph material); Yokohama, £19. *Java*—Batavia, £40. *Malta*, £75. *Mauritius*, £183. *Portugal*—Lisbon, £8. *Russia*—Kurch, £638; Odessa, £200 (telegraph material). *Riga*, £15. St. Petersburg, £30. *Siam*—Bangkok, £157. *Spain*—Bilbao, £714. *Straits Settlements*—Penang, £297 (including £86 telegraph material); Singapore, £273 (including £98 telegraph material). *Sweden*—Stockholm, £68 (telegraph material). *U.S.A.*—New York, £256. *Zanzibar*, £22 (telegraph material). Total £16,952, against £36,953 in the corresponding week last year (May 17 to 23).

COMPANIES' MEETINGS AND REPORTS.

West India & Panama Telegraph Co. (Ltd.)

The fifty-eighth ordinary general meeting was held on Wednesday, Mr. Walter Bishop Kingsford presiding.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, before proceeding to the ordinary business of the meeting, I regret to announce the death of Mr. William Stratford Andrews, who was for many years intimately associated with the affairs of the Company as a Director and afterwards as our Chairman. I am sure that all of you who knew him will sincerely join with his old oclleagues and the staff in very cordial sympathy with Mrs. Andrews and the family. As regards the accounts there is very little to which I need call your special attention. The receipts are £895 in excess of those for the corresponding period of 1904, and the expenses are £1,810 more. It is rather curious to notice how little variation there is in our receipts and expenses. For instance, in the expenses of the June and December half-years of 1905 there is a difference of only £1. 1s. 2d. As you will have seen from the report, several interruptions of the cables occurred in the early months of this year, caused to some extent, as we have reason to believe, by earthquakes which then took place. In these exceptional circumstances we felt that it would be impossible for our own ship, the "Henry Holmes" to alone overtake the repairs. Accordingly, we at once chartered the cable ship "Cambria," belonging to the Telegraph Construction & Maintenance Co., and we sent her out to the West Indies in March last. I am very glad to be able to report that she succeeded in doing the work assigned to her not only with thorough efficiency, but very promptly, and as a matter of fact she is now on her homeward passage. We have thought it well to strengthen our Board since I last had the pleasure of addressing you by inviting Sir John Cameron Lamb to become a Director of the Company. I am much pleased to tell you that Sir John has accepted our invitation, and I feel confident that his ability and long experience as a former Secretary of the General Post Office, and his intimate knowledge of telegraphic affairs, will be a very great advantage to us (hear, hear).

The Chairman then went through the correspondence which has passed between the Company and the Colonial Office on the subject of certain proposals made by the Company for extending the cable system in the West Indies. In this connection the Chairman (supported by the whole of the board of Directors) complained of a most remarkable and most unjustifiable speech made by the Governor of the Windward Islands (Sir Robert Llewelyn) to the Legislative Council of Grenada, reported in the "St. George's Chronicle and Grenada Gazette" of Feb. 17, 1906—as follows :—

"His Excellency: I will be quite candid with the Council. The principal object of the Government is to bring matters to a head. There can be no doubt that the service supplied to us is very unsatisfactory, so we hope to force the Company into liquidation so as to make room for an all-British Cable Company, who will buy up the old cables, or lay down new ones. We have been following the financial position of the Company, and I am afraid their position is getting worse every day. They can no longer borrow money to lay new cables or make repairs."

Continuing, the Chairman said he had addressed the strongest possible remonstrance to Lord Elgin, Secretary of State for the Colonies, asking him to demand from the Governor of Grenada the immediate withdrawal of these grossly improper and unfair statements, which were made publicly in the Legislative Council over which he was officially presiding, and have become widely known in the West Indies and among persons here who are interested in the islands. The Chairman continued: What I have just read to you explains the reduction of the Grenada subsidy. I may tell you that we have taken steps to let the Colonial Office know that we do not acquiesce in the reduction of the Grenada subsidy, and to urge that it be restored to its former amount. We shall also take every means in our power to bring about the restoration of the St. Vincent subsidy of £400 per annum. I followed up my letter of protest by a personal interview at the Colonial Office, in which I was accompanied by Sir John Lamb, and we took the opportunity of urging the claims of the Company to favourable consideration generally. We have also to complain of the treatment we have received in connection with other matters affecting the interests of the Company. In view of this serious position of affairs, we have communicated, not only with the Colonial Office, but also with the Treasury, the Admiralty, the War Office, the Post Office and the Cable Landing Rights Committee. We are, in fact, doing everything in our power to resist the unjust attack which is being made on the position of our Company—(hear, hear)—an old-established British company, having over 1,800 shareholders. Our Company has continuously carried on its work in the West Indies for 36 years, doing its very utmost to keep the system in efficient working order, and, as a matter of fact, at the present moment there is no interruption of communication throughout the Company's system. I now move the adoption of the report and accounts.

Mr. HENRY HOLMES: I beg to second that.

Mr. FREND congatulated the Board on having elected Sir John Cameron Lamb to a place on the directorate. Sir John no doubt would have noticed that this unfortunate Company did not do so well as the Post Office Savings Bank (laughter). As they all knew, the Directors had struggled for many years to keep up an efficient system of telegraphic communication with the West Indies, and during all that time the shareholders had got very little from their investment. Some people seemed to be at the throat of the Company; but shareholders must all be thankful and grateful to the Board for the manner in which they had defended the interests of the Company. No sooner, it appeared, had the Directors got clear of one difficulty than another difficulty cropped up; indeed, it had been one continuous struggle on the part of the Directors and shareholders. As regarded the attack of the Governor of the Windward Islands, referred to by the Chairman, he suggested that if that gentleman liked to buy up the Company he was perfectly at liberty to do so at a fair price. He thanked the Chairman for telling them about the subsidies, and suggested that the service should be withdrawn from those colonies that did not pay. He asked for some information regarding an item in the balance-sheet under capital expenditure, cables, stations, landlines, instruments, concessions and other assets, as per last account, £1,314,756. 2s. 7d. That item appeared in their accounts from half-year to half-year, and he should like some information regarding it. He noticed in the accounts certain amounts charged in respect of insurance of ship and cable, and hoped that all the Company's property was fully insured. What would happen if, for instance, an earthquake carried the whole lot away?

Mr. QUICK (accountant to the Company) answering these points, at the request of the Chairman, said that, as regarded the item of capital expenditure, it was the cost, from first to last, of the entire cables, landlines, instruments and concessions of the Company. The capital expenditure, of course, was uninsurable, and if an earthquake were to sweep them away that would be serious for the shareholders. The item had remained all these years exactly the same as it was to-day, because they had not added to it; but they would know, as well as he did, it was not worth anything like the amount at which it stood in their books. On the other side of the balance sheet, however, they would find from time to time an amount was taken from revenue in respect of depreciation and also as a renewal fund to meet any special renewals that might be made.

The resolution was carried unanimously.

The retiring Director, Mr. W. B. Kingsford, was then re-elected, as were the retiring auditors, Messrs. Deloitte, Plender, Griffiths & Co.

Mr. FREND proposed a hearty vote of thanks to the Board of Directors.

Mr. O'BEIRNE: I have pleasure in seconding that. I think that more than ever the Directors deserve our thanks and also our sympathy and I think we can assure them of our cordial support in entering their strong protest against the action of the Colonial authorities and of the other parties concerned. I consider that the action of the Governor and of the others is abominable, and that some protest ought also to come from this side of the table (hear, hear).

The motion was agreed to.

The CHAIRMAN: On behalf of my colleagues and myself, I thank you very sincerely for the kind vote of thanks you have just passed. Such a vote at all times is a great encouragement to Directors, but to-day, in the specially difficult circumstances of the Company with which we have to deal, it is doubly helpful and doubly gratifying to us to be assured that we have your thorough confidence and support.

The proceedings then terminated.

BUENOS AYRES ELECTRIC TRAMWAYS (1901) (LTD.)—At the meeting on Friday Mr. C. S. Grenfell said the largely increased net profit for the year was accounted for by the fact that in 1905, for the first time, their complete system was in operation for the whole year. Running expenses had perceptibly decreased, having averaged 6·97d. per car mile run, a saving of nearly 1d. per mile on 1904.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The report of the directors for the past year states that the result of the year's operations is a satisfactory improvement, the best so far attained. Revenue from the supply of power and rent of plant amounted to £100,524. 16s. 7d., £2,299. 5s. 4d. was received from other sources, making £102,824. 1s. 11., the working profit being £54,410. 5s., or £5,959. 8s. 6d. in excess of that for 1904. To the £54,410. 5s. is added £4,525. 9s. 1d. brought forward, making £58,935. 14s. 1d. £24,097. 4s. 10d. has been carried to a renewal account, comparing with £16,670. 11s. 1d. set aside for depreciation in 1904. There remains £34,838. 9s. 3d., and the directors recommend a dividend of 1s. 6d. per share (7½ per cent.) carrying forward £12,338. 9s. 3d. The total energy generated during the year was 10,688,925 kw.-hours, against 10,266,410 in 1904. The steam turbine in course of erection when the last report was issued has been in operation since June and has proved satisfactory in working. Having regard to the increasing demands for electrical energy in the Witwatersrand district, the directors contemplate important extensions of the company's plant. Negotiations are proceeding with the Transvaal authorities with a view to obtaining such a revision of the company's license as will place the enterprise on a more advantageous footing, and which will also take cognisance of the altered technical conditions brought about by the progress of electrical science.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 last shows that the revenue amounted to £65,846. 3s. 6d., from which is deducted £15,731. 16s. 7d. for ordinary expenses and £13,274. 17s. 9d. for expenditure on maintenance of cables, leaving £36,839. 9s. 2d., to which is added £1,676. 7s. 8d. from preceding year, making £38,515. 16s. 10d. £1,761. 13s. 3d. has been provided for income tax, £26,000 has been transferred to general reserve and an interim dividend of 2 per cent., (absorbing £4,621. 16d.) was paid on Dec. 1 last. The directors now recommend a final dividend of 2 per cent. (tax free), making 4 per cent. for the year, £1,510. 11s. 7d. being carried forward.

NEW COMPANIES.

DELHI ELECTRIC TRAMWAYS AND LIGHTING CO. (LTD.) (88,758).—Reg. May 14, capital £170,000 in £1 shares (140,000 "preferred and participating" and 30,000 ordinary), to adopt agreements with the Punjaub Electric Traction Co. (Ltd.), and Bruce Peebles & Co. (Ltd.), for the construction and equipment of certain tramways and an electric lighting and power installation in the municipality of Delhi, to construct or acquire, equip, own and work electric and other tramways, railways and other works, and to carry on the business of an electric tramway, light and power company in India or elsewhere. First directors, Col. B. Scott, T. W. Stratford-Andrews (managing director of the Indo-European Telegraph Co.), J. M. Campion and A. W. Tait. Reg. office, Basildon House, Moorgate-street, London, E.C.

LONDON & CONTINENTAL ELECTRIC CARRIAGE CO. (LTD.) (88,803.)—Reg. May 17, capital £120 in £1 shares, to carry on the business of manufacturers and repairers of carriages, cabs, omnibuses and other vehicles driven by electricity or other power, &c. First directors: A. R. Wagg (stockbroker) and A. J. Schwelm (stockbroker).

CITY NOTES.

MEMORANDA (May 24).—Bank rate 4 per cent. (since May 3, 1906). Price of silver $30\frac{5}{16}$d. per oz. Consols $89\frac{5}{8}$—$89\frac{3}{4}$ for money, $89\frac{11}{16}$—$89\frac{13}{16}$ for account; 2½ per cent. annuities $88\frac{3}{8}$—$88\frac{5}{8}$. Consols Pay Day, June 1. Stocks and Shares Continuation Days, May 29 and June 12; Ticket Days, May 30 and June 13; Pay Days, May 31 and June 14; Mining Share Carry-over Day, May 28.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—This company has this week invited applications for 140,000 6 per cent. preferred and participating shares of £1 each at par. Letters of allotment have been posted.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed May 30 a special settling day in a further issue of £100,000 deferred ordinary stock of the *British Columbia Electric Railway Co.* (*Ltd.*) and have ordered same to be quoted. The committee have also granted quotations to a further issue of 30,000 £5 fully-paid ordinary and 20,000 £5 fully-paid cumulative preference shares of the *Urban Electric Supply Co.* (*Ltd.*), £400,000 4 per cent. debentures of the *India Rubber, Gutta Percha & Telegraph Works Co.* (*Ltd.*), and £40,000 £5 fully-paid ordinary and 46,261 £5 fully-paid 6 per cent. cumulative preference shares of the *Yorkshire* (*West Riding*) *Electric Tramway Co.* (*Ltd.*) The Committee have been asked to appoint a special settling day in and grant quotations to a further issue of 5,000 £1 (fully paid) and 128,063 £1 (15s. paid) shares of *Marconi's Wireless Telegraph Co.* (*Ltd.*), to appoint a special settling day in 18,851 £1 fully-paid vendor's shares of the *National Electric Construction Co.* (*Ltd.*), and to allow $4,635,000 $1,000 5 per cent. sinking fund coupon bonds and $1,978,000 capital stock of the *Manila Electric Railroad & Lighting Corpn.* to be quoted.

THE UTAH LIGHT & RAILWAY CO.—This company is to be taken over by a corporation consisting of Anglo-American capitalists, with a capital of $25,000,000.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 19	1,274	- 9	51	68,069	- 203
Airdrie	,, 11	216	+ 21	19	4,084	+ 419
Anglo-Argentine	,, 20	15,297	+ 2,065	20	201,684	+ 31,780
Ashton-under-Lyne Corp	,, 12	830	+ 48	8	2,652	+ 239
	,, 19	332	+ 27			
Ayr Corporation	, 19	130	- 96	1	130	- 96
Baker St. & Waterloo Ry.	,, 19	1,359	...	10	14,589	...
Barnsley	,, 11	161	+ 2	19	2,982	+ 36
Barrow	,, 11	221	+ 3	19	4,059	+ 250
Bath Electric Trams, Ltd.	,, 16	800	- 72	20	13,815	+ 1,860
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 19	615	+ 272	7	3,924	+ 1,276
*Birmingham & Mid.	,, 11	1,369	- 532	19	26,183	- 7,222
Blackburn Corporation	,, 16	1,061	+ 63	¶7	7,763	+ 605
Blackpool Corporation	,, 17	526	- 99	6	5,107	+ 213
Blackpool and Fleetwood	,, 19	374	- 9	20	5,579	+ 196
Blackp'l St. Anne's & Lytham	,, 17	291	- 30	§28	5,713	+ 616
Bolton Corporation	,, 20	1,873	- 29	7	14,854	+ 586
Bournemouth Corporation	,, 16	1,487	+ 443	†7	10,711	+ 3,175
Bradford Corporation	,, 19	4,251	+ 44	7	31,595	+ 1,710
Brighton Corporation	,, 20	825	- 113	7	6.469	- 242
Bristol Trams & Carriage	,, 18	5,036	+ 224	14	65,795	+ 3,240
Buenos Ayres & Belgrano	,, 20	3,693	+ 375	20	71,629	+ 5,049
Buenos Ayres Elec. Trms	April 21	1,403	+ 213	16	22,672	+ 4,863
Burnley Corporation	May 19	1,120	+ 18	7	8,456	+ 468
Burton Corporation	,, 20	232	- 45	§7	2 073	- 161
Bury Corporation	,, 13	973	...	6	5,975	...
Calcutta Tramways Co.	,, 19	R40,763	+ R2,681	20	R871,602	+ R90 812
Camborne-Redruth	,, 19	112	- 3	3	20,808	+ 61
Cardiff Corporation	,, 12	1,923	...	6	11,886	...
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 11	62	- 1	19	1,217	+ 328
Central London Railway	,, 19	6,693	- 22	20	136,017	- 4,369
Chatham & Dist. Lt. Rys.	,, 17	644	+ 101	†19	11,859	- 105
*City of Birm'gh'm Tram Co	,, 11	5,285	- 596	19	98,455	- 5,328
*City & South London Rly.	, 20	2,671	+ 185	20	57,163	+ 195
Colchester Corporation	,, 17	197	+ 21	§8	7,677	- 1,333
Cork Electric Trams Co.	,, 17	497	- 76	20	8,468	- 158
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 11	418	- 53	19	7,917	- 423
Dover Corporation	,, 19	208	+ 29	7	1,600	+ 154
Dublin & Lucan Railway	,, 18	106	- 23	‡20	1,962	- 119
Dublin United	,, 18	4,967	- 723	‡20	92,466	+ 1,415
Dudley—Stourbridge	,, 11	780	- 74	19	14,740	+ 220
Dundee Corporation	,, 16	1,033	+ 154	§52	49,437	+ 5,389
East Ham Council	,, 19	924	+ 93	7	6,510	+ 8 6
Exeter Corporation	,, 18	259	- 306	7	1,883	- 358
Gateshead & Dist. Trams.	,, 11	937	+ 67	19	17,367	+ 847
Glasgow Corporation	,, 19	16,516	+ 363	51	785,376	+ 52,382
Glossop	,, 19	130	+ 12	20	2,512	+ 246
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 11	228	+ 5	19	3,945	+ 172
Gt. Northern & City Rly.	,, 10	1,797	+ 215	20	85,987	+ 1,629
Greenock & Port Glasgow	,, 11	649	- 6	19	11,275	+ 742
Halifax Corporation	,, 16	1,601	+ 107	7	10,791	+ 567
Hartlepool Tramways	,, 11	267	+ 21	19	4,910	+ 310
Hastings Elec. Trams Co.	,, 17	624	...	20	9,434	...
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 19	2,101	+ 82	7	15,320	+ 117
Ilford Dist. Coun.	,, 19	495	+ 23	7	3,496	+ 204
Ilkeston Dist. Council	,, 16	132	+ 8	7	846	+ 2
Ipswich Corporation	,, 19	367	- 27	7	2,785	- 87
Isle of Thanet Co.	,, 19	392	- 41	32	9,641	- 849
Keighley Corporation	,, 17	145	...	45	6,433	...
Kidderminster & District	,, 11	95	- 23	19	1,830	- 2
Kilmarnock Corporation	,, 19	160	- 11	1	160	- 11
Kirkcaldy Corporation	,, 16	217	- 7	11	2,316	- 87
Lanarkshire Trams Co.	, 17	931	+ 183	†20	16,761	+ 8,756
Leamington	,, 11	142	+ 97	19	2,680	+ 1,291
Leeds Corporation	,, 19	5,965	+ 286	7	42,687	+ 2,556
Leicester Corporation	,, 19	2,227	+ 117	20	41,548	+ 4,020
Leith Corporation	...	...	...	...	...	...
Liverpool Overhead Rly.	,, 30	1,313	- 177	20	27,890	- 2,101
Liverpool Corporation	,, 12	10,657	+ 139	19	186,603	+ 5,468
*London County Council	,, 12	26,046	- 11,234	6	158,822	+ 75,531
London United	,, 18	6,573	+ 271	†20	106,793	+ 5,231
Lowestoft	,, 19	120	- 15	34	4,356	- 102
Maidstone Corporation	,, 17	109	- 16	7	739	- 98
Manchester Corporation	,, 19	12,872	+ 200	7	91,013	+ 4,464
Mersey Railway	,, 19	1,663	+ 168	20	34,376	+ 2,009
Merthyr	,, 11	198	+ 21	19	8,491	- 27
Metropolitan Dist. Railway	,, 20	8,100	+ 829	20	159,296	+ 9,773
*Metropolitan Elec. Trams	,, 11	8,361	+ 787	19	57,092	+ 18,444
Middleton	,, 11	318	- 26	19	5,770	+ 312
Nelson Corporation	,, 19	131	- 1	8	1,019	+ 100
Newcastle-on-Tyne Corp.	,, 19	3,741	+ 168	7	27,398	+ 1,278
Newport (Mon.)	,, 19	576	- 17	7	4,238	+ 193
Northampton Corporation	,, 18	411	+ 18	7	2,873	+ 76
Oldham, Ashton & Hyde	,, 11	566	+ 24	19	10,066	+ 375
Oldham Corporation	,, 20	1,610	+ 73	8	13,869	+ 781
Perth (N.B.) Corporation	..	...	...	...	...	...
Perth (W. A.) Elec Trams	,, 18	1,403	+ 34	‡20	30,886	+ 1,558
Peterborough	,, 11	118	- 25	10	2,019	- 145
Pontypridd District Coun.	,, 19	158	- 2	7	1,215	- 43
Portsmouth Corporation	,, 19	1,760	- 11	7	12,880	- 258
Potteries	,, 11	1,788	+ 163	19	32,820	+ 1,797
Preston Corporation	,, 16	714	+ 114	...	...	...
Reading Corporation	,, 17	598	+ 11	...	..	...
Rochdale Corporation	,, 19	973	+ 401	7	7,200	+ 3,190
Rotherham Corporation	,, 17	472	+ 60	7	8,226	+ 284
Rothesay	,, 11	112	+ 27	19	1,605	+ 333
Salford Corporation	,, 21	3,981	- 134	7	31,289	+ 805
Sheerness	,, 9	56	- 12	19	940	- 165
Sheffield Corporation	,, 20	4,879	+ 501	8	40,786	+ 2,493
Southampton Corporation	,, 16	921	+ 7	†7	5,992	+ 105
Southend Corporation	,, 16	323	+ 8	7	2,204	+ 87
Southport Tramways	,, 11	270	- 22	19	4,864	+ 56

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	May 11	786	+ 81	19	14,826	+ 2,288
Stalyb'dge, Hyde, &c., Jt. Bd.	..	...	...	...	...	...
Stockport Corporation	,, 18	1,026	+ 426	7	6,442	+ 2,444
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	,, 16	369	...	20	7,104	...
Swansea Trams	,, 11	792	+ 12	19	14,151	+ 4,165
Swindon Corporation	, 16	190	+ 12	¶6	1,240	28
Taunton	,, 11	42	- 3	19	790	- 37
Tynemouth and District	,, 11	197	- 47	19	3,465	- 65
Tyneside Trams Co.	,, 16	431	+ 37	20	7,618	+ 475
Wallasey District Council	,, 19	722	- 26	7	5,258	+ 127
Walsall Corporation	,, 19	520	+ 51	18	9,810	+ 748
Warrington Corporation	,, 17	366	+ 34	7	2,509	+ 258
West Ham Corporation	,, 17	2,246	+ 652	7	15,719	+ 5,723
Weston-super-Mare	, 9	75	- 21	19	892	+ 11
Wolverhampton Corpn.	,, 16	810	...	7	5,690	...
* Wolverhampton District	,, 11	397	+ 19	19	7,339	+ 669
* Worcester	,, 11	266	- 42	19	4,633	- 438
Wrexham	,, 11	90	- 3	19	1,797	- 47
Yorkshire W.R. Trams	,, 20	678	+ 20	20	14,771	...
Yorkshire Woollen District	,, 11	901	+ 252	19	15,849	+ 4,906

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., May 23.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to May 23. Highest.	Business, Week to May 23. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs. ex rights	7 —7½	5 10 4	Ap, Oct	7¼	7⅛
5	2/9	Do. 5½% Cum. Pref.	5⅞—6⅛	4 10 0	—	6 1/16	5 15/16
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	..	..
5	..	Brisbane Electric Trams. Invest Ord.	⅞—1⅛	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4¼	5 17 6	—	4 3/16	4 1/16
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	13 —16	4 13 9	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115 —118	5 1 6	—	116¼	..
St.	5%	Do. Pref. Ord. Stk	109 —112	4 9 3	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	0[illegible]⅛	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	102%—104%	4 6 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord	3¼—3½	4 18 8	—	3⅜	3 5/16
5	8/0	Do. 6 per Cent. "A" Cm. Pref	5⅝—5⅞	5 2 6	—	5¾	..
5	8/0	Do. "B"	5 —5½	5 7 0	—	5 1/16	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	107½	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	102 —104	4 16 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	103 —107	5 3 0	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	100 —105	5 14 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	9¼—9¾	4 2 0	—	9⅝	..
5	2/6	Do. Nos. 105,001 to 137,610	8½—9	4 9 0	..	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 3	—	107	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 —97%	5 2 6	..	97	93½
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —97	..	..	94½	..
St.	..	Do. 6% "B" Ditto	86 —90	..	..	8[illegible]½	85½
1	..	Lisbon Elec. Trams Ord.	1 1/16—1 3/16	..	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102 — 105	4 15 0	Ja, Jul	—	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —108	4 12 6	..	—	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	144 —147	..	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	99%—101%	5 0 0	..	100½	99¾
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	4 15/16	4 13/16
5	5/1	† Calcutta Elec. (1-50 000)	8½—9	4 14 0	—	8⅞	8⅝
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	10 —11	—	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	100 —102	4 18 2	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113 —116	5 3 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref. ex 7½d. on a/c of arrears	⅞—1	6 0 0	—	..	..
1	1/6	Rand Electric	1¼—1⅜	—	—	..	..
1	..	River Plate Electricity Co. Ord.	1⅞—1⅞	..	..	..	..
1	1/2⅖	† Do. 6% Non. Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4 17 0	..	102½	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	5 7/16	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	..	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 —103	4 17 0	..	101⅞	101¼

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 23.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to May 23. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	11⅝	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 8 3	..	..	—
5	3/6	Bromley (Kent) El. Lt. & Power Shares	3⅛—3⅝	4 18 0	..	..	—
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾—9¼	5 8 6	—	8⅝	..
5	3/6	Do. 7 per Cent. Pref.	8¾—9¼	3 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 —105	3 16 3	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 12 6	Feb, Aug	4½	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	102½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 —4¼	5 6 0	—	4	—
5	2/3	Do. Do. (1903)	3¾—4¼	5 6 0	—	4⅛	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	5½	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —109	4 2 6	Jn, Dec ..	..	—
10	7/0	City of London Electric Lighting Ord.	10½—11¼	5 6 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—13½	4 9 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	—	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	3 —3 1/32	4 0 0	April, Oct	..	..
5	5%	Do. Do. 5% non cum. pref.	5⅛—5⅝	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8 —9	5 11 0	—	8½	8¼
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¼	4 18 0	Mar, Sept	11 15/16	11 11/16
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	100 —102	4 8 0	..	102	101¾
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	..	..
5	5/0	Hove Electric Lighting Ord.	8¼—8¾	5 5 0	—	8 11/16	8 11/32
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 —11	4 11 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 2	..	99	—
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4½	London Electric Supply Ord.	2 —2½	4 0 0	—	2 7/32	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	3 19 2	Mr, Jn, S, D	..	..
5	10%	Metropolitan Electric Sup. Ord.	9¼—9½	5 8 0	April, Oct	9 5/16	9⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 0 0	Jan. July	5⅝	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Jn, Dec ..	111½	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 3	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 —103%	4 7 4	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11¼—11½	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 —104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅜—7⅝	5 6 8	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾—6	4 5 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	31/32—1	3 0 0	Mar, Aug	—	..
100	4½%	Do. 4½% Deb.	101 —102	4 8 3	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½—11½	5 8 0	Feb, Aug	10 15/16	10⅞
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	3	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	—	..	..	—
1	0/8¾	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	4 —4½	5 11 0	—	4¼	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	—	4 13/16	4⅛
St.	4½%	Do. 4½% 1 Mort. Deb.	101 —103	4 7 4	..	..	—
5	6/6	Westminster Elec. Sup. Ord.	10 —11	5 18 0	Mar, Sept	10 11/16	10⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16—5 9/16	4 10 0	..	5⅜	..
5	..	Do. Issued at 7/6 premium all paid	5 5/16—5 9/16	..	..	5 15/32	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 —96	4 3 4	..	94¾	94¼
1	1/0	Bath Elec. Trams Pref. Ord.	29/32—31/32	5 8 6	..	..	..
1	0/6	Do. 5% Cum. Pref.	31/32—1 3/32	4 11 6	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 —104	4 6 6	..	102½	102
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	..	—
10	8½%	Bristol Tramways and Carriage Ord.	15½—16	5 6 0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10½	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	6⅝—7⅛	4 4 0	—	7	6¾
10	6/0	Do. 6 per Cent. Cum. Pref.	9⅜—9⅞	6 1 0	Feb, Aug	9 11/16	9¼
St.	5%	Do. 5 per Cent. Perpetual Debs	114 —117	4 5 6	..	116	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 —95	4 14 9	..	..	..
St.	4%	Central London Ordinary Stock	88 —90	4 10 0	June, Dec	90	87½
St.	4%	Do. 4 per Cent. Pref. Stock	99 —101	3 19 0	..	101	99½
St.	4%	Do. Deferred Stock	77 —80	5 0 0	..	79	78
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	112	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 —95	4 4 0	..	94	93
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 —5¼	4 15 0	..	..	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	39 —41	4 10 0	Feb, Aug	40	39½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	121	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	—	—
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½—4	10 0 0	..	3⅞	3¾
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	—	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	—
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	—	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	106 —107	4 4 0	Jan, July	—	—
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 —2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1⅛%	Liverpool Overhead Railway Ord	3 11/16—3 15/16	3 13 0	Feb, Aug	—	—
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9¼—9¾	5 8 0	—	9¼	9⅛
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 —99	4 1 0	—	97¾	97½
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	31/32	15/16
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½—1½	..	May ——	..	..
10	8/0	Potteries Electric Traction Ord.	7½—8½	6 4 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8 —9	5 11 0	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	—	—	—
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	95	..
..	5%	Underground Elec. Rys. Co. of London	93 —98	5 2 0	—	97¾	96½
St.	3½%	Waterloo and City Ord.	99 —102	3 3 8	June, Dec	..	—
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 —3½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	95 —97	4 13 0	..	..	..

Shre.	Last Dividend	Name.	Price Wed., May 23.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 23. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	3¾—4	5 0 0	..	3 31/32	3⅞
1	7½d.	Do. Pref	1⅛—1⅜	3 14 0	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	5 19 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 —107	4 4 0	..	.	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅞—2⅜	..	..	2 3/32	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 —85	4 14 0	..	..	..
2	1/0	Brush Electrical Engineering	⅝—⅞	..	March ..	¾	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	85½	..
5	10,0	Callender's Cable Con. Ord. xd & bonus	11 —12	4 6 8	Jan, July	11½	11 7/16
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6	4 3 4	Jan, July	6	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	..	..
1	4½d.	Castner-Kellner Alkali Co.	1 1/16—1 3/16	5 1 6	..	1 5/32	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 —102	4 8 0	—	100	99⅞
1	9½d.	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	—	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2¼	3 6 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%—97%	5 1 0	Jan, July	97¼	97
5	10/0	Dick, Kerr & Co. Ord.	1¾—1⅞	5 8 0	Sept ——	—	..
5	3/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept ——	1¼	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	—	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	—	Feb, Aug	1⅝	..
5	2/6	Do. (£5 paid)	2½—3	—	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	4 1/32	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	4¾—5¼	5 14 0	..	5 1/16	4 31/32
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	104	..
2	1/7½	Electric Construction Co.	½—¾	9 6 6	July ——	19/32	..
2	2/9½	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 —13	5 15 0	Feb, Aug	12½	..
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	5⅝	—
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 —111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½—59½	..	..	—	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17 —18	2 17 2	Feb, Aug	17⅝	17½
100	..	Do. 4% Debs. Red.	99½—101½	..	..	100¾	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	15/16	..
1	7½d.	Do. 6% Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 10 0	..	..	..
12	4/0	Telegraph Construction & Mainten'ce.	32 —34	5 6 0	Mar, July	33½	32½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 —104	3 17 0	Jan, July	..	..
1	5/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16—2 9/16	5 15 0	..	2 9/16	2 7/16
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1¼	4 0 0	..	1 7/32	..
St.	5%	Do. 5% Non-Cum. Preferred	112 —116	4 6 0	—	116½	116
St.	4%	† Do. 4% 1st Mort. Deb. Stock Red.	103 —105	3 16 0	..	103½	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 —108	4 3 8	—	107	..
5	—	Willans and Robinson Ord.	1¼—1¾	—	Apr, Oct	—	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	—	Apr. Oct	3	2 31/32
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 —85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	3½—4	—	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	88	..
St.	15/0	Anglo-American	67 —69	4 14 0	F, My, Ag, N	68	67½
St.	30/0	Do. Preferred	114 —116	5 4 6	F, My, Ag, N	114⅞	114
St.	10/0	Do. Deferred	26⅛—26⅜	..	F, My Ag, N	26 5/16	26⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	96½—98½	4 1 3	Jn Ap, Jy, O	98	..
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	8⅞	—
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb. Aug	..	—
5	2/0	Direct Spanish Ord	3⅛—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 8	Jan, July	..	..
50	4/0	Direct United States Cable	15¾—16¼	4 6 0	Ja, Ap, Jy, O	16⅛	15⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	142 —145	4 16 6	Ja, Ap, Jy, O	144¼	143½
St.	7/6	Do. 3½ per Cent. Pref. Stock	89 —91	3 17 6	Ja, Ap, Jy, O	91	90½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106 —108	3 14 0	May, Nov	107½	..
10	6/6	Eastern Extension xd & bonus	14—14½	4 16 6	Ja, Ap, Jy, O	14 5/16	14
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	106¾	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	38 0	G. N. (of Copenhagen) with coupon 67	39 —41	5 17 0	Jan, July	41	39⅝
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	101 —103	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57 —59	5 10 0	May, Nov	58⅜	57 15/16
100	$1	Mackay Companies Common	76 5/16—76 11/16	2 12 0	Jan, July	—	..
100	4%	Do. Preference	75 5/16—75 13/16	5 5 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	1¼	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 —103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾—10¼	4 17 6	..	..	..
5½	—	West Coast of America	¾—⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100 —103	3 17 8	Jan, July	..	..
10	—	West India and Panama	1 1/16—1 3/16	..	May, Nov	1⅛	..
10	6/0	Do. 6% 1st Pref.	7¾—8¼	7 5 6	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	5½—6½	..	May, Nov	—	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14 —14½	4 17 6	Mr, Jn, O, D	14⅜	14 1/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 15 6	..	103½	..
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	97½	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 —103	4 17 0	..	..	..
5	8/0	Chili Telephone (fully paid)	7⅞—8⅛	4 18 0	August ..	7 15/16	..
1	0/4½	Monte Video Telephone Ord.	15/16—1 1/16	3 15 8	—	—	..
1	0/6	Do. 5% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 —112	5 7 0	—	110⅞	110
St.	5%	Do. Def. Stock	108 —110	4 11 0	—	109⅞	108¾
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	13¼	13⅛
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	11⅝	11⅜
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 7 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104 —106	3 15 6	—	104¾	104½
1	0/9⅜	† Oriental	1⅜—1½	4 0 0	April, Oct	1 7/16	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	..	..
St.	24/7½	Do. 4% Red. Deb. Stock	99 —101	3 19 0	..	—	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	..	..
5	8/0	United River Plate	7 —7½	5 6 8	July ——	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —112	8	June, Dec	—	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	—	..	..
10	2/0	Globe Telegraph and Trust	11⅝—11⅞	4 15 0	Ja Ap, Jy O	11 11/16	11½
10	3/0	Do. 6 per Cent. Pref	14¾—15	4 0 0	Ja Ap, Jy, O	14 11/16	14½
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 8	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

THE ELECTRICIAN:

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NOTES.

ON the occasion of the annual "visitation" to Greenwich Observatory by the Board of Visitors on Wednesday, a report by the Astronomer-Royal was presented which deals with an important matter. It appears that the new power station of the London County Council Tramways may possibly disturb to a serious extent the work of the Greenwich Observatory. Two causes of disturbance are mentioned. In the first place it appears that the chimneys of the station, which is situated exactly on the meridian of Greenwich, interfere with the observation of stars near the north horizon, and it is feared that the effect of the heated air arising from the chimneys will render the results of these observations untrustworthy. Further, vibration effects have already been noticed, which, it is thought, will seriously affect the value of observations by reflection from a mercury horizon. Up to the present, however, so far as we are able to judge, the work of the Observatory has not been appreciably impeded. The matter is certainly one for compromise, and we trust that it will be taken up by the two sides in a proper judicious spirit, without that intolerance which has characterised the disputes between the supporters of pure and applied science on previous occasions.

◆

THE attention of dynamo designers has to be directed to so many problems of a purely electrical nature, that there is at times apt to be a risk that the mechanical aspect of the subject is not so fully considered as it should be. An article by Mr. R. LIVINGSTONE, which we conclude in this issue, deals with the design of commutators from this point of view in a very practical way, and forms an interesting contribution to a subject upon which comparatively little has been written. We are inclined to think that many of the troubles which were experienced, especially with commutators of great length, in the earlier days of large multipolar machines, might to a large extent have been avoided if considerations of the kind set forth in this article had been taken into account, instead of, as was too often the case, the mechanical design of the commutator being entrusted to a draughtsman without special experience in this class of work.

◆

THE *Tribune* has done much to turn aside the reproach frequently levelled at daily papers that the notes on scientific matters appearing in their columns usually display considerable lack of knowledge. For some weeks past the Hon. R. J. STRUTT, F.R.S., has been contributing a column of scientific notes to our new daily contemporary, for which he deserves the thanks not only of the readers of the *Tribune*, but also of scientific men who can feel that their work is correctly explained to the layman. We fear, however, that to some extent Mr. STRUTT has not yet acquired the journalistic habit of mind which a writer to a daily paper should possess, for in this week's scientific notes he devotes about one-third of the space allotted to him to the discovery by Dr. HUESSLER of magnetic alloys of non-magnetic metals, a discovery which was made in November, 1903. In fact, Prof. FLEMING and Mr. R. A. HADFIELD, in a Royal Society Paper last June, published some elaborate tests on these alloys, which showed that for small magnetic forces the permeability of the material was not greatly inferior to that of cobalt or low-grade cast-iron, and occupied a position intermediate between that of the ferromagnetic and the merely paramagnetic bodies. Mr. STRUTT concludes with the suggestion which we made in a leading article on April 14, 1905, that it is conceivable that experiment may lead to the discovery of a material possessing a magnetic permeability higher even than iron.

◆

SINCE Mr. J. B. BURKE announced his discovery that radium could produce in gelatin growths simulating colonies of living organisms, a number of capable observers have repeated some of his experiments, and have witnessed some of the phenomena he described, but they have not supported his claim to have created living matter. Among the savants who have scrutinised closely the action of radium on bouillon, Sir William Ramsay is prominent; and the conclusions he reached were, briefly, that the growths proclaimed by Mr. Burke, were in all probability, no more than swarms of minute bubbles of helium formed in the gelatin by the continuous disintegration of radium, its emanation, or other descendents. Sir William Ramsay pointed out that it might be expected that a speck of radium in gelatin would coagulate the portion immediately around it, and thus enclose itself in a "cell-wall." As fast as the helium was produced the cell would swell, and, may be, "bud"; and thus the yeast-like subdivision that is so remarkable a feature of "radiobes" might be purely mechanical in essence.

It is only fair to Mr. Burke to say that in his recent book, "The Origin of Life"—a verbose volume of 350 pages—he discusses justly this bubble hypothesis, and urges against it that the life of such a growth would be a thousand years, a period much longer, he says, than the time for radiobes to reach maturity. But, truth to tell, the information he gives on this last point is so scanty and vague that this objection takes rank at present as merely a bald statement.

Another and more damaging onslaught has now been made on the radiobe, with, we fear, fatal effect. Mr. W. A. D. Rudge, in the current issue of the *Proceedings* of the Cambridge Philosophical Society, describes his experiments with barium and radium salts on gelatin media. He finds that he gets cultures like radiobes by using these or other salts that have insoluble sulphates. Now, since in the process of manufacture gelatin is treated with sulphur dioxide, and since, besides, most radium preparations contain a large percentage of barium, he believes that the growths produced by radium in gelatin are the results of the diffusion and precipitation of barium. Further, and more convincing still, he has proved that if the gelatin be first "sterilised," in the sense of precipitating out of it all the sulphuric contamination, then no growths at all are produced by radium or other elements. Moreover, if a trace of soluble sulphate be added to the purified gelatin, it at once again acquires the power of fostering growths. Tap water, even, contains sufficient sulphates to yield the necessary contamination; and this shows how slight is the foundation on which a radiobic structure can be reared. Thus, on the whole, we have here evidence enough before us to conclude that the radiobe is—in more senses than one—dead.

An application of the Hermite process at Poplar, for the purpose of manufacturing small quantities of disinfectant for gratuitous distribution, is described elsewhere in this issue. Success is claimed for it by Dr. F. W. Alexander, the Medical Officer of Health for the insalubrious borough, and for his sake we trust that the experiment will continue successful, as he has shown considerable courage in adopting the process in the face of much adverse criticism, and is to be commended for his perseverance in overcoming many difficulties in the way of working the process practically. When employed on a small scale, as at Poplar, it may prove useful; but those who read the results obtained must be warned that the effective sterilisation of large quantities of sewage by means of electrolysed sea water (whether real or artificial) is quite another matter. Moreover, the inhabitants of Poplar must not assume that, because they may pour a few ounces of Dr. Alexander's excellent deodoriser down their drains, they will be quite immune from disease; and Dr. Alexander will be well-advised if he ascertains, after working the plant for a few months, whether a similar benefit might not be derived at a cheaper price by the distribution of the better known disinfectant which goes by the name of chloride of lime.

Another Local Section of the Institution of Electrical Engineers.—A movement is on foot to establish a local section of the Institution of Electrical Engineers in Sheffield, and a meeting of local electrical engineers has been held to discuss the question.

"Electric" Fires.—Among the remarkable announcements of fires "due to fusion of electric wires" we have seldom seen one so absurd as the following paragraph in the *Sheffield Daily Telegraph*:—"On Monday evening, a fire occurred in a dwelling-house at Bridlington, caused through the fusing of a wire, the electric battery having been affected by a lightning flash."

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904 ..	—
Tangier—Cadiz	Feb. 17, 1906 ..	—
Paramaribo—Cayenne	April 20, 1906 ..	—
Sydney—Nelson	April 26, 1906 ..	*May 28, 1906
Cape Haitien—Puerto Plata ..	May 15, 1906 ..	May 29, 1906

* One cable restored.

The San Francisco Earthquake.—The *Western Electrician* reports that the operator at the De Forest station at Galveston, Texas, noticed most peculiar disturbances of his apparatus on the Tuesday night before the San Francisco earthquake and the following days. On afterwards comparing his observations with the earthquake reports, he found that the disturbances to his apparatus corresponded with each shock, but in all cases anticipated them by some hours.

The Short-Circuit in Argyll-place.—A short-circuit on the mains of the St. James' and Pall Mall Electric Light Co., in Argyll-place, London, W., which took place on Monday morning, alarmed several passers-by, and a report was inserted in several of the evening papers to the effect that the gas main had exploded. As a matter of fact there was no question of leakage from, or explosion of, a gas main, and the following is an exact statement of what happened. A short-circuit occurred on a vulcanised bitite feeder, laid solid in creosoted wood troughing, with the result that a quantity of inflammable gas was evolved from the bitumen and fired. No serious damage was done beyond the breaking of a couple of windows facing the street.

Electric Power Supply in London.—Writing to the *Daily Chronicle* last week Mr. B. H. Thwaite suggests a widening of the scope of the inquiry which is now being conducted by the Hybrid Committee of the House of Commons into the London County Council Electric Power Bill. He proposes that the following series of investigations should be taken in hand:—

1. As to whether the scheme formulated on behalf of the London County Council will enable existing local and statutory distributing authorities, weighed down as they are by the incubus of the heavy cost of the distributing mains, to successfully compete with the electric energy developed by gas engines fed with producer gas, or what is known as suction gas power?
2. As to whether or not the power should be generated directly on the coalfields of Leicestershire, Derbyshire, or Nottinghamshire for transmission, electrically and by aerial conductors, at the high pressure associated with modern practice?
3. As to whether the chemical as well as the heat value of the coal should or should not be recovered to reduce the cost of power generation?
4. Whether or not the heat from the coal should be converted into power directly in gas engines or indirectly in steam boilers and steam engines?

The Tynemouth Electricity Undertaking.—In connection with the note which we published in our last issue to the effect that an agreement had been come to between the Newcastle-on-Tyne Electric Supply Co. and the Tynemouth Corporation, under which the Corporation are to receive a supply in bulk from the company, we are now able to give the prices and further details of the arrangements that have been arrived at. The Corporation will pay a fixed sum of £2,000 per annum to the company for the first 1,250,000 units of continuous current that is delivered to them. After that ½d. per unit will be paid for every unit until the supply amounts to 2,000,000 units in any year, and for every unit above 2,000,000 units ⅓d. will be paid. In addition, a charge of £2 per annum is made for every kilowatt of maximum demand above 1,000 kw. As a set-off against these low charges, the Corporation have to run their generating station during peak time in the winter, *i.e.*, daily between 2 p.m. and 10 p.m. from November to February inclusive, with the exception of Saturdays, Sundays and holidays, and in certain other circumstances the Corporation station may be called upon to assist in supplying the load. The company will supply and fix at their own cost the plant for converting their three-phase current to continuous current. Some large consumers in the Tynemouth district, however, will take their current direct from the company through independent sub-stations, but in these cases the Corporation will collect the accounts and retain 5 per cent. of the money received. The agreement is for a period of 21 years, but is terminable by the Corporation at the end of 15 years, and will come into force on July 1st.

City & Guilds of London Institute.—The annual report of the City & Guilds of London Institute which has now been issued, referring to the question of the reorganisation of existing or projected institutions for instruction at South Kensington, states that the executive committee have from the first been anxious to avoid unnecessary duplication of the work of the Royal College of Science, so far as the Central Technical College at South Kensington is concerned. The executive committee of the Institute has therefore expressed its desire to the departmental committee on the South Kensington Institution to enter into some arrangement under which the colleges at Kensington might be brought into line, with a certain amount of interchange of students and with the great advantage of interchange at various times in the career of students. At the same time the Institute desires to continue to be identified with the Central College and to look for a very considerable amount of control over it—in fact to keep its college, but to conduct it as a joint scheme. This view has been acquiesced in by Mr. Haldane, the chairman of the departmental committee. The report states that it is now for the President of the Board of Education to take the next step, and the executive committee have appointed a special committee to confer with him. With regard to the financial position of the Institute, the City Corporation have reverted to their previous contribution of £500 for the next five years; the Mercers' Company have reverted to their original contribution of £2,000 and the Vintners' Company had increased theirs from £100 to £150. The number of students attending the Central College during the winter term has shown an increase over that of previous years, 372 taking diploma and special courses and 59 from the Royal College of Science and School of Mines, making a total of 431, as against 415 during the whole of the previous session. After the end of the present session the fees will be increased from £30 to £36 a session. The new wing of the Technical College, Finsbury, is now completed, a work which the council had been enabled to carry out by the aid of special contributions and the assignment of £10,000 from the general funds of the institute, making a total of £30,000. The report also contains an account of the progress of the work of all the branches of the institute's operations. The total income of the Institute for the past year amounted to £56,443. The annual general meeting was held on Monday at the Mercer's Hall, Cheapside, Lord Halsbury presiding. The chairman referred to the report above abstracted, and stated that the representations there made had since been agreed to in principle both by Mr. Birrell and Mr. Haldane. The council now suggested that a draft charter should be prepared by the Board of Education and submitted as a basis for further consideration and discussion.

Opening of the Greenwich Generating Station and Vauxhall Bridge.—On Saturday afternoon Mr. Evan Spicer, the chairman of the London County Council, opened both the new Vauxhall Bridge, which has been constructed by the London County Council, and the Greenwich power house, which has been erected in conjunction with the Council's tramway system. Mr. N. W. Hubbard, chairman of the Improvements Committee, was in the chair at the proceedings in connection with the opening of Vauxhall Bridge, which took place first, upon a platform erected at the northern end. The structure is noteworthy in that it is the first bridge in London to carry tramways across it. The London County Council were empowered under the Vauxhall Bridge Tramways Act of 1896 to lay tramways across the new bridge, which itself was authorised in 1895. The conduit system, of course, has been laid down, and thus there is a tramway in a straight line from Victoria Station to Camberwell Green, linking up several important railway systems with the South of London. Lady Carrington having performed the opening ceremony, the members of the Council and their guests walked across the bridge, where special tramcars were waiting to convey them to the Greenwich generating station, at the opening ceremony of which Capt. the Hon. Fitzroy Hemphill, chairman of the Highways committee, presided. A full description of the works appeared in *The Electrician* for February 23rd, March 2nd, 9th, 16th and 23rd, and it is only necessary here to refer to the chief points in the speeches, which were mainly of a congratulatory character. Prominence was given by all the speakers to the efforts of the Council's officers in connection with the stations, but it was left to Mr. Allen Baker, M.P., to pay a special tribute to the work of Mr. J. H. Rider, the Council's electrical engineer, who, he stated, was responsible for the whole of the design of the works, and to whom special thanks were due. Mr. Baker also stated that one of the chief reasons for the delay in erecting the Greenwich station was the indecision as to whether the original site contemplated at Camberwell should be used or the Greenwich site. As soon as the policy of the Council with regard to the northern tramways was decided, it was at once apparent that Greenwich would be the more suitable, and he might mention that the saving in the cost of fuel at Greenwich as compared with Camberwell would be £30,000 per annum. One striking feature of the delay in the erection of the Greenwich works was that the ratepayers would have been saved £150,000 if they could have supplied their trams from the commencement, and, as it was, £20,000 per annum would be saved henceforth, compared with what was being paid for energy from the companies at the present time. The present equipment of the works was sufficient to drive 800 cars over 80 miles of tramways, whilst when the second portion was completed there would be sufficient energy to drive 1,500 cars over the whole of the northern and southern systems, and the carrying capacity would be about 200,000,000 passengers per annum. The machinery was subsequently set in motion, and the visitors returned to London by special steamboats provided by the County Council.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, June 1st.**

ROYAL INSTITUTION.

9 p.m. Evening Discourse by Prof. H. Moissan on "L'Ébullition des Metaux.'

THURSDAY, June 7th.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Meeting at the Finsbury Technical College, Leonard-street, City-road. A Lecture will be delivered by R. P. Howgrave Graham on "Electric Oscillations and Wireless Telegraphy."

FRIDAY, June 8th.

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On the Solution of Problems in Diffraction by the aid of Contour Integration," by H. Davies; (2) "The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo," by A. A. Campbell Swinton; (3) Experiments with a Vibrating Steel Plate exhibited by Messrs. Newton & Co.; (4) "Fluid (liquid) Resistance," by Col. de Villamil.

SATURDAY, June 9th.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

3·15 p.m. Visit to Harrogate Electricity Works. Members will meet at Harrogate Railway station at 3·15 p.m.

ON DIRECTED WIRELESS TELEGRAPHY.*

BY PROF. DR. F. BRAUN.

(Translation.)

(*Concluded from page 224.*)

The Experiments.

§ 7. The experiments were carried out on a large open space near Strasburg. Wooden poles, 20 metres high, were planted at the corners of an equilateral triangle, whose sides were 30 metres long (see Fig. 3). The air wires, each approximately 33 metres long, terminated in the wire nettings N_1 and N_2 (see Fig. 4) stretched parallel to the ground and at a small distance above it. N_1 consisted of copper wire and was 3 sq. metres in size, while N_2 was of iron wire and 4 sq. metres in size. The variable capacities c_1 and c_2 and the variable self-inductances p_1 and p_2 were used for the convenient adjustment of the frequencies of the systems. From the observation hut (which is approximately at the centre of the triangle) the wires run horizontally—at a height of about 2·5 metres above the ground—to the transmitting poles. The wires are directly excited from circuits containing capacity. By choosing a suitable degree of coupling one is able to obtain in all three wires oscillations of equal frequency and with a desired ratio of amplitudes. The second oscillation, which exists in each system, was much weaker and differed appreciably in the two systems. Besides, the resonance curves of the two systems show appreciable differences in the logarithmic decrements of the slower and more rapid oscillation respectively. The length of the stronger wave (whose frequency was the same in both systems) was 120 m., but the slower wave in system I. had a length of about 150 m., that in system II. of about 165 m.

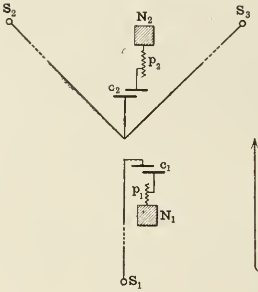

Fig. 4.

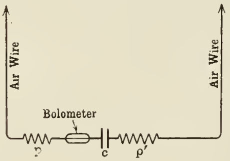

Fig. 5.

The requisite phase differences can be calculated from the dimensions, and are 180 deg.–78 deg. for an absolute minimum in the direction $\alpha = 0$, and 180 deg. + 78 deg. for an absolute minimum in the direction $\alpha = 180$ deg.

These phase differences were produced by the methods of Dr. Papalexi and Dr. Mandelstam, methods which these gentlemen intend to describe later on. The phase differences were measured by the method described by me in the former *Electrician* article already referred to. Bolometers of small resistance (about 1·10 ohms) were employed as measuring instruments, being connected up in accordance with Tissot's bridge arrangement (*Journal de Physique*, 1904, p. 528). The portable galvanometer used was of the Deprez d'Arsonval type with mirror. It was made by Messrs. Hartmann and Braun. The distance of the scale from the instrument was 50 cm., and one division on the scale corresponded to 6×10^{-9} amperes. The resistance of the galvanometer circuit was 1,050 ohms.

Experiments were made in the following two directions :—

(*a*) Investigation of the field in the case of a fixed phase difference.

(*b*) Investigation on the influence produced on the field by an alteration in the phase difference.

§ 8. *Investigation of the Field in the case of a Fixed Phase Difference.*—On the assumption that all three transmitting wires are equal, and that the conditions around the transmitting triangle are symmetrical in all directions, it would be possible to cause the field to shift by 120 deg. by interchanging the conditions of the transmitting wires. Assume, for instance, that the oscillation in S_1 passes through zero value while the oscillations in S_2 and S_3 are of the phase δ (with corresponding amplitudes). If, now, S_2 be excited by the phase 0, while S_1 and S_3 are excited by the phase δ, the field will have shifted by 120 deg. By repeating this operation, the field can be shifted by another 120 deg. In this way it is possible to examine the field for azimuths 0, 120 and 240 deg. with a fixed point of observation. The changing was done by means of a change-over switch in the small transmitting station at the centre of the triangle. It was observed during the experiments that the systems oscillated differently before and after the change-over, thus indicating that the three transmitting wires were not equal electrically. The observations at the fixed point also pointed to asymmetries. It follows that the field is not actually zero even if the conditions of zero field for the direction $\alpha = 0$ are fulfilled. In the experiments, for instance, the maximum field measured in the direction $\alpha = 0$ was $E^2 = 30$, but this field could not be reduced to zero, but only to the small value $E^2 = 2$.

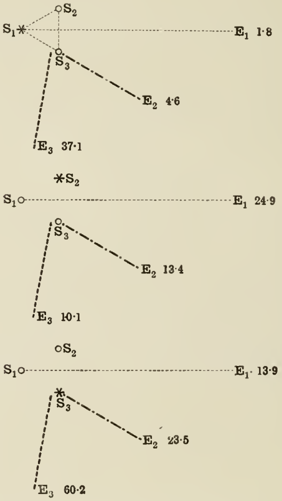

Fig. 6. ($\delta = 80°$. $S_1 = 1$; $S_2 = S_3 = 0{\cdot}5$).

On account of the observed asymmetries, which are thought to be caused by the presence of groups of trees and buildings, observations were also made at the two other points E_2 and E_3. The fixed observation point E_1 was about 1,300 metres from the transmitting system and in the direction given by $\alpha = 0$. The receiving wire at this place was fixed to a pole 20 metres high. Measurements were made with a bolometer having a high vacuum. The platinum wire of the bolometer was 0·02 mm. in diameter, its resistance being about 10 ohms. As will be gathered from Fig. 5, the wire of the bolometer was connected in series with the receiving wire between the variable coil p and the variable air-condenser c. The auxiliary current was supplied by two accumulators having a resistance of 70 ohms. The portable galvanometer, which has already been alluded to, was used for the receiving experiments, the resistance of the galvanometer circuit being 550 ohms. At the receiving stations E_2 and E_3, the wire was carried by a pole in two sections, the lower section consisting of a wooden pole 8 metres long, the upper portion consisting of a brass tube 7 metres in length. This pole could be easily fixed anywhere with the aid of three stay-ropes. Of course, the electric connections were the same as at E_1. Between E_2 and E_3 and the triangle the distances varied from 600 to 650 metres. Fig. 6 gives the results of the tests. E_1 denotes the direction towards the permanent point of observation, while E_2 and E_3 indicate two directions of the portable stations. The figures given are the mean values of the galvanometer readings and are, therefore, a measure of the square of the field at the points concerned. The sensitiveness of the bolometer was nearly the same in all cases, but only those figures can be directly compared which relate to the same point of observation. This is indicated by differently-dotted lines. The transmitting wire with zero phase is indicated by an asterisk, while the wires with phase-shifted oscillations are shown by small circles. Fig. 7, which shows the complete distribution around the triangle, follows from Fig. 6 by assuming that the interchange of the wires only causes a rotation of the field by 120 deg. at a time. Table II. contains the calculated squares of the field. It is seen that the field depends greatly on the azimuth, as would be expected, and the disturbing influence of the existing asymmetries is also discernible.

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* This article was received from Prof. Braun at the end of January, but at his request the translation was postponed several weeks, as, owing to his ill-health, Prof. Braun was unable to correct proofs. A further delay was unfortunately caused by subsequent press of work in our translating department and drawing office.—Ed. *E.*

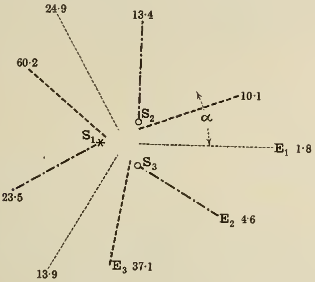


Fig. 7. (See Table II.)

Table II.—$\delta=80°$, $S_1=1$, $S_2=S_3=0{\cdot}5$.

α	0	30	60	90	120	150	180
E^2 ..	1·46 ..	2·94 ..	8·51 ..	17·45 ..	27·77 ..	36·57 ..	39·98

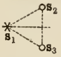
§ 9. *Investigation on the Influence of an Alteration in the Phase Difference on the Field.*—The receiving station was left unaltered (azimuth $\alpha=0$), but the phase difference at the transmitting end was altered and measured, and observations were made with the bolometer of the amplitudes of the resulting field. During the experiments the wires were successively interchanged, so that the fields were obtained for the azimuths $\alpha=0$, 120 and 240 deg. Table III. contains the calculated fields for phase differences near to, and rounded off from, those used in the experiments. These figures are made use of in Table IV., in which the largest observed values are arranged side by side with the calculated and approximate values. A more accurate calculation is not needed. It must not be forgotten that the observations extended over a considerable time. Hence, the working depended on many factors, for instance, on the regularity of the turbine operating the interrupter, on the discharge, and on the sensitiveness of the bolometer. Besides, even the permanent receiving station consisted only of a tent, which was nearly open and offered scant protection against the sun and wind. It is surprising, therefore, that the agreement is as close as it actually is.

Table III.—*Calculated Squares of the Field* (E^2).

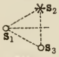
α.	E^2.	E^2.	E^2.	E^2.
0°	1·384	0·146	2·616	3·854
30°	1·612	0 294	2·094	3·412
60°	2·162	0·851	1·046	2·357
90°	2·725	1·745	0·275	1·255
120°	3 140	2·777	0·068	0·431
150°	3·685	3·657	0·021	0·049
180°	3·340	3·998	0·640	0·002
$\delta=$	30°	80	210	260°

Table IV.—*Observed Squares of the Field.*

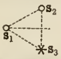
A—*i.e.*, the point of observation lies in the direction $\alpha=0$.

— —	Phase-difference.	Square of field.	
		Observed.	Calculated.
	27° 77° 207° 257°	22·0 3·0 17·0 40·3	14·7 1·6 27·3 40·0

B—*i.e.*, the point of observation lies in the direction given by $\alpha=120°$.

	27° 77° 207° 257°	27·5 30 1 1·8 8·0	33·0 30·0 0·8 4·0

C—*i.e.* the point of observation lies in the direction given by $\alpha=240°$

	27° 77° 207° 257°	19 7 18·3 1·5 13·8	.. ..

If no influences were at work to destroy the symmetry, the observed values of the field would be the same in Table B as in C. Athough the figures of both tables depend in much the same on the phase-difference, yet the disagreements between the various figures prove the existence of disturbances. Nevertheless, the experiments on the whole (especially when considered in conjunction with further checking experiments which need not be discussed at present) lead to the conclusion that the field can be calculated with an accuracy sufficient for practical purposes on the basis stated. I therefore give a few diagrams relating to other asymmetrical fields.

§ 10. *Some other Fields.*—The parameters are given in the figures. The diagram (Fig. 8) relates to an arrangement more or less parabolic in form. It is clearly seen from Fig. 13 how the distribution of the field approximates more and more to that of a transmitting wire which radiates with equal strength in all directions. In this figure the vectors represent the field itself and not E^2. At this Institute we have investigated the field produced by a transmitter which was placed near the axis of a Hertz parabolic mirror. In this experiment the length of the mirror was about equal to its height, and the place chosen for the transmitter was found by trial to give the best results. The investigation was carried out with a Righi resonator. By making chalk marks on the floor where the resonator discontinued action, a curve was obtained which resembled the innermost curve in Fig. 13, but had not even such a good shape. It is easily seen, however, that both curves have the same significance. If f denotes the field at

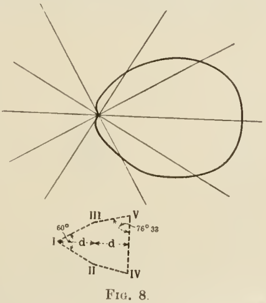


Fig. 8.

Phase of I. = 0.
„ II. and III. = −90°.
„ IV. and V. = −180°.

Amplitude of I. = 1.
„ II and III. = 1.
„ IV. and V. = 0·5.

$\lambda=4d$.

unit distance from the transmitter, and ρ the vector of the field curve in the corresponding direction, then

$$f = c\,\rho. \qquad (1)$$

Hence the field ϕ in the same direction, but at a distance r,

$$\phi = f/r. \qquad (2)$$

Let it be assumed that the receiver discontinues to act when the field has diminished to a certain value ϕ_o, this value being $\phi_o = f/\mathrm{R}$, in which R signifies the limiting distance of action. Hence, from (1) and (2),

$$\phi_o = f/\mathrm{R} = c\rho/\mathrm{R}, \quad i.e., \ \rho/\mathrm{R} = \phi_o/c = \text{constant}.$$

In words, the limiting distance is proportional to the vector of our curve. The assumption that the action of the receiver is determined by the square of the field, does not invalidate the conclusion that the limiting distance is proportional to the vector; it only means that the proportion factor (and the absolute value of the limiting distance) changes.

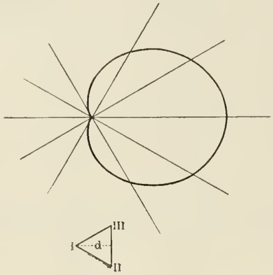


FIG. 9.

Phase of I. = 0.
" II. and III. = −110°.
Amplitude of I. = 1.
" II. and III. = 0·5.
$\lambda = 8\mathrm{d.}/\sqrt{3}.$

From the above we may conclude that the arrangement corresponding to the innermost curve of Fig. 13 gives results as to the field distribution which are at least as good as those obtained with the Hertz mirror of the dimensions stated.

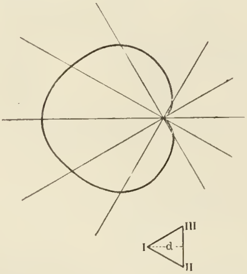


FIG. 10.

Phase of I = 0.
" II. and III. = 97° 45′.
Amplitude of I. = 1.
" II. and III. = 0·5.
$\lambda = 8\mathrm{d.}/\sqrt{3}.$

Although the length of the oscillator was only slightly less than that of the mirror, its depth was about five times the focal length and about four times the distance of the oscillator from the vertex of the parabola. The focal length of the mirror was 10 cm.; its depth was 48 cm., while its aperture was 96 cm. in diameter. If this mirror arrangement were magnified to correspond to the case of Fig. 13 ($\lambda = 120$ metres), one would obtain a reflector (consisting of wires closely arranged side by side; cf. par. 11) of 30 metres height, 340 metres length and about 120 metres depth, having an aperture of 240 metres. On the other hand, the arrangement of Fig. 13, consisting of four air wires at the corners of a rectangle, 60 metres by 30 metres, would give results at least as good and would also possess the advantage that the direction of the maximum field could be rotated through an angle of 180 deg., or, if the phases be altered, also through 90 deg.

It is now possible to focus the effects at a given point by making the phase differences at this point equal to 0, 2π, &c. A well-known optical analogy is Soret's grid, which produces along its axis a number of dark and light foci whose position depends, *ceteris paribus*, on the wave-length. By altering the latter it is possible to shift the point of maximum field. If several waves are emitted from each of the transmitting wires, then all those waves whose phase differences at the point of observation are not 0, 2π . . . lose automatically in effect by reason of this kind of dispersion effect.

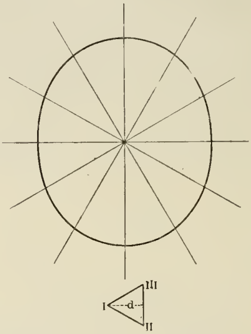


FIG. 11.

Phase of I. and II. = III.
Amplitude of I. = 1.
" II. and III. = 0·5.
$\lambda = 8\mathrm{d.}/\sqrt{3}.$

§ 11. The question remains to be answered whether the results of our experiments could not be directly obtained by simply using the *three transmitting wires as reflectors.* As already mentioned, the three air wires were arranged in a parabola whose focal length was about 3 metres. A single wire was placed near this focus to act as radiating source. The other wires, after being tuned to this wire at the focus, were used as reflectors. As a check the wires were made non-resonant during part of the test, and the position of the radiating wire was also changed. The observed results are given in the following table. The sketches on the left-hand side show the arrangement adopted. In the experiments 1 to 4, the transmitting wire S was at an equal distance from S_2 and S_3 and at a distance d from S_1. In the experiments 5 to 8 S was at an equal distance from S_1 and S_2, while its distance from S_3 was d_1 ($= 9$ metres approximately). The bolometer readings, which were taken as being proportional to the square of the field, are given in the table against the heading E^2. E_1 is the point of observation which had the azimuth $\alpha = 0$, and was about 1,300 metres distant.

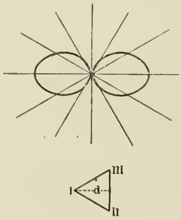
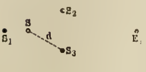


FIG. 12.

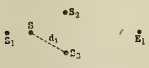
Phase of I. = 0.
" II. and III. = 180°.
Amplitude of I. = 1.
" II. and III. = 0 5
$\lambda = 8\mathrm{d.}/\sqrt{3}.$

The tests demonstrate that the mirror action of the arrangement above is useless for practical purposes. No doubt it would be necessary to employ a much closer arrangement of

Table V.



d	6 m.	8 m.	10 m.	Remarks.
E^2	3·2	3·0	2·9	The wires S_1, S_2, and S_3 are broken at their centres, and are consequently non-resonant.
E^2	3·1	2·8	2·7	All wires are resonant.
E^2	3·7	..	3·1	S_1 is non-resonant. S_2 and S_3 are resonant.
E^2	2·7	..	2·5	S_1 is resonant. S_2 and S_3 are non-resonant.



$d_1 = 9$ m.		
$E^2 = 2·2$	....	All wires are non-resonant.
$E^2 = 1·9$; 2·7	....	All wires are resonant.
$E^2 = 2·3$	....	S_2 and S_3 resonant. S_1 non-resonant.
$E^2 = 2·4$	....	S_1 resonant. S_2 and S_3 non-resonant.

wires and to make the focal length $\lambda/4$. As far as can be judged from the small observed values, it would seem that there is actually some mirror action, although the difference in this respect between resonant wires and non-resonant wires is not clearly pronounced.

According to other tests, which followed those just recorded, the action of neighbouring wires must be considered as a "screening" action. This term, which has been adopted for the want of a better one, does not express the thing quite accurately in our case, for such a "screening" action may occur not only when the "screen" is between the radiating source and the point of observation, but also when it is behind the radiating source and acting as a reflector. With closed systems this is easily demonstrated—for instance, with the aid of two condenser circuits which act inductively on one another. A cardboard screen covered with tin foil will give the same results, whether inserted between the two coils (which are flat) or under the primary coil.

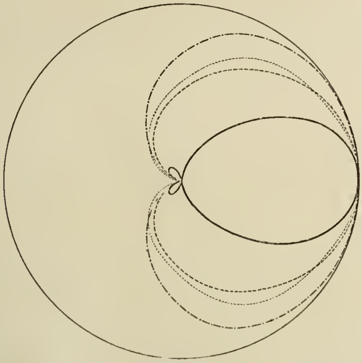


FIG. 13.

——— Four transmitters arranged at the angles of a rectangle (sides: $a = 0·25l$, $b = 0·5l$). $\delta = 270°$.

— - — - — · Two transmitters: distance apart, $a = 0·25l$. $\delta = 270°$ $s_1 : s_2 = 1 : 1$.

.... Three transmitters arranged at the angles of an equilateral triangle (sides: $a = 0·25l$). $\delta = 270°$. $s_1 : s_2 : s_3 = 1 : 0·5 : 0·5$.

- - - - - - - Four transmitters arranged at the angles of a square (sides: $a = 0·25l$). $\delta = 270°$. $s_1 : s_2 : s_3 : s_4 = 0·5 : 0·5 : 0·5 : 0·5$.

The outer circle gives, for comparison, the field of a transmitter radiating uniformly in all directions.

§ 12. A question of much practical importance is this: Do the receiving instruments as used in practical wireless telegraphy (such as the coherer) remain inactive when the average field vanishes, or are disturbances in the uniform operation of the sending wires unavoidable—disturbances which would hardly influence the average values, but might suffice to cause the receiving instruments to respond? This question could not be definitely answered since—in the given conditions at the fixed point of observation—the field never attained zero value in the tests and the ratio of minimum to the maximum squares of the field was only as 2 to 28. A substantially correct answer to the above question was obtained in the following way, however: The receiver was shifted out of the best resonance position—for which the small field was just sufficient to cause the receiver to respond—to a new and less favourable position. The signals then nearly all ceased at once, and did not return—that is to say, the apparatus at the transmitting station worked with a uniformity which was sufficient for practical purposes. It may be concluded, therefore, that there were no irregularities at the transmitter sufficiently strong to influence the receiver. At the point where one signal ceased all the signals practically ceased. When the transmitting air-wires were interchanged by means of a change-over switch, the receiver responded at once and in an absolutely reliable manner.

Considering all the experiments together, there can be no doubt (1) that the electromagnetic fields produced at the distant point by the arrangement of transmitting wires as described above can be calculated with sufficient accuracy from the simplified theory, and (2) that the methods used for procuring phase differences are sufficiently reliable.

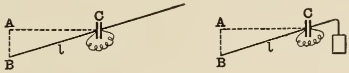


FIG. 14.

§ 13. So far no attention has been paid to arranging the receiving station in such a manner as to favour waves coming from a given direction. Such arrangements are possible, however, and some such arrangements were described by me in an article in the *Physikalische Zeitschrift*, IV., 1903, p. 363. One of these arrangements is shown in Fig. 14. The receiving air wire is half a wave-length long. It is not perfectly horizontal, but slants at a small angle towards the incoming wave. The excitation is then proportional to the vertical component of the incoming wave. At the same time the wave proceeds along the wire, the time taken being half the oscillation frequency since the horizontal projection of the wire is practically as long as the wire itself. Hence, the E.M.F. travelling along the wire is in phase with the wave proceeding along the wire, and we get resonance. A marked maximum effect is obtained if the vertical plane through the wire coincides with the direction of the incoming wave.

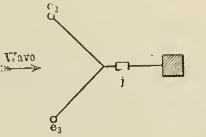


FIG. 15.

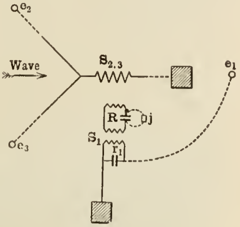


FIG. 16.

Frequently, the same station will be used both as receiving station and transmitting station for directed waves. In such cases the arrangement of Fig. 15 may be adopted, in which e_1, e_2 and e_3 are three wires arranged at the corners of an equilateral triangle; the positions of e_2 and e_3 with regard to the distant transmitting station are as indicated in the sketch. An advantageous receiving direction is obviously obtained by using e_2 and e_3 only. If these wires are in the plane of the waves they are excited simultaneously, and may be used for exciting the coherer, as shown, for instance, in Fig. 15. A slanting position towards the plane of the wave means a comparatively small excitation, of course. Combinations of various kinds are so obvious—and have partly already been employed—that it is not necessary to describe them here at length. If e_2, e_3 and e_1 are to be used, the phase-lag of e_1 resulting from the geometrical disposition must be increased to -180 deg. (*i.e.*, the lag must be increased to 180 deg. and the direction of current reversed). Methods for obtaining this result (either by employing ohmic resistance or an inductive or direct coupling) were described in my former article. A diagram of connections of one such arrangement is given in Fig. 16. The currents induced in e_2 and e_3 are in phase with one another, and are added together in the coil $S_{2,3}$. They act inductively on the resonance circuit R in which the indicator j is included in any known manner (when a coherer is used, for instance, the arrangement is as shown in the diagram). Let us assume that the currents induced in e_1 lag by 90 deg. behind the currents in e_2 and e_3. The currents in e_1 are again shifted by $\pm$ 90 degs. by the action of the resonance circuit r_1. Hence they act from the coil S_1 onwards in the same sense with regard to the indicator circuit (R) as do the currents in $S_{2\,3}$.

In actual practice, the results are especially good in those cases in which the phase differences (produced either through time lag or differences in distance) are 90 degs. or nearly so. The methods alluded to are also useful for producing these phase differences. The scientific aspect of the problem is more or less covered by the above and the former communications, and the methods are now being introduced into practice by the German Gesellschaft für drahtlose Telegraphie (Telefunken). I must acknowledge the help given me by my assistants, and especially by Dr. Papalexi, who worked with circumspection and untiring perseverance.

NEW ELECTRIC TRAINS ON THE METROPOLITAN RAILWAY.

The Metropolitan Railway Co. have recently put into service some new trains, the equipment of which is somewhat different from that of the older electric trains in use on this company's lines. A number of these trains are already in regular use on the Inner Circle, and several more are almost ready for service.

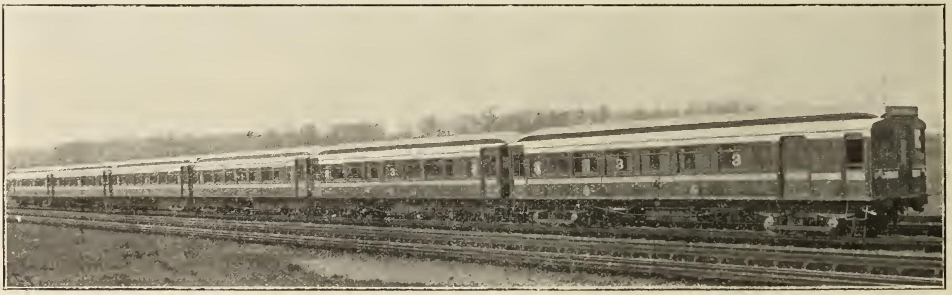


Fig. 1.—Complete Train.

A general view of one of the trains is given in Fig. 1. They are all composed of six coaches, of which the two end cars are the motor cars. The four centre cars do not carry motors; the two of these which are next to the motor cars are ordinary trailers, but those in the centre are fitted with driving gear, so that during the hours of light traffic the six car train can be divided into two parts, and each three-car train thus formed can be driven from either end. Each motor car is provided with four motors which, together with the whole of the rest of the electrical equipment, were supplied by the British Thomson-Houston Co. The car bodies were built by the Amalgamated Carriage Co., of Birmingham, and are in general respects similar to some of those used on the earlier Metropolitan electric trains.

The under frames are of steel throughout, and the bodies are of teak with steel panels inside and outside, reaching to the lower rail of the windows, so that the coaches are practically fireproof up to this point. A special fire-resisting cement is used to cover the floors, which are also of steel. The interiors are well finished in light varnished wood with the ceilings painted white. The two centre cars, which are first class, are divided into smoking and non-smoking compartments by a door. Centre side doors are not used, passengers entering and leaving only by the sliding doors at the ends of the cars. These doors are opened and closed by the attendants by means of conveniently placed handles through the medium of chains passing over pulleys.

The trucks have pressed steel frames, and were entirely constructed in England. All the springs are of ample length, and were carefully adjusted after the full weight of the bodies had been set down, and care was taken in the arrangement of the equipment to balance the weight evenly on both sides. These points, together with the slightly large size of wheels employed (38 in.), have no doubt contributed to the steady running and absence of swaying noticeable on these cars. The brake shoes are placed on the centre line between the wheels on each bogie, and act smoothly without jar or chattering.

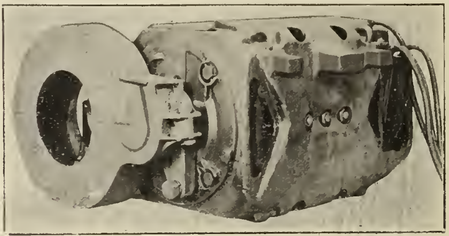


Fig. 2.—Motor and Gear Case.

The motors are of the G.E. 69 type, fully enclosed and rated at 200 b.h.p. on the usual one-hour rating. They are similar in every respect to those used in the cars of the District and Baker Street & Waterloo Railways; but there are eight motors per train, as against six on the seven-car trains of the District Railway (see *The Electrician*, Vol. LI., p. 64) and four on the lighter trains of the Baker Street & Waterloo (see *The Electrician*, Vol. LVI., p. 745). An illustration of one of the motors is given in Fig. 2, from which it will be seen that they are of the box type with unsplit cases, so that the armatures can only be removed by slinging the motors out of the truck and removing the end plates. The motor frame is arranged for "nose" suspension, but is also provided with safety lugs to prevent the motor from falling in case the nose should break. The single-reduction gears are of cut steel enclosed in malleable cast-iron gear cases. Each pinion carries 19 teeth, and engages in a 64-tooth gear wheel, which is split in halves to facilitate mounting on the axle. The motor leads are protected by flexible metallic armouring, one end of which is sweated in a brass plug tapped into the motor frame, while the other ends are coupled to the connection boxes on the underframe above the motors by standard pipe unions. This provides mechanical protection for the motor leads, and permits of their being easily uncoupled when it is desired to remove a motor.

All the motors on the train are controlled by the Sprague-Thomson-Houston electromagnetic multiple unit control system generally similar to that employed on the Central London, North-Eastern, District and Baker Street-Waterloo Railways. With the exception of the master controllers and switchboards, the whole electrical equipment is suspended beneath the floors of the cars and attached to the cross beams of the underframes so that no bolts pass through the floors. The contactors, reversers and circuit-breakers are contained in separate asbestos-lined metal covers, and all cables and wires for the motor, control and lighting circuits are run in heavy solid-drawn steel tubes which are screwed into cast-iron junction and terminal boxes containing terminals on slate bases wherever a joint is made.

The eight motors on the complete train are divided up into four independent units, each complete with its own control equipment, so that, if necessary, any pair of motors can be used alone to propel the train. All the control apparatus was manufactured at Rugby.

A point of difference from the equipments on the tube railways is the adoption of a pair of "main 'bus" cables right along the train, serving to put all the positive and all the negative contact shoes in parallel respectively. This enables a much longer gap in the conductor rail to be bridged over without interruption of the current than would be the case if no power cables were taken along the train, and enables a separate train line for the lighting circuits to be dispensed with. It will be remembered that the Board of Trade regulations prevent the use of main power cables along the train in the case of tube railways, where, in case of breakdowns, the under-part of the cars are not accessible.

All the positive and negative collector shoes on one motor car are connected together respectively, and each has its own main fuse immediately above it. From the shoes the circuit is taken through a pair of main switches, one on each pole, on the switch panel in the driver's cab. Fuses are also placed at intervals along the main 'bus line by means of which sections can be isolated in case of short-circuits. Each pair of motors has its own complete set of main control apparatus independent from the other pair. The case, which can be seen in Fig. 1 under the centre of the car, contains one set of contactors, 14 in number, which control the current for one pair of motors, a similar case on the opposite side of the car containing those for the second pair. The circuit-breakers and reversers for each pair are arranged in separate cases nearer to the ends of the car. These parts of the equipment, except for their number and arrangement on the frame in two separate groups on account of the two independent units into which the car equipment is divided, are exactly similar to those already described and illustrated in *The Electrician*, Vol. LI., p. 64, in connection with the cars of the District Railway. It will be remembered that the contactors are normally held open by gravity assisted by a spring so that they can only remain closed when current is flowing through the actuating coils. Renewable contacts are provided and a powerful magnetic blow-out prevents undue arcing. The motor resistances are of the usual grid type, divided into five sections and are situated close behind the contactors so that only very short leads are required. The connections are arranged for the "bridge" system of changing over from series to parallel without breaking the circuit.

The switchboard in the driver's compartment is on the partition separating it from the luggage compartment so that all the back connections are readily accessible. There are two slate panels, one above the other, and the switch gear for the equipment of each pair of motors is kept as distinct as possible. On the top panel are placed the positive and negative main switches referred to above, a double-pole switch for each control circuit and a circuit-breaker trip switch which opens all the circuit breakers along the train. On the lower panel are the switches for the air compressor motor circuits, including a switch for cutting out the automatic governor of the compressor motor on the car in question. At the bottom of the panel are the two-control circuit cut-out switches, breaking every contactor circuit separately, by which the whole control apparatus for either pair of motors on the car can be entirely put out of action. These take the form of small drum type controllers. Several fuses for the control circuits are also provided. It is thus seen that both poles of every circuit are brought up to this board, from which any part of the equipment can be cut out if necessary.

In front of the driver's position, on the left of the compartment, is the master controller, with the usual arrangement so that the circuit is broken if the driver loses his grip on the handle, and with the reversing barrel interlocked with the main barrel. The brake valve is to the left of the controller, and an ammeter is provided in view of the driver. Situated immediately behind the driver is the wheel for the emergency hand brake. A lighting panel is also placed in the driver's compartment, and this is provided with a double-pole throw-over switch, so that when the train is in the sheds the lighting circuit can be changed over to a plug-and-socket connection, to which a flexible cable can be attached.

The two driving trailers in the centre of the train are fitted with master controllers and brake valves, neatly concealed behind a door in the vestibule, and are provided with double-pole control circuit switches and circuit braker trip switches, together with a change-over switch and plug for the lighting circuit. The actual switches controlling the lights and heaters are mounted on small marble panels inside the cars, which also carry Siemens-Schuckert type cartridge fuses for each lighting and heater circuit.

The only cable couplings between the cars are the double-pole plugs for the main 'bus lines, the multiple couplers for the 10-core control circuit cables and a separate plug for the compressor equalising train line. This last is provided in order to enable either compressor motor to be worked by the governor of the other in the event of its own governor becoming defective and having to be cut out. No separate lighting train line is required, as the lighting circuit is simply tapped off at a T box from the main 'bus line.

One motor-driven air compressor is mounted under each motor car. These are of what is known as the CP 22 type with two single-acting cylinders and have a capacity of 25 cubic ft. of air per minute. They are driven by enclosed series motors through single reduction gearing and are controlled by an automatic governor which is set to cut out when the pressure in the reservoir rises to 90 lb. per square inch and to cut in when it falls to 80 lb. per square in. This governor simply opens and closes contacts of similar nature to those of the main contactors through an ingenious but simple arrangement of springs and levers, as no starting resistances are required. The brakes are of the standard Westinghouse quick-acting type and the compressed air is also used to work the whistles.

We cannot conclude this article without expressing our indebtedness to Mr. C. Jones, electrical engineer to the Metropolitan Railway, for permission to inspect the trains, to Mr. Nesbitt, the superintendent of the erecting shops at Neasden, and to the British Thomson-Houston Co. who kindly placed particulars and photographs of the trains at our disposal and whose engineer, Mr. J. B. Cox, gave up some valuable time in explaining the equipment to our representative. The Metropolitan Railway Co. are also converting some existing compartment carriages for electrical working which will be ready for service in a short time.

Notes on Overhead Equipment of Tramways.—In the discussion at the meeting of the Institution of Electrical Engineers on Messrs. Tweedy and Dudgeon's Paper on the above subject, reported on page 211 of our last issue, it will be remembered that the lightest pole allowed under the British standards was referred to by two speakers as one which gave a 6 in. temporary deflection with a pull of 500 lb. We are asked, however, to point out that the figure, according to the standard specification, should have been 750 lb. and not 500 lb.

ELECTRIC LOCOMOTIVES ON THE METROPOLITAN RAILWAY.

We are now able to give some further particulars of the electric locomotives in use on the Metropolitan Railway, which were briefly referred to in *The Electrician*, Vol. LV., p. 258. Eight of these locomotives, which were supplied by the British Westinghouse Company, are now in service and two are almost ready. At present they are used between Baker-street and Harrow for drawing trains of the Metropolitan Railway which run to Aylesbury and Verney Junction. Beyond Harrow the line is not at present electrified, and these trains are taken on by steam locomotives. Each electric locomotive makes the run between Baker street and Harrow with a 120 ton train in the average time of 22 minutes, including four intermediate stops of 20 seconds each. This corresponds to an average speed of 26 miles per hour, which is 13 per cent. in excess of the contract requirements. This section of the line includes some heavy grades, notably one of 1 in 44 and one of 1 in 60, whilst there are long grades of 1 in 90 and 1 in 100. The locomotives are also employed in hauling goods trains, and are capable of drawing a 250 ton train at 27 miles an hour on the level. The weight of each locomotive is 50 tons, distributed equally over the four axles, and the maximum draw-bar pull which they can exert is 20,600 lb. An acceleration of 1 mile per hour per second is obtainable on the level with a 110 ton train, and the rate of braking is 1·75 miles per hour per second. The general appearance of one of the locomotives is shown in Fig. 1. The over all length is 35 ft. 9 in., the over-all width 9 ft. and the height from the rail level to the top of the cab 12 ft. 3 in.

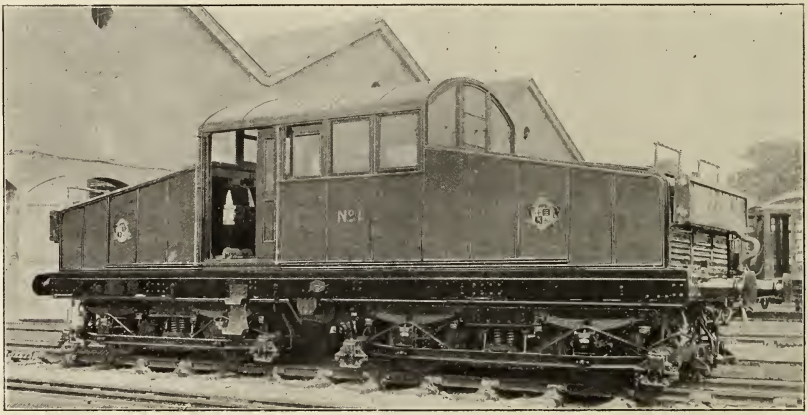


Fig. 1.—50-ton Electric Locomotive.

The main frames are made up of heavy-rolled steel sections riveted together and securely braced and are carried by two trucks of pressed steel with 36 in. wheels and axles 6½ in. in diameter. The cabs are of steel plate riveted to an angle iron framework. The frames and trucks were furnished by the Metropolitan Amalgamated Railway Carriage & Wagon Co.

Each truck is provided with a motor of the Westinghouse No. 86 type rated at 300 H.P. These motors are of somewhat small size for their power and are cooled by forced air circulation, for which purpose a small electrically driven blowing fan is installed in the driver's cab. Owing to the cooling effect thus produced the motors attain very low temperatures in actual working. For instance, after three complete return trips between Baker-street and Harrow with a train of 120 tons at a schedule speed of 26 miles per hour, the temperature rise was found to be only 250°C. on the armature and 33°C. on the commutator. A set of characteristic curves for one of these motors is given in Fig. 2.

Each pair of motors is controlled by a Westinghouse unit switch controller of the turret type, situated under the sloping portions of the cab at each end. Each of these controllers consists of 15 pneumatically-operated switches or circuit-breakers provided with magnetic blow-outs. Each switch is actuated by a compressed-air piston working in a vertical cylinder with air pressure at about 45 lb. per square inch. The reversers for each pair of motors are operated by similar mechanism. The compressed air is admitted to the operating cylinders of the controllers and reverser by electromagnetic needle valves. The current used in these electromagnets is derived from a 14 volt storage battery carried on the locomotive, and is controlled by the master controller which is conveniently situated at the driver's right hand. This master controller is a small controller of the drum type, and provides for energising the various valve magnets of the main controllers and reverser in their proper sequence. Automatic acceleration gear is not fitted.

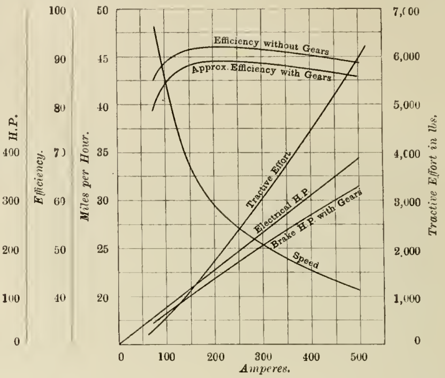


Fig. 2.—Characteristic Curves of No. 86 type Motor, 570 Volts. Gear-ratio, 22/60. 36 in. Wheels.

In addition to the motor-driven blower referred to above, there are also provided two motor-driven vacuum pumps, exhausting at different speeds, for working the vacuum brakes which are fitted to the older trains with which the locomotives are used, and one air compressor for furnishing compressed air for the Westinghouse brake system of the newer trains and for actuating the electro-pneumatic controllers. The switch gear for this auxiliary apparatus is carried on a marble panel fixed on a column in the centre of the cab, which also contains switches, main and control circuits, battery, charge and discharge switches and other gear. The driver's apparatus, which consists of the master controller and brake valves, is arranged in duplicate, one set being placed at each end of the cab so that the driver may obtain an uninterrupted view in front of his locomotive in whichever direction he is travelling.

Our thanks are due to the British Westinghouse Company, from whom some of the above information was obtained, and to Mr. C. Jones, electrical engineer to the Metropolitan Railway Co., and Mr. Nesbitt, superintendent of the erecting shops at Neasden, for facilities accorded to our representative.

CORRESPONDENCE.

DIRECTED WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your editorial article of this week's issue you write upon the subject of "Directed Wireless Telegraphy." If you refer to my patent No. 14,449 of A.D. 1899 you will see that I have described and illustrated a method of sending and receiving by means of two vertical air wires placed half a wave length apart.

Shortly after the date of this patent I conducted some practical experiments on this principle in a field at Greenwich, near the works of the Telegraph Construction & Maintenance Co. The vertical wires were between 15 ft. and 20 ft. high, and the best distance apart on trial was found to be about 10 ft., rather closer than theory would seem to demand.

The distance between the sending and receiving stations was $\frac{1}{4}$ of a mile. When the transmitting or receiving wires were turned sideways on to the line joining the two stations, signals failed to come through. The efficiency of transmission and reception, when the wires of the transmitting and receiving stations were end-on, was so great that, if the spark coil was excited with one dry cell and the spark balls were caused to touch (except for the small distance the metal was kept apart by the lacquer with which the balls were covered), the almost invisible spark, caused by the make-and-break of the circuit of the dry cell through the primary of the spark coil, was sufficient to influence strongly the receiving instrument at the far station, although at that time the receiving coherer was of a very insensitive and crude nature.

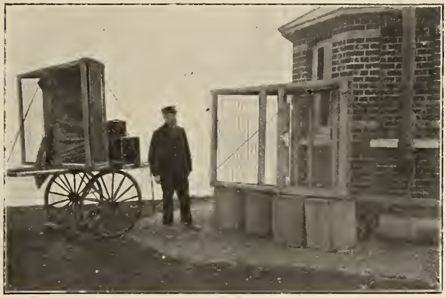
From what I can see, these experiments were made before those of Hauptmann von Sigsfeld.

With regard to systems of directed radiation by placing vertical wires on the arc of a parabola, at the focus of which was the equal vertical sender, I think I can again claim to be the first to have attacked this problem in a practical manner. About the year 1902 Sir Henry Hozier and myself conducted some practical experiments in signalling with directed Hertz waves by means of mirrors constructed of straight vertical wires. These mirrors were of parabolic shape, 4 ft. in height, the vertex being one-quarter wave length distance from the vertical wire or oscillating cylinders. Under these conditions signals were transmitted over a distance of 2 miles, the mirrors being erected one at the old lighthouse and the other near Lloyds' signalling station at Beachy Head.

Later on signals became weak and ceased altogether; the mirrors were then brought closer together, and in some cases failed to signal when only separated by a few yards.

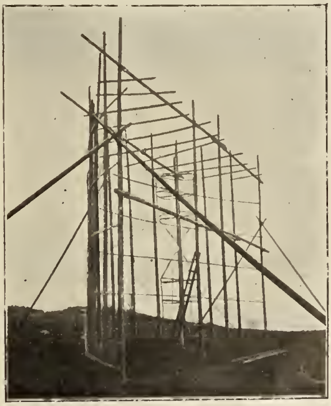
This failure was eventually traced to dirt on the spark balls which required to be kept highly polished for the finest effects. The best length of spark was found to be about $\frac{1}{16}$ in. When the spark-gap was properly attended to, signalling was most satisfactory up to a distance of 2 miles. Rocking the sending mirror in a vertical direction had little effect on the received signals, but moving the mirror sideways, even through a slight angle of arc, completely stopped communication; in fact, the chief difficulty was in getting the two mirrors correctly in line, especially on the long distances.

I enclose a photograph for your inspection, which I think clearly shows the composition of the mirrors. These experiments being considered satisfactory, it was decided to try the mirrors on a much larger scale. Accordingly oscillating systems of gauze cylinders with a spark-gap between the two cylinders, both together, 15 ft. in height, were erected, one at Dungeness and the other at Shorncliffe Camp, 14 miles apart. Parabolic mirrors of wire netting were placed at the back of the spark systems. The mirrors were 20 ft. in height. The wave-length was 15 ft. I enclose a second photograph, showing the arrangement of these mirrors. With a spark-gap of $\frac{1}{2}$ in. at Dungeness, signals were received at Shorncliffe, but these signals were not considered strong enough for demonstration purposes.



SMALL MIRROR USED ON THE BEACHY HEAD EXPERIMENT.

Due to my health and the pressure of other matters, further experiments were postponed and finally abandoned. The construction of these mirrors is described in the English patent 14,449 of A.D. 1899, already referred to.



LARGE REFLECTOR USED FOR THE SHORNCLIFFE EXPERIMENT.

Not only have I arranged in the specification for vertical wires to be placed behind the vertical sender, but I have described and subsequently tried a method of insulating the mirror and joining one side of the spark-gap, which is usually earthed, to the mirror, so that the wires may be electrified and act more vigorously as part of the radiating system.

This, it seems to me, is what Braun now suggests doing, but he appears to be taking greater care that all parts of the mirror are electrified and oscillate in proper phase relations

with the vertical sender, but still I think that with a straight wire joining one side of the spark-gap to the vertex of the reflector, this proper phase relation would more or less naturally follow; but of this I would not care to be too insistent.—
Yours, &c., S. G. Brown.
London, May 26.

[The patent contains seven claims, the second, fifth and seventh of which read as follows :—

2. In wireless telegraphy, the combination with the transmitting or receiving apparatus of two parallel vertical radiating or receiving wires attached one to each side of the spark-gap or coherer and arranged at a distance apart which has a definite relation to the length of the signalling waves, substantially as described for the purpose specified.

5. In wireless telegraphy, the combination with the transmitting or receiving apparatus of two wires attached one to each side of the spark-gap or coherer and bent so as to enclose an area.

7 In wireless telegraphy, a reticulated metallic parabolic mirror or reflector placed behind the wave-radiating or receiving wires substantially as described.

—Ed. *E.*]

THE EARTHQUAKE AND FIRE AT SAN FRANCISCO.

The accompanying illustrations show some of the effects of the earthquake and fire at San Francisco. The damage done to the electric supply stations in San Francisco itself was very considerable, the San Francisco Gas & Electric Co. alone losing two power stations and eight sub-stations The desolate appearance at one of the stations destroyed is shown in Fig. 1, which is from the *Electrical World*. Some of the old generating stations in the Potrero district escaped serious injury, and a station of the Mutual Electric Light & Power Co. near the water front is able to resume operations on a large scale. The town was, however, without either gas or electricity supply for 12 days, and even candles and oil lamps had to be extinguished by 10 p.m. by order of the military officials in control. The total damage to the electric light and power systems has been estimated at from one to three million dollars Great progress has been made towards resuming the supply, and as early as May 12th several residences in the western district were lighted again for the first time. Arc lighting has been resumed in the streets of Mission and Potrero districts and other limited sections in the southern part of the city.

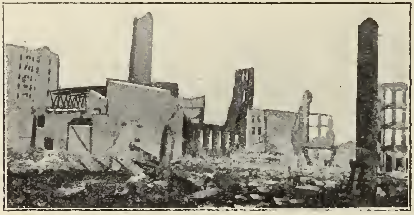


Fig. 1.—Ruins of Jessie Street Station.

The extent of the damage to the property of the United Railroads of San Francisco is placed at $1,250,000. According to the *Street Railway Journal*, this company had within the earthquake and fire area about 100 miles of track, laid for the most part as double track, in 50 miles of streets. Of this mileage, 60 miles was operated by the overhead trolley and 40 miles was operated by cable The cable lines suffered the most from the effect of the earthquake and fire, as the concrete foundations were badly twisted and broken by the force of the shock. In many cases also the slot rail closed up, either on account of the twisting of the foundations or warping by the heat. Of the electrical lines within the fire area, of course, all the feeder and overhead work was destroyed, although the poles in many cases can be straightened and utilised. So far as can be learned, the electric railway tracks did not suffer materially from warping of rails, although in a few isolated cases, the tracks heaved as a result of the earthquake and threw the rails out of alignment, but it is believed that all of the electric railway mileage can be very quickly repaired as soon as the danger from tottering walls has been removed and the débris cleared away.

Traffic has been gradually resumed on most of the electric lines, the first car having started on April 27th, but there seems to be no prospect of operating any of the cable roads inside of six months. In fact, it seems quite likely that some of the cable lines of the city will never again be operated as such, and that the earthquake and fire will have the effect of hastening the conversion of many miles of cable roads to electric working. The mayor has already issued a temporary permit for stringing trolley wires on Market-street, which was formerly a cable line, and cars are now run on this line by electric traction.

Some very curious deformations of the tracks were produced by the earthquake. A striking example of this is shown in Fig. 2, which we reproduce from the *Engineering News*. In other places the whole roadway sank several feet, leaving the side walk, which was on better foundations, at its original level.

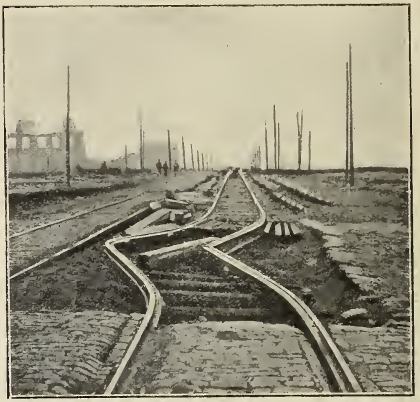


Fig. 2.—Street Railway Track on 4th Street near Bryant, distorted by Earthquake.

One of the effects of fire on a steel pole carrying overhead wires is shown in Fig. 3, which is from the *Electrical World*, and gives a good idea of the tangle produced in the overhead systems.

The loss to the telephone system is given as $1,800,000, but the entire underground system is practically intact, which fact will simplify in a great measure the restoration of the telephone service throughout the city. The lateral cables, where they entered the houses, were burned off, and men are now at work cutting off these laterals in the manholes and soldering them up to keep out moisture.

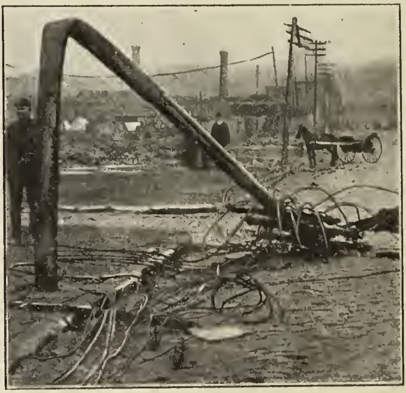


Fig. 3.—Steel Pole bent by Heat.

It is expected that 75 per cent. of the exchange business will be restored in about nine months. The telegraph service was only absolutely interrupted for about three hours after the great earthquake shock, and it is said that the first messages to the outside world after the calamity were sent by an official of the Western Union Telegraph Co., who mounted a 30 ft. pole and made direct communication through one of the few undamaged lines, as the central offices had been wrecked.

MECHANICAL DESIGN OF COMMUTATORS FOR DIRECT-CURRENT GENERATORS.

BY R. LIVINGSTONE.

(*Concluded from page 210*).

[ERRATA.—In Fig. 10 of this article in our last issue, p. 209, $CN^2/10^6$ should have read $\rho N^2/10^6$, and in Fig. 11, K and V should have been κ and ν respectively. Also on the same page, 11th line from the bottom for "The angles θ and δ," read "The angles θ and ϕ."]

The following example will illustrate the use of the formulæ: Commutator 36 in. diameter, 14 in. long for an eight pole machine running at 320 revs. per min. $\theta = 3$ deg. $\phi = 30$ deg. Leads 1 in. wide; mica "V" rings $\frac{1}{10}$ in. thick; mica between bars $\frac{1}{32}$ in. thick; 560 bars.

$$\rho N^2 = 1{\cdot}75 \times 10^6 \text{ and } P = 15{\cdot}9.$$

From equation (1) wearing depth of copper should be $1\frac{5}{16}$ in. Then if copper is allowed to wear until $x = \frac{3}{16}$ in., total depth of $x = 1\frac{1}{2}$ in. From Fig. 10, $l = 6\frac{1}{4}$ in. and from the assumptions I have suggested $l_1 = 3\frac{1}{8}$ in. and copper below "V" will be 1·46 in. Area of bar will now be $32\frac{1}{4}$ sq. in. = B.

Centrifugal Stresses.—When worn down to $x = \frac{3}{16}$ in.

From equation (2) $f_1 = 2{,}100$ and $\delta = 0{\cdot}05$.

From equation (6) $f_2 = 2{,}800$.

Remainder of stresses will have a maximum value when commutator is new.

For stress at f_3, $\frac{D}{L} = 1{\cdot}21$ and from Fig. 5 $\alpha = 16$ deg.

In Fig. 11—R and $R_1 = \frac{1}{8}$ in.

Then $\left.\begin{aligned} l_2 &= 1{\cdot}25 \\ l_3 &= 3{\cdot}8 \\ L_1 &= 6{\cdot}6 \\ m &= 1{\cdot}43 \\ d &= 1{\cdot}32 \end{aligned}\right\}$ Fig. 6.

From equation (9) $f_3 = 1{,}280$.

" " (10) $f_4 = 205$.

Now total volume of copper is 2,750 cubic inches = V.

And $\left.\begin{aligned} h &= 2{\cdot}1 \\ b_1 &= 1{\cdot}55 \\ b_2 &= 0{\cdot}2 \\ l_5 &= 1{\cdot}4 \\ \text{diameter} &= 31{\cdot}1 \end{aligned}\right\}$ Fig. 7.

Then from equation (11) $f_5 = 1{,}840$.

Area of bolts given by formula (14) is 4·375 sq. in.—that is, 14—$\frac{3}{4}$ in. diameter = 4·3 sq. in., say.

Then bolt stress due to centrifugal force given by formula (13) is

Copper, new $V = 2{,}750$. $f_7 = 2{,}950$.
" worn down $V = 1{,}200$. $f_7 = 1{,}280$.

Initial Stresses.—New $f_7 = 12{,}000$.

Expansion Stresses.—In Fig. 8—

$l_c = 85$ $B_c = 32{\cdot}25$ when new, $B_c = 15{\cdot}15$ worn down.
$l_m = 17{\cdot}5$ $B_m = 32{\cdot}25$ " $B_m = 15{\cdot}15$ "
$l_{cu} = 11{\cdot}9$ $B_{cu} = 154{\cdot}0$ " $B_{cu} = 93{\cdot}0$ "
$l_e = 97{\cdot}5$ $B_e = 2{\cdot}37$ " $B_e = 2{\cdot}37$ "
$l_b = 16{\cdot}6$ $B_b = 3{\cdot}44$ " $B_b = 3{\cdot}44$ "
$B_i = 2{\cdot}37$ " $B_i = 2{\cdot}37$ "

Then from equation (15) $\eta = 0{\cdot}039$.

With hard drawn copper bars, C.S. end rings and flaked mica between bars, the following values for Young's modulus may be taken :—

$$E_c \text{ and } E_{cu} = 16 \times 10^6$$
$$E_e \text{ and } E_b = 30 \times 10^6$$
$$\text{and } E_m = 0{\cdot}75 \times 10^6$$

Then from equation (16) when commutator is new $f_i = 6{,}800$, when commutator is worn down $f_i = 4{,}780$ due to expansion.

The initial stresses when worn down will be exactly proportional to the expansion stresses. We can now obtain the combined stresses from the equation given. They will be as follows :—

—	When new.	When worn down.
η	0·039	0·039
η_1	0·108	0·108
f_{i+e}	18,800	13,230
f_f	29,600	29,600
f_c	2,950	1,280
Cf	19,880	13,940

Then the combined stresses at the different points in the commutator will be

Overhanging copper from front cut $kf_1 = 22{,}800$*
" " rear cut $kf_2 = 30{,}000$*
Copper in "V" $f_3 = 8{,}700$
Mica pressure in "V" $f_4 = 1{,}380$
End ring $f_5 = 12{,}400$
Bolt stress $f_7 = 19{,}880$

Types of Construction.—In Fig. 12 are shown some modern types of commutator construction. Type *a* is one which is largely used by the Westinghouse Company with very satisfactory results. The bush is in one piece with the armature spider, so that relative movement of the armature and commutator is impossible. One disadvantage which this type has is that rear "V" must be of cast iron, unless the whole spider is made in cast steel. Another disadvantage is that the studs connecting the bush to the end ring are so short that the expansion of the copper increases the stresses considerably.

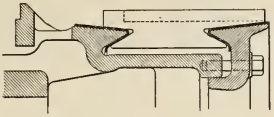


FIG. 12.—TYPE *a*.

The type of construction which was shown in Fig. 1 has been adopted by Messrs. Dick, Kerr & Co. with excellent results. It is a type which has some particularly good points. Both end rings are of cast steel, and in cases where bars are so long that high expansion stresses would ensue, the bolts are turned down to the same diameter as at the bottom of the thread. This allows of considerable expansion of the copper without unduly increasing the bolt stress. One slight disadvantage which this type has, is that it is possible for the commutator to have a small movement relative to the armature. This is kept extremely small, however, by making the arms of the commutator spider very massive, and no trouble has ever been experienced from this cause.

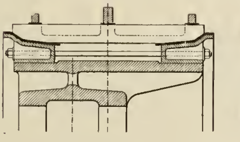


FIG. 12.—TYPE *b*.

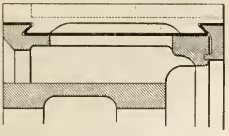


FIG. 12.—TYPE *c*.

Type b is a construction the writer adopted in a design for a very long commutator. It will be noticed that the bolts are carried the full length of the commutator. This allows of considerable expansion of the copper without overstraining the bolts. The longitudinal expansion of the copper was in this case almost $\frac{1}{32}$ in.

Type c.—This type is an example of a bad design, which shows a considerable saving in copper compared with previous designs. It is all right from the manufacturers' point of view to cut out the copper as shown, but it makes an extremely weak commutator. Even if the bar is of sufficient strength to withstand the stresses due to centrifugal force, initial tension, and expansion, when new, the allowable wear will be extremely small. Prof. Goodman describes the practice of loading a column on a side bracket as "barbarous." The same term might as fitly be applied to this practice.

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* These are high and l and l_1 must be reduced until kf_1 comes within 20,000 and kf_2 comes within 28,000. kf is the stress assuming that the overhanging copper does not deflect, and is really a measure of *stiffness*.

Type d.—In this type of construction the end rings are in sections, so that any of the commutator segments can be easily taken out without disturbing the whole commutator. It seems a big sacrifice of strength for a doubtful advantage. When it is necessary to renew any of the segments, it is much better to send the whole armature back to the makers, who have all the necessary appliances for such work, and who fully understand the construction. Nothing will shorten the life of a commutator more than unskilful tinkering with it. This type has also the disadvantage that the short length of the bolts, combined with the additional length of copper between the "V"s, is conducive to high-expansion stresses.

Commutators such as type *c*, and indeed *all* commutators, should have some means of indicating when the bars are worn down as far as they can be with safety. Even a small hole drilled in a few of the bars on the limit line of wear would indicate when it was necessary to renew the commutator. A form of section of bar which is frequently said to increase the strength of the commutator is a < section.

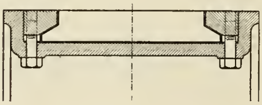


Fig. 12.—Type *d*.

The advantages of this section, however, are more imaginary than real. The section does prevent buckling (if that was necessary), and it certainly does prevent any individual bar being displaced by a blow from a hammer on the outside of the commutator, but the stresses due to centrifugal force, initial tension and expansion are just the same as they are in a commutator with the ordinary section of bar. These bars are slightly more expensive, and the cost of building a commutator with them is greater than with the ordinary type of bar, and I do not think that the slight advantage which this section does possess is worth the additional cost.

The process of building a commutator may be summed up as follows:—

1st. The bars and the mica are built together in a jig with $\frac{1}{8}$ in. Fuller board between the clamp ring and the copper.

2nd. The jig is thoroughly tightened up.

3rd. The bars are heated to a temperature of 200°F. to 250°F. for a period of at least four hours.

4th. The jig is again tightened up and the commutator allowed to cool down.

5th. The end "Vs" are now machined out to gauge, the gauge being 0·02 in. larger in diameter than the corresponding female gauge for the mica end rings.

6th. The end rings are now put on and tightened up.

7th. The outer jig is released and the surface of commutator turned up.

The successful running of a commutator depends on the workmanship quite as much as on the design, and only the most experienced workmen should be allowed to build up a commutator. Extremely good judgment is required when tightening up the jigs and end rings in order to get the correct tension. Too much pressure is quite as bad as too little, as it often leads to the overstraining of the material and consequent loosening of the bars when run for the first few times.

The form of jig most generally used is that shown in Fig. 13. This consists of a massive outer shell surrounding a thinner split ring. A large number of screws pass through the outer ring and press on the inner one. When the commutator is being pressed together, care should be taken that its circular shape be retained. It is possible in a jig of this description to press the commutator into whatever shape you please. The form of jig I consider most satisfactory, however, is the hydraulic wheel tyre press. With this form of jig you *know* what pressure you are putting on the commutator; with the jig shown in Fig. 13 you can only guess or, at the best, calculate very roughly. The mica between bars is usually of soft amber mica cut from sheets and built up to the required thickness. Flaked mica, however, of any ordinary quality can be used with good results. The mica is pasted together with shellac to the necessary thickness, then pressed for 12 hours in a mica press, steam heated to a temperature of about 250°F., the pressure being 500 lb. to 1,000 lb. per square inch. It is then taken out and cut into rectangular strips the size of the bar and afterwards milled to thickness. The treatment of the micanite "V" rings is of great importance, and every care should be taken to get them perfectly smooth and of uniform thickness. Any inequalities of the ring are sure to cause trouble and soft spots usually leads to high bars. The mica used should be of the softest quality of amber mica, and so thin that it will stand bending round a very small radius. One form of mould used is that shown in Fig. 14. When moulds are new they should be well waxed, and both male and female portions covered with prepared paper, so that the micanite ring will easily leave the mould.

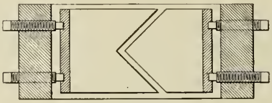


Fig. 13.

The mica is then bent into the female portion, each layer being pasted to the previous layer with shellac until a sufficient thickness is obtained. The two portions of the mould are now put together and pressed under a hydraulic press with a pressure of 2,000 lb. per square inch of projected area of mica. I have known lower pressures than 2,000 lb. per square inch used with satisfactory results; in fact, one writer advises 450 lb. per square inch. The most satisfactory results will be obtained by using the higher pressure, however, as the pressure on the "V" portion of the micanite ring when built into a commutator, frequently amounts to 1,500 lb. square inch, and it is advisable to press the micanite rings with a greater pressure than they will receive under running conditions. The micanite ring should be kept under pressure for at least 12 hours, and during that time the mould should be kept at a temperature of 250°F. to 300°F.

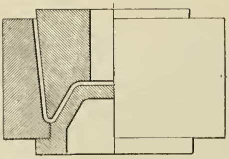


Fig. 14.

It will be necessary to use steel moulds for the higher pressure, though cast iron would be quite good enough for 450 lb. per square inch. All micanite rings should be made in one piece up to 20 in. diameter. Above that diameter it is difficult to get them uniform and they should be made in sections, each section being half the total thickness required. The whole ring is then built up in two layers with the joints staggered. The object of having fuller board between the copper and the jig is to allow the insulation between the bars to be tested before end rings are put on, so that if there are any small particles of copper bridging over any two segments they may be removed.

The best method of heating the commutator is by means of a gas ring. This simply consists of a piece of iron tube, bent to a circle and having small holes on the outer diameter. One end is connected to the gas supply and the other end plugged up. Commutators can be heated very rapidly in this way, and time is usually a consideration in a modern works. The same remarks apply to the method of heating the mica moulds.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

(*Continued from page 168.*)

Dynamo Exploders.—These are practically dynamos in miniature, the armatures of which can be revolved by a rotary crank, a pull-over lever, or a vertical rack-bar, geared direct, or into a train of wheels in contact with the armature spindle. This type of exploder is most reliable and is in extensive use for blasting on a larger scale and where easy portability is not an essential requirement.

In Fig. 7 a sectional view of an American machine, made by the firm of Macbeth, of New York City, is shown. Rotary motion is obtained in this design by pulling upward on a handle. In order to steady the machine it is provided with projecting flanges, K, on which the operator may place his feet, so that by his weight he holds the machine down firmly in place, while he is enabled to exert his strength to the best advantage in an upward pull. By this act the armature is revolved through the mechanism about to be described, thereby exciting the field magnet and sending a suitable current over the line. Within an enclosing box, A (Fig. 8), is mounted the exploder proper B and the mechanism for driving it. So far as the purely electrical portion is concerned, it consists, as usual with dynamo exploders, of a pair of small electromagnets wound with series exciting coils, and having an armature, *a*, revolving in the polar gap of the field.

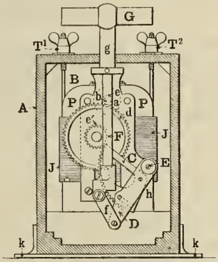


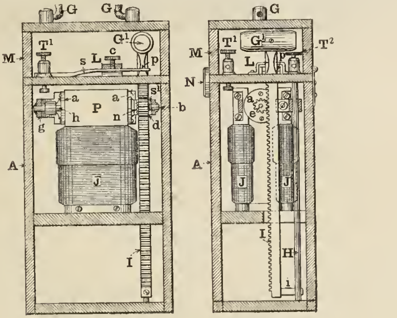
Fig. 7.—Macbeth "Pull-up" Dynamo Exploder.

On the shaft *b* of this armature is fixed a pinion, *e*, with which meshes a driving gear, *d*, fixed to another pinion, e^1. This latter pinion is engaged by a sector, C, carried by a vibrating arm, D, fixed on a rocking shaft, E. The outer end of this arm is connected by a link, *f*, with a vertical sliding pull-up bar, F, which passes out through the top of the box, and carries a handle, G, being guided in its vertical motion by a tubular bearing, *g*. By pulling upon the handle G the arm B is swung from its lower position (as shown in the figure), and causes the sector C, through the train of wheels, to drive the armature at a multiplied velocity. At the extreme upstroke of the handle, the sector passes out of gear with the pinion e^1, permitting the armature to revolve freely. In order to accomplish this result, the sector (the tooth-pitch of which, when in the normal engaging position, is in the arc of a circle concentric with the axis of the shaft E) is itself pivoted to the arm D eccentrically on a pivoted stud, *h*, whence, by turning on this stud, the sector teeth are brought out of gear with the teeth of the pinion.

In operation, the rotation of the armature under its momentum continues until stopped by friction, after which the handle will be released and dropped back to its place. During the return movement the sector will also fall back into its lower position. If the handle be dropped back quickly, the sector, in falling, will remain out of contact with the pinion, but, if lowered slowly, it will drop against, and its teeth will click over, the latter as it moves down.

These pull-up blasting machines are primarily intended for firing low-tension fuses in considerable numbers, ranging from 20 to 100 simultaneous shots according to the dimensions of the machine.

Fig. 8 illustrates another exploder of American origin, but familiar, nevertheless, in England under the name of the rack-bar exploder. It will be noted by reference to these figures that the circuit-breaking key is placed in the top of the wooden containing case; this modification of an older pattern has been made in order that it may be kept always dry and easily accessible for cleaning. A rod, H, is also provided for guiding and steadying the rack bar I, as shown in the end view. It is a well known fact that the field magnet and armature of a small dynamo may be quickly brought to the point of saturation, and that, when the current is at its maximum, the breaking of the circuit causes the entire induced current generated in the coils to be discharged, either through the air at the point of rupture of the current, or through a derived circuit connected with the terminals of the field-magnet. In the exploder under consideration, advantage is taken of this knowledge, and also of the fact that an accelerated is more effective than a uniform rotation of the armature in bringing about magnetic saturation. The mechanism of a rack-bar exploder is as follows: A field magnet, J (Fig. 8), is formed with soft-iron pole-pieces, P, secured to a yoke, in any usual way, and wound with a predetermined quantity of insulated copper wire. The polar extremities are bored out to receive a Siemens H-type armature. Upon the end of the armature shaft *b* is placed a commutator, *h*, which is touched on diametrically opposite surfaces by a pair of commutator springs (not shown in the illustration), secured to, but insulated from, the yoke. Upon the opposite end of the armature shaft, between the armature and the yoke, is placed a pinion, *d*, provided with a series of ratchet teeth, *n*, on its inner face. These are adapted to engage similar but oppositely arranged teeth, formed on the end of the armature. Between the pinion and the yoke there is placed a spiral spring, that tends to press the former forward into engagement with the ratchet teeth, *n*, of the armature. A rack bar, I, passes through the top of the casing A (which supports the dynamo) and extends downward towards the bottom of the box. At the lower extremity of the rack there is a right-angled arm, *i*, extending from the side of the rack opposite the teeth, which is drilled to slide on a guide rod, H, the latter being secured to the top and bottom of the casing, parallel with the path of the rack bar I. The latter passes between the yoke and the end of the armature, and is held in gear with pinion *e* by a roller journaled in the yoke behind the rack-bar. The upper end of the bar, projecting above the top of casing A, is provided with a handle, G¹, by which it is moved; and a pin, *p*, is inserted between the handle and the top of the casing and allowed to project a short distance from each side of the bar. A spring key, *s*, forked at its free end, and embracing the rack bar below the pin *p*, is secured to the top of the case. A bridge, L, extends



Side View. End View.

Fig. 8.—"Rack-Bar" Dynamo Exploder.

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over the spring key, and is fitted with a contact screw, *c*, which normally touches the back of the key. The armature is wound in the usual way, and the two ends of the winding are connected respectively to each half of the commutating cylinder *h*. The springs (that is, the brushes) which make contact with the surface of the split cylinder are joined in series with the field magnet winding, and the free ends of the latter lead to the binding screws T^1 T^2, upon the top of the containing case. The terminal T^1 is connected electrically with the key, and the terminal T^2 with the bridge. By means of this arrangement of the circuit the field magnet and armature are normally short-circuited. The terminals, handle and key are enclosed by a cover, M, hinged to one side of the box, and shutting down over them. The cover, in turn, is secured in a closed position by a lock, N, and provided with a handle, G^1, wherewith to carry the machine.

In the operation of firing, the handle is raised, thereby rotating the pinion *e* on the armature shaft without turning the armature, a clutch connection being arranged for this purpose. On pushing down the rack bar, a quickly-accelerated rotary motion is imparted to the pinion, thereby rotating the armature and generating a current which passes through the field winding, screws, plates, key, contact screw and yoke. Very little current passes along the external circuit owing to the comparatively low electrical pressure and the high resistance of the firing line. The current produced in this manner increases rapidly as the rack bar descends, and excites the field magnets and armature to saturation—or approximately so—just before the bar reaches the extreme limit of its downward travel. At the point referred to, the pin *p* strikes the spring key *s* and breaks the electrical connection between the screw *c* at the instant the maximum current is reached, so that the extra induced current from the field magnet and armature windings is forced to pass through the external circuit, thus igniting the fuse included therein, and bringing about the explosion of the charge.

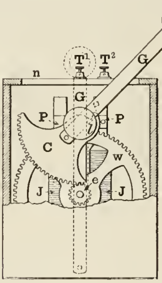
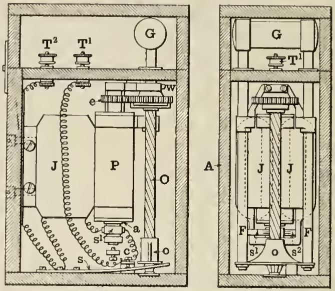


Fig. 9.—Dynamo Exploder, "Pull-over" Type.

As is well known, the superimposed E.M.F. obtained when the circuit of an electromagnet is broken is very much higher than that generated in normal working; and, whereas the direct current from the dynamo could not pass through the external circuit owing to the great resistance of the latter, the superimposed E.M.F. readily enables it to do so as soon as the short-circuit is broken.

Another well-known American machine is illustrated sectionally in Fig. 9. As in those already described, the armature of a series-wound dynamo is rapidly rotated, and means are taken to shunt the external circuit until the field magnets are fully excited. The connections are thereafter automatically broken, and the entire accumulated current instantly transferred, in its volume and intensity, to the outside or firing circuit. The rotation of the armature in this example is effected by means of a toothed segment, C, through the medium of the gearing shown. The tooth face of the segment is so proportioned in length relatively to the circumference of the pinion *e* that the traverse of the former on the pinion will operate to rotate the latter through the distance of one complete revolution only on its shaft. A ratchet-and-pawl mechanism (not shown) works in connection with a clutch device, so that when the segment rotates the pinion in the direction of armature rotation, the gear will also be turned; but when operated in the reverse direction by the segment, the clutch will disengage the gear and the latter remain idle. The actuating bar G is so arranged that when not in use it may be slid downward in the hub *l* and be practically enclosed within the case, as indicated by the dotted lines in Fig. 9.

Messrs. Siemens Bros. & Co. have introduced a new form of dynamo exploder, Fig. 10, differing greatly in construction from any of this firm's older types. Inside a strong wooden case, A, is firmly fixed a series dynamo, and on the axis of its armature, *a*, which is vertical, is fitted a pinion which gears into a wheel, *w*, mounted by a ratchet-and-pawl coupling on a screw spindle or twist, O. The latter is fitted to revolve in two bearings, and has rapid screw threads (similar to an Archimedean drill stock) engaged by a nut, *o*, which is on a crosshead connected by two rods, F, F, to a handle, G. These rods, which are carried through guides, project through the upper part of the machine. The nut, *o*, usually rests on a spring, *s*, which is strong enough to support the weight of the nut, crosshead rods and handle, and which makes a contact, short-circuiting the terminals T^1, T^2 through the magnet coils and armature. On pulling up the handle G the nut *o* causes the screw spindle O to revolve, but does not affect the wheel *w* (the ratchet and pawl being arranged so as to engage the wheel *w* with the spindle O when it is rotated by the ascent of the nut). On pushing the handle G sharply down, the wheel *w* is rotated, causing the armature *a* to revolve rapidly. The armature, by its revolution, generates current which, passing through the coils of the magnet, excites the field, causing generation of increased current, until the nut *o*, striking the spring *s*, breaks the short-circuiting contact, whereupon the current generated passes by the terminals T^1, T^2 to the line, and thence to the fuses.



Side View. End View.

Fig. 10.—Siemens "Twist" Exploder.

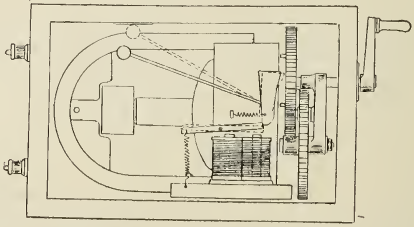


Fig. 11.—Evershed's Automatic Exploder, showing "Tell-tale" Mechanism.

One of the latest improved dynamo exploders is that manufactured by Messrs. Evershed & Vignoles. It is known as the "automatic exploder," and comprises a dynamo, to give 100, 200, 300, or 400 volts; an automatic switch, to ensure firing at full voltage; and an audible tell-tale, which indicates when the switch is on. The machine is substantially the same as Messrs.

Evershed's familiar testing dynamo. It embodies every improvement which characterises the modern dynamo, and is a good exploder just because it is a good dynamo. The armature coils are wound through holes in a laminated and perfectly insulated iron core. The field magnets are claimed to be absolutely permanent. Careful attention has been given to the mechanical features of the dynamo. The armature spindle runs in roller bearings, and the current is collected by means of patented elastic roller brushes. The gear wheels and pinions have machine-cut involute teeth of ample strength, and the handle axle is fitted with a water-tight and dust-tight gland where it passes through the end of the wood case The general arrangement of the automatic exploder is shown in Fig. 11.

In two novel features the Evershed exploder differs, not alone in design but in principle, from every other machine now used for the purpose. Hitherto the operator of an exploder has been required to press a button closing the firing circuit as soon as he *thinks* he is turning the handle at sufficient speed. With this machine he is not required to think—or even called upon to press a button. The exploder contains an automatic switch, which closes the firing circuit as soon as the voltage reaches the necessary value. For example, if the machine is intended to give 100 volts, the automatic switch is once for all adjusted for that voltage, and no matter under what conditions the machine may be working, it is absolutely impossible for the firing circuit to be closed unless there are at least 100 volts available for firing.

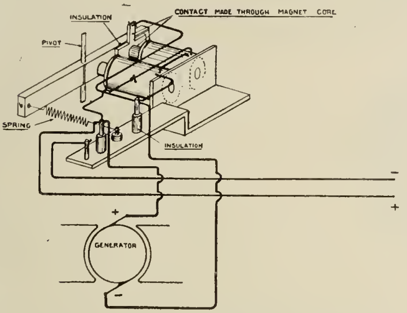


FIG. 12.—DIAGRAM OF CONNECTIONS OF EVERSHED'S AUTOMATIC EXPLODER

To indicate the efficient working of the dynamo and the automatic switch, the exploder is fitted with an audible telltale which is brought into action whenever the automatic switch closes the firing circuit.

The tell-tale consists of a simple trip hammer which strikes the inside of the wooden case; the hammer is so arranged that it remains out of gear so long as the automatic switch is "off," but instantly comes into gear when the switch closes the firing circuit. In this way the loud noise made by the hammer affords audible indication to the operator that the dynamo is working properly and that the automatic switch has closed the firing circuit, and that consequently there must be at least the full rated voltage of the machine available at the external terminals.

The audible tell-tale enables a man to satisfy himself, before attempting to fire a shot, that the exploder is working properly and giving its rated voltage. The test is made in a couple of seconds, and it is just as easily done in a dark heading as in broad daylight. In the event of a miss fire, the tell-tale clearly indicates the fact that the full rated voltage of the machine was applied to the firing-circuit wires, and that the defect is in the fuse or in the wires leading to it. The automatic exploder gives its full-rated voltage when the handle is turned at less than 100 revs. per min. A fraction of one revolution in the hands of a smart operator will give the speed required.

A diagram showing the exploder connections is shown in Fig. 12, and the tell-tale mechanism is explained by reference to Fig. 11.

(*To be continued.*)

IN HOW SMALL A TOWN IS IT POSSIBLE TO OPERATE AN ELECTRIC LIGHTING PLANT SUCCESSFULLY?*

BY R. B FORSTER.

About two years ago I heard a gentleman state at one of our meetings that it was not possible to operate an electric lighting plant successfully in a town of less than 5,000 inhabitants. I do not, however, intend to bring forward a series of arguments against this statement; it will be more to the point if I describe a small plant which has been for some time successfully operated in a town of 800 inhabitants, in competition with a gas company. The plant referred to is that of the village of Western Springs, Illinois (about 17 miles west of Chicago). There are plants successfully operated in American towns smaller than this, but as I have no authentic information regarding them I must confine my remarks to this particular one.

The conditions under which it is worked are by no means ideal, as the power house is situated some distance from the railroad. This, of course, necessitates hauling all the coal, and, owing to the high price paid for labour, it adds considerably to the cost of the fuel. There are three horizontal tubular boilers—one 6 ft. by 12 ft. and two 4 ft. 6 in. by 12 ft. The large one is worked at a pressure of 100 lb. to the square inch, and the two smaller ones at a pressure of 80 lb. to the square inch, only the large one or the two smaller ones being worked at the same time. The engine is a 100 H.P. simple "Ideal" with piston valves, and runs at 300 revs. per min. It is belt-coupled to a 1,000 volt 60 kw. two-phase dynamo, the field current being supplied by a $1\frac{1}{4}$ kw. exciter driven by a belt off the dynamo shaft. Mounted on the dynamo are two adjustable rheostats, one in each phase. From the dynamo the two phases are brought separately to a high-tension switchboard. The switchboard is very simple, and consists of only two double-pole double-fused switches, two ammeters, one voltmeter, and one ground detector for test purposes.

The outside work is carried out with overhead bare conductors strung on wooden poles. There are two pairs of mains, one pair connected to each phase of the dynamo. One pair is used for private lighting and the other for street lighting, the line voltage in each case being transformed from 1,000 to 110 volts by means of transformers fixed on the poles. On the street-lighting mains there are 100 32 c.p. lamps and six Jandus arc lamps.

For private lighting, two insulation-covered wires are strung from the secondary of a transformer to the attic of the house, where they are brought through the wall in two porcelain tubes to the main switch.

The load on the street mains is $13\frac{1}{2}$ amperes all the year round. On the private lighting mains there are 80 consumers, which give a summer load of about 12 amperes and a winter load of 15 amperes. In summer the engine is run for about seven hours per day, and in winter for about 12 hours per day. In addition to the electric lighting plant there are two direct-connected Blake pumping engines for pumping water from the springs in the vicinity to the water tower which supplies the village with water. Each pump is capable of delivering 35,400 gallons of water to the tower per hour, but as only 177,000 gallons are required per day, it is only necessary to run one pump for five hours per day.

As regards the working expenses and receipts, I found it very difficult to obtain figures, but I have it on good authority that for the last year the total expenses were $6,000 and the total receipts $6,746. This only shows a profit of $746, but it must be taken into consideration that the plant supplied light to the village as well. The price charged to the consumers was 10 cents per kilowatt-hour.

Incandescent Lamp Leading in Wires.—An American patent has been granted to Mr. H. F. Wood for a method of constructing incandescent electric lamps by which, instead of securing the vacuum-tight joint by platinum, use is made of a band of copper shrunk tightly about a portion of the glass envelope to form therewith a vacuum tight joint. Each conductor which supports the usual filament passes radially outward to a copper ring which is shrunk about a tubular portion of the bulb. The rings are of such diameter that they may be easily passed over the tubular portion. After the rings are in position, the parts are heated until the glass becomes soft. Air pressure is then exerted to force the glass into intimate contact with the rings. When cool, the rings, having a higher coefficient of expansion than the glass, necessarily contract faster, and thus shrink tightly about the glass, and form an air-tight joint. The rings are made exceedingly thin—about $\frac{1}{100}$ in.—in order that the glass may not be cracked or sheared by the force of contraction of the ring.

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* Abstract of a Paper read before the Dublin Section of the Institution of Electrical Engineers May 10th.

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PATENTS.

The Annual Report of the Comptroller-General of Patents, Designs and Trade Marks is always an instructive document, but the report, just received, for the year 1905 is more interesting than usual. To begin with, it is the first report which can give any indication of the effect of the new rules which govern the method of taking out patents, and, secondly, considerable additions have been made to the tabular matter and statistical data. Included in this is a chart, which we reproduce in our abstract of the report on another page. It shows to what an enormous extent the number of inventions appertaining to the electrical industry exceeds, year by year, the number of inventions in other branches. Thus, in 1904, 2,055 inventions related to applications of electricity, while only 848 were in connection with the textile industry, 770 were on chemical subjects, and 492 and 312 respectively dealt with agriculture and shipbuilding. The greatest percentage advance was recorded in the number of inventions relating to electric motors, rotary engines and turbines and electric lamps. Railway signalling has also attracted more inventive attention than usual, while the number of new patents relating to wireless telegraphy has decidedly decreased. Although arc and incandescent lamps are, as we have said, among the most popular subjects for patents during the past few years, the Comptroller announces that the same increase in 1904 was not repeated in 1905, while, on the other hand, there have been more mercury vapour lamps than before.

Coming now to the general statistics as to patents, we find that there has been a falling off last year of 2,623 in the number of Provisional patents filed, accompanied by an increase of 2,830 in the number of Complete Specifications; these represent 12 per cent. and 18 per cent. of the 1904 totals. At first sight it might be thought that the increase in the number of Complete Specifications in spite of the falling off in applications for Provisional protection implies that the patents generally have been more valuable, so that a smaller proportion have been dropped in the Provisional stage. There is a simpler explanation, however. Under the new rules, the time that must elapse between the application for a Provisional patent and

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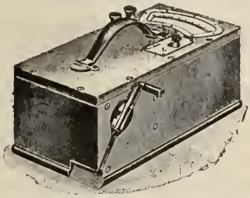

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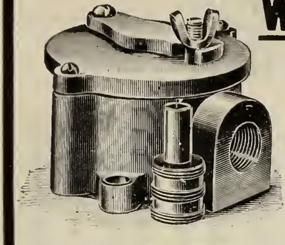

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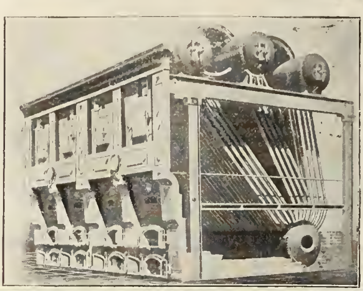

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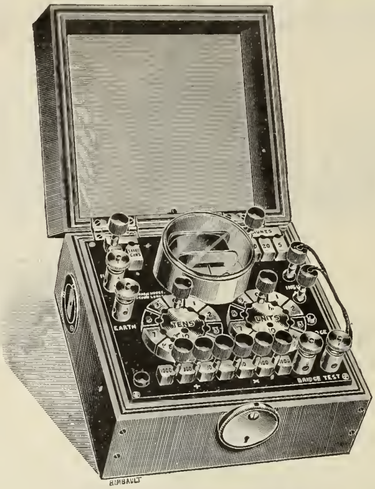

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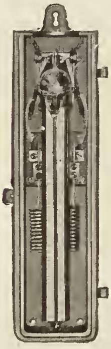

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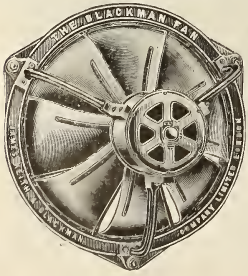

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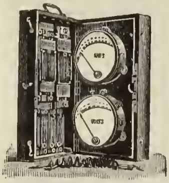

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the lodging of a Complete Specification has been reduced from nine to six months, and in consequence, all of those Provisional specifications taken out in the second quarter of 1905, which the inventors decided to go on with, have had to be completed during the same year. Thus we must look rather to the "Provisionals" than to the Completes for an indication of growth of inventive genius, but this indicates a decrease and not a growth. However, the Comptroller has an explanation for this fact also. He is of opinion that the decrease is due to the anxiety of inventors in 1904 to lodge their patent applications before the end of the year, instead of leaving them over until the next year, to save the new additional sealing fee of a guinea paid for the official search for novelty made under the new rules. This may account partly for the diminution in the total figures, but we cannot think that it does so entirely. Even apart from the extra fee, which represents a large proportion of the fees paid for a four-year patent, there can be little doubt that the new rule prescribing a partial official search for novelty has acted as a deterrent to patentees. The fact that a patent is ear-marked by an official "reference" if, in the opinion of the Patent Office officials, it has been partly anticipated by another and the patentee refuses to amend it, may frequently be sufficient to decide an inventor to keep his idea secret rather than to bring it to the Patent Office. The Comptroller somewhat ingenuously remarks that patent agents and their clients have readily embraced the opportunity of amending their specifications in such cases, but it is natural that they should do so, as otherwise the patents are to all intents and purposes marked officially as invalid. We doubt, moreover, whether the expense of making this search is justified. It has necessitated an enormous increase in the Patent Office staff and in the salary list, and taken at its best the search is but an incomplete one, for it extends only to previous British patents, and not to other sources of publication. We fail to see, also, what is the value of the search either to the patentee or the public. The issue of the patent without an official ear-mark does not imply that, even within the limits of knowledge of the patent examiner, the patent is valid. It only means that it has not been anticipated by a British patent within the previous 50 years. Those who follow patent actions in the law courts know well that the "anticipations," brought forward to prove the invalidity of a patent, consist largely of foreign patent specifications (particularly American) and articles in British and foreign technical journals. In fact, the patentee is in reality no better off with his patent under the new rules than he would have been with the cheaper patent under the old rules, and we fail to see that the number of costly patent actions will be sensibly diminished. Moreover, from figures given in the present report it may be seen that the examiner's opinion is by no means infallible. Of the 10,379 cases of investigation 60 per cent. were reported by the examiner to show anticipations. In the majority of instances the patentee amended his specification, but the Comptroller-General was called upon to hear the case on 803 occasions. In only 154—*i.e.*, 19 per cent. of these cases—was the objectionable "Reference under Rule 10" ultimately inserted, and thus apparently in the remaining 81 per cent of the occasions in which the patentee appealed to the Comptroller from the decision of the examiner, the case was given against the officials and in favour of the inventor. This means that the examiners were found to have reported incorrectly on over 6 per cent. of the patents they had to investigate. We hope that we have drawn a wrong inference from the report by the absence of a proper explanation in it of the figures we have quoted, but if their meaning is as we read it, it certainly shows that the new system of patent procedure, in addition to being more cumbersome and expensive, is decidedly defective.

VISIT OF FOREIGN ELECTRICAL SOCIETIES TO GREAT BRITAIN.

We give below the full programme of the tour which will be made in Great Britain by the foreign engineering societies, under the auspices of the Institution of Electrical Engineers, from June 25th to July 7th :—

London.

The Headquarters during the Visit will be at the Hotel Cecil.—The central committee rooms at the Hotel Cecil, known as the Empire Suite, and situated on the ground floor, will be open daily during the meeting for the registration of members, issue of badges of membership, programmes, tickets, &c.

Saturday and Sunday, June 23rd and 24th.—10 a.m. to 4 p.m., members and guests are requested to register at the central committee rooms.

Monday, June 25th.—9 a.m., central committee rooms open. 1:30 p.m., the party will assemble at the committee rooms, Hotel Cecil. 1:40 p.m., motor 'buses to Waterloo Station. 2 p.m., special train leaves Waterloo Station (No. 6 platform) for Teddington to convey the party to the opening of the new electrotechnical laboratories of the National Physical Laboratory by the Rt. Hon. R. B. Haldane, H.M. Secretary of State for War. 5 p.m., return special train leaves Teddington for Waterloo. 7 p.m., reception and banquet at the Hotel Cecil, by invitation of the General Reception committee and members or the Institution of Electrical Engineers.

Tuesday, June 26th.—9 a.m., central committee rooms open. 9:30 a.m., the party will assemble at the committee rooms, Hotel Cecil, and will divide into groups for visits to the following places of electrical interest: Group A will visit the General Post Office telegraphs and telephones and the London-wall Exchange of the National Telephone Co. (viâ Aldwych Subway and the Central London Tube Railway); group B will visit the Greenwich generating station of the London County Council (by special electric cars from Waterloo Bridge); group C will visit the Bow generating station of the Charing Cross, City & West End Electricity Supply Co. (by special motor omnibuses from the Hotel Cecil); group D will visit the Lots-road, Chelsea, power station of the Underground Electric Railways Co. (by special motor omnibuses from the Hotel Cecil); group E will visit the Shepherd's Bush power station of the Central London Railway Co. (starting from Trafalgar-square station of the Baker-street & Waterloo Tube Railway and changing at Oxford-street station into the Central London Tube Railway). After the visits groups A, B and C will be conducted to the Ship Hotel, Greenwich, and groups D and E to Earl's Court Exhibition for luncheon. 9 p.m., reception and conversazione by the President, the President Elect, and the Council of the Institution at the Natural History Museum, South Kensington.

Wednesday, June 27th.—9 a.m., central committee rooms open. The party will assemble at the Hotel Cecil. 9:30 a.m., departure for Paddington, thence excursion to Windsor, luncheon at the White Hart Hotel and a trip up the Thames to Cookham, returning to London about 7 p.m.

Birmingham.

Thursday, June 28th.—8:15 a.m., special train leaves Euston. Breakfast will be served on the train. 9:28 a.m., arrive Blisworth, for Stratford-on-Avon (see Alternative below). This excursion is limited to 50 persons. 9:55 a.m., arrive Rugby. Those wishing to visit works at Rugby alight here. They will continue their journey at 12:6 p.m. to Birmingham, arriving there at 12:50 p.m. Visits in Rugby to the works of the British Thomson-Houston Co. and Willans & Robinson. 10:42 a.m., arrive Birmingham (New-street Station). Carriages will be provided to convey the various parties to the following works: Messrs. Belliss & Morcom, the Summer-lane station of the Birmingham Corporation electricity works, the Metropolitan Amalgamated Carriage & Wagon Co. (Ltd.), the Wolseley Tool & Motor Co. (Ltd.), Adderley Park, Messrs. Elkington & Co. 12:50 p.m., arrival at Birmingham of party from Rugby. 1:30 p.m., luncheon at the Grand Hotel, Birmingham, by invitation of the General Reception committee, the Local committee and the members of the Institution of Electrical Engineers. 3 p.m., visits to the new buildings of the university at Edgbaston, and to the works of General Electric Co. at Witton, the Birmingham Small Arms Co. (Ltd.), Sparkbrook. 5:30 p.m., reception by the Lord Mayor of Birmingham at the Council House. Tea and refreshments will be served and the picture galleries will be open to the visitors. 7 p.m., leave Birmingham (New-street station) for Manchester. Dinner will be served on the train. 9 p.m., arrive Manchester (London-road).

Alternative Excursion to Stratford-on-Avon.

(Ladies are invited to take part in this excursion.)

9:28 a.m., the party visiting Stratford-on-Avon will alight from the special train of the London & North-Western Railway on arrival at Blisworth at 9:28 a.m., and they will proceed thence to Stratford-on-Avon by the East and West Junction line. 9:33 a.m., leave Blisworth for Stratford-on-Avon. 10:45 a.m., arrive Stratford-on-Avon. The party will be met by guides, and carriages will be provided to take the visitors to the Council House where a formal reception will be held. Afterwards a drive to Ann Hathaway's cottage will be made, and on their return to Stratford luncheon will be served at the "Golden Lion." Visits to Shakespeare's house, the grammar school, the Memorial Theatre, the old church. 4 p.m., leave Stratford-on-Avon by Great Western Railway special train. 5 p.m., arrive Birmingham (Snow Hill). On arrival the party will proceed to the Council House to the reception of the Lord Mayor of Birmingham. 7 p.m., leave Birmingham (New-street) for Manchester with the rest of the party. Dinner will be served on the train. 9 p.m., arrive Manchester (London-road).

MANCHESTER.

Friday, June 29th.—9:45 a.m., reception by the Lord Mayor of Manchester and the Mayor of Salford at the Town Hall. 10:10 a.m., leave the Town Hall by electric cars for visit to the Corporation electricity works at Stuart-street. 10:40 a.m. arrive at Stuart-street Station. 12 a.m., leave Stuart-street Station for the Town Hall. 12:45 p.m., luncheon at the Town Hall, Manchester, by invitation of the Lord Mayor of Manchester, the Mayor of Salford and the Electricity committees of Manchester and Salford. In the afternoon visits will be made to: 2:45 p.m., the British Westinghouse Electric & Mfg. Co. (Ltd.), Trafford Park. 5 p.m., the Ship Canal Works (electrical equipment at No. 9 Dock). 6 p.m., the Ship Canal Works (Pomona Dock). After this visit, the party will return by special cars to the Midland Hotel, arriving at 7 p.m. 8:35 to 9:30 p.m., reception and conversazione at the Victoria University, Manchester.

LIVERPOOL.

Saturday, June 30th.—9:5 a.m., leave Manchester (Exchange Station). 9:15 a.m., arrive Liverpool (Lime-street). 9:50 a.m., leave Lime-street by tramcar for Lister Drive power station. 10:15 a.m., arrive Lister Drive power station. [Alternative: As an alternative to this visit a river trip has been arranged, including a visit to one of the Cunard Company's liners for ladies and for any other visitors who may desire to take part in this excursion. Those choosing this excursion will meet the other visitors at the lunch arranged for 1:15 at the Exchange station. In case the weather should be unfavourable, it could be arranged for ladies and any other visitors to substitute for the trip on the river a visit to the Walker Art Gallery, Derby Museum, St. George's Hall and other public buildings of interest.] 11:15 a.m., leave Lister Drive by tramcar, passing through the principal streets of Liverpool, to the Dingle station of the Liverpool Overhead Electric Railway. 12 noon, leave Dingle station, prssing along line of docks to Seaford station, L. & Y. Railway, and on to Exchange station by L. & Y. Electric Railway. 1 p.m., luncheon will be given by the Tramways and Electric Power and Lighting committee of the Liverpool Corporation at Exchange Station Hotel. 2:30 p.m., leave Exchange station by L. & Y. electric train for Formby power station, returning to Exchange station by 3:45 p.m. 4 to 6 p.m., reception by Lord Mayor of Liverpool at Town Hall. 6:45 p.m., visitors will return to Manchester by the special train from Lime-street station and dine at their hotels. 7:25 p.m., arrive Manchester (Exchange station).

WINDERMERE.

Sunday, July 1st.—8:30 a.m., leave Manchester. 10:50 a.m., arrive Windermere. Drive by coach from Windermere to Grasmere. Luncheon at Grasmere, after which the drive will be continued to Keswick. 5 p.m., arrive Kewick. 7:30 p.m., leave Keswick for Glasgow. Dinner will be served on the train. 10:55 p.m., arrive Glasgow (Central).

GLASGOW.

Monday, July 2nd.—9:30 a.m., brakes will be provided to convey the visitors to Pinkston tramway and Port Dundas electricity power stations of the Glasgow Corporation. 1 p.m., luncheon at the City Chambers by invitation of the Right Hon. the Lord Provost and Corporation of the City of Glasgow. In the afternoon, alternative visits to various works and other places of interest will be arranged. The visitors will return to their hotels to dine. 9 p.m., reception and conversazione at the University by the Right Hon. Lord Kelvin, Chancellor of the University and Chairman of the Glasgow Local Section.

Tuesday, July 3rd.—9 a.m., leave Glasgow for Renfrew. Visit to the works of Messrs. Babcock & Wilcox. On returning from the works the party will again take the train and proceed to Greenock, where they will embark for an excursion on the Clyde on the turbine steamer "Queen Alexandra," by invitation of Messrs. Babcock & Wilcox. They will return to Glasgow early in the evening, and dine at their hotels. 9 p.m., reception and conversazione at the Art Galleries, Kelvingrove Park, by the Right Hon. the Lord Provost and Corporation of the City of Glasgow.

EDINBURGH.

Wednesday, July 4th.—8:55 a.m., leave Glasgow (Central). 10 a.m., arrive Edinburgh (Princes-street), Visits to various places of interest. 1 p.m., luncheon by invitation of the Right Hon. the Lord Provost and Corporation of the City of Edinburgh. Afternoon. Excursions about Edinburgh and the neighbourhood. 6:5 p.m., leave Edinburgh (Waverley). Dinner will be served on the train. 8:41 p.m., arrive Newcastle-on-Tyne.

NEWCASTLE-ON-TYNE.

Thursday, July 5th.—In the morning visits to Messrs. Swan, Hunter & Wigham Richardson, Wallsend; the Newcastle Electric Supply Co. (Ltd.). Luncheon. Afternoon: Visit to the Tyne Commissioners' works. Return thence by the electric railway of the North-Eastern Railway Co. to Newcastle-on-Tyne. The visitors will dine at their hotels.

Friday, July 6th.—9:20 a.m., leave Newcastle-on-Tyne.

LEEDS.

Friday, July 6th.—11:55 a.m., arrive Leeds (Central). Reception by the Electricity and Tramway committees. 1:30 p.m., luncheon by invitation of the Electricity and Tramway committees. 3 p.m., visits to Corporation electricity works and tramway power station and car sheds, and to the works of Messrs. Greenwood & Batley (Ltd.) and of Messrs. Kitson & Co. For ladies and their friends an excursion to Roundhay Park will be arranged. 8:30 p.m., conversazione at Leeds University.

Saturday, July 7th.—Visits to the Leeds copper works, the Hunslet engine works and the Yorkshire Electric Power Co.'s generating station. An excursion will be made to Harrogate, where the visitors will be admitted to the baths, Winter Gardens, drinking wells, Kursaal and electricity works, and thence a drive will be made to Fountains Abbey and Studley Royal, where luncheon will be provided. The party will return from Harrogate to Leeds (Central), and leave for King's Cross, London, arriving about 10:30 p.m. Those desirous of returning to London earlier in the day can avail themselves of the ordinary trains of the Great Northern Railway.

PATENTS IN 1905.

The twenty-third report of the Comptroller-General of Patents, Designs and Trade Marks has just been issued.

The receipts from patent fees were £238,047, as compared with £222,971 in 1904, an increase of £15,076; from designs fees £4,783, as compared with £4,466, an increase of £317; and from trade marks fees £13,234, as compared with £15,964, a decrease of £2,730. The decrease in trade marks fees is accounted for by the fact that a smaller number of renewal fees became payable in 1905 than in the preceding year.

The total expenditure on behalf of the office amounted to £159,296, as compared with £213,842, a decrease of £54,546. While the payments for salaries, &c., exceeded those of the preceding year by nearly £10,000, there was a saving of £7,000 on the cost of stationery, books, &c., and the amount spent upon the Patent Office extension was less by nearly £54,000, the cost of the site having been mainly defrayed in 1904.

The number of letters and correspondence forms despatched from the office in 1905 was 232,000, and the number of parcels of publications 99,000, as compared with 208,000 and 96,000 respectively in 1904. The staff of assistant examiners was increased during the year from 110 to 129.

Sec. 1 of the Patents Act, 1902, which requires an official investigation to be made for the purpose of ascertaining whether inventions sought to be patented have been in whole or in part claimed or described in the specifications of prior date over which the search is required by the section to extend, came into force on January 2, 1905, in accordance with the order of the Board of Trade made on August 12, 1904. Preparations had been made prior to the end of 1904, by strengthening and reorganising the staff and systematic arrangement of the search material, to enable the new and important duties imposed on the Patent Office by the section to be undertaken with a reasonable prospect of success. The Comptroller-General continues:—

"It is satisfactory to be able now to report, at the conclusion of the first year of the operation of the section, that thanks to the ability and strenuous exertions of the staff, several of whom have been compelled to work under very high pressure throughout the year, the greater part of the more serious difficulties involved in the new procedure have been surmounted, and the section is on the whole working very smoothly and satisfactorily, although experience has shown that the staff requires further reinforcement and the search material further sub-division and re-arrangement, if the work is not to be allowed to fall unduly into arrear.

"Patent agents and their clients appear to realise that it is to the interest of inventors that they should be informed of prior anticipating specifications, and they have in most cases readily embraced the opportunity of amending their specifications so as to distinguish clearly their inventions from those to which attention has been directed as the result of the examiner's investigation. In endeavouring to avoid the prescribed reference to prior specifications the tendency has been to define more clearly and particularly the features of the invention that the applicant has added to the stock of knowledge in the particular art, and the general effect has undoubtedly been to improve the specification.

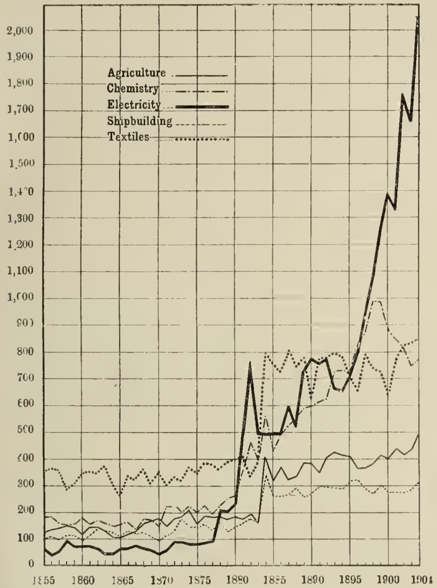
"Rule 4 of the Patents Rules, 1905, which has for the first time rendered it necessary that the statement of the invention claimed with which a complete specification must end should be clear and concise as well as separate and distinct from the body of the specification, has moreover had considerable effect in checking undue multiplication and repetition of claims. In one case only has there been an appeal to the law officers during the year against a decision of the Comptroller under this rule. This appeal was heard by the two late law officers sitting together, who affirmed the decision (XXIII. R.P.C., p. 89). It is now the practice of the Patent Office to call on applicants and patent agents to justify claims such as were allowed in that case in every specification in which they occur.

"The work under the new act has been carried out with less difference of opinion between the officials and the applicants or their representatives than might have been expected, having in view the great changes of procedure which have been introduced. In a very large number of cases no hearing before the Comptroller under sub-sec. 6 of sec. 1 has been found necessary, the requisite amendments having been made by the applicant or his agent, either directly as the result of the receipt of the official letter notifying anticipations or after conference with the examiner. During the year the examiners made in 10,379 cases the investigation required by the section. In over 60 per cent. of these cases the examiner reported that the invention had been wholly or in part anticipated, and in the great majority of these cases the specifications were amended. Where the applicant and the examiner did not agree as to the amendment of the specification, or where no action was taken by the applicant within the time prescribed by rule, a hearing under sub-sec. 6 of sec. 1 was appointed. Of 1,335 hearings fixed for the purpose of determining whether a reference to any prior specification ought to be made in the specification by way of notice to the public, 532 were rendered unnecessary, in consequence of the abandonment in 108 instances of the application, and of the amendment in 424 cases of the specification, prior to the date of the hearing (see Appendix N). Formal decisions were given in 803 cases, and in 154 cases the reference under Rule 10 was ultimately inserted. Only one appeal from these decisions has been made to the Law Officer under sub-sec. 7 of sec. 1. This appeal has not yet been decided.

"The applications received in 1905 numbered 27,478, as compared with 29,702 in 1904, a decrease of 2,224, or 7·4 per cent. Of these applications, 19,819 were accompanied by a provisional specification and 7,659 by a complete specification. It appears from these figures that the examination under sec. 1 of the Act of 1902 has caused no diminution in the steady growth of the number of applications accompanied by complete specifications, which has continued since 1884. Whereas the applications accompanied by provisional specifications decreased in 1905 by

2,642, or 11·8 per cent., those accompanied by complete specifications increased by 418, or 5·8 per cent. The number of complete specifications filed after provisional specifications shows the large increase of 2,407, or 27·7 per cent., but this is mainly due to the fact that sec. 1 of the Act of 1902 has reduced the period prescribed for filing a complete specification after a provisional specification from nine to six months, and thus all the complete specifications which would otherwise have been filed within a period of 15 months have had to be filed within a period of 12 months. The total number of specifications received was 38,569, as compared with 38,386, an increase of 183, or 0·5 per cent. There were 1,660 applications made by way of communication from abroad, of which 889 came from the United States of America, 376 from Germany, 110 from France, 36 from Canada and 24 each from Italy and Switzerland. The applications made in this country under the provisions of the International Convention of 1883 by inventors in other States of the Union numbered 1,635, as against 1,503 in 1904. The number received from the United States was 548, from Germany 495, from France 412, from Switzerland 41, from Sweden 38, from Belgium 35, from Italy 29, from Norway 13, from Denmark 13, from New Zealand 5, from Spain 3, from Mexico 2 and from Tunis 1. There were no applications under the Convention from Brazil, Ceylon, Cuba, Japan, The Netherlands, Portugal, San Domingo or Servia.

A table is given showing the countries from which the applications were received. Those from the United Kingdom have fallen from 20,030 in 1904 to 19,064 in 1905, a decrease of 4·8 per cent., and those from foreign States from 8,958 to 7,659, a decrease of 14·5 per cent., while, on the other hand, those from British colonies and possessions have risen from 714 to 755, an increase of 5 7 per cent. The particular colonies which show the largest increases are Canada, with 189 applications, as compared with 155 in 1904; the Transvaal, with 70, as compared with 57; New South Wales and West Australia, with 65 and 27, as compared with 45 and 14; and Ceylon, with 12, as compared with 4. From Natal the number received decreased from 24 to 13. Among Foreign States the largest decreases are shown by the United States of America, Germany and Belgium, which sent respectively 2,903, 2,519 and 147 applications, as against 3,596, 2,809 and 234 in 1904. Japan, on the other hand, sent 13 in 1905, as against 6 in 1904.



Out of a total number of 14,786 patentees to whom patents were granted in 1905, 2,505 were resident in the United States of America, 1,956 in Germany, 806 in France, 216 in Austria-Hungary, 178 in Switzerland, 146 in Belgium, 113 in Canada and 105 in Sweden. The proportion of patents granted to foreigners in each of the five years was respectively 50·3, 47·3, 47·4, 46·5 and 42·3.

The total number of patents which expired during the year was 13,498, and the total number of new patents sealed was 14,786. Thus the number of existing patents was increased during the year by 1,288.

No petitions were filed during the year for the grant of compulsory licences under sec. 3 of the Act of 1902.

The names of six patent agents were added to the register during the year, the total number on the register on December 31st being 254.

An appendix shows in tabular form the progress of inventions during the past 50 years in each of the 146 classes to which inventions are allotted according to the official classification.

The total number of complete specifications for 1904 was considerably greater than it has been for any other year, although the number of applications was slightly less than in 1896 and 1897, when extraordinary activity was displayed in the cycle industry. The most striking advance is shown in all types of prime movers, but particularly in electric motors, rotary engines and turbines, and air and gas engines, which have since 1901 increased to the extent of 87, 85 and 66 per cent. respectively. In the class Electric Lamps, &c., the largest percentage increase is shown in the mercury vapour type of lamp, for which the numbers have increased from 34 to 65, but incandescent and arc lamps have also increased to the extent of 51 and 20 per cent. respectively.

The accompanying chart shows the development of some of the staple industries during the past 50 years, as shown by the number of patented inventions in each year. The five industries selected are agriculture, chemistry (including electro-chemistry), electricity, shipbuilding and textiles. The most striking fact revealed by the chart is the change in the relative positions of the industries during the last half century. At the beginning the highest position was taken by textiles, which had approximately double the number for chemistry and six times the number for electricity, whereas at the end electricity has advanced from the lowest to the highest, and has now considerably more than double the numbers for textiles and chemistry and four times the number for agriculture. The advance of electricity in recent years is very remarkable. It will be seen from the chart that the movement began in 1878, and made great strides in 1881 and 1882, fostered, no doubt, says the Comptroller-General, by the Electric Lighting Exhibition at the Crystal Palace. During these five years the number of patented inventions increased eightfold, but in the following year the number dropped very considerably, and in 1884, when the numbers for nearly every other class were more than doubled, owing to the operation of the Act of 1883, the number for electricity remained stationary. Since that time, with the exception of a temporary set-back in 1893 and 1894, the subject has made enormous developments, and has increased three-fold in the last 10 years.

Under the heading "Trend of Invention in 1905," the report says: "The decrease of about 8 per cent. in the total number of applications as compared with the previous year was possibly due to the anxiety of inventors at the end of 1904 to lodge their applications before the Act of 1902 came into force, and thus to avoid not only the official search for novelty prescribed by that act, but also the payment of a sealing-fee before a patent could be granted. The inventions relating to motor cars showed a corresponding diminution, but considerable development was made in speed gears and wheel tyres. There was a remarkable falling off in all other forms of locomotion, including railways and tramways, road vehicles, cyles, and flying machines, while the number of applications relating to harness and sadlery decreased nearly 30 per cent. On the other hand, there was a striking increase, to the extent of 81 per cent., in the number of inventions relating to railway signalling, largely due to the unfortunate occurrence of several 'tunnel mysteries' during the year. It is strange that none of this increase was shared by the allied subject of wireless telegraphy, which during the same period showed a considerable falling off. Much attention was directed to turbines, as in the previous year, and there was a growth of 24 per cent. in the number of inventions for pumps. A striking development in both gas and oil lamps was due mainly to improvements in the construction and application of incandescent mantles. The number of applications relating to arc and incandescent electric lamps decreased considerably, although the number of mercury vapour lamps continued to increase."

DISINFECTION BY HYPOCHLORITES.

In *The Electrician* for September 22, 1905, we published a report "Upon the Manufacture of Electrolysed Salt Water for Disinfecting Purposes," by Dr. F. W. Alexander, medical officer of health to the Metropolitan Borough of Poplar, and the plant has now been erected.

The apparatus, which is constructed to deal with 185 gallons per day of eight hours, takes up a surprisingly small amount of space. The electrolysers are arranged in four tiers or terraces. The fluid to be electrolysed flows into the first set of cells at the top of the terrace, and here the solution attains a strength of about 1 gramme of available chlorine per litre of fluid. It then flows over into the second cell, where the amount of available chlorine is about doubled, and so on to the third and fourth, when it leaves the apparatus carrying about 4 grammes of active chlorine per litre.

As might be expected, sea water is not the electrolyte employed at Poplar, as the carriage of the large amount of liquid employed would make the cost prohibitive. Furthermore, owing to the considerable amount of organic matter which is contained in sea water, it is found that it is difficult to obtain a high concentration of active chlorine. The solution employed at Poplar consists of 20 parts of a saturated solution of magnesium chloride with 100 parts of a saturated solution of sodium chloride.

The mixed solution is placed in a tank above the electrolyses and is allowed to flow at a given rate (3½ pints per minute) into the first cell. The flow is regulated by allowing the solution to pass by means of a ball cock first into a small cistern so that the difference of level in the main feed tank may not alter the speed with which the solution is fed into the electrolysing cell. Each cell contains zinc cathodes and platinum anodes. The platinum anodes consist of thin platinum wire wound over flat slate surfaces. It is claimed that only magnesium hypochlorite is produced and sodium chloride merely acts as a conductor of the current. How this is proved we are at a loss to understand, and are much more inclined to the opinion that at the end of the operation a mixture of magnesium and sodium hypochlorite is obtained. When sea water is electrolysed by the Hermite method it is found that the solution is weakly alkaline. On electrolysing the solution of sodium chloride and magnesium chloride the solution is distinctly acid.

Dr. Alexander had extreme difficulty when the plant was first set up in obtaining a solution which was stable, it being found that within a few hours the oxidising properties were very much reduced. The difficulty has now been got over by adding small quantities of magnesia to the electrolyte as it leaves the electrolysing cells, thus neutralising the free hypochlorous acid. By this treatment, the solution when kept in closed carboys or bottles keeps its strength for weeks and even months. We reproduce the analytical numbers as found by the analyst of the *Lancet* :—

Sample number.	Strength when made Feb. 13, 1906.	Strength on March 6, 1906.	Strength on March 12, 1906.	Strength on March 19, 1906.
1*	5·68	5·60	5·60	5·40
2..........	4·82	4·75	4·70	4·68
3..........	4·40	4·04	3 97	3 62
4..........	4·26	4·04	4·00	3·75
5..........	4·26	3·97	3 90	3 80
6..........	3·69	3·47	3·46	3·40

* This was made on February 23rd.

The four rows of cells contain 40 electrodes and are connected in series which are worked with a current of 15 amperes at 240 volts. A certain amount of the current energy is dissipated in heat, the solution entering the apparatus at 60°F. and leaving it at about 90°F. It is not possible to obtain solutions of much greater strength than 4 grammes per litre, without using some external method for cooling. As, however, the solution is always diluted before being used for disinfecting purposes, there is no necessity to increase the amount of active chlorine in it. From time to time it is necessary to clean the electrodes which become coated with magnesium oxychloride. The formation of this oxychloride, although to a certain extent a disadvantage, is also of use because it helps to prevent the cathodic reduction of the hypochlorite. When preparing sodium hypochlorite it is found advantageous to add small quantities of a magnesium or calcium salt in order to minimise reduction.

The Poplar Borough Council distribute the disinfectant fluid in bottles, and use it for watering the streets. It most certainly has very powerful deodorising properties, the extremely offensive odour from a bucket of very rotten fish was almost immediately suppressed by pouring on about 1 pint of the fluid. Whereas 1 pint of carbolic fluid cost 8½d., we are informed that the hypochlorite fluid, with electric current at 1½d. per unit, only costs ½d.

PARLIAMENTARY INTELLIGENCE.

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LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL

(*Continued from page 228.*)

Thursday, May 24.

Mr. VESEY KNOX, who is representing Chiswick, Hornsey, Finchley, Wimbledon, Beckenham, Bexley and Dartford, opened his case for all these opponents.

One witness was called for each of these districts. For Beckenham it was stated that an arrangement come to last year with the Administrative Co. was more advantageous to the Council than anything proposed by the County Council. Under the County Council's bill a tramway supply given outside Beckenham under a special act would be competed for. Further, if the clause allowing supply in contiguous areas were put into the bill, the County Council could do all that was necessary without actually including Beckenham. The Chiswick opposition was somewbat different inasmuch as the local authority is not the authorised distributor, but has an agreement with the Chiswick Electric Supply Co. Objection is, therefore, taken to the possibility of this bill prejudicing the agreement with that company. Terms might be come to by the L.C.C. with the Chiswick Co. by which the former could give a supply direct to manufacturers and which could continue for all time, so that when the Chiswick Council purchased the works of the local company they would be deprived of that supply. In cross-examination, it was admitted that the Chiswick Co. were not opposing the bill. The chairman suggested that an amendment of certain clauses would meet these objections. It was stated, however, that there was a general objection, on the grounds of local government, to another municipal authority coming into the area. For Hornsey it was mentioned that Mr. Hammond had acted as consulting engineer, and for the output he anticipated, the capital cost had been £100,000, instead of the £70,000 of his estimate. Many of the witnesses referred to efforts that have been made to come to terms with the L.C.C., but, as they were conducted without prejudice, details were not gone into. It was indicated, however, that beyond offering to supply at the lowest possible price consistent with the interests of the ratepayers, the County Council did not state a price. Clause 35 was generally objected to.

Mr. VESEY KNOX, in addressing the Committee on behalf of the authorities above mentioned, said that the total rateable value was £2,000,000, whilst £500,000 had been spent in all upon the provision of electrical undertakings. He appealed to the Committee on the broad principle of local self-government, not to include these districts in the area of the bill against the wish of the elected representatives of the ratepayers. The suggestion in this bill of trading outside its area on the part of a local authority was without precedent. If the proposal had been to include the outside areas within the County of London it would have been a different matter, but in this case the outside authorities had no sort of voice or representation with regard to the administration of the undertaking. He had searched for a reason for inclusion in the bill, but could find none, and he submitted that no good reason had been given in the evidence. Mr. Knox then went to clauses in the bill under which he said competition would be possible—for instance, the tramways supplied by Bexley outside its area by Parliamentary sanction.

The CHAIRMAN said the Committee had considered this point and was agreed that if the consideration of clauses was ever reached they would feel bound to take into consideration, in this connection, the capital expended on behalf of the ratepayers in electric supply.

At a later stage the CHAIRMAN said that, speaking for himself, with regard to clause 35, that where local authorities have expended considerable sums of money on generating stations, and assuming that the L.C.C. did say to the Board of Trade that they could supply cheaper, he felt that the Board of Trade must be empowered to take that expenditure into account and to make some provision in connection with this, which was equitable.

Mr. KNOX asked why he should be put under a sort of electrical police supervision in this matter. There was no reciprocity.

Sir FRANCIS LOWE: Would the County Council be prepared to go forward without Clause 35?

Mr. CLEASE, for the L.C.C., suggested that this was a matter of clause, and could be dealt with after the preamble was proved.

Mr. WATSON RUTHERFORD differed from this view, because the clause seemed to him to be the basis of the bill. As the Chairman had spoken for himself, he thought it only right that other members should speak for themselves on this point, and he was bound to say that the bill seemed to him unreasonable in respect to this clause.

Sir FRANCIS LOWE agreed with this view.

Mr. VESEY KNOX, continuing his argument, said that the price under the London County Council Bill (which, however, was not binding), so far as Bexley was concerned, was 0·4d. dearer than the binding arrangement come to last year with the Administrative Co. In conclusion he referred to the slow movement of the L.C.C., and suggested that this fact accounted for the comparatively few miles of electric tramways inside the County of London, whereas many smaller outside authorities had an almost equal mileage of track. It had taken five years to get half the Greenwich generating station at work. He would much prefer, if a bulk supply were to be given, to have it in the hands of the various county councils in which the outside authorities were.

Monday, May 28.

Mr. HARPER, addressing the Committee on behalf of the Middlesex County Council, said that the general outlines of the schemes were incompatible with the inclusion of any portion of Middlesex. For instance, the sites of the generating stations had not been chosen with due regard to the whole of the area, but for other reasons, whilst the portion of the area of Middlesex that had been scheduled was a purely residential one between the manufacturing portions of Middlesex and London. Further, the supply to the tramways in Middlesex was contracted for until 1930, so that this supply, as far as the bill was concerned, was gone. If the needs of Middlesex in this connection ought to be dealt with jointly with London, it ought to apply to the whole of Middlesex. At the same time, the opinion of the Middlesex County Council was that municipal electric supply should either be dealt with as regards individual counties or by combinations of county councils which could be carried out under the Local Government Act of 1888. Under the bill, the consumers outside the County of London, as mentioned by the witnesses, might be charged more than the consumers inside the County, and this was a state of things which ought not to be sanctioned.

The opposition of the East Ham Corporation was then taken.

Mr. BANKS MARTEN, a member of the Corporation, gave the general details of the electrical undertaking at East Ham, showing that the result has been a financial success, with only three years complete working. The load factor at East Ham was 22 per cent., practically the best of all the authorities outside London.

Mr. HUTCHINSON having addressed the Committee,

Mr. WEDDERBURN, K.C., without calling evidence, addressed the Committee on behalf of the Woolwich Borough Council. He said that he did not oppose the L.C.C. being the bulk supply authority, but the opposition was to the undesirable control given by the bill over the prices charged by the Woolwich Council and the supply generally. The Woolwich Council had got special powers to supply electrical energy in bulk to contiguous districts, but by the passage of this bill, just as the Woolwich Council had at considerable expense got rid of all competition, this competition would be revived. The Woolwich Council did not desire to limit the authority of the County Council as to the supply of energy for power purposes, but wished to retain the lighting of any premises, such as railway stations, L.C.C. schools, premises partly within and without its area, &c. Then with regard to clause 35, he contended that there should be a schedule of prices in the bill, as clause 43 enabled the prices to be raised. And with regard to the latter clause, he submitted that some limit should be inserted as to the extent of any increase in the price. Further, in connection with clause 35, he asked that the particular circumstances to be taken into account by the Board of Trade, under a reference to it by that clause, should be specifically mentioned, and that the clause generally should be limited in its application to distributors who take a supply from the County Council, and also only during the time when the County Council could give a supply, and not at any time, as the bill now permitted. The Woolwich Council also agreed with the outside authorities against their inclusion, not wishing that the London ratepayers should run any risk of a loss on the outside districts.

The Kent Electric Power Company's case was then heard.

Mr. A. A. CAMPBELL SWINTON, joint engineer to the company, was called. He said the company was authorised in 1902 to supply electrical energy in the County of Kent and had raised £300,000. Land had been acquired to the extent of 5½ acres at Frindsbury, where 100,000 H.P. of plant could be erected. The plant installed had a capacity of 5,000 kw. and contracts had been entered into for supply at cheaper prices than those mentioned by the County Council.

In the course of conversation with the Committee, Mr. HUTCHINSON, who appeared for the company, said that whilst his company objected to inclusion in the area of the bill, yet it was thought reasonable that the Council should have the "contiguous area" clause in their bill, which would give practically all the powers now asked for.

Mr. A. B. CAINE, on behalf of the Marylebone Borough Council, asked for some protection with regard to the very large sum that had been paid for the acquisition of the portion of the Metropolitan Electric Supply Co.'s business in Marylebone. Much of this money, he said, represented goodwill and did not exist in any tangible form.

Mr. WILLIAMS, in putting the case for the Stepney Borough Council, referred to the favourable terms contained in the agreement which that body made with the Administrative Co. last year, and which he had been informed the company was willing to give again this year. In criticising the bill Mr. Williams pointed out that it did not contain any compulsion as to the amount of reserve fund that should be set aside, and he urged that if the bill were passed there should be inserted the provision that this should be at the rate of one-tenth the paid-up capital, as in all commercial undertakings. He also made the suggestion that the existence of this bill would be an incentive to the Council to withhold the granting of loans to borough councils and so force them to take a supply from the Council.

It was agreed that Mr. Arthur Wright should give evidence to-morrow on behalf of the Stepney Council.

Mr. BLENNERHASSETT, for the Westminster City Council, said he offered the most strenuous opposition to the proposals of the bill, both as to its principle and its clauses, and went at considerable length into the proceedings that have led up to the promotion of the bill. He expressed the opinion that but for the promotion of the Administrative Co.'s bill this bill of the County Council would never have been promoted. Westminster, he said, was served by seven electric supply companies, the generating station of one of which was purchasable—viz., that of the Central Electric Supply Co.—and the City Council of Westminster did not wish to have this right of purchase prejudiced by the introduction into their area of a scheme like that proposed by the L.C.C. Apart from this consideration, it was felt that a power scheme promoted by a company was preferable in the interests of the general body of ratepayers, in that there would be no risk.

At the conclusion of this case, members of the Committee asked questions as to the laws which governed the granting of loans in London to borough councils. It was made clear that all the borough councils were forced to obtain the consent of the L.C.C., and if this was refused there was an appeal to the Local Government Board. The councils, however, are not bound to borrow from the County Council.

Tuesday, May 29.

Mr. FREEMAN announced that the County Council had seriously considered the objections that had been taken to clauses 11 and 35, and in order to be quite fair all round the following amendments were suggested. Clause 11 defines the persons and bodies to whom the Council may supply energy, and it was now proposed, first of all, to delete the reference in this clause to Government departments. The next amendment was that any authority supplied under this clause should not use more than 20 per cent. of the total energy for lighting purposes without the consent of the authorised distributor. This concession was made in deference to the objection that the Council might by supplying a railway company take away from the authorised distributors the existing supply for lighting the railway stations. The clause was also amended in special application to Poplar and Bermondsey that no docks should be supplied. This was by reason of the fact that in these districts there were some docks only a very small portion of which were outside the area, and the Council did not wish to take advantage of this technicality in order to give a supply on the ground that the premises were partly within and partly without the area.

Mr. WILLIAMS, on behalf of Stepney, claimed to be in the same position as Poplar, and yet he had not been granted this clause.

Mr. RUTHERFORD (member of the Committee) asked why this amendment was not made general in its application.

Mr. FREEMAN said that these were the only two boroughs in the peculiar position mentioned so far as he knew, but if Stepney or any other council could prove that they were in this position, then the clause would be granted to them also.

Mr. RUTHERFORD said he still thought this amendment should be made general. The method adopted was not the right way to deal with this matter.

Mr. FREEMAN said the Council considered the proposal a perfectly fair one. Continuing the amendments proposed to clause 11, he said that it was also intended to alter it so that the Council could not supply its own schools, coroners' offices, weights and measures testing offices, parks, open spaces, fire brigade stations and such buildings which were, or might be, supplied by the existing authorised distributors, except where such premises were already supplied by the Council itself.

The amendment to clause 35 was that after five years, instead of three, the Council can draw the attention of the Board of Trade to the prices charged by authorised distributors if the Council were in a position and willing to give a supply, but the distributor had the reciprocal right, at the same time, to ask that the price of the L.C.C. should be reduced, and, further, the Board of Trade could make it obligatory upon the Council to give a supply at a definite price.

Mr. COURTHORPE MUNRO then addressed the Committee on behalf of the Metropolitan Boroughs of Bermondsey and Fulham. He said he objected to competitive powers being given to the London County Council which already had quasi-judicial powers over the borough councils. As an instance of the effects of such competitive powers being granted, he referred to the attitude of the Council with regard to sanctioning electric lighting loans since this bill was first promoted, and mentioned that applications made by Shoreditch, Fulham and Bermondsey for loans for extensions had been temporarily "hung-up," and were only granted eventually because the loans were needed in order to meet immediate requirements. With regard to the so-called concession to Bermondsey, under clause 11, referred to by Mr. Freeman above, Mr. Munro said it was ridiculous, because if the consent of the borough council were refused there was to be an appeal to the Board of Trade, and with the County Council's usual persistence, he imagined that they would keep on applying to the Board of Trade until, from the borough council's point of view, the game would not be worth the candle, and eventually the County Council would get in.

Mr. ARTHUR WRIGHT, the consulting electrical engineer to the Stepney Borough Council, as agreed on Monday, was then called. He said that he objected to the possibility of any loss made on the outside area falling upon the rates of London, and that was why his Council had entered into the agreement with the Administrative Co. last year. He regarded this bill as restricting the market open to the Stepney Council; in other words, if this bill passed they would be deprived of the very favourable terms offered by the company last year, which were 35 per cent. cheaper than those offered by the County Council for the same load factor.

Mr. SANDERS, on behalf of the Islington Borough Council, said that the attitude of his council towards this bill was precisely the same as they had adopted last year towards the Administrative Co.'s Bill.

Dr. MANSFIELD ROBINSON, the town clerk to the Shoreditch Borough Council, in putting the case for that authority, said that the Shoreditch Council had obtained prices from the various promoters of power schemes this year, and these showed that the proposals of the L.C.C. were 50 per cent. dearer than the others. Whilst, on the one hand, they had the greatest difficulty in getting a price at all from the Council, he had a signed and sealed contract with the promoters of the Additional Co.'s Bill which guaranteed a supply to the Shoreditch Council at 0·63d. per unit. If, in face of the fact that other promoters were quite willing to give a cheaper supply, the Committee passed this bill, he asked that it should contain clauses which permitted of the existing stations linking up as was originally agreed to by the County Council In the course of further remarks Dr. Robinson said that it was the opinion of the Shoreditch Council that a scheme such as the St. Neots could be conducted without any Parliamentary powers, for it appeared probable that the company could carry out its works without breaking up the streets. For instance, so far as Shoreditch was concerned, from Enfield, where the overhead wires ended, the mains could be brought into Shoreditch by wayleaves along the Great Northern Railway and the tunnels of the Great Northern & City Railway, and so reach the centre of Shoreditch without breaking up a single street.

Mr. C. H. WORDINGHAM was called as an independent expert in support of the theory that greater use should be made of the existing generating stations by a system of linking up. His evidence, however, was greatly discounted by the fact that Dr. Robinson, in opening the case, had strongly advocated the St. Neots scheme. In fact, the chairman went so far as to say that he did not think Mr. Wordingham could assist the Committee, although he was permitted to express his views.

Mr. NEWTON RUSSELL, the resident electrical engineer to the Shoreditch Council, was next called, and stated that a scheme of linking up five of the borough councils electrical undertakings in the East End of London had been prepared, by which 10,000,000 units could be generated at 0·51d. per unit.

The case for the North Metropolitan Electric Power Supply Co. was then gone into.

Mr. JAMES DEVONSHIRE, managing director of the company, gave details of what was being done in its area to develop the supply of electrical energy. Greatest progress, he said, had been made in the portion of the area taken in by the County Council Bill. The unfair competition suggested by the bill was strongly resented by his company, and he further pointed out that no competition between power companies had yet been sanctioned by Parliament. Mr. Devonshire also explained the conditions of his Act of Parliament, such as the revision of prices, compulsion to supply, relation of price to dividend, &c.

The Committee then adjourned until Tuesday, June 12, when the opposition of the North Metropolitan Co. will be continued.

Mr. NIELD, in the House of Commons on Monday, asked that the terms of the reference to the Committee considering the London County

Council Electric Power Bill should be enlarged in order that evidence might be taken, and a report made, upon the general question of the cheapest and best method of generating electricity in bulk and also the practicability of establishing a central authority for large areas on the lines of the Metropolitan Water Board.

Mr. LLOYD-GEORGE, in a printed reply, said it was now too late to suggest any alteration of the terms of reference, but he did not think the Committee would be precluded from considering the points mentioned.

LONDON OUTER CIRCLE RAILWAY BILL.

Sir C. Doughty's Committee of the House of Commons continued its consideration of the London Outer Circle Railway on Friday of last week, and again during the present week. It will be remembered that it is intended to work the railway on the single-phase system.

Financial evidence has been heard from Sir J. Dixon-Hartland, M.P., Lord Montagu of Beaulieu, Mr. R. H. Cox, Mr. J. H. Bethell, M.P., and others, all of whom asserted their conviction that the capital for the railway would be easily found, and that each of them would take a substantial interest in the scheme if the bill were passed.

Engineering evidence was called from Mr. C. A. Brereton and Sir Douglas Fox as to the permanent-way construction and other civil engineering details.

Mr. STEPHEN SELLON gave statistics of what he thought would be the probable traffic on the line. He said he had taken the progress of the population and traffic returns upon the North London and other railways over a varying period as a basis upon which to work, without in any way regarding the present line as a parallel one with existing lines as they are to-day. By 1911 he calculated that the line would earn from passenger traffic £12,594 per mile per annum. This took nothing into account for traffic handed over by the existing railways. In the same way he estimated that £66,000 per annum would be earned from goods traffic. He therefore considered that these figures represented the worst possible condition of affairs, for the figures given above were on the assumption that the line was a self-supporting one.

In cross-examination Mr. SELLON said that he had estimated 50 per cent. as working expenses, and that he believed the line would in ten years of being opened earn £60,000 a year.

In reply to this remark the CHAIRMAN expressed the opinion that Mr. Sellon was a very sanguine man.

Mr. PHILIP DAWSON, of Messrs. Kincaid, Waller, Manville & Dawson, was called with regard to the electrical arrangements in connection with the scheme. He said that it was intended to work the railway on the single-phase system with overhead wires, similar to that in use on the New York Central Railway. In the event of the company generating electricity itself lands had been scheduled at Tottenham and Heston, and the cost of acquiring these would be £300,000. For the overhead equipment of the line he estimated that £303,000 would be necessary, and that for the electrical equipment of the rolling stock, assuming 34 trains, £374,000 would be required, making a total of £977,000 as the cost of construction, electrical equipment and land. If the electrical energy were purchased from an outside source the first item would disappear. The trains would be so equipped that they could operate on the Metropolitan Railway system. He had estimated a ten-minutes' service, and the seating capacity of each train would be 300 passengers. If steam traction were employed the cost of equipment would be reduced by one-third.

The CHAIRMAN pointed out the discrepancy between the figures given by Mr. Cripps in his opening for the cost of electrical equipment—namely, £500,000—and the figures now given by Mr. Dawson, which made a total of £603,000.

Mr. FITZGERALD, for the promoters, said that Mr. Cripps had spoken in round figures, and that Mr. Dawson's figures were the correct ones.

Further local evidence was then called in favour of the railway, and this closed the case for the promoters.

Mr. WEDDERBURN, K.C., opened for the opposition on behalf of the Finchley Urban District Council.

Several oppositions were postponed until after the Whitsun recess, that of West Ham, at the request of the committee who agreed with the objection taken to certain level crossings in the borough.

The opposition of private owners was then gone into.

The Committee adjourned until June 12.

WIRELESS TELEGRAPHY BILL.

The House of Lords went into Committee on this bill on Friday, May 18. The bill has passed all its stages in the House of Commons.

LORD AVEBURY stated that he had been asked by the committee of Lloyd's to either move the rejection of the bill, or that it should be referred to a Select Committee. The complaint made to him was that the Government was exercising its monopoly in such a manner as to ignore the claims of the shipping and mercantile community. Two of the wireless telegraph companies had written to him to the same effect. As, however, he had not been able to investigate the allegations he did not feel justified in opposing the bill, but would ask that the Government would grant a reasonable lapse of time before the next stage was taken.

The EARL OF GRANARD acquiesced in the last suggestion of the previous speaker. Further, in consequence of representations made by the Marquis of Londonderry, the period for which the Act would continue in force the powers of the Act of 1904 would be reduced from six to three years. Since the Act of 1904 was passed, 119 licences had been applied for, 91 had been granted and were in process of being granted, 14 had been abandoned, and the remainder were still under consideration.

The MARQUIS OF LONDONDERRY suggested that the period in the Act should be two years instead of three.

The EARL OF GRANARD said he could not consent to a less period than three years. This amendment was agreed to.

The bill was considered by the Standing Committee of the House of Lords on Monday, and reported without further amendment.

CENSUS OF PRODUCTION BILL.

We give below the gist of the bill (so far as it affects the engineering industry), which has been introduced by the Government, providing for the compilation of a census of production. The census in question is to be taken in 1908 and subsequently at such intervals as may be determined by the Board of Trade. The object of the measure is to secure statistics of the trade of the country by returns made by individuals or firms, and in the schedule the list of those required to make returns includes the occupier of every factory or workshop within the meaning of the Factory and Workshop Act, 1901, every person who by trade or business executes works of construction, alteration or repair of railroads, tramways, &c., or of laying, altering or repairing gas or water pipes, or telegraphic, telephonic or electric lines. These definitions include local authorities carrying on trade or business. Any person refusing to answer or wilfully giving a false answer to any question shall be liable to a fine of £10 for each offence. The forms which will be provided on which the information is to be given, include the nature of the trade or business, output, materials used, days and hours worked, persons employed, wages paid, and plant and machinery used. The information thus given is not to be published except for the purposes of the act, and no person not engaged in connection with the census shall be entitled to inspect it. Every person engaged on the census will be required to make a declaration that he will not disclose any of the information so obtained. Any contravention of this disclaration shall be deemed a misdemeanour.

DISTRICT RAILWAY EMPLOYEES.

In answer to Mr. Will Thorne, in the House of Commons on Monday, who complained that, as a consequence of the reduction in the number of cars constituting the trains on the District Railway, 60 guards had been discharged, Mr. LLOYD-GEORGE said that it was found more advantageous to only have six cars instead of seven on the trains. The number of trains was being rapidly increased, however, and the company informed him that there were now 440 train men in their service as compared with 120 during the time when steam traction was employed.

MISCELLANEOUS.

The Preston, Chorley & Horwich Tramways Bill was passed by the Unopposed Committee of the House of Commons on Friday last week. The bill seeks an extension of time for the tramways authorised in 1903, the authorisation of certain new lines and the abandonment of others. Five years for the completion of works is asked. The bill also provides for the acquisition of certain lines by the Wigan Corporation.

The Watford & Edgware Railway Bill was considered by the Unopposed Committee of the House of Commons on Thursday last week. The objects of the bill are for an extension of time for the acquisition of land and the construction of works under the Company's Act of 1903, and the transfer to the company of certain powers of the Edgware & Hampstead Railway Co. The Committee found the preamble of the bill proved.

The South Lancashire Tramways (Extension of Time) Bill, which has already passed the House of Lords, was considered by the Unopposed Committee of the House of Commons on Thursday last week. The bill, the preamble of which was found proved, asks for an extension of time for the construction of tramways authorised in 1900, 1901 and 1903. The bill was allowed to proceed.

Folkestone, Sandgate & Hythe Tramways (No. 2) Bill.—In our last issue we gave an outline of this bill, to which there was practically no opposition. The case for the promoters was concluded on Friday, and, after hearing the one opponent, Lord Radnor, the Committee of the House of Lords passed the preamble of the bill, and it was ordered to be reported for third reading.

The North Metropolitan Tramways Bill received Royal Assent on Monday.

The Northamptonshire & Derbyshire Tramways Bill was read a second time in the House of Commons on Monday.

The following bills were read a third time in the House of Lords on Monday:—County of Durham Electric Power, Cumberland Electricity & Power Gas, and Southport & Lytham Tramroads (Extension of Time).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Modern Polyphase Machinery." By Andrew Stewart. (London: S. Rentell & Co.) 5s. net.

"Science Abstracts." May. Section A—Physics. Section B—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Kelly's Directory of the Building Trades," 1906. (London: Kelly's Directories, Ltd.) 30s.

LEGAL INTELLIGENCE.

Attorney-General and Others v. Pontypridd Urban District Council.

Last week the Court of Appeal (the Master of the Rolls and Lords Justices Romer and Cozens-Hardy) delivered judgment in this appeal from a judgment of Mr. Justice Farwell.

The action was brought at the relation of the trustees of the late Baroness Llanover to restrain defendants, their contractors, &c., from erecting or permitting to remain upon any portion of land at Gwernygerwn, Treforest, which was purchased from the trustees in 1902, any building or works not required or intended for the defendants' electric lighting undertaking or from permanently using any part of the land for any other purposes than that for which it was originally acquired—viz., the production and supply of electricity. The relator trustees also claimed an injunction to restrain defendants from so using any part of the land as to create a nuisance. The facts of the case were reported in our issue for Aug. 18, 1905, but may be briefly recapitulated. In April, 1903, defendants applied to the Local Government Board for permission to use a part of the land for a refuse destructor, but were told the Board had no power to sanction its use for any other purpose than that for which it had been acquired. The trustees refused to accept a reconveyance of part of the land (on which it was proposed to erect the destructor) and then to convey it back again to defendants, the latter paying the costs. Defendants then went through the form of conveying part of the land to a Mr. Davis and taking a re-conveyance from him, the undertaking to re-convey being a condition of the conveyance.

At the conclusion of the legal arguments, the MASTER OF THE ROLLS, in giving judgment, said that the first question was, Under what powers did defendants acquire the piece of land—*i.e.*, under what statutory powers were defendants acting when they acquired the site of the dust destructor? Mr. Justice Farwell had found as a fact that the land had been acquired under powers conferred by the Electric Lighting Acts, and with that conclusion of fact he entirely agreed. The next question was, Did those acts give defendants the right to build and use the dust destructor when built on the land so acquired? If they did, it could only be by virtue of its being necessary and incidental to the supply of electricity; if it was not necessary or incidental to that object then its construction was ultra vires. That again raised the question whether a dust destructor could be considered as "incidental" to electric lighting. Mr. Justice Farwell had come to the conclusion that it was not, but that its construction had been undertaken for getting rid of the dust and refuse which the council was obliged to remove, and consequently that it was ultra vires the powers of the Council. He (the Master of the Rolls) was clearly of opinion that from the very first the object of the council was to acquire the land for tramways and electric lighting, and that the evidence showed conclusively that the dust destructor was not incidental or necessary to the council's electricity generating scheme. He thought the appeal should be dismissed with costs.

Lord Justice ROMER concurred, but thought the order in the Court below should be varied by making a declaration that the user by defendants of the part of the land purchased for the erection of a dust destructor, according to the scheme prepared by them, was outside their powers of dealing with it and ought to be restrained, and then to let the injunction run on in general terms restraining them from using the land except for generating electricity and generally for all such acts and things as might be necessary and incidental to such supply, following the words of sec. 10 of the Electric Lighting Act of 1882.

Lord Justice COZENS-HARDY concurred.

General Electric Co. (Ltd.) v. Jones.

The Court of Appeal (Lords Justices Vaughan Williams, Stirling and Fletcher Moulton) had before them this week an appeal by plaintiffs from an order of Mr. Justice Sutton.

Mr. SHEARMAN, K.C., for appellants, said the appeal was from an order refusing an application by plaintiffs that the action (brought against Thomas W. Jones, trading as D. Jones & Sons, Swansea) be remitted to Mr. Pollock, official referee. Having regard to the nature of the action he submitted it was not one which could possibly be tried by a jury. Plaintiffs undertook to fit up electrical plant for pumping, ventilating, hauling and other purposes in the Cawdor and Marnant collieries owned by defendant. Plaintiffs were nine months doing the work and at the end of that time defendant gave them notice to quit alleging that their work was defective and useless, and that, as a result, his mines became flooded. Plaintiffs replied that the floods had nothing to do with breakdown of their work but to the breakdown of defendant's own apparatus. There were two or three consolidated actions, and the total sum claimed by plaintiffs was £6,500. After turning plaintiffs out of the works defendant sold his collieries and plaintiffs had not got a penny for the work they had done. Defendant said that in July, 1904, plaintiffs agreed to supply him with a complete electrical equipment for pumping, ventilating and other purposes connected with the colliery within eight weeks. Defendant further said that he had no knowledge of electrical machinery, and relied on plaintiffs' skill and judgment. Plaintiffs (defendant went on to state) continued their attempts to equip the colliery until July, 1905, and he alleged that their machinery was useless and a total failure, that their work had been negligently, improperly and unskilfully done, and that plaintiffs' breaches of contract had resulted in the Cawdor colliery being flooded and damaged. The counterclaim of defendant alleged damage, and it would involve an extraordinarily complex inquiry. The only way was to let the question be tried along with the counterclaim.

Lord Justice MOULTON thought defendant did not say that all the goods were not worth the price at which they were charged. The goods he objected to amounted to no more than about £300.

Mr. MEAGER, for defendant: What I say is that the whole equipment is useless to us. I do not object to the goods article by article, but put altogether they no not constitute a complete electrical equipment for my colliery. By the contract plaintiffs undertook to complete the installation in eight weeks. He referred to various instances of flooding of the mines, and said it was a question of fact for the jury as to whose fault it was that the flooding and breach of contract took place.

At the conclusion of the arguments, Lord Justice VAUGHAN WILLIAMS said in his opinion they could not interfere with the discretion exercised by the Master and the learned judge.

The other Lords Justices concurred, and the appeal was dismissed, with costs.

Dudley Corporation v. Dudley, Stourbridge & District Electric Traction Co. (Ltd.)

In the Chancery Division on Wednesday, Mr. Justice Swinfen Eady heard a special case stated by the Arbitrator appointed to fix the price to be paid by the Corporation for a light railway taken over from the company.

Mr. CRIPPS, K.C., for the company said the point the Court was asked to decide was one arising in connection with the principle upon which the price of the light railway was to be determined. The railway was being sold pursuant to an agreement and a certain light railway order. The original agreement was that the price should be ascertained by the Board of Trade, but that had been superseded by an agreement to send the matter to arbitration so that the question could be raised. The real point was the basis upon which the award ought to be made. Whether the railway ought to be valued as an income-earning property, or upon the principle by which tramways were valued under the Tramways Act, 1870. The railway was about 2 miles of single line, but the question affected all light railways constructed under the Light Railways Act. Sec. 63 of the act provided that local authorities in whose district such light railways were constructed might within six months after the expiration of 25 years or within six months within each subsequent period of seven years require the company to sell the railway on the terms of the Corporation paying the fair market value as a going concern. With regard to the railway in question, an agreement was entered into between the Corporation and the company which provided that the company should construct the railway and at the expiration of four years from August, 1898, the Corporation should purchase and the company should sell it, the price to be settled by the Board of Trade. There was no reference in the agreement to any special method of settling the price. The railway was duly constructed, and it was sold on Sept. 25, 1901, to the defendant company. At the expiration of the four years the Corporation gave notice to purchase all the railway works within the borough. The company denied the right of the Corporation to purchase, and commenced an action to restrain them, but it was decided against the company. The parties then agreed to refer the settlement of the price to an arbitrator, and Mr. H. Graham Harris, who was appointed, submitted the special case. The Corporation's contention was that if they purchased on the basis of the railway being a profit-earning concern, the company would be getting the profits twice over. According to the arbitrator, on the basis contended for by the Corporation, the value would be £16,000 odd, and on the basis claimed by the company it would be £32,576. The former, however, was merely for the rails, and the latter included 10 single-deck cars.

Mr. BALFOUR BROWNE, for the Corporation, submitted that the question was the interpretation of the agreement entered into between the parties, and, to ascertain that it was necessary to look at the Order. Looking at the agreement, it was reasonable to suppose that the parties contemplated that the price to be paid for the railway when it came to be bought at the end of four years would be a price based upon the constructural value and not on the basis that the company were to have an exclusive right of working the tramway for ever.

At the conclusion of the arguments, His LORDSHIP reserved his decision.

Workmen's Compensation.

At Manchester County Court on Monday, before Judge Parry, application was made for an award under the Workmen's Compensation Act by Mrs. E. Bagnall and her infant son. Mr. Ernest H. Bagnall, the husband and father, died as the result of an accident sustained in the works of Levinstein & Co., chemical manufacturers, Manchester, where he was employed. On Jan. 12 last Mr. Bagnall was carrying out the duties of a chemist at the works, when he scratched his leg. Some chemicals got into the wound, blood poisoning was set up, and he died on Feb. 25. His earnings for the three years preceding his death were £687. 10s. It was not admitted that Mr. Bagnall was a workman within the definition of the act, and the question for the Court to decide was whether the Workmen's Compensation Act applied to him. The terms of service existing between Mr. Bagnall and respondents were embodied in an agreement, and Mr. Byrne contended (for applicants) that certain clauses confirmed the view that Mr. Baguell was a workman.

Judge PARRY suggested that Mr. Bagnall was in the position of a foreman dyer.

Mr. BYRNE: Yes. He worked as a foreman, and when he had to go away in consequence of his accident his place was supplied by a foreman dyer.

Mr. ACTON (for respondents) submitted that the principle laid down in the case of Simpson *v.* the Ebbw Vale Co. by the Court of Appeal applied. Mr. Bagnall was not a workman in the ordinary sense; Mrs.

Bagnall possessed no rights over those of her husband, and if he had lived the result of proceedings under the act must have been adverse to him. If employers were henceforth to regard their liability as extending to managers of departments and gentlemen of education and position, as well as to those who were treated in ordinary parlance as workmen, it would completely alter the state of affairs as regarded premiums and liabilities.

The JUDGE said the case was one of some little difficulty. He had read "Simpson *v.* Ebbw Vale Co." carefully, and had arrived at the conclusion that all it came to was that the Court of Appeal refused to interfere with the findings, on certain facts, of a county court judge. He regarded it as utterly irrelevant whether a man was M.Sc., D.D., M.A. or president of the Royal Academy; it seemed to him that if he did manual work within a works he thereby earned his living by that which brought him within the Workmen's Compensation Act. That man was employed as a chemist, and it was clear from the evidence that he worked the bulk of his time—five-sixths—in the works. He was not a man in a black coat sitting in a laboratory engaged in chemical research. He was as much exposed to danger as any workman earning 20s. a week, and probably more, because he apparently had more dealing with the vats full of poisonous liquors, and he had to lean over them and deal with them in a manual way. He decided that Mr. Bagnall was a workman within the meaning of the act, and awarded the applicant £300. There would be liberty to apply with a view to appeal. He granted costs on the C scale.

In re London Electrobus Co. (Ltd.)—In the Chancery Division on Friday an order was made for rectification of the register by removing the names of shareholders. The circumstances were similar to those already reported in *The Electrician.* The company did not appear.

PUBLIC TIME SERVICE.

A deputation appointed by the Glasgow Corporation have recently visited the Continent for the purpose of investigating the systems of public time service adopted in some of the principal cities. A report has now been issued which states that in every system of synchronous clocks either pneumatic or electrical impulses are transmitted at regular intervals from a central apparatus to the subsidiary clocks, where the impulses actuate or regulate the hands. Electrical impulses are employed in the systems in operation at Berlin, Antwerp, Brussels, and also by the Standard Time Co. of London, while both pneumatic and electrical are employed in Paris. The principal electrical systems are (1) the system of electrically-propelled clocks by which impulses are transmitted from the master clock, and actually drive the mechanism of the clocks, which have no spring, weights or escapement common to ordinary clocks; and (2) the system of electro-mechanical clocks, to which the impulses are sent out at less frequent intervals, and merely set the hands of the subsidiary clocks (in this case driven by springs or weights) to the correct position, at the same time winding up the spring, the escapement being worked in the usual way. In the case of turret and other large clocks the winding is done by hand or by current derived from the electric-light mains. An important point is that the electrically-propelled clocks will come to a standstill whenever the impulses fail to reach them; whereas under like circumstances, the electro-mechanical clocks will continue to go for some time, before the expiry of which the fault can be detected and made good.

Berlin first introduced electrically regulated clocks in 1870, and 16 years ago the Normal Zeit Co. (Ltd.) was entrusted with the task of providing a public time service in the city. The total number of this company's clocks now exceeds 6,000, and each clock has a self-contained movement, capable of working, if necessary, for four or five days without rewinding. The operations of regulating and winding are performed every four hours by electrical currents from the central station. In addition, a "reporting-back" arrangement is in use, whereby the loss or gain in time or the stoppage of the clocks is automatically recorded at the central station, thus enabling the error to be corrected before any inconvenience is caused to the public. The fact of the clocks being self-contained renders them independent of the line wire, as, in the event of an interruption, whether by accident or design, to the line or central apparatus, the clocks continue to go for four or five days.

The current for working is derived from accumulators charged once a week from the lighting mains, and the wires connecting the clocks to the central station are in underground cables, and are rented from the Imperial Post Office Telephone Department. The clocks are connected by single wire, and as many as 64 can be operated on one circuit. The master clock which controls the entire system is wound daily, and regulated from the Observatory. In addition, a "stand-by" master clock is provided, and is automatically switched into circuit in the event of an interruption taking place in the principal clock. The functions of the master clock are (1) to transmit the currents at proper intervals for regulating and winding the subsidiary clocks and (2) to operate the "reporting-back" apparatus already referred to. By the latter arrangement the condition of working of every subsidiary clock is indicated on a moving paper strip once during every four hours. The attendant can detect at a glance errors or stoppages, thus obviating the necessity of policemen or citizens reporting the irregularities. It also leads to a saving of time in rectifying faults, and prevents inconvenience to the citizens by the delay which otherwise would be caused.

The Normal Zeit system is also in use at Bremen and Stettin.

In Antwerp, the Normal Zeit system was introduced three years ago. All essential details in the system are the same as in the German capital. Some trouble is experienced from contacts of wires on telephone poles taking place, and the stoppages from this cause usually amount to one or two per week. There are at present nine turret clocks, 122 public clocks, and 183 clocks in offices and dwelling-houses.

The system presently in use in Brussels was erected by M. Nolet in 1857, and the results have been fairly satisfactory. The master clock is regulated from the Observatory, and the subsidiaries are of the "System Nolet" type of electrically propelled clocks. The clocks, of which there are over 300 are connected to the central station by overhead wires. It is said that negotiations for the installation of a Normal Zeit system are now in progress. At St. Gilles, a suburb of Brussels, some 50 clocks of the "system Tordoir" are used, which possess practically like constructional features with the "Stockall," used in the first experimental installation of electric clocks at Glasgow.

In Paris a commission was appointed in 1876 to consider the question of providing a public time service, but, owing to the estimated cost amounting to a considerable sum, only 36 electric clocks were erected on the front of certain public buildings in the city. The master clock in the Observatory controls two subsidiary master clocks—one operating seven, the other eight circuits. This installation has not been extended, but a few double-dial pneumatic clocks ("system Popp") have been placed in some of the principal streets. Several thousand similar clocks are rented by the company to hotels and private individuals. The use of these entails the laying of a special system of piping conveying the compressed air from the central station to the subsidiaries; they work best when in close proximity to the station. This method may be considered quite out of date for the purpose of furnishing standardised time throughout a city or large town, partly on account of the excessive cost of the piping, and partly because the system does not possess the advantages furnished by an electrical one.

There is no municipal system of synchronous public clocks in London, but the Standard Time Co. undertakes to regulate the clocks of over 800 subscribers by means of overhead lines.

In America there is no municipal time service. Telegraph, telephone and time-signal systems are in the hands of private companies. The Western Union Telegraph Co. undertakes the keeping to correct time, for their subscribers, clocks in all parts of the country. Most of the subscribers use the electrically wound mechanisms of the Self-Wound Clock Co. of Brooklyn, which resemble those of the Normal Zeit Co. The standardising signal is sent from Washington Observatory. In New York about 3,000 people subscribe for a time service at a rate of £3. 12s. per annum. In some of the recently erected office buildings in American cities electric clocks are provided in each room by the landlord. This time service is held out to likely tenants as an extra inducement, and is considered to be, to the up-to-date man of business, quite as necessary as an electric light, water, gas or telephone service.

The report concludes with the following recommendations as to the establishment of a municipal time service in Glasgow:—

1. To proceed at once to establish a complete public time service, combined with the supplying and lending of clocks, &c., to offices, shops and warehouses, as has been done by the Normal Zeit Co. in Berlin and Antwerp.

2. In the event of the foregoing recommendation being approved, to remit back to the sub-committee on clocks to negotiate with the companies as to the terms and conditions upon which they would be prepared to undertake the work of establishing and carrying on for a period of years a system on the lines indicated, with option of ultimate acquiral by the Corporation.

3. Should the Corporation not agree to the proposals contained in the two previous recommendations, to arrange with either Messrs. Barr & Stroud or the Magneta Co. for an extension of their respective systems, as the Standard Time Co., which operates the Normal Zeit system in this country, admit that their system, if restricted to a small number of clocks, cannot be erected and carried on economically.

4. If recommendation No. 3 is adopted, to remit to the sub-committee to obtain offers from the two firms referred to, schemes and estimates for an extension of their respective systems.

5. To appoint an independent expert to examine the turret clocks and to report as to the repairs necessary to put them into proper working order.

6. To fit up a reporting-back arrangement to each turret clock and a small dial in connection with any public time service which may be installed in the city, to indicate the correct time to the attendant in the clock chamber when setting the hands.

7. To continue in the meantime the methods of hand-winding and chiming of the turret clocks presently in use, as the existing clocks do not readily lend themselves to an alteration in this direction.

8. To erect new clocks in the towers of the Victoria U.F. Church at Eglinton Toll, and of the Kinning Park U.F. Church at the corner of Scotland-street and Shields-road; also on the pillar at Saracen Cross.

Trunk Telephones.—A new Birmingham trunk telephone exchange was formally opened on Thursday last. On Saturday evening the transfer from the old to the new quarters was commenced. There will be 25 switch sections in use in the new room, and an arrangement by which, at night-time, when there is no necessity for the whole of the section to be working, the work can be concentrated on nine sections. There are two spare switch sections which will be available in the event of one of the sections failing, and two which will be ready when further extensions are necessary. Each section is capable of holding five lines, and there is, therefore, spare accommodation for 20 trunk lines.

THE EASTERN AND ASSOCIATED TELEGRAPH COMPANIES.

By the invitation of Sir John Wolfe Barry, K.C.B., about 130 guests were present at a dinner at the Trocadero Restaurant, London, on Monday, including the Marquis of Tweeddale, K.T., Lord Kelvin, O.M., G.C.V.O., Lord Allerton, the Right Hon. St. John Brodrick, Sir A. Binnie, Mr. John Gavey, C.B., Sir John Denison-Pender, K.C.M.G., Mr. F. A. Bevan, Sir A. J. Leppoc Cappel, C.I.E., the Hon. George Peel, Mr. D. H. Goodsall, the Hon. A. G. Brodrick, Sir H. Mance, C.I.E., Mr. F. A. Johnston, Mr. J. Coppen, Mr. A. R. Hardie, Mr. F. E. Hesse, Mr. W. Hibberdine, Mr. E. Steer Hodson, Mr. W. Judd, &c.

After the toast of "The King" had been honoured,

Mr. JOHN GAVEY proposed the toast of "Submarine Telegraphy," and said that in this country we had every reason to be proud of the origin and progress of submarine telegraphy, which was initiated in this country, the first submarine cable having been laid from our shores. Since that time every effort had been made to extend the range of submarine telegraphic communication to all parts of the world, and at the present time Great Britain occupied the position of having made and laid with its own capital the vast proportion of all the submarine cables of the world. Among the assets of the submarine cable companies was a fleet of repairing vessels which would form a respectable fleet for a moderate sized State, but with a difference. The fleet, if owned by a State, would be intended for war and for the destruction of life, while the fleet of the great telegraph companies was concerned in securing telegraph communication throughout the world and the promotion of the happiness and comfort of mankind. He might mention a subject which was doubtless of interest to them—namely, the prospects of submarine telegraphy when confronted with wireless telegraphy. For him to express a very definite opinion would be in the nature of a prophecy. What was said when gas was first introduced as to the extinction of the tallow candle industry, and when the electric light came along as to the extinction of the gas industry, might be said in regard to the prospects of submarine telegraphy when confronted with wireless telegraphy. But the use of candles became greater than ever, the gas companies' shares were still excellent investments, which proved that there was in each case room for both. This, he thought, without adopting the prophetic vein, could be said in the case of submarine telegraphy and wireless telegraphy. The new system should serve to supplement and assist the old. He had much pleasure in proposing the toast, and coupling with it the name of Sir John Denison-Pender, K.C.M.G.

Sir JOHN DENISON-PENDER said it was a pleasant task for him to acknowledge the kindly manner in which Mr. Gavey had proposed the toast of "Submarine Telegraphy," and especially so in regard to his remarks concerning the Eastern and Associated Telegraph Companies. Mr. Gavey was perhaps better able than anyone else in this country to judge of the Companies' work. He feared that in whatever he might say there would be little new, as those present that evening at the kind invitation of Sir John Wolfe Barry, the chairman of the Companies, were associated in their daily life with the business of submarine telegraphy. They were all proud to know that the first capital invested in submarine cables was British, and that, although the first cable ever laid was a failure, yet it was in that failure that they ultimately found success for a great enterprise (cheers).

Sir JOHN WOLFE BARRY then proposed "The Directors and Staffs of the Associated Companies," and said the toast he was proposing was very dear to his heart. It was now six years since he became chairman of the Eastern and of two of the Associated Companies, and as chairman his duties brought him into contact with many members of the staff, but not so frequently as he would desire for various reasons, the chief of which was that the staff was scattered, not only in many offices in London and other parts of the United Kingdom, but all over the habitable globe. He valued very much his position as chairman, and in his large and long experience of public life he could say that he knew of no board of directors better chosen than those of the Associated Telegraph Companies. He had made many lasting friendships, and he took that opportunity of thanking them for the support they had always given him as their chairman. The boards of the companies recognised most thoroughly that they had great public duties to perform as well as their duties to the staffs of the companies, who so ably served them and the public. The shareholders' interests also had to be considered, and for all these reasons considerable responsibility rested with the directors. In mentioning the directors of these companies, he could not forget the name of their former chairman, Sir John Pender—(cheers)—without whose enterprise submarine telegraphy would have halted, and perhaps might never have come to the position it now occupied. His near neighbour, Lord Kelvin (and nobody knew better) informed him that Sir John Pender, by his indomitable perseverance and foresight saved the situation for the Atlantic companies, and if it had not been for him the Eastern and Associated Companies would never have come into existence. They must all bear these facts in mind when dealing with the position of submarine telegraphy. They had 168 stations and also 16 ships, these aggregating a total of 18,000 registered tons. The great enterprise of submarine telegraphy was a credit to the British nation, and it was pleasant and interesting for them to hear what the British had done for submarine telegraphy as compared with other nations of the world. Speaking for the directors, he could assure the staff that they had their profound sympathy and appreciation (cheers). No one could doubt that as long as Sir John Denison-Pender occupied his position as adviser on the delicate questions subsubmitted, which came before him as managing director of the companies, sympathetic consideration would be given to the interests of the staff by the boards upon which Sir John Denison-Pender sits. He concluded by referring to a letter he had received from the Prince of Wales eulogising the services of the staffs during his extended tour to Australia and his recent tour in India. He gave them the toast of "The Directors and Staffs of the Associated Companies," coupled with the name of the Marquis of Tweeddale; Mr. A. R. Hardie, for the Eastern Company; Mr. F. E. Hesse, for the Eastern Extension Company; and Mr. E. Steer Hodson, for the Western Company (cheers).

The MARQUIS OF TWEEDDALE, K.T., in responding, said it was a great honour to have his name coupled with the toast, and he would be discharging his duty in the best way by expressing, on the part of the directors, their great satisfaction at the kind terms in which Sir John Wolfe Barry had referred to their services. Sir John was a man of great experience and wide knowledge of men and affairs, and no one was more competent than he to judge the merits of the directors, and he could assure him that the good opinion which he entertained of them was highly valued and appreciated.

Mr. A. R. HARDIE, Mr. F. E. HESSE and Mr. E. STEER HODSON replied for the staffs of the Associated Companies.

Mr. F. A. BEVAN then proposed "The Chairman."

Sir JOHN WOLFE BARRY, who was received with loud cheers, replied, and proposed the health of "The Visitors," coupling the toast with the name of Lord Kelvin.

Lord KELVIN said he was precluded from making a speech, but he thanked them very sincerely for the manner in which the toast had been received. He could not but go back to old times, for he was full of old memories. His (Lord Kelvin's) old friend Mr. Saunders was present that evening, and they owed a great deal to Mr. Saunders, who was formerly in the Atlantic Company's service, and latterly and for many years in that of the Eastern Company. He was very happy to see him with them.

The proceedings closed with the National Anthem.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Manchester Tramways committee invite applications for the positions of rolling-stock superintendent and works manager. The superintendent must be a qualified electrical and mechanical engineer, with practical experience; and the works manager will be in charge (under the rolling-stock superintendent) of the car repairing works. Applications to the committee, 55, Piccadilly, Manchester, by June 11. Further particulars are given in an advertisement.

Whitehaven Corporation invite applications for the position of manager of the municipal electricity undertaking. Salary £250, with privilege of taking two premium pupils. Applications to the town clerk (Mr. Thos. Brown) by June 8. See an advertisement.

Aston Manor Council require an assistant science master (electrical engineering, mechanics, &c.). Salary £130 per annum.

London County Council require several assistants in the engineer's department. Salaries £4 to £5 per week. Applications by 10 a.m. June 5.

Mr. P. J. Watts, borough electrical engineer at Whitehaven, has resigned in order to take up an appointment under the Admiralty.

Argentina.—The "Review of the River Plate" states that Concordia Municipality have received authority to invite tenders for constructing and working electric tramways.

The amalgamation of Tres Arroyos Electric Light Co. and the Cia de Electricidad de la Provincia de Buenos Aires has been approved by the Government.

R. von Wentzky & Co.'s concession for an electric tramway between Barracas, Retiro and Villa Devoto has been declared lapsed as the concessionaires have not signed the contract.

Quesada & Gallo have applied to the Minister of Public Works for authority to construct a tube railway under the Plaza Mayo.

Barrow-in-Furness.—It was reported to the Council on Monday that there had been an increase of 80,000 units in the year's output at the electricity works, and the gross profit was over £800. The receipts from supply of current to the tramways were only £2,500.

Belfast.—A report on the system of charging for electric current prepared by the city electrical engineer (Mr. Victor A. H. McCowen) has been approved by the Tramways and Electrical committee. The revised scale includes a reduction in the flat rate for private lighting of ½d. per unit (from 4½d. to 4d.), and in the charge for energy for power to large users the initial charge of 2d. per unit being reduced to 1¾d. when the consumption exceeds 10,000 units and to 1½d. when exceeding 20,000 units per quarter.

All consumers will have the option of being charged on either the flat rate or the maximum demand system (6d. per unit for 182 hours maximum demand per half-year and 1¾d. after). For power and heating the charge is to be reduced to 2¼d. per unit when consumption exceeds 2,000 units per quarter, 2d. over 5,000 units, 1¾d. over 10,000 units and 1½d. per unit over 20,000 units per quarter. And a specially reduced price of 1d. per unit for power when the supply is controlled by time switch. The minimum charge for stand-by supply is £6. 10s. per kilowatt per annum The committee have reduced the flat rate of 4d. per unit for places of worship to 3½d.

Belgium.—Among the numerous establishments at Liège engaged in the manufacture of firearms one company stands out as of particular importance, the Fabrique Nationale d'Armes de Guerre, at Herstal. The factory buildings of this company cover an area of about 10 acres, and the machinery at the works is entirely driven by electricity generated on the works and representing about 1,800 H.P. The whole of the company's manufacturing operations are conducted by machinery, the small amount of hand labour employed being engaged exclusively in finishing and packing. About 3,000 hands are employed in the works where, besides firearms, bicycles and motor vehicles are manufactured.

Birmingham.—Ald. Beale gave the Council on Tuesday some particulars of the progress of the municipal tramway undertaking.

He said that the tramways department was practically a new undertaking. The Tramways committee were launching into a very large scheme, and spending a large sum of money. A new tramway undertaking would not expect any return except a deficit until their lines were at work. Fortunately, however, the committee had a little tramway in Steelhouse-lane (a mile of line), on which the average fare per passenger was less than 1d., and yet the receipts were £18,500 in 12 months. The Steelhouse-lane line had not only furnished the money to pay interest and sinking fund on capital, but had also borne an abnormal amount of expense. They had also been able to put £4,300 to reserve. They would have help from the Dudley-road route in July, and anything else they could open, and three months' working of the recently-electrified steam routes, and hoped that they were now safe from any deficit on revenue account.

Blackpool.—The accounts of the electricity department for the year ended March show capital expenditure £188,155, an increase of £895.

The revenue was £32,769 (against £32,857), including £16,502 from private lighting, &c., £9,052 for current supplied to the Corporation tramways and £1,133 to Blackpool, St. Annes and Lytham Tramway Co. and £5,644 for public lighting. Working expenses were £14,969 (against £15,454), leaving £17,800 gross profit (against £17,403). Capital charges were £11,680 (£11,503) and net profit £6,120 (£5,900), of which £2,740 has been placed to reserve, £3,000 to relief of rates and £380 to completion of payment for coal elevator.

The borough electrical engineer (Mr. C. Furness) states that during the four years the undertaking has been under the present management the coal consumed has decreased from 15,289 tons in 1902 (which cost £7,867 and generated 2,262,516 units) to 9,987 tons in 1906 (which cost £4,520 and generated 3,154,325 units). This greater economy is attributed to the use of condensers (since 1904), and to the adoption of superheaters and other modifications in the plant. The coal used in the past year cost 0·34d. per unit generated, against 0·84d. in the year to March 1902.

Bolton.—The gross capital of the electricity undertaking at March 31 was £269,818, equal to £44. 11s. 2d. per 1,000 units sold, against £256,821 (£47. 1s. per 1,000 units) in 1905.

The year's receipts were £42,377 (against £38,975), and included £19,255 (against £17,968) for private lighting, £112 (against £119) for public lighting, £6,398 (against £4,715) for power, and £14,963 (against £14,588) for tramways. Meter rentals were £200 (£340), and of motors £810 (£716), and profit on fittings trade account was £638 (£529). Working expenses were £15,811 (£14,837), the gross profit being £26,566 (against £24,138). After payment of capital charges £6,921 (£7,282), and placing £13,563 (£12,708) to depreciation (which includes sinking fund), the net profit was £6,109 (£4,148), of which £6,000 (£5,557) has been applied to relief of rates. 7,107,744 units were generated (6,457,194), 1,357,597 supplied for private lighting (1,265,684), 9,438 to public lamps (9,694), 3,264,757 to tramways (3,182,903), and 1,423,759 to motors (1,000,348). 418 motors (3,535¾ H.P.) are connected, against 351 (2,819¼ H.P.). There are 1,911 private consumers, with the equivalent of 220,792 8 c.p. lamps (against 1,733 and 192,195). The average prices received for current were for private lighting 3·39d. (against 3·40d.), public lighting 2·85d. (2·96d.), motors 1·07d. (1·13d.), and tramways 1·1d. (same as previous year). Total working expenses were 0·626d. per unit (against 0·652d.), and total costs (including capital charges and depreciation) 1·437d. (1·531d.) All the items in the costs (except repairs) show an appreciable improvement upon the previous year's good record.

Bonuses to Motormen.—In the annual report of the manager of the Blackburn Corporation tramways, it is stated that the payment of bonuses, amounting to £70, to drivers to encourage them to save current, has resulted in the cost of power being reduced by nearly £300.

Bradford and Spen Valley Tramways.—Bradford Tramways committee have decided not to proceed with the scheme for linking up the Spen Valley and Bradford tramways by extending the Cleckheaton and Low Moor lines to the Bradford boundary at Oakenshaw.

Cardiff.—For the year ended March 31 the income of the tramways department was £113,903. 6s. 10d. and the total expenses £110,109. 12s. 9d., leaving £3,793. 14s. 1d. Traffic expenses were £38,176, general expenses £6,661, power cost £10,898 and general repairs to permanent way, cars, &c., £11,276. 8s. 3d. Traffic receipts were £104,724. 11s. 9d., against £104,210s. 2s. 24,127,641 passengers were carried, against 24,134,363; and the receipts per mile worked out at 9·74d., against 9·15d.

Chester.—From Sept. 30 the charges for current for private lighting will be reduced from 4d. to 3½d. per unit, and for power from 2d. per unit for the first 500 units per quarter and 1¼d. after to 1½d. per unit for the first 200 and 1d. after.

"Civil Engineering."—We have been notified that a new paper entitled "Civil Engineering" (described as the only civil engineering journal yet published) was to make its appearance on May 21. Some of our old-established contemporaries in the engineering branch of journalism may consider that they have occupied this field to some considerable extent. The conductors of "Civil Engineering" describe it as "the last blank in periodical literature filled," and, to crown all, we learn that one of the special features will be "the immense thickness of the paper (160 lb. per quad ream) which had to be specially made to order by the ton, and only two paper mills in England would undertake the contract." We publish these particulars because great stress is placed upon them in the announcement made concerning the new journal. "160 lb. per quad ream" conveys little idea, we fear, of the immense thickness of the paper, and it would be, we presume, unusual to give an order for paper for this class of enterprise for anything less than "per ton." No explanation is given for the shyness of English paper mills at undertaking this order, and in this respect the conductors of our new contemporary have, we fear, laid themselves open to misconstruction. Probably our new contemporary has other than these doubtful claims to recommend it, and we wish it all success.

Colne (Lancs.)—An unopposed inquiry was held last week into the Council's application for sanction to a further loan of £5,300 for electric lighting extensions.

Colliery Exhibition.—The third international colliery exhibition, organised by Mr. H. G. Montgomery, M.P., will be opened on 12th inst. at the Agricultural Hall, London, by the President of the Board of Trade, Mr. D. Lloyd-George, M.P. The most up-to-date machinery for coal cutting, washing, hauling, conveying and pumping will be in motion, and the exhibition will be thoroughly representative of our great colliery industry. A special section is to be devoted to life-saving apparatus, and that used in the Courrières mines will be on view. Models of improved couplings for railway trucks will also be shown. The exhibition remains open until June 20.

Croydon.—The Corporation have applied for sanction to a further loan of £22,830 for electricity extensions.

"**Doing Too Much Work**."—Peculiar evidence was given at the Manchester Police-court on Wednesday in an assault case. A moulder employed at a large engineering works at Trafford Park was charged with assaulting a fellow workman, also a moulder, and, according to the evidence of complainant, both members of their trade union.

It appeared that defendant was fined by the Society for "doing too much work." The man assaulted said the other man had blamed him as having caused the fine, but he was only a witness called at a meeting of the Society. Defendant denied the assault, and said the other man had aggravated him and timed him at his work.

The STIPENDIARY: It is very unusual for a workman to be fined for doing his best, but at the same time I don't want to do the Society any wrong.

Another member of the Society said the crux of the question was that the Society would not allow a member to inaugurate piecework, and the defendant was doing too much, which was unfair to the other men, because he was much faster at his work.

The STIPENDIARY (to defendant): You did strike the defendant, and therefore you have broken the law. It seems to me this case is one out of the ordinary. You are apparently a good workman, and able to do better work than the other men, but the result of being able to do this, in my opinion, is that your Society does not wish a good workman to earn as much as possible. In these days, when technical schools are provided where working men and others can gain knowledge of their respective trades, I cannot conceive a Society interfering with a good workman.

Defendant was fined 1s.

Dundee.—The Electricity committee have further considered the report of the city electrical engineer (Mr. H. Richardson) as to the erection of a new generating station, but progress has been delayed owing to the difficulty of securing a suitable site. An enlarged committee has been formed to make a selection. In the meantime Mr. Richardson has been authorised to obtain an additional generating set of 1,200 H.P. to meet the coming winter's demand.

The revenue of the Electricity department for the past year was £30,922. 19s. 4d., and the expenses (including interest and sinking fund) were £23,211. 10s. 6d., leaving £8,180. 8s. 3d., from which £6,020. 19s. 2d. has been written off the balance of cost of the main cable alterations and improvements made two years ago, and £1,100 to complete the machinery and plant repairs. This makes a total of £14,000 paid off in three instead of five years, as allowed by the Corporation. The cost of current for lighting has been reduced by ½d.—from 4d. to 3½d. per unit—and a further reduction is to be conceded to the Tramway department—from 1⅓d. to 1¼d.

The convener (Mr. Brownlee) referred to the reduced working charges, and said their engineer (Mr. Richardson) was to be congratulated upon the results which he had achieved during the year.

Messrs. Urquhart Lindsay & Co., of Blackness Foundry, have asked for terms for the supply of current for power to the extent of about 80 H.P. Mr. Richardson has been entrusted with the negotiations.

Electricity in Mining.—The Tredegar Co. are carrying out extensions of their electrical power installation. About 500 kw. of electrical energy is to be transmitted from Tytrist power station (Tredegar) to McLaren Collieries for winding, pumping, coal cutting and for driving the ventilating fan.

Electric current is generated at 550 volts at the station, then stepped up to 6,600 volts for transmission over the mountain between the Sirhowy and Rhymney Valleys (about 3 miles) to McLaren Collieries, where the current will be transformed from 6,600 to 550 volts. The ventilating fan and winding gear will each be driven by a 250 H.P. motor. The winding gear is provided with three types of brake: one controlled by hand or foot, a second by electrical power, and a spare third in case of overwinding. Extensions are also being carried out at the Bedwellty Collieries—viz., from 150 kw. to 300 kw. The plant is being supplied by the British Westinghouse Co.

Electric Power Applications.—The Westminster Electric Supply Corpn., Eccleston-place, Belgravia, S.W., are issuing to householders in their area of supply an instructive pamphlet on "Some Minor Applications of Electric Power for Trade Purposes and in Shops." After calling attention to the advantages of electricity from the point of view of cleanliness, health, reduced fire risks, and general economy, a comparison is made between electricity and gas as heating and cooking agents. This is followed by a brief statement of the advantages of electricity as a power agent over gas and also over manual power. The pamphlet contains a number of good and apposite illustrations of electrical apparatus, and concludes with a long list of trades and appliances for which electric power can be used with advantage and economy. The company is already supplying electrical energy for power at 1d. per unit, and has decided to open a show-room for three months from June 1 at 96, Victoria-street, S.W., where most of the apparatus referred to in the pamphlet may be seen in operation. The issue of the pamphlet is undoubtedly a step in the right direction.

Engineering Standards Coded List.—Vol. III. of the "British Engineering Standards Coded List," issued by authority of the Engineering Standards committee, has now been published (price 25s. net) by Robert Atkinson (London) Ltd., 10, Essex-street, Strand, W.C. This volume deals with copper conductors and thicknesses of dielectric telegraph material, standards for electric machinery, tubular tramway poles and trolley grooves and wire. We learn from the Publishers' Note that the appreciation with which the first two volumes of these coded lists has been received has well justified the action of the Engineering Standards committee in placing within the reach of those interested in the committee's findings a telegraphic code containing the technical details of British standards and a series of coded phrases and tables enabling buyers and sellers to communicate by cable at a minimum of expense. The coded words are taken from Whitelaw's vocabulary. Vol. III. is provided with a good general index, and contains, besides the coded lists, much information concerning the Engineering Standards committee and its constitution, as well as of the institutions and associations co-related in support of the work carried out by the Engineering Standards committee. It is essential that such a list should be well and clearly arranged and printed and strongly bound, and in all respects the third volume of these lists embraces these essentials.

Farnworth.—An inquiry was held here yesterday (Thursday) into the application of the Council for sanction to borrow £5,000 for electric lighting extensions.

Fatalities.—On Tuesday evening a workman, named Monro, employed at the Emily mine of the Arniston Coal Co. accidentally came in contact with a live wire while operating a coal cutting machine, and received a fatal shock.

We regret to learn that a workman named Harrison was killed on Wednesday at the works of Callender's Cable & Construction Co., Belvedere, Kent. It is reported that Harrison, who had been employed in the high-tension department of the company for many years, was assisting in testing operations when he received the shock which caused his death.

Gloucester.—There was a profit of £1,402 on the past year's working of the electricity undertaking, compared with £1,090 in the previous year.

The deficiency on the municipal tramways last year was £3,538. 3s. 5d., against £1,761. 9s. 1d. for the first 11 months.

Hammersmith (London).—The Council are to obtain (at a cost of 36 guineas) 12 "Chameleon" electric signs, giving particulars of rates of current, &c., and these will be distributed amongst electrical fitters and ironmongers to be placed in prominent positions in their shops and show rooms in the borough.

Hampstead (London).—The total revenue of the electricity department for the year ended March was £70,147, and after paying working expenses, interest and instalments of loans, the net profit was £13,159.

The chairman of the Lighting committee (Mr. Gadsby) said that the purchase of the undertaking of the North-West London Electric Supply Co. nearly a year ago for about £12,000 had proved a satisfactory investment, as £3,460 had already been realised by sale of plant, about £1,000 worth remained to be sold, and the revenue from the consumers who were taken over already amounted to £7,861. The cost of generation again showed a decrease from 1·88d. per unit in 1905 to 1·78d. per unit in 1906.

Heckmondwike.—The Council are applying for sanction to a further loan of £19,000 for extensions, &c., of the electricity works. The present borrowing powers are for £21,000, but about £35,000 has been expended, and there are extensions of mains, &c., to be made.

Hull.—The annual report of the electricity department for the year ended March 31 states that 4,119,963 units of electric current were sold, an increase of 907,151 over 1905.

The equivalent of 257,926 8 c.p. (in lamps, motors, &c.), was connected, an increase of 16,814. The number of power consumers was 500, with a total motor connection of 3,234 H.P., increases of 95 consumers and 563 H.P. respectively. During the year the Electric Lighting Committee had inaugurated a motor-hiring scheme, which it is hoped will materially increase the sale of current for power. The gross profit was £24,370, representing 7·15 per cent. on capital outlay. Interest absorbed £10,723 and sinking fund £7,757, meter depreciation £1,317, and switchboard renewals £1,500, leaving £3,727 to be carried to reserve. Over £2,800 has been set aside for depreciation and renewal of plant. There was a notable reduction in all items of cost except repairs and maintenance, and in that particular the policy of the committee was to keep every portion of the apparatus up to the highest standard of repair possible. During the year there were no breakdowns. Further steam plant and generators are being put in to deal with next winter's load. The capital expended is £324,230, an increase of £21,297. 5s. 8d. during the year. £8,631 has been written off meters, leaving £315,599. 3s. 5d.

Increase in Price of Manufactured Goods.—At the meeting of the National Electrical Manufacturers' Association held on 21st inst. it was unanimously resolved: "That in view of the constant and considerable further rise in the price of raw material which has taken place since Dec. 4, when an advance of 5 per cent. was instituted, a further advance of 5 per cent. on all electrical goods be enforced, commencing as from June 1, making a rise of 10 percent. on all net prices."

Islington (London).—Mr. Percy E. Rycroft, chief assistant electrical engineer, has been promoted to the position of deputy engineer at an increased salary of £350 per annum. In moving the recommendation, the chairman of the Lighting committee (Mr. Vorley) spoke very highly of the economies which Mr. Rycroft had effected in the works.

Italy.—Just over a year ago the electric tramway service at Catania was opened to the public, and there is every indication that the venture will prove a great financial success. Power is provided by two Dowson gas-producer sets, each of 500 H.P., and this source of power will be sufficient for the electric lighting service which the owners of the electric tramway system are preparing for public use.

Leeds.—The City Council have applied to the L.G. Board for sanction to utilise money already authorised to be borrowed in the purchase of electrical plant. Particulars of the tender accepted for the plant are set out in another column.

Leyton.—The Council have decided to substitute electric lamps for the whole of the remaining gas lamps in the district at a capital cost of £2,216, and an increased annual expenditure of £628.

The electrical engineer (Mr. F. Harman Lewis) and the surveyor (Mr. W. Dawson) are to report as to the lamps to be converted during the current half-year.

Sanction has been received to the borrowing £17,819 for electricity supply extensions.

Light Railways.—An order for authorising Barking Council to acquire lands for an extension of the Barking Light Railways has been submitted to the Board of Trade. Objections by July 16.

The Bath Electric Tramways (Light Railway Extensions) Order, 1906, has been submitted to the Board of Trade for confirmation. Objections by June 19.

The Board of Trade have confirmed the Woking & Bagshot Light Railway Order.

London County Council.—On Tuesday it was agreed to loan £15,427 to Bermondsey, £22,303 to Islington and £2,650 to Poplar for electric lighting.

Tramways.—With regard to the reconstruction for electric traction of portions of the northern tramways, it was reported that a difficulty had arisen as to the material for paving the carriage way between the rails, and it was agreed that the Highways committee take any necessary steps for submitting the matter to arbitration.

Car Ploughs.—It was agreed that the manufacture and fitting of car ploughs, for which a contract was entered into with the British Westinghouse Co., be now executed by the staff of the tramways department at a cost of £1,800.

Engines.—It was agreed to accept the offer of the London Electric Supply Corpn. to purchase for £7,000 two engines at the Loughborough Junction temporary generating station.

Training of Motormen.—In view of the approaching electrification of the northern tramways and the construction of new lines, it was decided to equip a school at the Clapham tramways depôt, where the men can not only deal with the running of a car, but inspect the work in connection with repairs.

Purchase of London Southern Tramways Undertaking.—The Highways committee reported that Lambeth Borough Council were now willing to contribute one-third the cost of a modified scheme of street widening, and it was recommended that a special meeting be called to consider the offer of the company to sell its undertaking.—Agreed.

London United Tramways.—Col. Yorke, on behalf of the Board of Trade, inspected extensions of these tramways between Brentford and Hanwell, to Richmond Park gates, and through the Maldens and Coombe Council's area to Wimbledon. The public service to Kingston and to New Malden commenced on Saturday.

Luton.—The Council, who are considering the question of constructing electric tramways, have sent a deputation to Lincoln to inspect the C.B. surface contact system of traction.

Mansfield.—The Council have applied for sanction to a further loan of £8,000 for extensions to the electricity undertaking.

Marriage.—On Tuesday Mr. W. F. Stamp, chief assistant electrical engineer at Devonport Corporation electricity works, was married to Miss Mabel P. Clarke, of Stoke, Devon.

Marylebone (London).—After the re-wiring in connection with the change of pressure of 11 of the flats and two staircases of Bickenhall-mansions, the Phœnix Fire Office refused to endorse the policy unless the work was done over again in steel tubing. The cost of this would be £34 per flat. The owners of the mansions offered to pay one-third of the cost and the whole cost of re-decorating if the Council performed the work. An agreement to this effect is to be entered into.

Metropolitan Water Board.—The Works and Stores committee have decided to establish telephonic communication between 21 pumping stations in the New River district, at a cost of £140 per annum.

Newark.—The Council have decided not to engage in municipal electricity supply. Companies are to be invited to submit terms, &c., for establishing and maintaining electricity works in the town.

Newport (Mon.)—There was a net profit of about £1,600 on the past year's working of the municipal electric tramway system.

The electric lighting accounts also show a small net profit.

Obituary.—The death is announced of ex-Bailie W. Paton, of Glasgow, the first convener of the Tramways committee.

Oxford.—The Council have decided to invite tenders for leasing the local tramways, which are to be converted to electric traction.

Personal.—On Thursday last the members of Sheffield Corporation electric supply department made a presentation and to do honour to Mr. J. W. Beauchamp, deputy manager of the undertaking, on the occasion of his approaching marriage. A handsome case of Sheffield cutlery was subscribed for by the staff and workmen of the department, and in making the presentation the general manager and engineer (Mr. S. E. Fedden) spoke in eulogistic terms of Mr. Beauchamp's services to the Corporation and valuable assistance to himself. Mr. Beauchamp responded and tendered his thanks for such a practical token of the good fellowship and esteem of his co-workers.

The name of Mr. E. C. Theedham, of the Dudley Electrical Co., has been added to the Commission of the Peace for the borough.

Poplar (London).—Under the agreement for the supply of electric current to the London and India Dock Co., the company is to pay to the Borough Council a rent of £30 per annum for the service; the agreement to be for five years, terminable at option of company at end of three years, subject to company paying £50 towards cost of removal of cable. The charge for a minimum consumption of 300,000 units per annum is to be 0·885d. per unit, and 0·9d. per unit for a minimum of 200,000 units. Should the annual consumption not reach 300,000 units the company is to have the option of charging at the standard tariff rate of £3 per k.w., plus 0·8d. per unit.

Plymouth.—The Electricity committee considered the annual report of the borough electrical engineer (Mr. E. G. Okell) on Tuesday.

The gross profit on the year's trading was £12,261, and after paying interest and sinking fund charges the net profit was £3,908, which has been carried to reserve. After writing off £860 in respect of coal stores, the reserve now stands at £7,800. The capacity of the station is 75,000 8 c.p. lamps, and the present load is 60,000 8 c.p. The current year's income is estimated at £22,500 and the expenditure at £11,000, leaving gross profit £11,500. After payment of dividends, interest and sinking fund the estimated net profit is £1,432. The price of current for power is to be reduced by ¼d. per unit to 1¾d., the price charged for current supplied to the Corporation tramways. The charge to private consumers for lighting is to be reduced by ¼d. per unit, and a rebate of 1d. per unit on current consumed between midnight and 3 p.m. The charge for current for private lighting, therefore, will be 2¾d. per unit for 15 hours a day, and 3¾d. from 3 p.m. to 12 p.m. The reductions operate as from April 1 last.

Public Institution Lighting.—It was reported to the Metropolitan Asylums Board on Saturday that the gas lighting at the Downs Schools was unsatisfactory. Latterly the deterioration had become pronounced.

The engineer-in-chief (the report continued) had discovered that the defective lighting was due to corrosion in the gas pipes which had now been in use for many years. If gas was to be continued as an illuminant, practically the whole of the system would have to be replaced at a cost of £500. At the same time, in consequence of the increased demands on the X-ray apparatus, used for treating the children for ringworm, an outlay of £100 would be required to provide additional electric current. The desirability of adopting electric light was therefore raised. The cost of wiring, fittings, mains, switchboards, &c., was estimated at £2,700. The South Metropolitan Electric Lighting and Tramways Co. had offered to supply current at 2½d. per unit, and the engineer calculated the saving to be affected by the change (after allowing for renewals, &c.) at £25 per annum. The Children's committee considered the introduction of electric light would effect a saving of £25 per annum on the lighting bill, give 25 per cent. better light and purer air, there would be greater cleanliness and less expenditure on cleaning and painting, and a saving of expenditure on the renewal of accumulators for the X-ray apparatus and on running laundry machinery. From all points of view the committee had decided in favour of the electric light, and recommended that the Works committee be instructed to take the necessary steps for carrying out the installation.—The report was adopted.

Staffs. County Council have decided to expend £1,600 on an electric light installation, £900 on telephones, and £400 on fire alarms at the new Cheddleton Asylum building.

Radcliffe.—In future the charges for current for power used between 6 a.m. and 6 p.m. will be 2d. per unit up to 60 units per H.P. per quarter; between 60 and 100 units 1¾d., 100 and 200 1½d., 200 and 250 1¼d. and over 250 1d. per unit.

Rotherham.—Capital expenditure on the electricity undertaking during the year ended March was only £954, bringing the total to £47,905. The year's revenue was £10,723. 9s., including £6,088 for 974,027 units supplied to tramways, £4,455 for 237,653 units for lighting, and £219 for 32,419 units supplied to motors. Working expenses were £4,899. 13s. 6d., leaving £5,823. 16s. gross profit. After meeting capital charges there is a surplus of £2,006, of which £1,929 has been placed to depreciation and renewals account.

The capital account for the tramways is £114,358, an increase of £2,941. Traffic receipts were £23,650, total receipts being equal to 10·02d. per car-mile Working expenses were £18,117, including £6,088 for current, gross profit being £6,097. Interest, sinking fund and bank interest required £5,927, leaving £1,646 net profit.

Rotterdam.—On Sept. 18 last the first electric tramway commenced running in this city, and although only one line is at present in working order, it is hoped that the greater portion of the entire system will be completed this year.

Rugby.—The price of current to consumers of 500 units per quarter will be 5d. per unit; second 500 4½d, beyond 4d., less 5 per cent.

Russia.—Telegraphic and telephonic communication has now been established with the interior of Lapland. It is expected that the telephone will prove a great help to the local fishermen who find keen competitors in the Norwegians.

At Abo (Finland) there is a possibility of a system of electric tramways being constructed and operated, and it is considered that the British manufacturer of electric tramway plant and material will have a chance in the competition for contracts for this work.

Shrewsbury.—The chairman of the Lighting committee (Ald. Deakin) started a new 350 kw. steam dynamo at the electricity works on May 21.

Subsequently refreshments were served at the electrical engineer's office, and in response to the toast of his health Ald. DEAKIN said their financial position was such that they might reasonably look forward to making a concession in price to consumers. They must, however, place themselves on firm ground, and for that reason he wanted to build up a reserve fund. They had been greatly complimented by experts in being able to produce current at so low a price, but for that they were indebted to their engineer, Mr. C. M. Johnston, to whom a vote of thanks was passed. Mr. JOHNSTON, in acknowledging the compliment, praised the members of his staff for their excellent work.

Southwark (London).—The Council have decided, in order to form a definite opinion of the value of the "Excello" flame lamp for illuminating purposes, to erect nine additional lamps, at a cost of £102. 16s.

Spain.—The "Madrid Gazette" of May 23 states that an application has been made to the Directorate General of Public Works, Madrid, for a concession for an electric tramway between Puente del Rey and Viella (Lerida), and that applications on terms more favourable will be received up to June 23.

Stettin (Pomerania).—The tramway company owning the tramways in this city (Stettiner Strasson-Eisenbahn Gesellschaft) has a capital of £200,000. The receipts in 1905 amounted to £64,500. The average takings per kilometre were 3½d., equal to about 5½d. per mile. The company owns its own generating station, operates 34½ miles of line, and carried 14,062,631 persons during the year. A dividend of 6½ per cent. has been declared.

Street Lighting.—The Yorkshire Electric Power Co., Leeds, is issuing to local authorities, &c., in the company's area of supply a pamphlet giving particulars of the advantages of electricity over gas for street lighting. The various methods of electric street lighting, types of lamps, &c., are clearly described and illustrated.

Tampering with Electricity Meters.—At Chelmsford, recently, a motor engineer named Knights was summoned for "fraudulently preventing an electric meter from duly registering the quantity of electricity supplied on March 6," and fined £2 and 4s. costs.

Train Lighting.—We have received a copy of a pamphlet giving particulars of the Leitner-Lucas system of train lighting fully described in *The Electrician* for July 7, 1905.

Trolley Wires.—The British Thomson-Houston Co., Rugby, write:—

> In view of the discussion of Messrs. Tweedy and Dudgeon's Paper on "Overhead Equipment," regarding the peculiar wear of the trolley wire which occurs mainly at and near the supporting ears, it is of interest to call attention to the B.T.-H. flexible trolley wire ear, which overcomes entirely the effects complained of. This ear practically allows the wire to have free movement in any direction and entirely avoids the hammer blow, so objectionable where the rigid type of ear is used. The weakening effect, due to heating the wire when soldered ears are used, is obviated by the mechanical clip. This form of ear is fully protected by patents, and any firms guilty of infringement will be proceeded against. Should any tramway engineer desire to test these ears a sample will be sent for this purpose, free of charge, by applying to our Supply Department, Head Office, Rugby.

Uruguay.—The Public Works committee of the Legislature has reported favourably on the petition of the Empresa del Tranvia á la Union and Maroñas to convert their system to electric traction. The company seeks a 75 years' concession, exemption from taxation on machinery, &c. A new line, about three miles in length, is to be built within five years, and current is to be taken from the Commercial Tramways Co.

Wishaw (N.B.).—The Council have decided not to entertain an offer from a company to purchase the municipal electricity undertaking.

Worcester.—At March 31 the capital expenditure of the electricity department was £127,385, an increase of £1,554 during the year. The total receipts were £14,946, including current supplied to the local tramway company £2,582. Working expenses were £7,597. The gross profit was £7,348. Interest and sinking fund charges were £7,646, leaving a deficit of £298 against £1,290 in the previous year. The equivalent of 48,543 32 watt lamps is connected, against 45,632. The maximum load was 787 kw. Working costs were 1·602d. per unit sold (against 1·883d.). 1,344,452 units were generated, 147,094 supplied to public lamps, 325,580 to tramways and 586,340 to private consumers.

York.—The Council have rejected a motion to instruct the Electric Light committee to obtain expert opinion as to the actual value of the municipal electricity undertaking.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Portsmouth Corporation invite tenders for the supply of tramway feeder cables; also for 16 double-deck tramway electric motor cars. Tenders to the town clerk (Mr. Alex. Hellard) by 10 a.m. June 5.

Handsworth (Staffs.) Education committee invite tenders by June 5 for wiring education offices and schools at Perry Barr and Handsworth.

Gravesend Electricity committee are prepared to receive applications from firms willing to undertake free and assisted-payment wiring.

The managers of *West London School District* want tenders by 11 a.m. June 8 for 12 months' supply of electric light fittings. Mr. F. G. Beeching, Ashford, Middlesex, is clerk,

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

Bradford Education committee require tenders (by noon June 9) for electric lighting at Hanson New Junior School and for electrical fittings for laboratories at Belle Vue and Hanson Schools.

Dartford Council want tenders by 4 p.m. June 19 for 12 months' stores, including electricity meters, cut-outs, house-service cable, oils, &c.

Shipley Council want tenders by noon June 14 for the electric lighting of new baths and workshops. Specifications, &c., from the electrical engineer.

Manchester Electricity committee want tenders by noon June 12 for 12 months' stores, including incandescent lamps, castings, oils, &c.

Pontypridd Council want tenders by June 4 for 2,640 yds. of paper insulated 0·3 triple-concentric feeder and pilot cables.

Finchley Council want tenders by 5 p m. June 11 for water softening plant.

TENDERS RECEIVED AND ACCEPTED.

Leyton Council have referred the following tenders to the Electricity committee for consideration:—

Car Bodies.

Hurst, Nelson & Co.	£16,400	Brush Co.	£12,600
Milnes, Voss & Co.	12,240	Dick, Kerr & Co.	13,960
Ditto (amended tender)	12,400	British Thomson-Houston Co.	12,600

Radial Axle Trucks.

Brush Co., £3,715 and £27,368 (for 40 cars).

British Thomson-Houston Co.	£3,715	0	Peckham Eng. Co.	£3,847	18
			Mountain & Gibson	3,667	10

Electrical Equipments and Assembling of Cars.

Raworth's Traction Patents (Ltd.)	£15,938	13	6	Brush Co.	£11,853	0	0
British Thomson-Houston Co.	10,892	13	3	Dick, Kerr & Co.	12,238	2	0
				British Westinghouse Co.	11,213	7	6

The Stirling Boiler Co., of Motherwell, have been entrusted by Newcastle-upon-Tyne Electric Supply Co. with a further large order for a complete boiler-house plant, a duplicate of the boiler house now being installed at Carville power station, Wallsend. The Stirling Co. also have in hand further repeat orders for boiler plants for Sheffield Corporation tramways and Grimsby electricity works, and have received the order for a large five boiler plant for Madras tramways.

Poplar (London) Council received 33 tenders from 18 firms for overhead bunkers and coal handling plant. As the tenders have not yet been considered no tender has been accepted. The following firms tendered:—

Wantage Engineering Co., Graham, Morton & Co., G. Fletcher & Co., Spencer & Co. (two tenders), Babcock & Wilcox (four tenders), Pierson & Co., Head, Wrightson & Co., New Conveyor Co. (two tenders), Jenkins & Co., Gibbon Bros. (four tenders), Lowca Engineering Co., Edgar Allen & Co. (two tenders), Samuel Cutler & Co. (two tenders), Westwood, Wrights & Brierley, E. Bennis & Co. (four tenders), J. Hitchen & Co., Barry, Henry & Co. (two tenders), Ashmore, Benson Pease & Co. (two tenders).

Messrs. C. A. Parsons & Co. have obtained orders for a 200 kw. turbo-alternator for A. Russell & Co. (Scotland), a 200 kw. turbo-alternator (for Japan), a 400 kw. turbo-generator for Consett Iron Co., and a 316 kw. steam turbine generator for John Brown & Co. (Sheffield), in addition to a repeat order for a 3,500 kw. turbine alternator for the Carville power station of the Newcastle-on-Tyne Electric Supply Co.

London County Council have received the following tenders for the road work for the reconstruction of the Islington to Highbury tramways:—

Robt. W. Blackwell & Co. (*accepted*)..	**£26,538 16 11**
J. Mowlem & Co...	30,039 0 0
Dick, Kerr & Co. ..	28,063 19 11
J. G. White & Co...	27,496 2 5

The contractors will be permitted to sublet to the Anderton Foundry Co. the manufacture of the yokes and castings, and to Bayliss, Jones & Bayliss the tie bars, &c.

Glasgow Corporation have accepted the following tenders for annual supplies for the electricity department: Callender's Co., single and triple concentric and l.t. cables; W. T. Glover & Co., o.h.t. cables and small cables and flexibles; Ferranti Limited and Chamberlain & Hookham, meters; Sloan Electrical Co. and H. Tuchman, carbons.

London County Council have accepted the following tenders for annual stores for their asylums:—

Edison & Swan Co., for electric lamps for Bexley and Horton Asylums at £57. 1s. 3d.; Mackey's Electric Lamp Co., electric lamps for Claybury Asylum and the Epileptic colony at £14. 4s. 4d.; Baxter & Caunter, for electrical sundries for Bexley Asylum at £22. 2s.; and Pryke & Palmer, for electrical sundries for Claybury and Horton Asylums and the Epileptic colony at £53. 7s.

Leyton Council have accepted the following tenders for coals Lockett & Judkins, hand-picked Linby small hard steam coal 14s. 11d., Bolsover small hard steam coal 14s. 5d.; M. H. Abbott & Co., Newstead small hard steam coal 14s. 10d., Bestwood nutty slack 9s. 10d., Insdale nutty slack 10s. 8½d. The Electricity committee are to make experiments as to the comparative value of the various coals.

Stoke-on-Trent Council have accepted the following tenders:—

Halpin & Co., thermal storage vessel, £533. 10s.
Willans & Robinson, steam generating set, £1,550.
Ditto, condensing plant, £547.
Morris-Hawkins Electrical Co., balancer and booster, £301.

London County Council have agreed that the seven electrical equipments for which the tender of Jessop & Appleby Bros. was accepted on April 10 be obtained from the British Westinghouse Co. as an extension of their present contract for £1,379.

The Streets committee of the City of London (Court of Common Council) have placed an order for 1,000 incandescent lamps with the British Thomson-Houston Co. for use in the various buildings of the Corporation, at a cost of about £40.

The Lancashire Dynamo & Motor Co., Trafford Park, Manchester, have received three orders from the India Office during the past few weeks, aggregating in all 67 motors, the major part of the interpole type.

Leeds Corporation have accepted the tender of Willans & Robinson for supply of a steam turbine, alternator, exciter and condensing plant at £13,925, with the option to the Council of purchasing a similar set of plant at the same price within 18 months.

The Great Eastern Railway Co. have placed an order with Balcke & Co. for an open-type cooling tower (for 300,000 gallons of water per hour) for the company's new power station at Stratford.

Leek Council have accepted the tender of the Industrial Engineering Co. for a 120 kw. gas-driven generating set at £1,899. The gas engine is by the Campbell Gas Engine Co. 21 firms submitted tenders.

Croydon Corporation have accepted the tender of R. W. Blackwell & Co. for the electrical equipment of the Whitehorse-road tramway extension at £604.

Burnley Electricity committee have accepted the tender of Yates & Thom for a new 30 ft. by 8 ft. Lancashire boiler.

Leyton District Council have accepted the tender of Venner & Co. for annual supply of meters.

B.T.-H. Tramway Equipments.—The following orders have recently been placed with the British Thomson-Houston Co. for electric tramway equipments:—

Manchester Corporation, 27 equipments; Derby Corporation, four equipments; Metropolitan Electric Tramways (Ltd.), 40 equipments; National Electric Construction Co., 18 for Torquay and 16 for Mexborough; Manx Electric Railway Co., two 4-motor equipments. The four first-named are 2-motor equipments.

BUSINESS NOTICE.

We are informed that a report which appeared in a daily contemporary yesterday to the effect that Babcock & Wilcox (Ltd.) and the Stirling Boiler Co. (Ltd.) contemplate a fusion is incorrect. The only foundation for the rumour is a deal between certain financial interests, which will not affect the companies and in which the companies are not interested.

BANKRUPTCIES, LIQUIDATIONS, &c.

On Monday a meeting was held of the creditors of Albert Dickinson, electrical engineer, 19, Upper Mill-hill, and Dixon-lane, Wortley. Liabilities £3,521. 0s. 8d., assets £1,388. 16s. 4d. Estate was left in hands of Official Receiver.

Mr. Percy Coles, Tower-chambers, Moorgate-street, London, E.C., has been appointed trustee in the failure of Thos. Hodgkinson (trading as Electro Neurotone), 186, Goldhawk-road, London, W.

Mr. Arthur Chas. Bourner, Bush Lane House, Cannon-street, London, E.C., has been appointed trustee in the failure of Geo. Wm. Warner & Arthur Philip Bowen, electricians, &c., 12, Holbein-place, London, S.W.

Claims against the Havana Electricity Co. (Ltd.) are to be sent by July 6 to Mr. J. T. Claxton, Finsbury-pavement House, London, E.C.

Claims against the Webster Electrical Engineering Co. (Ltd.) to Mr. Wm. M. Gray, District Bank-chambers, Bradford, by July 6.

A meeting will be held on July 6 at 27, Martin's-lane, London, E.C., to receive an account of the winding up of the Electric Turbine Gas Retort Charging and Discharging Machine Co., Ltd.

Sale by Auction.—Mr. John Sulley will sell by auction on the works, 2 and 4, Dodd-street, 17-23, Farrance-street, Limehouse, London, E., at noon on June 12, some specially-constructed machinery for rubber manufacturers, waterproofers, &c., including six indiarubber proofing machines, polishing and pumicing machines, washing mills, dough mixers, masticators, strainers, mixing mills, calenderers, g.p. digesters, semi-curer, two vulcanisers with rollers and trays, tubing machines and wire spinner, dry curing room or stove with gear complete, a 400 light dynamo, steam engine, boiler, shafting, pulleys, &c. The machinery, which may be viewed by appointment, will be on view on day prior to and on morning of sale. Catalogues and further particulars from the receiver (Mr. Edward C. Moore), 3, Crosby-square, E.C.; Crosse & Sons, 7, Lancaster-place, Strand, W.C.; Messrs. F. W. Hilbery & Co., 20, Great St. Helens, E.C.; and from the auctioneer, 46, Cannon-street, E.C., London.

Plant for Sale, &c.—Messrs. Sabberton Bros., engineers, Norwich, advertise for sale a 63 B.H.P. motor, starting switch, shunt regulator, &c.

Lead Wool.—The Lead Wool Co., of Snodland, Kent, have devised a new and simple method of making lead joints for mains and pipes for various purposes, and claim the method to be specially suitable for joints to pipes for telegraph and telephone wires, gas and water pipes, &c. The company, in addition to owning the licence for the manufacture of lead wool, hold patents for methods of making joints formed of metal wires or threads or strands of metal. The lead wool is sent out in strands formed of a sufficient number of the threads, each weighing about 1 lb. and about 3 ft. long. The method of applying this wool in the making of sound joints for various purposes is described in a pamphlet which the company have ready for circulation. We learn that this wool was first used in Germany about 12 months ago, and that its consumption is now very large. Factories have also been started in France, Italy, Switzerland and America.

Tool Handle Grip.—A simple contrivance for increasing the grip and control of hand tools has been put on the market by C. Nurse & Co., tool merchants, London. The illustration shows a simple form of attachment which can be used with any tool handle, after drilling a hole in the handle to admit of the insertion of the pin. The strain on the palm of the hand is relieved by the use of this attachment, and the user's control over his work is increased. Wherever a strong and steady forward pressure has to be exerted this useful grip will be found advantageous. The grip, being adjustable, can be used with any number of tools.

Catalogues, &c.—W. J. Furse & Co. have ready some new sheet lists of switches, enclosed fuses, switchboards, &c., and a catalogue (Section L) of electric and other lifts and haulage machinery. A section on collapsible gates is included.

The "Acme" time meter, which is placed on the market by the Acme Meter Co., London, has been designed to meet a variety of requirements, and is consequently made in several types. Type M.Z. is for tramcars, and can be used for continuous or alternating current of any voltage. Type Z is for continuous-current lighting circuits from 30 to 220 volts. The meter is continuously wound by an electric motor, and is claimed to require no manual attention. It is shunt wound, and so is independent of the current—that is, the same instrument can be used in a system of a given pressure for installations of any size. The meter is 5 in. in diameter, and weighs 3½ lb.

Messrs. Richardsons, Westgarth & Co. have ready a new pamphlet describing their convex splash bar cooling tower. This tower is composed entirely of wood—pitch pine for the framing of the heavier scantlings and red deal for the interior fittings, special machinery being employed in the manufacture of these fittings. A special preservative is used which materially increases the durability of the timber. A full description of the working of this tower and a number of good illustrations are given in the pamphlet.

Machine draughtsmen will be interested in a neat little corner curve which has been placed upon the market by W. J. Brooks & Co., and is intended as a time-saving substitute for compasses for rounding off angles, &c., in machine drawings and for drawing small curves. The device is supplied at 1s.

Gent & Co., Leicester, have ready a circular list describing the "Nugent" inch-by-inch water-level indicator. The transmitting apparatus in this device is in an all-metal case, vapour proof, and so may be exposed to wet and inclement weather without detriment. The indicator is in an airtight case which guards the internal mechanism. The transmitter and gear of this indicator are shown in the accompanying illustration.

"Nugent" Water Level Indicator.

Single-phase alternate-current induction motors (types A.C. and A.S.) are listed in a new circular issued by T. Harding Churton & Co., Leeds. A description of the motors is given, with tables of B.H.P. and speeds on circuits of various periodicities, for motors from $\frac{3}{4}$ to 70 B.H.P., together with particulars of starting torque and starting current, efficiency, power factor, &c. Motors for both short-circuited and wound rotors are dealt with. The list is illustrated.

John C. Fuller & Son, Bow, London, forward a new abridged list of accumulators for motor omnibuses, carriage and train lighting; also house-lighting sets. The Fuller cell, specially designed for motor garage equipment for charging motor-car and cycle accumulators, is shown in the accompanying Fig. 1, and the portable type for omnibus and carriage lighting and for phonographs and telephone central batteries in Fig. 2. These cells are made up in sets giving from 4 to 12 volts.

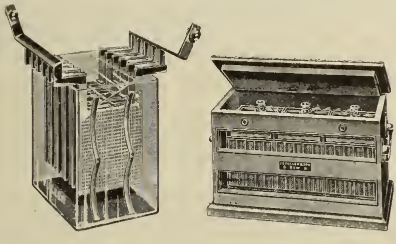

Fig. 1. Fig. 2.

The "Fuller" Accumulator.

A list of installations of electric motors in newspaper offices, printing offices and paper mills which have been carried out by J. H. Holmes & Co., of Newcastle-on-Tyne, has just been issued.

The Armorduct Mfg. Co. have ready a new catalogue of Armorduct specialities.

The Crypto Electrical Co. have a new circular price list ready relating to Crypto fan motors for continuous current.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) on May 23 to 29, with the ports of destination :—

Africa—Alexandria, £108; Cape Town, £137; Delagoa Bay, £108 (including £92 telegraph material); Durban, £3,999 (including £1,677 telegraph material); East London, £142; Port Elizabeth, £50; Port Said, £49. *Argentina*—Buenos Ayres, £694 (including £497 telegraph material). *Australasia*—Adelaide, £74; Christchurch, £25; Hobart, £15; Lyttelton, £51; Melbourne, £1,107 (including £515 telegraph material); Napier, £20; Otago, £1,985; Perth, £243; Sydney, £1,968; Wellington, £156 (including £39 telegraph material). *Belgium*—Ostend, £33. *Burma*—Rangoon, £121. *Canada*—Montreal, £53. *Ceylon*—Colombo, £699. *Channel Islands*, £132. *China*—Shanghai, £239. *France*—Boulogne, £10. *Germany*—Hamburg, £40 (telegraph material). *Gibraltar*, £1,250. *Holland*—Amsterdam, £132. *Hong Kong*, £181. *India*—Bombay, £2,871 (including £42 telegraph material); Calcutta, £4,398; Karachi, £10. *Italy*—Naples, £65. *Japan*—Nagasaki, £773; Yokohama, £3,581. *Malta*, £61 (including £44 telegraph material), *Mauritius*, £64. *Mexico*—Salina Cruz, £3,305. *Russia*—Batoum, £30; Kureh, £8,460; Odessa, £20; Reval, £180; St. Petersburg, £77. *Spain*—Vigo, £62 (telegraph material). *Straits Settlements*—Penang, £5; Singapore, £458 (including £30 telegraph material). *Sweden*—Stockholm, £147 (telegraph material). *Uruguay*—Monte Video, £65. *U.S.A.* New York, £104. Total £38,557, against £19,757 in the corresponding week last year (May 24 to 30).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

April 9, 1906.

8,446 Bailey, Plews & Anderson. Storage batteries.
8,452 Paulino. Production of voltaic strong-current arcs.*
8,457 Rivers. Electrical heating "element" or resistance.
8,499 Justice. (Deutsche Gasglühlicht A.-G., Auerges, Germany). Glow lamps.*
8,515 Hewson & Pyatt. Electric incandescent lamps.
8,526 Elektrizitäts-A.-G. vorm W. Lahmeyer & Co. Dynamo electrical machines. (Date applied for, April 11, 1905).*†
8,528 Johnson & Phillips, Tunley & Burn. Starters and regulators for electro-motors.
8,539 B.T.-H. Co. (G.E. Co., U.S.) Transformers.
8,552 Imray. (Siemens & Halske A.-G., Germany). Incandescent lamps.*

April 10, 1906.

8,605 Tourtel & Stafford-Hatfield. Electrically-wound clocks.
8,612 Cooper-Hewitt. Vapour electric apparatus. (Date applied for, April 25, 1905).*†
9,613 Thomas. Electric vapour apparatus. (Date applied for, April 25, 1905).*†
8,616 Leibius. (Leibius, Germany). Electric distance switch.
8,549 Roubtzoff. Electric bells.
8,654 Nicholson. Electric ignition for internal combustion engines.
8,656 Gebrüder Siemens & Co. Arc light electrodes with metallic insertions. (Date applied for, May 31, 1905).*†
8,657 Felten & Guilleaume-Lahmeyerwerke Act.-Ges. Liquid resistances. (Date applied for, April 12, 1905).
8,659 Thompson. (Gesellschaft für Drahtlose Telegraphie m.b.H., Germany). Detector for wireless telegraphy.*
8,676 Berry. Electrical heating apparatus.
8,680 B.T.-H. Co. (G.E. Co., U.S) Systems of control for electric motors.

April 11, 1906.

8,695 Andresen. Ignition devices for internal combustion engines.*
8,716 Veritys Limited & Dalziel. Switches actuating with the motion of a moving part.*
8,717 Veritys Limited & Dalziel. Supplying and controlling the voltage of electrical energy to railway carriages and like cases where the generator has a variable speed.
8,785 and 8,786 Elektrizitäts A.-G. vorm. W. Lahmeyer & Co. Improvements in dynamo electrical machines. (Date applied for, April 28, 1905).*†
8,787 Baronio, Muirhead & Edgar. Telegraphy.
8,792 Lentschat & Drahonowsky. Electric gas igniter for street lamps.*

April 12, 1906.

8,840 Imray. (Siemens & Halske A.-G., Germany). Incandescent bodies for electric lighting.*
8,852 Küpper. Device for electric igniter in marine guns when actuating at natural horizontal level.
8,870 Haynes. Sparking plug for internal combustion engines.
8,891 Steljes. Electric apparatus for making and breaking circuits.
8,895 Weinert. Arc lamps.*
8,902 Dawson & Buckham. Electrical apparatus for signalling for controlling the fire of guns.
8,908 Pringle. Collectors for vehicles receiving current from a line conductor.
8,909 Pringle. Indicating the pressure of trolley-poles or collectors.
8,924 Cowper-Coles. Electrodeposition of copper.
8,925 Cowper-Coles. Removing electrodeposited cylinders from mandrels.
8,931 B.T.-H. Co. (G.E. Co., U.S.) Regulating dynamo electric machines.
8,932 B.T.-H. Co. & Dawson. Dynamo-electric machines.
8,933 B.T.-H. Co. & Dawson. Supporting collecting rings for dynamo-electric machines.
8,934 B.T.-H. Co. & Dawson. Supporting end connections of dynamo-electric machines.
8,935 B.T.-H. Co. (G.E. Co., U.S.) Electric controllers.
8,936 B.T.-H. Co. (G.E. Co., U.S.) Signalling systems and apparatus.
8,937 Smith. Electromagnetic devices for alternating currents.

April 14, 1906.

8,945 Hellfritsch. Microtelephones. (Date applied for, April 15, 1905.)*†
8,951 de Pavillet & Dawson. High-tension distributor for multi-cylinder engines.
8,974 Frost. Railway signalling by electricity.

9,020 Bloxam. (Lux, Austria.) Filaments of tungsten or molybdenum for incandescence lamps.
9,026 Neu. Protecting high-tension overhead conductors.*
9,028 Schneider. Arc lamps.*

April 17, 1906.

9,035 Large. Arc lamp.
9,068 Fairweather. (International Telegraphic Call Co., U.S.) Selective signalling apparatus.*
9,086 Wommelsdorf. Induction electrical machines.*
9,089 Levy. X-ray apparatus.*
9,090 Chitty. Dynamo electric machines.
9,103 Greenwood & Brown. Electrically-propelled vehicles.
9,109 Siemens & Halske A.G. Incandescent lamps. (Date applied for, May 17, 1905.)*†
9,112 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.
9,115 Ransford. (Bayly, S. Africa.) Telegraph poles.
9,117 Ateliers Thomson-Houston (Anciens Etablissements Postel Vinay). Magnetoelectric generators. (Date applied for, 17/4/05.)*†

April 18, 1906.

9,142 Aberdeen Electrical Engineering Co. and Botting. Electrical wire conduit surface outlet-box.
9,164 Petersson. Electric furnaces for treating gases. (Date applied for, April 18, 1905.)*†
9,186 North. Electric bells. (Date applied for, April 22, 1905.)*†
9,191 Mackie. Automatically operating switches at given intervals.
9,203 Gianoli. Electric ignition for explosion engines. (Date applied for, April 20, 1905.)*†
9,204 Leitner. Dynamos for railway train lighting.
9,209 Hochenegg. Apparatus for intensifying electrical oscillations.

April 19, 1906.

9,225 Collins and Price. Automatic electric tell-tale for oil or gas lamps.
9,228 Frame. Electric tram rails.
9,234 Bergmann. Magnetoelectric ignition apparatus.*
9,244 Read. Electric irons.
9,245 Read. Electric kettles and water boilers.
9,253 Cooper-Hewitt. Vapour electric apparatus. (Date applied for, April 28, 1905.)*†
9,268 Bacon. Electromagnetic governor.*
9,271 Boddy. (Philips & Co., Holland.) Adaptors for incandescent electric lamps.
9,273 Siemens Bros. & Co. (Siemens & Halske, A.G., Germany.) Means for reducing the reflex action at points of connection of circuits differing in electrical properties.
9,276 McGillivray. Indication of current leakage in electric motors.
9,279 Johnson. (Badische Anilin & Soda Fabrik, Germany.) Production of long stable electric arcs.
9,284 Leitner. Incandescent electric lamps.
9,298 Casper. Electrodeposition of metals.

April 20, 1906.

9,313 Pieper. Automatic regulation of continuous-current electro-motors.
9,328 Rizzo. Electric ship log and indicator.
9,330 Moy, Bastie, & Ernest F. Moy (Ltd.). Electrical measuring instruments.*
9,341 De Kando. Supporting line wires of electric railways or tramways.*
9,343 Brockie. Electric arc lamps.
9,346 Justice. (Deutsche Gasglülicht A.-G., Auerges, Germany.) Pocket electric lamps.*
9,347 Dakhyl, Galanti, & Dakhyl. Secondary batteries.
9,348 Dawson & Buckham. Switches for use with electrical signalling apparatus.
9,349 Just, Hanaman, Landesberger, Salzmann, & Vereinigte Elektricitäts A.-G. Cement joints for incandescent lamp filaments,
9,351 Richard. Galvanometers.
9,357 Gercke. Neutralising deflecting forces acting on magnets.*

April 21, 1906.

9,383 Dixon & Speight. Electric ignition for internal combustion engines.
9,393 L'Hommedieu. Electroplating apparatus. (Date applied for, April 22, 1905.)*†
9,410 Knight. Electric bells and working same.
9,411 De Törley & Benkö. Generating electricity and apparatus therefor.
9,412 Stone. Space telegraphy. (Date applied for, May 4, 1905, being date of application in United States.)
9,415 B.T.-H. Co. (G.E. Co., U.S.) Signalling apparatus.
9,417 Stone. Space telegraphy. (Date applied for, May 4, 1905.)*†
9,420 Grote & Ely. Arc lamps.
9,422 Stone. Space telegraphy. (Date applied for, 5/10/05.)*†
9,425 Cowper-Coles. Manufacture of iron tubes by electro-deposition.
9,435 Hille & Muller. Treating sheet metal and depositing metallic coatings thereon by electrolysis.*

SPECIFICATIONS PUBLISHED.

1905 Specifications.

1,467 Pastor & Boom. Moving junction points of tramways, light railways and the like. (Date applied for, Jan. 25, 1904.)
4,362 Lake. (Direct Line General Telephone Co.) Telephone systems.
4,625 Childs. Electric hoist controllers.
5,721 Parker. Electric furnaces and the like.
7,149 B.T.-H. Co. (G.E. Co., U.S.) Electric motor-control systems for electric vehicles.
7 197 Rhodes, Perkins & Blakey. Reversing switch, lamp socket and plug combined.
7,286 Pfatischer. Electric motors and preventing sparking. (Date applied for, April 7, 1904.)
7,286a Pfatischer. Variable-speed motors. (Date applied for, April 7, 1904.) (Originally in 7,286/05.)
7,417 B.T.-H. Co. (G.E. Co., U.S.) Railway signalling.
7,418 B.T.-H. Co. (G.E. Co., U.S.) Relays for electric circuits.
7,732 Vaudrey. Electrically indicating and recording at a distance changes in level of liquid in reservoirs. (Date applied for, 4/11/04.)
7,842 Johnson & Paterson. Flexible armoured cables.
8,090 Zani. Trolleys for electric railways, tramways and the like.
8,122 Bennett. Construction of electric tramways.
8,200 Lake (Tesla). Transmission of electrical energy.
8,278 Mayer. Switches.
8,283 Deutsch & Electric & Train Lighting Syndicate. Universal joints.
8,305 Blackmore. Electric wiring and controlling systems.
8,391 Andrews. Electricity meters.
8,410 Arnheim. Electric selecting and switching devices for party line telephone and telegraph systems.
8,411 Arnheim. Central battery telephone systems.
8,567 B.T.-H. Co. (G.E. Co., U.S.) Electric distribution employing mercury vapour lamps or the like.
8,570 B.T.-H. Co., Holden & Garfield. Regulation of output of generators at varying speeds.
8,721 Westdeutsche Thomasphosphat-Werke G.m.b.H. Preparing nitrogen-oxygen compounds by electricity. (Date applied for, April 7, 1905.)
8,906 Hill. Distribution of electrical energy.
8,913 Von Zweigbergk. Controlling system for electric railways.
9,181a Hirst & Collings. Electric light candle fittings. Date applied for, Nov. 1, 1905.)
9,479 Electric & Ordnance Accessories Co. & Hall. Electric lighting of vehicles.
9,607 Fricker. Controlling electric switches in distributing systems.
9,713 Bell. Flexible support for electric lamps.
10,555 B.T.-H. Co. (G.E. Co., U.S.) Alternating current generators.
10,639 Moore & Strang. Regulating the load on direct-current generators.
10,644 Cummins. Automatic electromagnetic sanding gear.
10,707 Job. Switching devices for electric flash advertising.
10,892 & 11,536 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control.
11,146 Electric Equipment & Securities & Ruzicka. Resistances.
11,243 B.T.-H. Co. (G.E. Co., U.S.) Arc lamps.
11,344 Redmayne. Insulators for the live rails of electric traction systems.
11,614 Raworth. Controlling devices for electrically-propelled vehicles.
12,296 Lowry. Magnetically increasing adhesion between wheels and rails.
12,431 Field. Electrical phase indicators and other induction instruments.
13,025 Ridings. Arc lamps.
13,430 Tourtel. Coin-freed apparatus for electricity and the like.
13,577 Clarke, Chapman & Co. & Walker. Electric hoists for use on warships.
13,828 Boys. Receiving instrument for wireless telegraphy.
14,345 Electric & Ordnance Accessories Co., Hall & Garner. Switches for motor controllers and analogous purposes.
14,461 Jacoby. Electric organ actions.
14,660 Harrison. Vapour electric lamps.
15,265 Carlstedt. Electromagnetic vibrators.
15,769 B.T.-H. Co. (G.E. Co., U.S.) Electric soldering irons.
15,985 Arens. Electrical appliances for massage and the like.
16,131 Donlevy. Type carriers for telegraphic and the like machines.
16,249 Hooper & Duckham. Method of constructing and laying underground mains for the distribution of electricity.
16,301 Johnson & Thomsen. Arc lamps.
16,460 Jessen. Automatic starter for electromotors.
16,545 Jones & Jandus Arc Lamp & Electric Co. Electric arc lamps.
16,546 Jones & Jandus Arc Lamp & Electric Co. Arc lamps.
16,547 Drake, Jones & Jandus Arc Lamp & Electric Co. Arc lamps.
16,657 B.T.-H. Co. & Murphy. Arc lamps.
16,680 Dunlop & Stewart & Co. Ignition gear for internal combustion motors.
18,076 Bennett. Life-saving apparatus for electric vehicles.
18,102 Gell. Transmitters for automatic telegraph systems and the like.
18,380 Wright. Telephone attachments.
18,814 Thompson. (Deutsche Gasglühlicht Akt.-Ges., Auergesellschaft.) Electric incandescence lamp with filament of metallic tungsten.
19,638 Borchers, Günther & Franke. Electrolytic production of copper. (Date applied for, Oct. 4, 1904.)
19,691 Richardson. Trolley wheels. (Date applied for, Oct. 17, 1904.)
19,712 Blondel. Arc lamps.
20,749 Siemens-Schuckertwerke G.m.b.H. Overhead current collectors. (Date applied for, Oct. 27, 1904.)
20,960 Quertier. Non-reversing two way running trolley pole.
21,038 McNulta. Electrical transmission of power on motor vehicles and boats. (Date applied for, Dec. 10, 1904.)
22,121 Magnetzünder-Gesellschaft Unterberg & Cie. Actuating devices for magneto-ignition apparatus. (Date applied for, 2/28/05.)
22,939 Bacon. Electric control apparatus.
23,241 Brooking. Electric joint boxes.
23,662 Robinson. Expanding terminal connection for electric cables.
23,934 Boult. (Woodbridge.) Electrical distribution systems.
24,183 Imeson. Controller finger contact for electrical work.
24,293 Roos. Magneto-electric ignition apparatus.
24,538 Howorth. (Kellner, Kellner, Kellner, Kellner & Kellner.) Electrodes for electrolytic apparatus.
25,171 Kriéger. Controlling an electric motor. (Date applied for, May 24, 1905.)

COMPANIES' MEETINGS AND REPORTS.

Rand Central Electric Works (Ltd.)

The annual general meeting of this Company was held on Tuesday, Sir C. Rivers Wilson, G.C.M.G., C.B., presiding.

The SECRETARY (Mr. H. Rogers) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: The gross earnings of our Company during the year 1905 amounted to £102,824, as contrasted with £96,180 for 1904, giving an increase of earnings of £6,644. The work done by our plant shows an increase of 422,515 kw.-hours, or equivalent to about 4 per cent. These very satisfactory results have been attained at an increase of only £378 on actual administrative and working expenditure. That has resulted from the great care with which our works are operated by the general manager and his staff, and is also the direct result of the improvement in the plant which we have been carrying out for some considerable time, and Mr. Spengel reports he has little doubt that, during the current year, he will be able to effect some considerable reduction in the expenditure. The working profit for the year amounted to £54,410, being an increase of £5,959 over 1904, and, adding the carry forward of £4,525, we have a credit balance of £58,935. The report explains the recommendations of the Directors as to the distribution of that amount. You will see from the balance-sheet that £10,688 has been charged for construction of works, machinery, and plant generally. Of that amount £4,607 represents the balance of the cost of our new steam turbine of a capacity of 400 kw. The cost in situ of the turbine was estimated at £12,000, but the actual sum expended only amounts to £11,460. The rest of the £10,688 is represented by additional machinery and a new locomotive required in replacement of a worn-out engine used chiefly for the haulage of coal, and by improvements in the lightning protectors, oil filters and separators. There is an additional amount charged of £772 under the head of water supply, mainly for works for improving the fire service, and the renewal of pumping installation for the protection of the main building and dwelling-houses. The cash at bankers has increased by no less than £24,500; at Dec. 31 last it amounted to £99,488, and at the present moment our cash resources are no less than £115,700, so that, after payment of the dividend we propose, we shall have £93,200 available. That includes an amount accumulated for depreciation and available for providing the new plant which we have in contemplation. You will observe what a strong position that places us in, because the amount I have just mentioned represents so much less capital that will be required for the increase of our plant. There are only two items, I think, in profit and loss that I should allude to, the first is the £777 paid as royalty to the Transvaal Government under our Concession. I mentioned last year that we were in discussion with the Government as to the interpretation which should be placed upon our arrangement, by which we had to pay them a royalty of 2½ per cent. upon the net profits of the undertaking. The question was raised by the Government as to whether net profit should be struck before or after depreciation had been allowed for. I am glad to say the Government have adopted the latter view, so that in future we pay only on the net profits after deduction of depreciation. The other item is the sum of £24,097 which we propose to place to the renewal account which we have set up in substitution of the old depreciation account. As I announced at the last meeting, the amount hitherto set aside as depreciation has this year been utilised for the accumulation of a renewal fund, and the Directors have thought it prudent, in view of the satisfactory year's operations, to set aside a sum in excess of any previous year, so that they may be in a position to rapidly replace the present plant by more modern and economical machinery, which, together with the contemplated extension at the central station, will enable the company to successfully compete with any rival scheme. Under these circumstances, and bearing in mind the experience we have gained during the existence of the Company, we need have no apprehensions as to our being able, successfully, not only to hold our own, but I hope materially to add to the prosperity of the Company. In the meantime we have four engines in operation, together with the new steam turbine, making a total capacity of 3,200 kw., but we go on the principle, as far as possible, of keeping one engine in reserve, which we found it difficult to do until we had added the steam turbine to our plant. Therefore the normal capacity in operation should be 2,500 kw., though as a matter of fact Mr. Spengel reports that in the month of June last the maximum capacity was as much as 2,580 kw. We are always on the look-out for new business, and you will remember that some of our contracts fall in from time to time. One of the most important is the supply to the town of Johannesburg, and our contract with the municipality will come to an end during the present year. We have been taking steps to fill up the gap, and several new contracts have already been made, which will take a considerable amount of the supply, while other contracts are at the present time in negotiation. Therefore I do not think we need have the smallest apprehension, in view of the demand from the Rand, and our capability of supplying it, that there will be any intermission of business. Our local board are in negotiation with the Government with a view to obtain a modification of our contract and concession, and are now discussing the matter with the Government. The experience we have had up to the present time, and also the development of electrical science, would require no doubt a good many modifications of the contract, as contrasted with the concession when it was originally given. But we have been met by the Government in a friendly spirit, and your directors have little doubt that they will be able to successfully conclude their negotiations with the authorities. At the commencement of my remarks I pointed out that the net balance to our credit was £58,935, and I have also mentioned that the amount we propose to set aside out of that amount on account of renewal fund is £24,097, leaving a balance of £34,838. We had to consider carefully how we should deal with the question of dividend, and we came to the conclusion that we should be acting in the best interests of the shareholders in not forcing the pace too much, but that, in view of the possible fluctuations that are inseparable from every industry like ours, we should maintain a very conservative policy. We propose, therefore, to distribute £22,500 in payment of a dividend of 1s. 6d. per share, or 7½ per cent., carrying forward £12,338. You will observe that our position is strong, that our prospects are satisfactory, and that the outlook is hopeful. In confirmation of this, our progress is continuing into the present year, as by the end of April last our receipts were in excess of those for the corresponding period of last year by the satisfactory sum of £3,400. I now move the adoption of the report and accounts.

Mr. GEORGE VON CHAUVIN seconded the motion, which was at once unanimously agreed to.

Resolutions approving the dividends, and re-electing the retiring directors and auditors were then carried unanimously, and a cordial vote of thanks to the chairman and directors terminated the proceedings.

West African Telegraph Co. (Ltd.)

The twenty-first ordinary general meeting was held yesterday under the presidency of the Marquis of Tweeddale, K.T.

The SECRETARY (Mr. John Cambrook) read the notice calling the meeting.

The CHAIRMAN said: The net result of the year's working shows only a slight variation from the figures of the previous year. The gross income was, roundly, £65,800, or an increase of £4,900 on that for the year ended Dec. 31, 1904. Owing to interruptions of other companies' cables traffic was diverted to this Company's lines, under the African Cables Interruption Agreement, adding to our revenue to the extent of about £3,700, and a further increase was derivied from our investments on account of general reserve fund and interest of £1,200. In addition to these increased receipts our revenue has benefited to the extent of £2,800 in consequence of a reduction in the loss on exchange due to the improvement in the value of the Portuguese currency. These increases amount to £7,700. Against this, however, must be placed a reduction in the receipts from the South African joint purse and in the Portuguese traffic, amounting together to £2,800, leaving a net increase, as stated above, of £4,900. Turning to the other side of the account, the ordinary expenses have increased to the extent of £800, while the cost of maintaining our cables has been £3,400 more than last year, making a total increased expenditure of £4,200, so that on comparing the two years the net result in favour of the year under review is a small improvement of about £700. The total amount available for distribution is £38,515, and after providing for income tax, the Directors have transferred the sum of £26,000 to the general reserve fund and have paid an interim dividend of 2 per cent. They now propose to pay a final dividend of 2 per cent., making 4 per cent. for the year, and leaving £1,500 to be carried forward to the next account. The amount placed to reserve may seem large, but I need not remind you that the policy of building up the reserve fund has always commended itself to your Directors, and I am sure meets with the general approval, as the surest means of strengthening the Company. I now move the adoption of the report and the declaration of the dividend.

The motion was carried. The retiring director (Mr. Robert Kaye Gray) and the retiring auditors (Messrs. Deloitte, Plender, Griffiths & Co.) were re-elected, and a hearty vote of thanks to the chairman and directors terminated the proceedings.

BRUNNER, MOND & CO. (LTD.)—For the year ended March 31 the balance to credit of profit and loss was £704,469, which, with £87,535 brought forward, makes £792,004. The directors propose to pay a further dividend on the ordinary capital, bringing this to 35 per cent. for the year, placing £190,718 to reserve, writing £2,500 off patents account, and carrying forward £62,944.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting on Friday it was reported that at Ventnor and Bonchurch the equivalent of 18,353 8 c.p. lamps was connected, against 16,794 in 1905; at Sandown and Shanklin 14,839 and 12,269, at Newport and Cowes 24,790 and 22,035, and at Ryde and St. Helens 13,762 and 9,945 respectively. Including £143. 14s. 1d. from last year, the profit was £8,617. 11s. 4d. After paying interest (£5,542. 19s. 7d.) and preference dividend (£2,500) the balance was £574. 11s. 9d. £360. 1s. 6d. is written off preliminary expenses and £214. 10s. 3d. carried forward.

LANARKSHIRE TRAMWAYS CO.—At a recent extraordinary meeting a resolution was passed sanctioning the creation of additional capital to the amount of £54,000 (part of the additional capital of £216,000 authorised by the Lanarkshire Tramways Order, 1903) by the issue of 5,400 new shares of £10 each. The capital is required for the extension of the system from the present terminus to Cambuslang.

REUTER'S TELEGRAM CO. (LTD.)—Admiral Sir John Dalrymple Hay, who presided at the meeting on Wednesday, said the war between Russia and Japan brought home to them the necessity of thoroughly overhauling their news arrangements at the Far Eastern branches, and their arrangements had been remodelled. The company's business was on as sound a basis as ever, and they would doubtless share the satisfaction felt by his colleagues and himself that they were able to continue to pay the usual dividend and substantially build up the reserves.

UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO (LTD.)—At the meeting last week the chairman (Mr. Wm. Trotter) said the year's receipts showed a net increase of $28,607, compared with the previous year. The electrification of their lines had made great progress, and nearly 28 miles (out of 51) of single track had been completed; while the building of the power station was also progressing satisfactorily. Most of the materials, together with the heavy machinery, had been recently shipped, and the contractors expected that the bulk of the machinery for the power house would be shipped during the next few weeks and the cars before the end of July. A dividend of 2 per cent. on the ordinary shares was declared. The capital of the company has been increased from £500,000 to £800,000.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

AMALGALINE LIMITED. (88,856.)—Reg. May 22, capital £1,100 in 1,000 preference shares of £1 each and 2,000 ordinary shares of 1s. each, to acquire certain inventions relating to improvements in the jointing of cables, pipes, rods, tubes and the like, in a flux therefor, and in moulds for the metallic covering of joints in lead-covered cables, to adopt an agreement with T. Harden and S. L. Smith, and to carry on the business of founders, engineers, manufacturers of lead pipes, makers of electric light and other cables, &c. First directors: J. White, T. S. Dangerfield and S. L. Smith. Reg. office, 41, Holborn Viaduct, London, E.C.

ANDREWS & MUMFORD (LTD.) (88,836.)—Reg. May 21, capital £2,000 in £1 shares, to adopt an agreement with C. B. Andrews and W. J. Christison, and to carry on the business of electricians, electrical, mechanical and general engineers, makers of electrical tramcars, motor cars, &c., manufacturers of and dealers in dynamos, batteries and other electrical apparatus, &c. First directors: C. B. Andrews, R. R. Mumford (managing) and one other to be appointed by debenture holders. Reg. office, 1, Leather-street, London, S.E.

H. P. SYND. (LTD.) (88,942.)—Reg. May 26, capital £12,500 in £1 shares, to adopt an agreement with M. F. Armstrong and H. W. Fox, and to carry on the business of suppliers of electricity, electricians, manufacturers of and dealers in electrical apparatus, mechanical engineers, &c. First directors, H. W. Fox and M. F. Armstrong (life directors), P. S. Inskipp, F. H. Becker and A. Scott. Reg. Office, 701, Salisbury House, London Wall, E.C.

MATTHEW'S IMPROVED ELECTRICITY METER (LTD.) (88,909.)—Reg. May 24, capital £2,500 in £1 shares, to adopt an agreement with S. Matthews and to carry on the business of manufacturers of and dealers in electricity meters and other instruments and appliances, electrical and general engineers, &c. S. Matthews is one of the first directors, Reg. office, 35, Bucklersbury, London, E.C.

NATIONAL CONSTRUCTION CO. (LTD. (88,910.)—Reg. May 24, capital £60,000 in £1 shares, to acquire and turn to account any contracts, rights, concessions, &c., relating to railways, tramways, roadways, waterways, British and Colonial Government contracts, electrical generation, traction and supply buildings, transportation, lighting, &c., in any part of the British Empire. Reg. Office, 52, Queen Victoria-street, London, E.C.

NORTHERN ELECTRICAL SUPPLY STORES (LTD.) (88,725.)—Reg. May 10, capital £1,000 in £1 shares, to acquire business carried on at 92, Northumberland-street, Newcastle-on-Tyne, as the Edison Supply Co., to adopt an agreement with P. Hopper, and to carry on the business of manufacturers of and dealers in electric lamps, bulbs, bells, batteries, dynamos, accumulators, and other electrical goods, suppliers of electricity, &c. Reg. office, 92, Northumberland-street, Newcastle-on-Tyne.

SIEMENS BROS. DYNAMO WORKS (LTD.) (88,928.)—Reg. May 25, capital £300,000 in £10 shares, to acquire as from Jan. 1, 1906, the dynamo branch of the business of Siemens Bros. & Co. (Ltd.), hitherto carried on at Stafford and Westminster, to take over the assets and obligations of the said company so far as the same relate to the said Stafford works and the said London office, to continue such dynamo business and to enter into arrangements with Siemens-Schuckertwerke G.m.b.H. (Berlin) with regard to the management of the company's undertaking. The subscribers are: A. Siemens, C. F. von Siemens, G. von Chauvin, B. H. Antill, A. Sabine, W. H. Stafford and P. G. Ledger. First directors: A. Siemens, C. F. von Siemens, G. von Chauvin, Dr. A. Berliner and H. Natalis.

STATUTORY RETURNS.

COUNTY OF NORTHAMPTON ELECTRIC POWER & TRACTION CO. (LTD.)—Return to May 14 gives capital as £25,000 in 2,500 shares of £10 each, all of which have been taken up. £9. 5s. per share has been called up and £23,125 has been received. Mortgages and charges, nil.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—According to return to April 3 capital is £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each, of which 12,931 ordinary and 6,000 preference have been taken up. £94,655 has been received. Mortgages and charges, £30,000 first and £20,000 second mortgage debentures.

ERNEST F. MOY (LTD.)—The capital in return to April 10 is £10,000 in 8,500 ordinary shares and 1,500 preference shares of £1 each, all of which have been taken up. £9,992 has been received, leaving £8 in arrears. Mortgages and charges, £1,240.

HUDSON & BOWRING (LTD.)—Return to April 6 gives capital as £3,300 in £1 shares, of which 2,710 have been taken up. £1 per share has been called up on 555, and £555 has been received. 2,155 shares are considered as fully paid. Mortgages and charges nil.

LONDON UNITED TRAMWAYS (LTD.)—Return to March 19 gives capital as £2,500,000 in 125,000 preference and 125,000 ordinary shares of £10 each, of which 125,000 preference and 100,000 ordinary have been taken up. £10 per share has been called up on 89,000 preference, £4 per share on 39,993 ordinary and £10 per share on seven ordinary, and £1,050,042 has been received. £960,000 is considered as paid on 96,000 shares. Mortgages and charges, £1,331,000.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—Return to April 18 gives capital as £250,000 in £1 shares, of which 147,863 have been taken up. £129,012 has been received and £18,851 is considered as paid. Mortgages and charges, nil.

OKONITE CO. (LTD.)—According to return to April 13 capital is £120,000 in 32,000 preference and 16,000 ordinary shares of £2. 10s. each, of which 32,000 preference and 16,000 ordinary have been taken up. £2. 10s. per share has been called up on 100 ordinary and 110 preference and £525 has been received. £119,475 is considered as paid on 47,790 shares. Mortgages and charges: £57,200, of which £35,200 debentures are in hands of trustees for the company.

SHERARD COWPER-COLES & CO. (LTD.)—In return to Dec. 31, 1905, capital is £25,000 in 18,000 ordinary and 7,000 preference shares of £1 each, of which 6,856 preference and 18,000 ordinary have been taken up. £1 per share has been called up on 6,856 preference and 500 ordinary, and £7,356 has been received. £17,500 is considered as paid on 17,500 ordinary. Mortgages and charges £6,500 debentures.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—Return to March 28 gives capital as £325,000 in 65,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, nil.

UXBRIDGE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The capital in return to April 10 is £50,000 in £5 shares, of which 5,001 have been taken up. £5 per share has been called up on 4,956 and £24,780 has been received. £225 is considered as paid on 45 shares. Mortgages and charges, £33,400.

WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.)—Return to April 3 gives capital as £50,000 in £5 shares, of which 8,200 have been taken up. £41,000 has been received. Mortgages and charges: £39,700.

WITNEY ELECTRIC SUPPLY CO. (LTD.)—In return to April 9 capital is £10,000 in 5,000 preference and 5,000 ordinary shares of £1 each, of which 2,849 preference and 2,802 ordinary have been taken up. £1 per share has been called up on 4,651 shares, and £4,629. 2s. 6d. has been received, leaving £21. 17s. 6d. in arrears. 1,000 shares are considered as fully paid. Mortgages and charges, £3,500.

MORTGAGES AND CHARGES.

D.P. BATTERY CO. (LTD.)—A memorandum of satisfaction to the further extent of £1,000 of first debentures dated Oct. 29, 1901, securing £10,000, has been filed.

SYNCHRONISED ELECTRIC CLOCK CO. (LTD.)—Particulars of £2,500 debentures, created by resolution of Nov. 10, 1905, charged on company's undertaking and property, present and future, have been filed pursuant to sec. 14 (4) of the Companies' Act, 1900. No trustees.

TRACTION CO. OF THE UNITED KINGDOM (LTD.)—A memorandum of satisfaction in full of a charge, dated Dec. 23, 1902, and March 2, 1903, securing £3,000, has been filed.

CITY NOTES.

MEMORANDA (May 31).—Bank rate 4 per cent. (since May 3, 1906). Price of silver $31\frac{1}{8}$d. per oz. Consols $89\frac{9}{16}$—$89\frac{11}{16}$ for money, $89\frac{7}{8}$—90 for account; $2\frac{1}{2}$ per cent. annuities $88\frac{1}{2}$—$88\frac{3}{4}$. Consols Pay Day, June 1. Stocks and Shares Continuation Day, June 12; Ticket Day, June 13; Pay Day, June 14; Mining Share Carry-over Day, June 11.

COMPANIES STRUCK OFF REGISTER.—The following have been removed from the register of Joint Stock Companies:—Associated American Electrical Manufacturers, Bee-Bee Electrical Engineering Co., Harbourne Electrical Mfg. Co., Industrial Electric Co., Motor Power Co., Ozone Industrials Synd., Paris Singer Electric Carriage Co., Peking & North China Electrical Corpn.

ACCUMULATORENFABRIK AKTIENGESELLSCHAFT (BERLIN).—A dividend of $12\frac{1}{2}$ per cent. (the same as in 1905) has been declared.

OESTERREICHISCHE GASGLUHLICHT UND ELEKTRIZITATSGESELLSCHAFT (VIENNA).—A dividend of 30 per cent. (the same as last year) has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 13 a special settling day in a further issue of 5,000 £1 fully paid shares and 128,063 £1 (15s. paid) shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, and have ordered same to be quoted.

The Committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of 10,000 £5 fully paid 6 per cent. preference shares of the *London Electric Supply Corpn. (Ltd.)*, and also to allow 60,000 £10 6 per cent. cumulative preference shares and £600,000 $4\frac{1}{2}$ per cent. debenture stock of the *Bombay Electric Supply and Tramways Co. (Ltd.)* to be quoted.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend, payable 23rd inst., of 3s. per share (or at rate of 6 per cent. per annum, tax free) for the quarter ended March 31. The transfer books will be closed from June 16 to June 22 inclusive.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 26	1,305	+ 27	52	69,374	− 180
Airdrie	,, 18	226	+ 11	20	4,311	+ 431
Anglo-Argentine	,, 27	14,651	+ 1,755	21	316,335	+ 83,535
Ashton-under-Lyne Corp.	...	...	...	...	...	...
Ayr Corporation	,, 26	278	− 52	2	406	− 149
Baker St. & Waterloo Ry.	,, 26	1,383	...	11	15,972	...
Barnsley	,, 18	166	+ 6	20	3,147	+ 42
Barrow	,, 18	229	− 5	20	4,288	+ 245
Bath Electric Trams, Ltd	,, 23	796	+ 73	21	14,612	+ 1,933
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 27	611	+ 261	8	4,535	+ 1,588
***Birmingham & Mid.**	,, 18	1,444	− 434	20	27,632	− 7,706
Blackburn Corporation	,, 23	846	− 106	¶18	8,610	+ 478
Blackpool Corporation	,, 24	516	− 109	7	5,623	+ 94
Blackpool and Fleetwood	,, 26	399	− 59	21	5,978	+ 137
Blackp'l, St. Anne's & Lytham	,, 24	259	− 27	§29	5,975	+ 588
Bolton Corporation	,, 27	1,972	+ 98	8	16,826	+ 684
Bournemouth Corporation.	,, 23	1,388	+ 361	†8	12,093	+ 3,526
Bradford Corporation	...	...	...	...	...	...
Brighton Corporation	,, 27	810	− 169	8	7,279	− 412
Bristol Trams & Carriage	,, 25	4,898	− 31	15	70,693	+ 3,209
Buenos Ayres & Belgrano	,, 27	3,824	+ 352	21	75,453	+ 5,395
Buenos Ayres Elec. Trms.	April 28	1,367	+ 205	17	24,039	+ 5,068
Burnley Corporation	May 26	1,134	+ 89	8	9,590	+ 557
Burton Corporation	,, 27	276	− 29	§8	2,319	− 180
Bury Corporation	,, 20	864	...	7	6,839	...
Calcutta Tramways Co.	,, 26	R41,272	+ R4,011	21	R912,874	+ R[illegible]1,823
Camborne-Redruth	,, 26	110	+ 6	4	430	+ 21
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 18	88	+ 7	20	1,306	+ 345
Central London Railway	,, 26	6,464	− 251	21	142,481	− 4,620
Chatham & Dist. Lt. Rys.	,, 24	591	− 9	†20	12,450	− 114
***City of Birm'gh'm Tram Co**	,, 18	5,475	− 360	20	103,930	− 5,689
***City & South London Rly.**	,, 27	2,546	+ 73	21	59,809	+ 268
Colchester Corporation	,, 24	183	+ 13	69	7,860	− 1,320
Cork Electric Trams Co.	,, 24	504	− 57	21	8,972	− 215
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	,, 3	173	+ 10	8	1,650	+ 99
	,, 10	186	+ 9			
	,, 17	185	− 9			
	,, 24	314	+ 2			
Devonport & Dist. Trams	,, 18	400	− 6	20	8,377	− 429
Dover Corporation	,, 26	226	+ 41	8	1,824	+ 186
Dublin & Lucan Railway	,, 25	124	+ 2	§21	2,086	− 117
Dublin United	,, 25	4,784	− 839	‡21	97,219	+ 945
Dudley—Stourbridge	,, 18	832	− 28	20	15,572	+ 192
Dundee Corporation	,, 23	998	+ 165	§1	998	+ 165
East Ham Council	,, 26	821	+ 7	8	7,331	+ 822
Exeter Corporation	,, 25	253	− 38	8	2,136	− 396
Gateshead & Dist. Trams	,, 18	955	+ 71	20	18,323	+ 919
Glasgow Corporation	,, 26	16,911	+ 1,336	52	302,287	+ 53,768
Glossop	,, 26	128	+ 4	21	2,640	+ 250
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 18	256	+ 20	20	4,181	+ 192
Gt. Northern & City Rly.	,, 26	1,763	+ 175	21	37,750	+ 1,804
Greenock & Port Glasgow.	,, 18	707	− 13	20	11,982	+ 730
Halifax Corporation	,, 23	1,339	− 43	8	1[illegible],152	+ 532
Hartlepool Tramways	,, 18	273	+ 32	20	5,183	+ 342
Hastings Elec. Trams Co.	,, 24	607	...	21	10,041	...
Huddersfield	,, 26	1,412	+ 196	8	11,824	+ 1,300
Hull Corporation	,, 26	2,098	+ 62	8	17,418	+ 180
Ilford Dist. Coun.	,, 26	434	+ 26	8	3,930	+ 177
Ilkeston Dist. Council	,, 23	111	− 3	8	958	...
Ipswich Corporation	,, 26	358	− 40	8	3,144	− 65
Isle of Thanet Co.	,, 26	380	− 137	53	10,021	− 986
Keighley Corporation	,, 24	135	+ 9	46	6,568	...
Kidderminster & District	,, 18	115	+ 3	20	1,946	+ 1
Kilmarnock Corporation	,, 26	149	− 7	2	237	− 85
Kirkcaldy Corporation	,, 23	205	− 9	12	[illegible],321	− 46
Lanarkshire Trams Co.	,, 24	847	+ 154	†21	17,608	+ 3,910
Leamington	,, 18	149	+ 104	20	2,880	+ 1,396
Leeds Corporation	,, 26	5,922	+ 249	8	48,639	+ 2,938
Leicester Corporation	,, 26	2,099	+ 59	21	43,647	+ 4,115
Leith Corporation	,, 19	456	+ 254	1	456	+ 254
Liverpool Overhead Rly.	,, 27	1,410	− 108	21	29,300	− 2,209
Liverpool Corporation	,, 19	10,472	− 216	20	207,074	+ 5,252
***London County Council**	,, 26	24,482	+ 10,252	7	209,547	+ 97,672
London United	,, 25	5,794	− 146	†21	112,587	+ 5,085
Lowestoft	,, 26	128	− 12	35	4,484	− 2[illegible]4
Maidstone Corporation	,, 24	93	− 15	8	836	− 107
Manchester Corporation	,, 26	12,892	+ 589	8	103,905	+ 5,058
Mersey Railway	,, 26	1,748	+ 235	21	36,121	+ 2,244
Merthyr	,, 18	198	+ 7	20	6,690	− 20
Metropolitan Dist. Railway	,, 27	8,419	+ 1,163	21	167,715	+ 10,936
***Metropolitan Elec. Trams**	,, 18	3,703	+ 1,348	20	60,728	+ 19,792
Middleton	,, 18	331	− 14	20	6,131	+ 308
Nelson Corporation	,, 26	132	+ 8	9	1,181	+ 108
Newcastle-on-Tyne Corp.	,, 26	3,797	+ 214	8	61,193	+ 1,492
Newport (Mon.)	,, 26	580	+ 22	8	4,819	+ 215
Northampton Corporation	,, 25	380	− 1	8	8,253	+ 76
Oldham, Ashton & Hyde	,, 18	637	+ 70	20	10,644	+ 416
Oldham Corporation	,, 27	1,731	+ 135	9	15,600	+ 916
Perth (N.B.) Corporation	,, 23	142	...	1	142	...
Perth (W. A.) Elec. Trams	,, 25	1,444	+ 85	‡21	31,830	+ 1,618
Peterborough	,, 18	1[illegible]9	− 5	20	2,129	− 150
Pontypridd District Coun.	,, 26	150	+ 2	8	1,366	− 41
Portsmouth Corporation	,, 26	1,578	− 163	8	14,458	− 441
Potteries	,, 18	1,785	+ 183	20	64,606	+ 1,930
Preston Corporation	,, 23	647	+ 61	...	...	...
Reading Corporation	,, 24	561	+ 15	...	...	...
Rochdale Corporation	,, 26	946	+ 391	8	8,107	+ 3,542
Rotherham Corporation	,, 24	433	+ 24	8	6,660	+ 309
Rothesay	,, 18	122	+ 11	20	1,728	+ 345
Salford Corporation	,, 28	4,299	+ 12	8	65,588	+ 816
Sheerness	,, 16	54	− 10	20	994	− 176
Sheffield Corporation	,, 27	5,317	+ 411	9	46,058	+ 2,904
Southampton Corporation.	,, 23	865	− 43	†8	6,867	+ 62
Southend Corporation	,, 23	316	+ 3	8	2,519	+ 89
Southport Tramways	,, 18	278	− 40	20	5,142	+ 16

(a) These comparisons are with the corresponding period last year. † Minus 5 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	May 18	804	+ 95	20	15,681	+ 2,634
Stalyb'dge, Hyde, &c., Jt. Bd.	..	...	...	...	...	...
Stockport Corporation	...	...	...	...	...	...
Sunderland Corpn.	,, 27	1,277	+ 55	8	10,500	+ 654
Sunderland & District	,, 23	300	...	21	7,404	...
Swansea Trams	,, 18	810	+ 1	20	14,962	+ 4,567
Swindon Corporation	...	...	...	...	...	..
Taunton	,, 18	44	− 4	20	835	− 42
Tynemouth and District	,, 18	212	− 15	20	6,677	− 80
Tyneside Trams Co.	,, 23	358	...	21	7,976	+ 475
Wallasey District Council	,, 26	773	+ 12	8	5,982	+ 139
Walsall Corporation	,, 26	472	+ 80	19	10,282	+ 772
Warrington Corporation	...	...	...	...	...	..
West Ham Corporation	,, 24	2,060	+ 525	8	11,780	+ 6,248
Weston-super-Mare	,, 16	83	− 26	20	975	− 15
Wolverhampton Corpn.	,, 23	746	...	8	6,436	...
* **Wolverhampton District**	,, 18	414	+ 47	20	7,754	+ 717
* **Worcester**	,, 18	264	− 33	20	4,903	− 472
Wrexham	,, 18	95	− 5	20	1,893	− 53
Yorkshire W.R. Trams	,, 27	853	+ 156	21	15,624	...
Yorkshire Woollen District	,, 18	926	+ 285	20	16,775	+ 5,192

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., May 30.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to May 30. Highest.	Business, Week to May 30. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	**Anglo-Argentine Ord. Shs. ex rights**	7 —7½	5 10 4	Ap, Oct	7¼	7 1/16
5	2/9	**Do. 5½% Cum. Pref.**	5⅞—6⅛	4 10 0	—	6 1/16	5 15/16
St.	6%	**Do. Permanent 6% Deb. Stock**	140 —143	4 3 9	—	..	..
St.	5%	**Auckland Elec. Trams 5% Deb. (red.)**	104 —106	4 14 3	—	.	..
5	..	**Brisbane Electric Trams. Invest Ord.**	1 —1¼	..	..	.	..
5	2/6	**Do. 5 per Cent. Cum. Pref.**	4⅛—4⅜	5 4 0	—	4[illegible]	..
St.	4½%	**Do. 4½ per Cent. Db. Prov. Cts.**	94 —97	4 12 9	—	..	..
St.	6%	**British Columbia Elec. Rlwy. Def. Ord.**	115 —118	5 1 6	—	..	..
St.	5%	**Do. Pref. Ord. Stk**	109 —112	4 9 3	—	.	..
10	5%	**Do. 5% Cum. Perp. Pref. Stock.**	107 —110	4 11 0	—	.	..
40	4½%	**Do. 4½ per Cent. 1st Mort. Dbs.**	102%—104%	4 6 6	—	.	—
100	4½%	**Do. Vancouver Power Debs.**	103 —106	4 4 0	—	104	..
[illegible]	8/0	**Buenos Ayres and Belgrano Ord.**	8¼—8½	4 18 8	—	8[illegible]	8⅜
6	6/0	**Do. 6 per Cent. "A" Cm. Pref.**	5⅝—5⅞	5 2 6	—	..	..
[illegible]	6/0	**Do. "B"**	5 —5½	5 7 0	—	..	—
St.	5%	**Do. 5 per Cent. Debs.**	106 —108	4 12 6	—	..	..
St.	5%	**Do. 5% 2nd Deb. (red.)**	102 —105	4 15 0	—	..	..
St.	5%	**Buenos Ayres Elec. Trams (1901) Ltd.**	102 —104	4 16 0	..	102	..
100	5½%	**Buenos Ayres Grand National 5½% Pref. Debs.**	103 —107	5 3 0	..	..	—
100	6%	**Do. 6% 1st Deb. Bonds**	100 —105	5 14 0	..	..	.
6	4/6	**Calcutta Tramways (Nos. 1 to 105)**	[illegible]—9¾	4 2 0	—	[illegible]	9¼
5	2/6	**Do. Nos. 105,001 to 137,610**	8½—9	4 9 0	..	..	..
10	4½%	**Do. 4½% 1st Deb. Stock (red.)**	106 —108	4 3 6	—	..	..
1	0/6	**Cape Electric Tram Shares**	⅝—⅞	5 14 0	—	⅝	..
St.	5%	**Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)**	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	96 —98%	5 2 0	..	97	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	94 —98	..	..	..	..
St.	..	Do. 6% "B" Ditto	88 — 92	..	..	89	87¾
1	..	Lisbon Elec. Trams Ord.	1 3/16—1¼	..	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	102½	102
St.	5%	**Madras Elec. Trams 5% Deb. Stk.**	102 — 105	4 15 0	Ja, Jul	-	..
100	4½%	**Montreal St. Ry. Sterling 4½% Debs. (1922)**	102 —104	4 6 6	—	.	..
St.	5%	**Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.**	107 —109	4 11 6	..	107	..
..	$2	**Sao Paulo Tramway, Light and Power Co. $100 Stock**	144 — 147	..	..	..	..
..	5%	**Do. 5% 1st Mt. $500 Dbs.**	99%—101%	5 0 0	..	100½	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	..	..
5	5/[illegible]	† Calcutta Elec. (1-50,000)	8½—9	4 14 0	—	..	..
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	.	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
[illegible]	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½— 3	..	..	2⅝	—
St.	5%	Do. 5% Debs.	88 —92	5 9 4	—	..	..
10	..	Havana Electricity Co. Shares	10 — 11	—	—	..	..
100	5%	Do. 5% Dbs. iss. at 95, Scrip, all pd.	100 —102	4 13 2	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113 — 116	5 3 0	—	115	114
1	0/7½	**Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref. ex 7½d. on a/c of arrears**	⅞—1	6 0 0	—	1 1/16	..
1	1/6	**Rand Electric**	1 5/16—1 7/16	—	—	-	..
1	..	**River Plate Electricity Co. Ord.**	7/16—9/16	..	..	½	..
1	1/2¾	† **Do. 6% Non. Cum. Pref.**	⅞— 1	6 0 0	..	[illegible]	⅞
St.	5%	**Do. 5% Deb. Stock**	101 —103	4 17 0	..	101⅛	..
5	8/0	**Rosario Elec. Co. 6% Pref. (1-12,000)**	5⅛—5⅝	5 8 6	..	-	..
100	4½%	***Royal Elec., Montreal 4½% 1st Mort. Deb**	99 —102	4 8 0	Ap, Oct	—	...
..	5%	**Shawinigan Water and Power 5% Bds., Scrip**	101 — 103	4 17 0	..	102¼	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed. May 30.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to May 30. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 –12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	.	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 8 3	..	..	–
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛–5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾–9¼	5 8 6	–	..	..
5	3/6	Do. 7 per Cent. Pref.	8¾–9¼	3 15 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	102 – 105	3 16 3	–	..	.
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 – 5	5 0 0	Feb, Aug	4⅝	4½
5	2/3	Do. 4½ per Cent. Pref.	4⅜– 4⅞	4 12 6	Feb, Aug	..	.
St.	4%	Do. 4% Deb. Stock (red.)	101 – 103	3 17 6	–	102¾	101½
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4⅛– 4½	5 6 0	–	4¾	..
5	2/3	Do. Do. (1903)	3⅞– 4¼	5 6 0	..	.	.
5	3/9	Chelsea Electric Supply Ord.	5¼– 5¾	6 6 0	March ..	5¾	5½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 –109	4 2 6	Jn, Dec ..	..	.
10	7/0	City of London Electric Lighting Ord.	10½–11¼	6 6 6	Feb, Aug	10 15/16	10⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	12½–13½	4 9 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	128 –130	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 8 0	..	102¼	..
5	4%	County of Durham Elec. P.D. Ord. £3pd.	3 –3 3/32	4 0 0	April, Oct	..	..
5	5%	Do. Do. 5% non cum. pref.	5⅛–5⅜	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8 –9	5 11 0	–	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–12¼	4 18 0	Mar, Sept	11¾	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 –112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –103	4 7 4	..	101½	101
5	3/6	Folkestone Electricity Supply Co. Ord.	6⅛–6⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 6	–	..	..
5	5/0	Hove Electric Lighting Ord.	8¼–8¾	5 5 0	–	8 11/16	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtnbdg. Ord	10 –11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	102	..
3	2/4½	London Electric Supply Ord.	2 –2½	4 0 0	–	2 5/32	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5 [illegible]/32	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 –101	3 19 2	Mr, Jn, S, D	99½	..
5	10%	Metropolitan Electric Sup. Ord.	8¼–9¼	5 8 0	April, Oct	8¾	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	Jan. July	5 7/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 3	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 –103%	4 7 4	–	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12 –12¼	5 11 1	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅜–7⅝	5 6 8	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	6 –6¼	4 1 7	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	–
1	3%	Northern Counties Elec. Sup.	1 –1 1/32	3 0 0	Mar. Aug	–	..
100	4½%	Do. 4½% Deb.	101 –102	4 8 9	Jan, July	..	–
10	9/0	Notting Hill Electric Ord.	13 –14	6 8 0	March...	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½–7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –101	3 19 0	–	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	7	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 –98	3 12 0	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼–2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 –80	5 0 0	–	..	..
5	4/0	South London Electric Supply Ord	3 – 3½	5 14 0	..	..	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	..	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1¼–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3¾– 4¼	5 6 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	4¾	..
St.	4½%	Do. 4½% 1 Mort. Deb.	101 –103	4 7 4	..	101¼	100½
5	6/6	Westminster Elec. Sup. Ord.	10 – 11	5 18 0	Mar, Sept	10 13/16	10½
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16 – 5 9/16	4 10 0	..	5½	5 7/16
5	..	Do. Issued at 7/6 premium all paid	5 5/16 – 5 9/16	..	..	5 15/32	5⅜
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 –96	4 3 4	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/16	4 14 0	..	31/32	15/16
1	0/6	Do. 5% Cum. Pref.	31/32–1 3/32	4 11 6	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 –104	4 6 6	..	102	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 –103	4 7 9	..	102½	101½
10	9½%	Bristol Tramways and Carriage Ord.	15½–16	5 6 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	10 –10¼	3 18 0	..	..	–
St.	4%	Do. 4 per Cent. Debs.	103 –105	3 16 0	Feb, Aug	..	.
10	6/0	British Electric Traction Ord.	6¾–7¼	4 3 0	–	7 3/32	[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	9½–10	6 0 0	Feb, Aug	9 [illegible]/32	9 1/16
St.	5%	Do. 5 per Cent. Perpetual Debs	114 –117	4 5 6	..	116½	115
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 –95	4 14 9	..	..	..
St.	4%	Central London Ordinary Stock	88 –90	4 10 0	June, Dec	89¼	89
St.	4%	Do. 4 per Cent. Pref. Stock	99 –101	3 19 0	..	100½	..
St.	4%	Do. Deferred Stock	77 –80	5 0 0	..	78	–
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 –95	4 4 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞–5⅛	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 0	..	.	..
St.	1¾%	City and South London Rly. Con. Ord.	40 –42	4 10 0	Feb, Aug	40⅝	40
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	–	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½–15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾–4¼	9 8 0	..	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 –103	4 7 6	..	102¼	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 –12½	4 17 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	105½–106½	4 4 6	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 –85	4 14 0	–	..	..
10	1½%	Liverpool Overhead Railway Ord	3⅛–3⅜	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾–9¼	5 2 6	–	9	8¾
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 –99	4 1 0	–	98	..
St.	..	Mersey Con. Ord. Stock	4 –6	–	–	4½	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	–	5/32	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	–	31/32	15/16
St.	4½%	Do. 4½% Deb. Stock	102 –104	4 6 6	–	102½	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7 –8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8 –9	5 11 0	Feb, Aug	8½	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	–	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 –96	5 4 0	–	..	..
..	5%	Underground Elec. Rys. Co. of London	93 – 98	5 2 0	..	96⅝	..
St.	3½%	Waterloo and City Ord.	99 –102	3 3 8	June, Dec	101	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	95 –97	4 13 0	..	..	..

Shre.	Last Dividend	Name.	Price Wed., May 30.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 30. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	0½d.	Aron El. Met. 6% Cm. Pf.	½– ⅝	..	–	..	..
1	2/4½	Babcock & Wilcox Ord	3¾–4	5 0 0	..	4	3 31/32
1	7½d.	Do. Pref	1⅛–1⅜	3 14 0	..	..	–
1	4/0	British Insulated & Helsby Cables Ord.	6½–6¾	5 19 6	July, Feb	..	–
1	3/0	Do. 6 per Cent. Pref.	5¾–6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 –107	4 4 0	..	.	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 6	..	97¼	..
1	..	British Westinghouse 6% Pref.	1¾–2¼	..	..	2 3/32	1 31/32
St	4%	Do. 4 per Cent. Mort. Deb. Stock	80 – 85	4 14 0	..	..	..
1	1/0	Brush Electrical Engineering	⅝– ⅞	..	March ..	11/16	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	..	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 – 99	4 11 0	Mar, Sept	97½	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 –86	5 4 6	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord. xd & bonus	10½– 11½	4 10 6	Jan, July	11⅛	11
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6	4 8 4	Jan, July	5¾	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½–110½	..	Nov, May	110½	..
1	4½d.	Castner-Kellner Alkali Co.	1 1/16–1 3/16	5 1 6	..	1 3/32	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	–	100	99
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/32–1 5/32	7 10 0	..	–	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 – 2¼	3 6 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96% – 99%	5 1 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1¾–1⅞	5 8 0	Sept	1 13/16	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 –107	4 5 0	..	107	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	–	Feb, Aug	–	..
5	2/6	Do. (£5 paid)	2½– 3	–	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 – 88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 – 95	5 5 0	–	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾– 4¼	3 4 6	H'lf-yearly	4	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	4¾– 5¼	5 14 0	..	4 15/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 – 105	4 5 0	–	104	103½
2	1/7½	Electric Construction Co.	½– ¾	9 6 6	July	½	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 – 2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 – 92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½– 10	5 0 0	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	95 – 97	4 2 6	–	..	..
5	10/0	Henley's Telegraph Works Ord.	12 – 13	5 15 0	Feb, Aug	..	..
5	9/0	Do. 4½ per Cent. Pref.	[illegible]	4 1 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	109 –111	4 1 0	..	..	..
St.	..	Do. Do. Scrip (50% paid)	57½–58½	..	..	58½	..
10	15/0	India Rubber, Gutta Percha, &c., Wks.	17 –18	2 17 2	Feb, Aug	17 3/16	..
100	..	Do. 4% Debs. Red.	99½–101½	..	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾– 12¼	4 1 8	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32– 31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	⅞–1	6 0 0	..	15/16	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 –101	4 10 0	..	..	..
12	4/0	Telegraph Construction & Mainten'ce.	32 – 34	5 6 0	Mar, July	33¼	32
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 –104	3 17 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16– 2 9/16	5 15 0	..	2½	2 7/16
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1¼	4 0 0	..	..	..
St.	5%	Do. 5% Non-Cum. Preferred	112 – 116	4 6 0	–	..	..
St.	4%	† Do. 4% 1st Mort. Deb. Stock Red.	103 –105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	106 –108	4 3 8	..	..	..
5	–	Willans and Robinson Ord.	1¼ –1¾	–	Apr, Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2¾ – 3¼	–	Apr. Oct	2¾	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	80 –85	4 14 0	May Nov	..	..
		TELEGRAPHS.					
10	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –102	3 18 0	Jan, July	..	..
10	–	Amazon Telegraph	3½– 4	..	Jn, Dec ..	3½	3 7/16
100	5%	Do. 5% Debs. (red.)	83 –88	..	..	..	..
St.	15/0	Anglo-American	67 –69	4 14 0	F, My, Ag, N	..	..
St.	30/0	Do. Preferred	114½–115½	5 2 6	F, My, Ag, N	115½	114½
St.	10/0	Do. Deferred	27⅛–27⅜	..	F, My Ag, N	27⅛	27⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97 –99	4 1 0	Jn Ap, Jy, O	98	97¼
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	8½	..
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb Aug	..	–
5	2/0	Direct Spanish Ord	3⅛–3⅜	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent. Deb.	100%–103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable.	15¾–16¼	4 6 0	Ja, Ap, Jy, O	16¼	15⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 –103	4 7 6	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	142 –145	4 16 6	Ja, Ap, Jy, O	144½	144
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 16 0	Ja, Ap, Jy, O	91¼	90¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	107¼	107
10	6/6	Eastern Extension xd & bonus	13¾–14¼	4 18 0	Ja, Ap, Jy, O	14¼	14
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 4	Feb, Aug	106¾	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 3	Feb, Aug	100¼	100
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) with coupon 67	39 – 41	5 17 0	Jan, July	40⅞	40¾
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 –103	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57 –59	5 10 0	May, Nov	58	57⅞
100	$1	Mackay Companies Common	[illegible]	2 17 0	Jan, July	–	..
100	4%	Do. Preference	[illegible]	5 6 10	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	1⅛	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 – 103	3 17 6	June, Dec	101½	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	..
5½	–	West Coast of America	¾– ⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	101 –104	3 17 0	Jan, July	..	..
10	–	West India and Panama	7/16– 9/16	..	May, Nov	..	..
10	6/0	Do. 6% 1st Pref.	6½–7	8 11 4	May, Nov	7⅛	6⅞
10	–	Do. 6 per Cent. 2nd Pref.	5½– 6½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14 –14½	4 17 6	Mr, Jn, O, D	14⅜	14 5/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	105½	..
		TELEPHONES					
–	..	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	96 –98	..	..	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	–	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 –112	5 7 0	–	111½	110
St.	5%	Do. Def. Stock	108 –110	4 11 0	–	109	108
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 6	Feb, Aug	13	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	11⅜	–
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 – 100	3 10 0	June, Dec	99½	99⅜
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 –105	3 16 0	–	104½	104
1	0/9⅗	†Oriental	1⅜–1½	4 0 0	April, Oct	1 7/16	1⅜
1	0/7½	† Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 7 0	–	..	..
St.	24/7⅗	Do. 4% Red. Deb. Stock	99 –101	3 19 0	..	101¼	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 – 106	4 4 9	..	..	..
5	3/0	United River Plate	7 –7½	5 6 8	July	7¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜–5⅝	4 9 0	June, Dec	5½	5½
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 – 113	4 8 6	June, Dec	110¼	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 5% Cum. Pref.	4¾– 5¼	5 14 0	–	.	..
10	2/0	Globe Telegraph and Trust	11⅛–11⅜	4 15 0	Ja Ap, Jy O	11⅜	11¼
10	3/0	Do. 6 per Cent. Pref	14¾–15	4 0 0	Ja Ap, Jy, O	15	14¾
10	6%	Submarine Cables Trust (Cert.)	127 –130	4 12 3	April, Oct	..	–

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption, † Ex Dividend, ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

A good many experimenters have made investigations on the amount of light absorbed by frosting the bulbs of incandescent lamps, and by surrounding them with globes, and many investigations on the deterioration in candle-power of carbon filament lamps have been conducted. A somewhat new and startling phenomenon in connection with these subjects is brought to light in an article by Messrs. Cravath and Lansingh, which will be found in another column. These experimenters compared the life of lamps with clear glass bulbs, similar lamps enclosed in globes, and frosted lamps without globes. In accordance with American practice, the life of the lamps was defined as the time taken for the candle-power on constant voltage to fall to 80 per cent. of its initial value, and the unexpected result was obtained that frosting reduced the average life by something like 52 per cent. of its value for a similar clear glass lamp, while enclosure in globes only caused a diminution of life of about 5·5 per cent. No hint of an explanation of the physical connection of the rate of falling off of the light with the exterior condition of the frosted bulb is given in the article, and, indeed, the connection seems obscure. We must assume that every precaution was taken to ensure the similarity of the filament of the batches of frosted and unfrosted lamps; but still we prefer to await further confirmatory observations with other makes of carbon filament lamps before we accept Messrs. Cravath and Lansingh's surprising results as conclusive.

◆

The application of electricity in the flour trade, which we describe in another column, has both commercial and scientific interest. By passing a current of air over a flaming continuous-current arc and then through flour, the flour is bleached and an improvement in colour takes place which is very easily perceptible. The cost of the plant and its operation is extremely low in comparison with the improvement effected in the value of the flour, so that the process has achieved considerable industrial importance in a short time. In addition to the bleaching action, the owners of the process claim that it has the effect of artificially ageing or maturing the flour and of purifying it, and that it is even possible to produce a larger-sized loaf from the same quantity of flour, but of these claims we are unable to form an opinion. The action is attributed to the ionisation of the air, and not to the production of ozone, and it is seen from another article which we publish this week that the two effects are quite distinct. A simple explanation would be that the nitrogen is "fixed" by the arc, and that the gaseous compounds of nitrogen and oxygen react on the impurities of the flour and increase the proportion of nitrates in it. This hypothesis could easily be tested by systematic experiment, say, by using first pure oxygen and then pure nitrogen and excluding the air, then by allowing the arc to take place in nitrogen which was immediately brought in contact with air or ozygen and passed through the flour, and finally by producing the gaseous compounds of oxygen and nitrogen by ordinary chemical means and passing them through the flour in minute quantities.

◆

Prof. J. J. Thomson, in this month's *Philosophical Magazine*, goes with some detail into the question of the number of corpuscles in the atom, and now lays down firmly what he has previously merely hinted, that the number of corpuscles (*alias* electrons) in any atom is not greatly different from its atomic weight. The evidence he adduces is drawn from three physical phenomena widely different in nature, but each of the three chains of reasoning leads to practically the same conclusion. The first method of considering the question is based on the dispersion of light by gases. Looking on the atom of a monatomic gas as a group of negative corpuscles dispersed through a sphere of diffused positive electricity, it is evident that relative displacement of the parts of the atom will be produced by the electromagnetic forces of the light waves passing over the atoms. Thus the passage of light will give rise to what may be called polarisation of the atoms, which, in turn, will alter the specific inductive capacity—otherwise the refractive index—of the gas. The amount of the relative displacement in the atom will depend both on the time the electric forces act—that is, on the wave length—and on the masses of the corpuscles. Massless corpuscles, for instance, would move instantaneously for waves of every length. It is, however, well known that the refractive index of a gas depends on the wave length, a phenomenon called dispersion; and it is by connecting the masses of the corpuscles with the observed dispersion of a gas that Prof. THOMSON finds the number of corpuscles in the atom.

◆

THE second argument, drawn from the scattering of Röntgen rays by gases, has been remarked upon before in our columns. Mr. BARKLA'S experiments have shown that the amount of scattering depends on the atomic weight. Theory shows that it must depend also on the number of corpuscles in the unit volume. And, following up the suggested connection, Prof. THOMSON succeeds in forming an estimate of the number of corpuscles in the atom. Again, the third method applied to the problem of this Paper is based on the absorption, when they pass through matter, of the β-rays from radioactive substances. Here the absorption is regarded as due to the collisions between the particles that constitute the rays and the corpuscles that form the atoms of the medium. Thus the number of corpuscles in the cubic centimetre of matter can on these lines be deduced anew from the co-efficient of absorption. Now, the three methods of computation here briefly sketched all agree in yielding the striking inference that the number of corpuscles in the atom is virtually the same as the figure conventionally expressing the atomic weight—and thus, in particular, the hydrogen atom contains but one corpuscle. Taken as a whole, this demonstration, if final, is undoubtedly of extreme importance to the electric theory of matter, for it lifts away the barrier that mere complexity had raised against the investigator, which, in the day when even the hydrogen atom was believed a populous cluster of electrons, seemed impassable.

◆

THE fire which occurred on Friday last on the New York Subway throws interesting light on the behaviour of some of the so-called "fireproof" cars in use in America. According to the *Daily Telegraph*, the fire seems to have originated through a short-circuit caused by a collision of two empty trains. One car, which was of the copper-sheathed type, is said to have been entirely destroyed, and the amount of inflammable material contained in the "all steel" cars was sufficient to allow the fire to attain such proportions as to cause serious buckling of the frames. Fortunately no casualties are reported.

Honorary Degrees.—At the Oxford Commemoration on June 20th a number of honorary degrees will be conferred. Among them are the honorary degree of Doctor of Science to Prof. Alexander Graham Bell and Mr. John Milne, F.R.S.

Personal.—We are happy to announce that the Mr. Frank Bailey who was accidentally killed whilst out shooting last week was not Mr. Frank Bailey, chief engineer to the City of London Electric Lighting Co.

Electric Locomotives on the Metropolitan Railway.—*Erratum.* On page 250, column 1, last line, for "250°C." read "25°C."

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Tangier—Cadiz	Feb. 17, 1906	June 2, 1906
Paramaribo—Cayenne	April 20, 1906	—

The Albert Medal.—The Council of the Society of Arts has awarded the Albert Medal for the present year to Sir Joseph W. Swan, F.R.S., "For the important part he took in the invention of the incandescent electric lamp, and for his invention of the carbon process of photographic printing."

Wireless Telegraphy in Cross-Channel Steamers.—We understand that the arrangements for the wireless telegraph equipment of the passenger steamers of the Zeeland Shipping Co., plying been Queenboro' and Flushing in connection with the South-Eastern & Chatham Railway, have been completed, and that the mail steamers in both the day and night services are now fitted with apparatus for wireless telegraphy.

Patent Law Amendment.—Mr. Dundas White has introduced a bill into the House of Commons which is drafted to amend the present law relating to patents in the following respects:—

(1) To prevent the use of the word "patented" in connection with the subjects of expired patents; (2) To compel patentees to mark patented articles with the year and number of the patent, in order to enable the public to identify the patent in question; and (3) To prevent agents, whether registered or unregistered, from using the words "Patent Office," "Office for Patents," or any other words calculated to suggest that their business is officially connected with the Patent Office.

High-Tension Continuous-Current Transmission.—The new water-power station at La Plombière, near Moutiers, on the River Isère, which is to supply current to a part of the tramway system of Lyons, has now commenced operations. The electrical equipment is by the Compagnie de l'Industrie Electrique of Geneva, and the generating station contains eight continuous-current generators, each of 1,000 kw. capacity. Transmission is effected through the line of about 125 miles at a pressure of 57,000 volts. There is one pair of conductors, each 0·9 mm. in diameter, and the line loss is stated to be 10 per cent. The receiving station at Lyons contains five motor generator sets, each with two motors.

The Seebach-Wettingen Single-phase Railway.—The experiments on this line, which were described in *The Electrician*, April 20th, p. 8, have made considerable progress. The Swiss Federal railway authorities have completed their official tests on the section between Affaltern and Regenstorf, and a regular service is now running as far as the latter station. Some trouble was experienced at first from the interference of the power circuit with the telephones near the track, but this has now been to a great extent got over. Work is being pushed forward on the Regenstorf-Wettingen section; 4,700 train-miles have been run since the commencement of operations on January 15, 1905. The newer of the two locomotives, which has been in service since November 10, 1905, is equipped with some of the largest single-phase motors in use, being of 250 H.P. capacity each. As soon as the whole line is complete, a new 1,000 H.P. express locomotive will be put into service. It will be remembered that the whole of the equipment was supplied by the Oerlikon Company.

Variable Speed Power Transmission with Induction Motors.—Mr. William Stanley has patented in America the following system of working an induction motor at four different speeds: A double-frequency generator supplies 5 cycle current to the stator winding and 15 cycle current to the rotor winding of the induction motor, one or both, as may be desired. Assuming a two-pole induction motor, it will run at 300, 600, 900 or 1,200 revs. per min., according to the connections of the stator and rotor windings to the supply systems. When the stator winding receives 5 cycle current and the rotor winding is short-circuited on itself, the speed will be 300 revs. per min., less the slip. A synchronous speed of 600 revs. per min. is obtained by energising both the rotor and the stator simultaneously, the revolving fields in the two members being arranged to travel in the same direction. When the rotor winding receives 15 cycle current and the stator winding is short-circuited on itself, the speed will be 900 revs. per min., less the slip. A synchronous speed of 1,200 revs. per min. is obtained when the revolving fields in the two members are arranged to travel in opposite directions.

The Teltow Canal.—The ceremony of opening the new Teltow Canal, which connects the river Havel, near Potsdam, with a point on the Spree to the east of Berlin, was performed by the German Emperor on Saturday last. The canal has been constructed and will be worked entirely by the municipal authorities of Teltow, the total cost of construction having amounted to about £2,000,000. The greatest feature of the canal is that electric towing will be exclusively adopted and barges will not be allowed to be propelled in any other way. Electric towing locomotives are used, running on rails on the banks and supplied by an overhead wire. A special power station has been erected near the canal containing two generating sets, each driven by a 1,000 H.P. Zoelly turbine. Three-phase current is generated at 6,000 volts 50 cycles, and is converted to continuous current at 600 volts in sub-stations. Each tractor is capable of hauling a load of 1,500 tons at 3·3 miles per hour. On portions of the canal which pass through lakes, where it is impossible to tow from the bank, electrically-propelled tug boats are used. We hope to describe the electrical equipment in more detail in a forthcoming issue.

The Measurement of Short Intervals of Time.—In a note in *Comptes Rendus*, M. Devaux-Charbonnel describes a method of measuring very short intervals of time by means of the discharge of a condenser, for which a high degree of accuracy is claimed. The method is specially adapted for determining the period which elapses while the contact lever of some chronograph apparatus passes over from one contact to another in order to eliminate the error introduced by its appreciable time of action. A condenser of a capacity, C, is taken and shunted by a resistance, R. One side of the condenser is connected to one pole of a battery and to one terminal of a ballistic galvanometer. The other side is connected to the moving lever, and the two contacts are connected to the other terminals of the battery and galvanometer respectively. When the lever ceases to make contact with stud connected to the battery, the condenser commences to discharge itself through the resistance R until the other contact is reached when the remainder of the charge passes through the ballistic galvanometer. This has been previously calibrated by allowing the whole discharge to pass through it. The fraction of the charge passing through is equal to $e^{-\frac{t}{CR}}$ from which the time (t) can be calculated. Results of observations of the time taken to close a discharge key are given, and are of the order of 0·001 of a second.

The Effect of Lightning on a Hollow Lightning Conductor.—A Paper was recently read by Prof. J. A. Pollock and Mr. S. H. Barraclough before the Royal Society of New South Wales on the crushing of a hollow lightning conductor by the discharge. The piece of lightning conductor referred to consisted of a copper tube 17·5 cm. in length, with an external diameter of 1·8 cm. and with walls 0·1 cm. thick. The tube showed the characteristic appearance of a tube which had collapsed under external pressure. The authors regard the crushing as probably due to the electrodynamic action of the current and, assuming that the tube was rendered sufficiently plastic by the heat of the discharge to give way under an external pressure of not more than one atmosphere, they calculate that the current of the discharge, neglecting any consideration of its oscillatory character, must have reached a value of about 20,000 amperes. On the other hand, if the material was not rendered appreciably plastic the collapsing pressure required would be of the order of 400 lb. per square inch, which could be produced by a current of about 100,000 amperes. To illustrate the action of the current suggested above, extremely thin tubes were made by depositing copper electrolytically on silvered glass rods. The ends of the tubes were thickened and the glass rods afterwards removed. On passing a current along the tubes at a red heat they showed definite signs of collapse, though not the characteristic folding exhibited by the piece of lightning conductor. A mathematical investigation of the electrodynamic action of oscillating currents in a thin tube is then given, from which it appears that taking the frequency of the oscillations as about 10^6 per second, and if the pressure of an atmosphere is taken as equal to 10^6 dynes per square centimetre a current I_0 measured in amperes will produce an effect equivalent to that of an external pressure of n atmospheres if

$$n = \frac{I_0^2}{500 \times 10^6}, \text{ or } I_0 = 22{,}000 \times \sqrt{n}.$$

Electric Lighting in Japan.—The Osaka Electric Light Co. is an example of the rapid development which has recently taken place in the electrical industry in Japan. The company have now four distinct generating stations in the city. The equipment of these includes single-phase, two-phase and three-phase plant, in addition to some monocyclic machines. The older units are driven by reciprocating engines, but the more recently added machinery consists of Curtis turbo-generators, of which there are two of 500 kw. capacity in two of the stations and one 1,000 kw. set in another station, all for 2,300 volts 60 cycles. The 1,000 kw. and two of the 500 kw. sets are two-phase; the other pair of 500 kw. machines is three-phase. In addition to these are two 600 kw. two-phase alternators driven by cross compound horizontal engines. Both steam-driven and induction motor-driven exciters are employed. Another station is being built, for which two more 1,000 kw. Curtis turbine sets are on order. Current from the various stations is used principally for lighting, although a few motors are in use. There are at present about 85,000 lamps in circuit, 90 per cent. of the electricity for lighting being sold to customers under the contract system and not by meter. As is customary in Japan, all wires within the city limits are laid underground. Government inspection and supervision of all electrical work, whether of a public or private character, tends to insure a high standard in all electrical construction and operation. Government control also regulates the use of earthed circuits. These regulations require a complete insulated circuit on trolley lines within the city limits, and all Japanese cars within the city have, therefore, a double trolley line with no earth return.

An Electrically-driven Pumping Station.—The new pumping station of the Schenectady water works on the bank of the Erie canal is entirely electrically driven. The total capacity of the station is, according to the *Western Electrician*, 24,000,000 gallons per day, against a head of 110 lb. per square inch, or about double the old steam-driven plant, but only six attendants are employed as against a staff of nine in the old station. The plant consists of two 18 in. two-stage vertical shaft turbine-type pumps in a pit 21 ft. below the main floor, driven by direct-coupled vertical shaft three-phase motors, with short-circuited rotors. The speed of these units is about 800 revs. per min., and the weight is carried by a thrust bearing. This bearing consists of two plates or discs situated at the top of the shaft, the entire weight being supported by the horizontal bearing shield of the motor. Lubrication is effected by forcing oil under approximately 100 lb. pressure under the lower bearing surface. This oil is supplied by two vertical triplex pumps, each driven by a geared 3 H.P. induction motor. The two pump motors are rated at 800 H.P. at 800 revs. per min., and are wound for 550 volts three-phase 40 cycles. Since the main pumps are situated above the normal water level of the wells, a priming pump is installed. This consists of a 9 in. by 7 in. vacuum pump, driven by a geared 5 H.P. induction motor, which sucks the water up to the main pumps when starting. An electrically-driven drainage pump for the pit is also provided. Two independent three-phase 10,000 volt transmission lines carry power to the station, running from the sub-station of the Schenectady Illuminating Co. At the pumping station the 10,000 volt supply is stepped down by two banks of three 250 kw. single-phase air-blast transformers. The secondaries are arranged with starting taps and double-throw switches to give one-fourth and one-half voltage for starting the 800 H.P. main pump motors. The air-blast chamber is situated immediately below the transformer room, and is supplied by two independent motor blower outfits. The H.T. oil switches have automatic releases arranged to open first at the pumping-station end of the line, and then, in case of a heavy or prolonged short-circuit, the automatic switches at the sub-station in Schenectady will also open. Duplicate H.T. and L.T. 'bus bars are provided, and every precaution is taken to prevent breakdowns, including a spare oil pump for emergencies.

Windmills for the Production of Electrical Energy.—Some experiments have been made at Askow in Denmark by Prof. La Cour on the best form of windmills to adopt for driving dynamos, a short résumé of which is given in our Continental contemporaries. It was found that a windmill with four sails was the most suitable. The power obtainable of course depends on the velocity of the wind. With a sail area of 12 sq. metres and a wind velocity of 6 metres per second—that is, 2,592 cubic metres per second—we obtain a theoretical output of about 2 H.P. The losses, however, by resistance amount to about 14 per cent. which must be deducted to give the net horse-power obtainable. In addition to the actual windmill plant it is always necessary to have some reserve which can be used in a calm, and for this purpose Prof. La Cour recommends the use of an oil engine in preference to accumulators as being cheaper than a battery really large enough to meet all possible cases. The installation at Askow has been running two years and supplies 450 incandescent lamps as well as some arc lamps and a few motors. The capital cost of such a plant is given as follows :—

Windmill	£165	0	0
Oil engine	165	0	0
Battery	275	0	0
Dynamo	50	0	0
Automatic disconnecting gear	19	0	0
Switchboard, &c.	19	0	0
Land	145	0	0
Mains	70	0	0
Total	£908	0	0

The annual costs amount to

Supervision, lubrication and running expenses of windmill	£11	0	0
Running of oil engine (30 days out of the year)	6	10	0
Oil fuel	11	0	0
Lubrication	4	0	0
Total	£32	10	0

The receipts amounted to about £140 per annum, giving a profit of £107. 10s. or nearly 12 per cent. of the capital cost.

Niagara Power.—The following is the report of the International Waterways Commission concerning the investigation of conditions at Niagara Falls, which we reprint from the *Electrical Review* of New York :—

The commission has made a thorough investigation of the conditions existing at Niagara Falls, and the two sections have presented reports to their respective governments setting forth these conditions to which attention is invited. The following views and recommendations are based upon a careful study of the facts and conditions set forth in these reports :—

1. In the opinion of the commission it would be a sacrilege to destroy the scenic effect of Niagara Falls.

2. While the commission are not fully agreed as to the effect of diversions of water from Niagara Falls, all are of the opinion that more than 36,000 cubic ft. per second on the Canadian side of the Niagara river or on the Niagara peninsula, and 18,500 cubic ft. per second on the American side of the Niagara river, including diversions for power purposes on the Erie canal, cannot be diverted without injury to Niagara Falls as a whole.

3. The commission, therefore, recommend that such diversions, exclusive of water required for domestic use or the service of locks in navigation canals, be limited on the Canadian side to 36,000 cubic ft. per second, and on the United States side to 18,500 cubic ft. per second, and in addition thereto a diversion for sanitary purposes not to exceed 10,000 cubic ft. per second be authorised for the Chicago drainage canal, and that a treaty or legislation be had limiting these diversions to the quantities mentioned. The effect of the diversion of water by the Chicago drainage canal upon the general navigation interests of the Great Lakes system will be considered in a separate report. The Canadian section, while assenting to the above conclusions, did so upon the understanding that in connection therewith should be expressed their view that any treaty or arrangement as to the preservation of Niagara Falls should be limited to the term of 25 years and should also establish the principles applicable to all diversions or uses of waters adjacent to the international boundary and of all streams which flow across the boundary. The following principles are suggested :—

1. In all navigable waters the use for navigation purposes is of primary and paramount right. The Great Lakes system on the boundary between the United States and Canada and finding its outlet by the St. Lawrence to the sea should be maintained in its integrity.

2. Permanent or complete diversions of navigable waters or their tributary streams should only be permitted for domestic purposes and for the use of locks in navigation canals.

3. Diversions can be permitted of a temporary character, where the water is taken and returned again when such diversions do not interfere in any way with the interests of navigation. In such cases each country is to have a right to diversion in equal quantities.

4. No obstruction or diversion shall be permitted in or upon any navigable water crossing the boundary or in or from streams tributary thereto which would injuriously affect navigation in either country.

5. Each country shall have the right of diversion for irrigation or extraordinary purposes in equal quantities of the waters of non-navigable streams crossing the international boundary.

6. A permanent joint commission can deal much more satisfactorily with the settlement of all disputes arising as to the application of these principles, and should be appointed. The American members are of opinion that the enunciation of principles to govern the making of a general treaty is not within the scope of their functions; moreover, the jurisdiction of the American members is restricted to the Great Lakes system.

Legislation on the lines of this report has been introduced, both into the Canadian Parliament and the U.S. House of Representatives.

Experiments upon the Reduction of Different Oxides of Lead by the Electric Current.—In connection with the recovery of lead from the old accumulator refuse A. Lodyguine read a Paper before the last meeting of the American Electrochemical Society, in which he describes experiments carried out with the reduction of lead peroxide. He employed a mixture of 200 grammes lead peroxide, 100 grammes sodium chloride, 131 grammes sulphuric acid, and about 170 grammes water. The mixture was placed in a right-angled glass vessel, which had a lead plate placed at the bottom to act as anode. The solid material settled upon this plate, the fluid filling the upper space, and in this was placed a lead cathode. The whole vessel was closed in, except for an outlet tube to lead away chlorine gas evolved during the electrolysis. On closing the circuit, lead chloride immediately began to form in the solid material, also at the same time lead sulphate. The formation of both of these substances seemed to be uninfluenced by the current density. In a short time the solid particles had separated into layers. Directly on the anode was a layer of lead peroxide above this one of lead chloride, then lead sulphate, lead monoxide, and finally a layer of lead. After electrolysing for some time almost the whole of the peroxide was reduced to spongy lead. The following table shows the yield obtained under varying conditions :—

Current density.	E.M.F.	Watts.	Lead in grm.	Time.	Per gramme of lead.	
					Amp.-hours.	Watt-hours.
10·0	4·35	43·5	172·5	11·5	1·5	0·345
6 0	3·20	19·2	138·0	14 0	1·64	0·514
4·0	2·70	10·8	138·0	18 5	1·87	0·691
2·0	2·07	4·14	69·0	15·5	2·25	1·075
1·0	1·71	1·71	46 0	18·5	2·50	1·454
0·5	1·55	0·775	46·0	33·5	2·75	1·77
0·2	1·45	0 290	23·0	38·0	3·0	2·10

The current density is in amperes per square decimeter. One thus obtains at low current density a 73 per cent. yield of lead. With the cost of current at £3 per kilowatt-year, which is the cost given by the author, the cost of refining would work out to about 3s. 6d. per ton of pure lead. This does not, however, take into account the smelting of the spongy lead, in which there would very probably be considerable loss.

An Alternating-current Railway Signalling System.—A Paper was read a few weeks ago by Mr. J. M. Waldron, signal engineer to the Interborough Rapid Transit Co. at the New York meeting of the Railway Signal Association, and reported in the *Railway and Engineering Review*, describing the automatic signalling system in use in the New York Subway. In this case, as the rails are used as part of the return circuit, recourse was had to an alternating-current system of signalling in order to avoid the disturbances which the return currents would have caused, so that when the train shunts the track circuit the return-power circuit does not cause the track relay to remain in the clear position. The 60 cycle single-phase current which is used for the track circuits and also for lighting the signals is obtained from separate generators working at 11,000 volts in the main power house and transformed by oil-cooled transformers in the sub stations to 550 volts, at which pressure it is delivered to the signal cables which extend through the subway from sub-station to sub-station. In normal operation of the system, the transformers in all sub-stations are on the signal mains in multiple, and each station is provided with switchboards on which are mounted the necessary switches, circuit-breakers, ammeters, synchroscopes, &c., all of which are so connected that any sub-station can be cut off the line at any time, without interfering with the connection between adjacent sub-stations. In case the 11,000 volt 60 cycle cables leading from the main power house to the several sub-stations should break down, there is provided in each sub-station a 25 kw. transformer, which is connected by an oil switch to the 25 cycle 11,000 volt power circuit. This, at a potential of 550 volts, can be thrown on to the signal mains by means of a double-throw switch. The 25 cycle current is not intended for constant operation, as results from its use are not so satisfactory as from the 60 cycle current. A transformer with two secondary coils is placed at the exit end of each block, the primary coil being connected across the alternating-current mains. Cut-outs and fuses are placed in each of the primary connections. One of the secondary coils supplies current to the rails for track circuits at a potential of about 10 volts. The other is for lighting the signals at 50 volts. In the circuit between the transformer and the block rail is a grid resistance of 1 ohm and a 50 ampere 500 volt fuse. The purpose of the resistance is to prevent a dead short-circuit in the secondary coil of the transformer, when a train is in the block. At the signal end of the block, the alternating current passes from the rail through a 50 ampere fuse to a grid of 1 ohm resistance, then through a relay and impedance coil which are in multiple to the return rail; then through this rail back to the transformer or point of starting. The impedance coil has a winding of very low ohmic resistance around a laminated iron core, and is placed in the circuit in multiple with the alternating-current relay to prevent a harmful amount of direct current from passing through the relay. The alternating-current relay consists of two pole-pieces, which are made up by winding coils of wire around laminated iron cores, between which an aluminium vane moves through a quadrant of a circle. This vane is supported on jewelled bearings, and has mounted on its shaft, but insulated from it, the necessary springs for controlling signals and stops. Attached to the end of these springs are small pieces of graphite, which make contact with platinum on the tops of the stationary pedestals when the relay is energised; the relay is so adjusted that it will pick up at 3 volts—that is, it will cause the springs to make contact when there is a P.D. of 3 volts between the two rails of the track at the end of the block opposite the signal. In the normal working of the system there is a difference of about 6 volts maintained between the rails at the relay end of the block. As the relay picks up at 3 volts, this gives a working margin of 100 per cent. The block lengths average about 820 ft. Their lengths are equal to braking distance plus 50 per cent. when a train is making the greatest speed possible for it to make at that point.

A High-speed Electric Lift Installation.—The Majestic Theatre building in Chicago, which consists of a block of office buildings of 20 stories, in addition to the theatre itself, contains, according to the *Western Electrician*, some of the highest electric lifts in the United States. The motors and control apparatus are situated in a room 260 ft. above the street level, and the actual range of action of the lift is 249 ft. 6 in. The equipment was supplied by the Otis Elevator Co. The lifts are four in number, one being of somewhat heavier construction and designed for freight service as well as the carrying of passengers. The three passenger lifts are designed for a load of 3,000 lb. and a speed of 450 ft. a minute, while the goods lift will carry 4,000 lb. at a somewhat slower speed. Two of the passenger lifts can, if necessary, carry an average of four passengers each way, make six stops and have one car leaving the main floor every 67 seconds. The four motor equipments are contained in a small building on the roof of the main building, each being placed directly over its shaft. The motors are continuous-current machines of 35 H.P. capacity, running at about 60 revs. per min. when the car has attained normal speed. The motors are designed to take 150 amperes at 220 volts, but ordinarily only 90 amperes is required at starting, which promptly falls back to about 30 when the motor is up to speed. Sheaves and not drums are used for the hoists. Each motor has mounted on one end of its armature shaft a grooved driving sheave 32 in. in diameter. Under this sheave is an idle return sheave 37 in. in diameter. The cable, which is of wire, $\frac{5}{8}$ in. in diameter, comes from the car and passes over the driving sheave, down round the idle sheave, back over the driving sheave and to the counterweight. There are six turns of cables to each car and 12 turns over the sheaves. Safety is insured by a number of devices which work automatically. Attached to each driving shaft of each motor is a large and substantial brake pulley, which is enclosed by a strong pair of brake-shoes, applied by heavy springs. When the current is on these shoes are held away from the brake wheel, but if, for any cause, the current to the motors should be interrupted, this same interruption of the current would also act to release a magnetically-controlled device which would release the brakes, and they would be held against the brake wheel by the springs with sufficient pressure to stop the car almost instantly. In addition to this there is a centrifugal device, which is common in installations of this class, which, when the speed of the car in either direction attains dangerous proportions, automatically applies the brakes on the car. To this governor is to be added a device which opens the motor circuit automatically when the speed has gone beyond the limit. In each elevator shaft, near the upper and lower limits of travel, are placed three limit switches which are operated by the car successively as it approaches the top or bottom of the shaft. By means of these limit switches the car is brought slowly to a standstill, entirely independent of the operator, and independent of any device placed on the operating machine itself. Besides the devices described, there are placed on the bottom of the car and counterweight special oil buffers as a protection against shocks, should the car over-travel. For the control of each lift there is provided a special magnet controller. The controller contacts are provided with carbon breaks, which do away with any difficulty from sticking up. There are five points on the controlling switch in the car for "down" and five for "up." The control contacts on the control board are inter-connected, with the exception of one, which operates in cases of heavy overload. The control contacts act simply to cut in or out resistance in the motor-field circuit, regulating the speed of the motor. Each car is over-counterbalanced by means of a counterweight travelling in steel T guides. The amount of weight is adjusted to the average load to be lifted, so as to produce the most economical conditions of machine operation.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, June 8th.**

PHYSICAL SOCIETY.

8 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "On the Solution of Problems in Diffraction by the aid of Contour Integration," by H. Davies; (2) Mr. J. Goold's Experiments with a Vibrating Steel Plate exhibited by Messrs. Newton & Co.; (3) "Fluid (liquid) Resistance," by Col. de Villamil.

SATURDAY, **June 9th.**

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

3·15 p.m. Visit to Harrogate Electricity Works. Members will meet at Harrogate Railway station at 3·15 p.m.

THURSDAY, **June 14th.**

INSTITUTION OF MINING ENGINEERS.

11 a.m. Annual Meeting in the rooms of the Geological Society, Burlington House, Piccadilly. Among the Papers down for reading are (1) "The Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work," by W. C. Mountain. (2) "Electrically-driven Air Compressors," by A. Thompson.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Meeting at the Finsbury Technical College, Leonard-street, City-road, E.C. A Lecture will be delivered by Mr. R. P. Howgrave-Graham on "Electric Oscillations and Wireless Telegraphy."

FRIDAY, June 15th.

INSTITUTION OF MINING ENGINEERS.

10:30 a.m. Annual Meeting continued. Among the Papers down for reading are (1) "A Rateau Exhaust Steam-driven Three-phase Haulage Plant," by William Maurice. (2) "The Capacity Current and its Effect on Leakage Indication on Three-phase Electrical Power Service," by S. F. Walker.

THE CLASSIFICATION OF ALTERNATE-CURRENT MOTORS.

BY V. A. FYNN.

(Continued from page 207.)

Having thus fully defined and justified the lines on which the proposed classification is to be carried through, we can begin our task, after recapitulating the main points to be borne in mind and pointing out some of the distinctive features of the diagrams which will be used in order to illustrate the various types of motors.

A "series motor" is to be one in which the field excitation varies in some proportion with the armature current and the speed of which therefore varies with varying load.

A "shunt motor" is to be one in which the working E.M.F. and the field excitation remain practically constant independently of the load and the speed of which is also nearly constant for all loads, but is not necessarily a nearly synchronous speed.

A "conduction motor" is to be one in which the energy required for its operation is conveyed to the armature or rotor by conduction.

An "induction motor" is to be one in which the energy required for its operation is conveyed to the armature by induction.

A "neutralised motor" is to be one in which the armature ampere turns are opposed by practically equal and opposed stator ampere-turns. Any "induction motor" is ipso facto a "neutralised motor." A "conduction motor" may be neutralised by means of a coil connected in series relation with the armature, or a short-circuited coil placed in inductive relation to the flux produced by the armature ampere-turns. In defining a conduction motor it is not thought necessary to specify more precisely in which particular manner the same is neutralised.

A "separately-excited motor" is to be one in which the field excitation is derived from the mains directly or through the agency of such apparatus as transformers or converters, but which are independent of the motor itself, and whether the exciting current is taken to a winding on the rotor or on the stator. If in defining a motor the mode of excitation is not mentioned, it shall be assumed that the motor *is* separately excited.

A "self-excited motor" is to be one in which the exciting current is due to an E.M.F. generated in the rotor either by rotation or by static induction from the stator, or one in which this E.M.F. is generated in the stator by static induction from the rotor, and whether the exciting winding be placed on the rotor or on the stator, or on both.

A "motor with mixed excitation" is to be one in which the exciting current is partly due to an E.M.F. generated in the motor itself, as has been stated in the preceding paragraph, and partly to an E.M.F. derived from a source independent of the motor itself, and whether the exciting winding be placed on the rotor or on the stator, or on both.

A "compensated motor" is to be one in which some means or other are made use of in order to improve the power factor. It is not thought necessary for the present to include in the designation of a motor a more precise specification of such means. The "neutralising coil" is, of course, also a means of improving the power factor, but such a coil can never bring the power factor to unity, and it is not to be included in the term "compensated."

A "motor with independent brushes" is to be one in which only those coils are short-circuited which are actually bridged by the brushes, such brushes not being connected to the supply and not connected to each other.

Referring now to the diagrams, principally to Figs. 11 to 46, these all illustrate two-pole motors, and it is assumed that all rotor windings are of the Grammering type, and that the brushes bear directly on these windings, the latter being represented by a plain circle. Brushes carrying armature current only are shown black, those carrying field current only are shown white, and those carrying both armature and field current are shown shaded. The current is always supposed to enter the armature at brush a_1 or f_1.

The direction of rotation is indicated by a curved and feathered arrow.

The plain arrow placed within the rotor and not lettered indicates the direction of that field which the armature ampere-turns tend to produce along the axis to which the arrow is parallel.

A stator winding, marked S, produces the transformer field and conveys into the rotor not only the energy required for the operation of the motor, but also the energy necessary for its excitation, the arrow alongside such winding indicates the direction of the field produced by that component of the ampere-turns in that winding which goes to oppose the armature ampere-turns, it is not to be confused with the component of the ampere-turns in S, which is responsible for the transformer field and which is of a different phase.

A stator winding marked T produces the transformer field and only conveys into the rotor the energy required for the operation of the motor. The arrow beside such a winding has the same meaning as for S.

A stator winding, marked N, represents the neutralising winding, the direction of the field produced by its ampere-turns is given by an arrow alongside such winding. A stator winding, marked F, represents the field winding and the arrow placed alongside shows the direction of the motor field. If the motor field is produced by a winding disposed on the rotor, the arrow showing its direction is designated by F_0. The torque is due throughout to the interaction of the armature current and this motor field. Commutation conditions will not be considered in this contribution.

MOTORS WITH A SERIES CHARACTERISTIC.

Single-phase Series Conduction Motor (Fig. 11).—This motor is separately excited and reversible, the stator winding, F, providing the motor field at right angles to the armature brush line and to the armature field. The motor field is always practically in phase with the armature current, the torque per ampere is independent of the power factor, the latter, however, is bad owing to the great self-induction of the armature. The working E.M.F. is impressed on the armature by conduction, the back E.M.F. is generated by rotation in the motor field F.

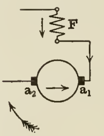


FIG. 11.

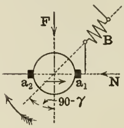


FIG. 12.

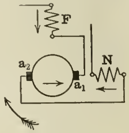


FIG. 13.

Neutralised Single-phase Series Conduction Motor (Fig. 12).—The stator winding B is not at right angles to the brush line, the ampere-turns in B not only provide the motor field in the direction F, but also the neutralising field in the direction N. The field component is proportional to sin γ, the neutralising component to cos γ. The back E.M.F. is generated by rotation in the component field F, the motor is not reversible, the power factor is better than that of the motor shown in Fig. 11, but it is not unity. In other respects the two motors are alike.

Neutralised Single-phase Series Conduction Motor (Fig. 13).—Similar in most respects to those just described, but reversible owing to the neutralising and field windings being separate. The current producing the neutralising ampere-turns is conveyed to the winding N by conduction.

Neutralised Single-phase Series Conduction Motor (Fig. 14).—Differs from the previous only in that the neutralising current is conveyed into N by induction instead of conduction. This means that a field of sufficient magnitude *must* remain in the brush axis if N is to be operative. The smaller the resistance of N the smaller the field required, it is consequently quite impossible to neutralise the armature self-induction in this manner as fully as in the manner shown in Fig. 13, and in order to obtain at all good results the amount of copper in the short-circuited winding N must be comparatively great.

Neutralised Single-phase Series Conduction Motor (Fig. 15).—Differs from the previous example in that the rotor is provided with two separate windings, the one with the brushes a_1 a being made use of as armature winding, the other with the brushes f_1 f_2 doing duty as field winding. The direction of the motor field is designated by arrow F_0, because due to a winding disposed on the rotor. Instead of two separate rotor windings a single winding could be used, the disposition of the brushes remaining the same.

Single-phase Series Induction Motor (Fig. 16).—The working E.M.F. and current are conveyed into the rotor by induction from T, with the help of a transformer field due to one component of the ampere-turns in T. This field serves for this purpose only. The motor field is due to the stator winding F, which is in series relation to T, the motor is, therefore, separately excited. The back E.M.F. is produced at the brushes a_1 a_2 by rotation in the motor field. The E.M.F. (E_r) produced in the rotor in the axis of the motor field, and by rotation in the transformer field, is not made use of. The rotor carries armature current only, and the armature reaction is neutralised because the energy is conveyed to it by induction. The motor is reversible; the power factor is good at speeds approaching or slightly exceeding the synchronous, the torque per ampere is independent of the power factor, which only affects the phase relation between transformer and motor field.

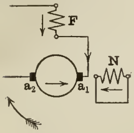


Fig. 14.

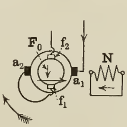


Fig. 15.

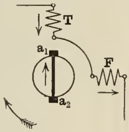


Fig. 16.

Single-phase Series Induction Motor (Fig. 17).—Differs from the previous example only in that there are four brush sets per pole-pair instead of two. These four sets are connected in pairs so as to short-circuit only those parts of the rotor winding (heavy lines in figure) which contribute by far the greater portion of the total E.M.F. induced in the rotor by the transformer field. Those portions of the rotor winding in Fig. 16 which are in the immediate neighbourhood of the brushes a_1 and a_2 are threaded by a very small proportion only of the total transformer flux, and although their relative resistance is the same as that of the other portions of the winding, they contribute a very small amount to the total rotor E.M.F., and in addition, it is difficult to neutralise the field they produce by means of the stator winding T. The arrangement of brushes shown in Fig. 17 enables a somewhat better power factor to be secured, and is equivalent to the use of a rotor winding with a better Kapp coefficient than that of a distributed winding.

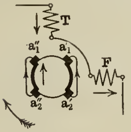


Fig. 17.

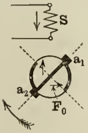


Fig. 18.

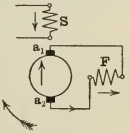


Fig. 19.

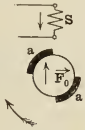


Fig. 20.

Self-excited Partly-compensated Single-phase Series Induction Motor (Fig. 18).—The working E.M.F. and the working current is conveyed to the rotor from S by induction, that working current also serves to excite the motor field. Part of the rotor winding (heavy lines in figure) does duty as armature winding and the rest as field winding producing F_0. The armature reaction is as fully neutralised as in the previous example, and although the whole of the rotor winding is in circuit between the brushes a_1 a_2, thus making the total winding resistance between these greater than that in Fig. 17, and equal to that in Fig. 16, yet these additional turns are not practically idle as in the two previous cases, but do duty as field winding. The power factor is improved by the E.M.F. (E_r) as has been more fully explained in connection with Fig. 8, and the efficiency is, if anything, better than that of Fig. 17, but the motor can only be reversed by moving the brushes or using a second set, and its speed can only be adjusted by varying the relative E.M.F. applied to S, by moving the brushes or inserting resistance between them.

Self-excited Single-phase Series Induction Motor (Fig. 19).—Differs from the previous example in that the rotor winding only carries armature current, a special field winding, F, being provided on the stator and connected in series with the rotor winding by means of the brushes a_1 a_2. This machine is not as fully neutralised as the motor shown in Fig. 17, and the total self-induction in the armature circuit is greater than in the examples given in Figs. 16 and 18, the motor is reversible, and can be easily regulated, but has a worse power factor and a worse efficiency than any of the last three examples. E_r is not made use of.

Self-excited Partly-compensated Single-phase Series Induction Motor with Independent Brushes (Fig. 20).—This is one of Elihu Thomson's original motors, and one in which not the whole rotor is short-circuited, as in Fig. 18, but only those coils which are bridged by the individual brushes. It is immaterial, as far as the principle of the motor is concerned, whether only one brush (a) or two such brushes are used, all that is necessary is that each brush shall not cover more than one quarter of the circumference of the commutator, and if two brushes are used that they shall be placed approximately opposite each other and in opposite quadrants, as determined by the axis of the transformer field and the normal to it. The ampere-turns in each short-circuited coil resolve themselves into two components, as has been more fully explained in the first part of this Paper, the one providing the ampere-turns responsible for the motor field F_0 and the other the armature ampere-turns. The rotor self-induction is opposed by E_r, but not as effectively as in Fig. 8. The greater the angle embraced by each brush the greater the risk of a detrimental exchange of current between coils under one and the same brush, since the E.M.F.'s induced in such differently positioned coils differ greatly in magnitude. The greater that angle the greater also the friction on the commutator and the greater the heating. Each of the brushes (a) can be split into a number of independent brushes at the cost of mechanical complications for small electrical advantages. The motor can only be reversed by moving the brushes.

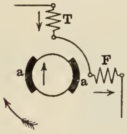


Fig. 21.

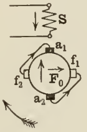


Fig. 22.

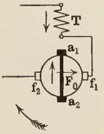


Fig. 23.

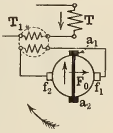


Fig. 24

Single-phase Series Induction Motor with Independent Brushes (Fig. 21).—If the independent brushes (a) are disposed symmetrically with respect to the motor field axis, then all those components of the ampere-turns induced in each short-circuited coil which would be responsible for the motor field cancel out, the components representing the armature ampere-turns alone remaining, the motor loses its self-exciting properties and the motor field must be excited separately. In the present case the winding F serves this purpose. The last two motors have a poor efficiency and a poor power factor. When the efficiency is particularly bad, the power factor may have a fairly high but entirely fictitious value. The motor is reversible.

Self-excited Partly-compensated Single-phase Series Induction Motor (Fig. 22).—When a single rotor winding is used, the machine is nothing but a very much improved form of the motor shown in Fig. 20, any risk of detrimental exchanges of current between neighbouring coils being avoided and the friction on and the heating of the commutator being much reduced. The motor becomes reversible by a simple alteration of connections. Thus, in Fig. 22, connecting brushes a_1 and f_1 also brushes a_2 and f_2 would reverse the direction of rotation.

Two rotor windings with separate commutators can, however, be used (the colour of the brushes refers to this case), brushes $a_1\ a_2$ then bearing on the one, and brushes $f_1\ f_2$ on the other. The current induced in the first winding by transformer action from S is taken through the second by way of the brushes $f_1\ f_2$. Such a motor is inferior to that shown in Fig. 18 as far as the efficiency of the rotor windings is concerned, owing to the Kapp coefficient of both armature and field winding being low—namely, only equal to that of a distributed winding—but it can be controlled with greater ease.

Partly-compensated Single-phase Series Induction Motor (Fig. 23).—The only difference between this machine and the one shown in Fig. 16 is that, instead of making use of field winding F disposed on the stator, it is the rotor which does duty as such, the current from the supply being taken through the rotor along an axis perpendicular to the transformer field axis and thus producing F_0. This small change when fully taken advantage of enables the motor to be fully compensated for any speed and any output by making use of the E.M.F. (E_r) as has been more fully set out in connection with Figs. 8, 18 and 22.

In the earlier examples this E.M.F. has been made use of to counteract the self-induction in the *rotor* circuit, but since the *stator* current is practically of the same phase as the rotor current, it is evident that the E.M.F. of self-induction of the stator circuit can also be directly counteracted by E_r if the rotor winding along the field axis is included in the stator circuit either directly or by means of transformers. In Figs. 8, 18 and 22 the improvement in the power factor due to E_r was brought about by reducing the lag of the rotor current behind the working E.M.F. (E_t); in Fig. 23 the same result is achieved by including E_r directly in the primary or stator circuit, and thus effectively counteracting the E.M.F.'s of self-induction in that circuit, thereby shifting the phase of the E.M.F. impressed on the motor terminals back and more nearly into phase with the stator current. The E.M.F.'s of self-induction which are to be equalled and opposed by this E.M.F. of rotation are produced in the stator winding T and in the field winding, which here is the rotor winding in the axis $f_1 f_2$, there is further a lag reflected from the rotor to be compensated for. The E.M.F. of self-induction in T has one component which varies with the magnetising current of the transformer field, and another which varies with the neutralising current; by far the greater E.M.F. of self-induction is that due to the field winding and which varies with the motor field. The "compensating" E.M.F. (E_r) varies with the transformer flux, and with the speed it is therefore evident that the power factor cannot be unity for all loads or speeds without careful adjustment; the arrangement in Fig. 23 does not lend itself to any such adjustment, and it is for this reason that it is classed as a partly-compensated motor. Further the ratio between stator and rotor is for low voltages, such as 100 or 200 volts, about 4 : 1, and for, say, 2,000 volts may rise to 20 or 30 : 1. It follows that the E.M.F.'s of self-induction of the stator will, with increasing terminal voltage, rise very much quicker than the compensating E.M.F. of the rotor and the latter must soon cease to exert any great influence on the power factor. The available number of field turns must also soon become *much* too small. Although the machine is not very pliable in this form, yet it is very useful for low voltages. It is, of course, reversible, and is separately excited.

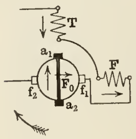


FIG. 25.

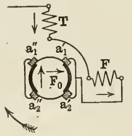


FIG. 26.

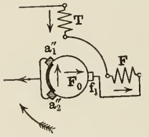


FIG. 27.

Compensated Single-phase Series Induction Motor (Fig. 24).—Differs from the previous example only in that the field winding disposed on the rotor is fed through a series transformer T_1; in this way, and by using a transformer of variable ratio, most of the objectionable features of Fig. 23 disappear, and high tension is avoided in the rotor. The machine becomes very much more pliable, its mode of operation, however, remains unchanged, a power factor near unity can be obtained for varying loads and speeds, but only by constant adjustment.

Partly-compensated Single-phase Series Induction Motor (Fig. 25).—Differs from the previous in that part of the field winding is disposed on the rotor and part of it on the stator. By so arranging the winding F that the number of its turns can be varied, the speed can be regulated in a convenient and inexpensive manner, whilst a good power factor is retained. This is a very useful form of motor for smaller sizes and lower voltages.

Partly-compensated Single-phase Series Induction Motor (Fig. 26).—Differs from the previous one in that the disposition of the brushes shown in Fig. 17 is made use of. This modification has many points in its favour for this class of motor over and above those advantages which have already been assigned to it, and can be used with advantage in combination with all forms of this class of motor. Four brush sets per pole-pair have to be used in any case, so that the number of brushes is not increased by reverting to the arrangement shown in Fig. 17, but the copper in the rotor is utilised to better purpose, the Kapp coefficient in both axes being greatly improved. In this case all the brushes carry not only the armature, but also the field current. That portion of the rotor winding which does duty as armature winding only is distinguished by heavier lines. The other portion does duty as part of the field winding, the rest being in this case disposed on the stator at F.

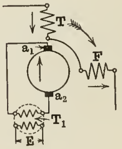


FIG. 28.

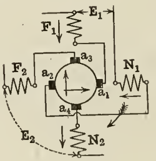


FIG. 29.

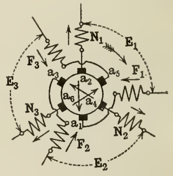


FIG. 30.

Partly-compensated Single-phase Series Induction Motor (Fig. 27).—Is a modification of the previous arrangement, in which the author cannot recognise any particular advantage. It is true that there is one brush set less, but the utilisation of the armature copper is worse, and the load on the brushes greater for the same length of commutator, that portion of the rotor winding which is distinguished by a heavy line does duty as armature winding and carries no field current. The current distribution is, of course, a little modified when a drum instead of a ring winding is made use of. The last three motors can be fully compensated by the addition of a series transformer.

Single-phase Series Induction-Conduction Motor (Fig. 28).—Has the same characteristic features as the motor shown in Fig. 16, but the armature brushes are not directly short-circuited. An E.M.F. (E) is impressed on these brushes by conduction, preferably by means of a variable ratio transformer T_1, in addition to the E.M.F. impressed on them by induction from T. The E.M.F. (E) may be derived directly from the supply or from T; as regards phase, it ought to very nearly coincide with the phase of the E.M.F. impressed on these same brushes by induction, and may be of the same or opposite direction to the latter. This E.M.F. may be used to regulate the output or speed or the motor or to improve the commutation of the machine, by suitably altering the ratio of transformer to motor field for varying speeds.

Neutralised Two-phase Series Conduction Motor (Fig. 29).—Is merely a duplication of the motor shown in Fig. 18, two E.M.F.s (E_1 and E_2) being applied to stator and rotor along two axes at right angles to each other, the arrangement and duty of the various windings will be clear from the drawing and lettering. The motor is separately excited and reversible.

Neutralised Three-phase Series Conduction Motor (Fig. 30).—Is the equivalent arrangement for operation from a three-phase system, all details can be gathered from the drawing and lettering. The motor is separately excited and reversible.

Series induction motors cannot be built for more than one phase.

(*To be concluded.*)

FLOUR BLEACHING WITH THE AID OF ELECTRICITY.

An interesting and useful industrial application of electricity, which is not generally known in electrical circles, is now finding considerable favour in the milling trade. It is essential to the miller that his flour should be of the purest white colour, and various bleaching processes have been employed from time to time, to which the flour is subjected after it has been ground. The latest of these is one that has been developed by the Alsop Flour Process (Ltd.), of 21, Mincing-lane, London, E.C., and, although it was only introduced about two years ago, we are informed that it has been adopted in a large number of mills both in this country and abroad.

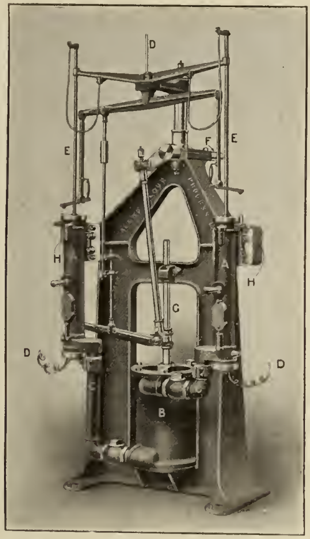


Fig. 1.—Flour-Bleaching Apparatus.

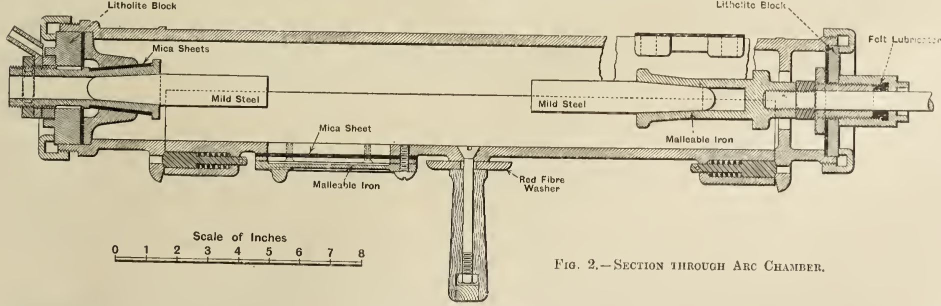


Fig. 2.—Section through Arc Chamber.

The method employed is briefly that a current of air is passed through a chamber containing a long high-voltage continuous-current arc, and is then led through the flour, which has been placed in an "agitator." The flour emerges from the agitator with a considerably whiter colour than that which it had originally. The explanation given by the company is that the air is ionised, and that the ionised air has a distinct bleaching action on the flour.

Two patterns of apparatus are employed. In the form shown in Fig. 1, a double-acting pump draws the air from the inlets HH through the chambers AA which contain the arc, whence it passes through the pipes CC to the cylinder B of the pump. The pump-piston rod G is driven by a pulley on the shaft F, and is connected through links to the rods EE, to which the upper electrodes of the arc are attached. On removing the covers, attached to the chamber A by means of the insulated handles, the arc is visible and the inside of the chamber can be got at for cleaning and for replacing the electrodes. Current is led in by the wires DDD. Fig. 2 shows the chamber in section. The electrodes between which the arc is struck are usually of mild steel or iron and are insulated from the walls of the chamber. They are provided with taper

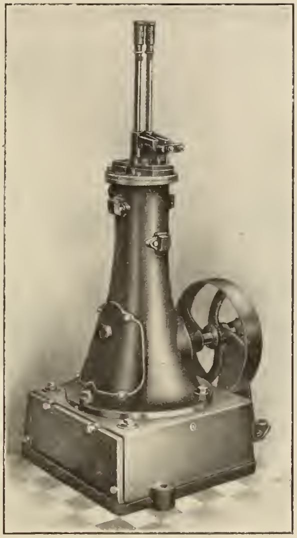


Fig. 3.—Newer Pattern of Flour-Bleaching Apparatus.

ends, which fit taper sockets, and, whilst being securely held, are easy of replacement. The suction-stroke of the pump starts when the electrodes are together, and thus the air flows through the chamber, as the arc is being lengthened by the raising of the upper electrode, until the arc is extinguished. During the pressure part of the stroke, the upper electrode descends again. As the pump is double-acting, there is a continuous stream of air, first through the arc chamber on one side and then through a similar chamber on the other side. A simple clutch arrangement similar to an arc lamp clutch allows for the burning away of the electrodes. The stroke imparted to the rocking lever is slightly longer than the maximum distance between the electrodes, and when the latter come together, the spring-controlled clutch releases the rod E for the remainder of the stroke, picking it up again on the return stroke.

A generator voltage of 400 is employed, but, to increase the length of the arc, an inductance of considerable size is included in the circuit. The length of arc employed is from 2 in. to 5 in. according to the size of the pump. The apparatus, of the type shown by Fig. 1, is made in three sizes : 4 in. piston diameter × 4 in. stroke, 7 in. × 7 in. and 10 in. × 10 in., and the speed is 50 revs. per min. With the largest sized pump, 30 sacks of flour can be treated per hour. There is in all cases a small resistance in series with the arc, which provides for an adjustment of current in addition to that obtained by altering the inductance in the circuit. The current employed ranges from $1\frac{1}{2}$ to 12 amperes in the largest size according to the output of flour, or the bleach required.

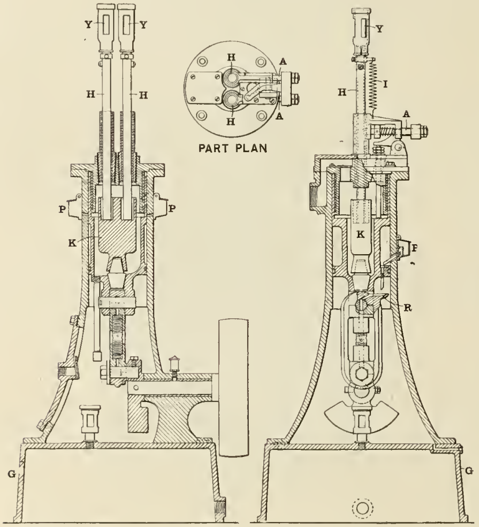


FIG. 4.—SECTIONS AND PART PLAN OF NEWER PATTERN OF FLOUR-BLEACHING APPARATUS.

An alternative and more compact pattern of apparatus, designed primarily for smaller outputs is shown in Figs. 3 and 4. Fig. 4 gives two sections at right angles. HH and K are the electrodes, but in this case it is the lower electrode which moves. This is of cast iron or steel, and two cylindrical holes are drilled in it, into which the upper electrodes HH enter. The lower electrode K is moved up and down by a crank, and is within the piston of the pump. The upper electrodes HH are tubular, and the air passes through them, entering by the rubber-seated valves YY. Two screw terminals attach the line wires to these, and the inductance is carried in the base G of the set. The inductance is kept cool by a circulation of air effected by the movement of the piston, the lower portion of the cylinder being enclosed and provided with check valves for this purpose. The upper electrodes pass through two sleeves against which they are pressed by a spring-controlled pin A seen in the left-hand section and the part plan. This allows the electrodes HH to slip when the bottom of the lower electrode reaches them, and the spring I holds up this spring clutch for the remainder of the stroke and the first part of the return stroke. The neat method of lubricating the system by means of the oil boxes PP and the cup R may be noted incidentally.

The air is led to a small tank to equalise the pressure and thence through the flour in the agitator. This machine is an iron cylinder, in which a series of blades revolve; the blades stir up the flour, and, being set at an angle, convey it from one end of the cylinder to the other. The flour thus passes continuously through, and is exposed to the action of, the treated air.

THE CONDUCTIVITY OF OZONISED AIR.

BY G. A. VOSMAER.

In view of the fact that air when ionised acts as a conductor of electricity and as an insulator when not ionised, and considering further that ionisation can be produced through the action of ultra-violet light, it is of interest to investigate the conductivity of ozonised air and ascertain whether it is capable of discharging an electroscope in the same way.

The 20 kw. ozone plant employed in these experiments was of the author's own design in which the dischargers consist of one sharp-edged and one flat pole connected to a 100 period 10,000 volt transformer, special arrangements being adopted to prevent sparking across.

One of the first things that was noticed was the fact that when the ozonised air was allowed to remain in the apparatus and not drawn through, thus involving an increasing concentration of ozone, the resistance offered to the passage of the discharge through the air showed a marked increase. Thus the secondary voltage had to be raised considerably in order to maintain the same intensity of discharge. This can, of course, only be done within certain limits, or sparking would take place; but it was observed that in highly-ozonised air containing about 8 grammes of ozone per cubic metre, the secondary voltage has to be about 20 per cent. higher than in air carrying about a quarter that amount. It thus appears that ozonised air is a worse conductor of electricity than ordinary air, although it is probable that a certain amount of ionisation is produced by the brush discharge. The ozone generated was therefore tested for its property of discharging a charged electroscope, but with entirely negative results.

The experiments were carried out as follows : An ordinary gold-leaf electroscope was surrounded by an earthed wire cage, and its knob well shielded by a metallic cylinder provided with two small holes, one of which allowed the passage of a glass tube conveying the ozonised air, while the other was left free for its escape. The gold leaves were observed by means of a telescope.

In the first experiment the electroscope was given a positive charge, and in order to ascertain whether the electroscope was properly protected against direct electrical influence, the current was turned on to the ozone apparatus, but no ozone was blown on to the knob of the electroscope. No change in the position of the leaves was observed. In the second experiment the electroscope was charged as before, but a current of ozonised air was allowed to pass for 10 minutes. Again no effect was produced.

These experiments were then repeated with the electroscope charged negatively, with the same result.

The experiments were made with highly ozonised air and again with a small percentage of ozone, but no positive result was obtained in either case. As a check, the same operations were performed with Röntgenised air, when, as expected, the electroscope was discharged.

It has sometimes been suggested that ozonisation of air is due, not to the electrification, but to the ultra-violet light of the discharge. Against this may be mentioned the fact that, if one discharger is working to its full extent, its luminosity (and output in ozone) is greatly diminished by the proximity of another, so much so that if the second discharger is placed at a distance of less than an inch, both are nearly extinguished, and if there is a third the middle one entirely stops working. This is a very remarkable fact, and is one of a great many unexpected phenomena which take place in connection with the production of ozone and upon which the author is still conducting some researches.

LEEDS ELECTRICITY SUPPLY ACCOUNTS.

The report of the City of Leeds Electricity committee shows a satisfactory growth of business and revenue coupled with a smaller addition to capital expenditure than has taken place in any previous year. The following table shows the diminution in costs of generation and distribution as compared with the precceding year :—

	Year ending March 25, 1905.	Year ending March 31, 1906.
Units sold for private lighting	4,871,731	5,102,979
Units sold for street lighting	217,997	682,404
Units sold for power and heating	1,940,953	3,411,876
Total units sold	**7,030,681**	**9,197,259**
COSTS PER UNIT SOLD.		
GENERATING COSTS.		
Coal	0·217d.	0·176d.
Oil waste, water and stores	0·024d.	0·021d.
Wages at station	0·118d.	0·089d.
Repairs and maintenance	0·106d.	0·069d.
	0·465d.	0·355d.
DISTRIBUTING COSTS.		
Wages	0·061d.	0·045d.
Repairs, water, stores, &c	0·133d.	0·086d.
	0·194d.	0·131d.
TOTAL WORKS COSTS	**0·659d.**	**0·486d.**
MANAGEMENT CHARGES, &c.		
Rents, rates and taxes	0·089d.	0·077d.
Salaries, stationery and establishment charges	0·195d.	0·165d.
	0·284d.	0·242d.
TOTAL COSTS (excluding capital charges)	**0·943d.**	**0·728d.**
Sundry charges due to change of system and extraordinary renewals	0·025d.	0·103d.
Interest	0·984d.	0·783d.
Redemption fund	0·954d.	0·752d.
TOTAL COSTS (including interest and redemption fund)	**2·906d.**	**2·366d.**

The total working expenses as analysed above amounted to £31,800, and the total receipts were £93,974, giving a balance of £62,174. Of this, as indicated above, interest and other capital charges absorbed £59,210, so that the net profit on the year's working was finally £2,964.

An analysis of the capital expenditure up to March 31, 1906, is given below :—

Account.	Total, March 31, 1906.	£ per kw.	Per cent. of total.
Land	£30,748	2 7	3·7
Buildings and foundations	128,464	11·3	15·5
Machinery	201,963	17·8	24·4
Mains and services	332,820	29·4	40·3
Sub-stations and transformers	87,374	7·7	10·5
Meters	24,410	2·1	3·0
Electrical instruments	14,118	1·2	1·7
Loose plant and tools	569	0·1	0·1
Office furniture and fittings	847	0·1	0·1
Coal barges	3,438	0·3	0·4
Cost of provisional order and transfer of undertaking	3,104	0·3	0·3
Total	£827,855	73·0	100·0

The number of consumers is 670, with a lighting connection equivalent to 32,511 8 c.p. lamps (35 watts) and a power and heating connection represented by 39,160 8 c.p. lamps. The aggregate horse-power of motors connected is 1,567, an increase of 40·1 per cent. over last year. During the year under review a 200 kw. alternator and engine were sold, so that the plant capacity of the station is now 11,340 kw. The maximum load on the plant at any one time was 6,730 kw. Tenders have been obtained, and are now under consideration, for one or two alternators, each of a capacity of 3,000 kw., to be driven by steam turbines. The largest sets previously installed were of 1,400 kw. capacity, and were driven by reciprocating steam engines.

GRIMSBY CORPORATION ELECTRICITY SUPPLY ACCOUNTS.

The annual report and accounts of the Grimsby Corporation Electricity Department have now been issued. The costs, although showing a slight increase over last year's working, are very creditable, considering the conditions and size of the station. The following table taken from the revenue account gives a summary and analysis of the costs reduced to pence per unit sold to customers :—

	Year ending March 31, 1906.
Units sold for traction	460,200
Units sold for public lighting	105,746
Units sold for private lighting	556,111
Total units sold	**1,122,057**
COSTS PER UNIT SOLD.	
GENERATING COSTS.	
Coal (including delivery) and other fuel	0·305d.
Oil, waste, water and stores	0·032d.
Wages at station	0·280d.
Repairs and maintenance	0·136d.
	0·753d.
DISTRIBUTING COSTS.	
Wages, repairs, renewals, stores, &c. (including mains, meters and public lamps)	0·146d.
TOTAL WORKS COSTS	**0·899d.**
MANAGEMENT CHARGES.	
Rents, rates and taxes	0·067d.
Salaries, stationery and establishment charges	0·230d.
Insurance	0·018d.
Special law charges	0·005d.
	0·320d.
TOTAL COSTS (excluding capital charges)	**1·219d.**
Interest, &c.	0·023d.
Interest on mortgage debt	0·655d.
Instalments of principal repaid	0·432d.
TOTAL COSTS (including capital charges)	**2·329d.**

The working expenses, analysed above, amounted to £5,699, and the total receipts were £11,996, giving a balance of £6,297. Of this, interest and other capital charges absorbed £5,238, and £55 was set aside for bad debts, leaving a final profit on the year's working of £1,004. An analysis of the capital expenditure up to March 31, 1906, is given below :—

Account.	Total March 31, 1906.	£ per kw.	Per cent. of total.
Buildings	£15,294	17·0	18·4
Machinery	28,481	31·6	34·3
Accumulators	1,829	2·0	2·2
Mains	26,684	29·7	32·2
Meters	2,567	2·8	3·1
Electrical instruments	3,282	3·7	4·0
Office furniture	215	0·2	0·2
Public lamps and posts	2,487	2·8	3·0
Siding to works	714	0·8	0·2
Tools	179	0·2	0·2
Law charges	587	0 6	0·6
Sub-station	732	0·8	0·9
Total	£83,051	92·2	100·0

The plant capacity of the station is 900 kw. The private supply connections are equivalent to 52,283 8 c.p. lamps and the number of consumers is 503. The motor connections aggregate 513 H.P. and the maximum load during the year was 702 kw.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

(*Continued from page 257.*)

Primary and Secondary Cell Exploders.—A low-tension fuse consists, as has been seen, of a pair of wires short-circuited through a metallic connection having about 1 mil (0·001 in.) diameter and ⅛ in. length. It will be self-evident that such fuses can be ignited by a single primary or secondary cell, providing, of course, that the resistance of the firing line is not excessive.

High-tension shots cannot usually be fired by similar means. Persons employed in shot-firing would, however, be ill-advised to accept this statement in any absolute sense, because the resistance of a H.T. fuse may accidentally coincide with that of a L.T. fuse, in which case it could be fired in the same way. It is necessary to make this explanation since several narrow escapes from accident have taken place owing to want of knowledge on the point.

It is not to be supposed that anyone would at the present time contemplate the use of fluid primary cells for shot-firing purposes. "Dry" cells are, however, extensively used, and where the L.T. system of ignition finds favour there can be little doubt that an exploder made up of one, two or three small cells provides the handiest and cheapest "machine." Used in a common-sense way a "battery"—to use the colliery expression—is quite as reliable as any other means of ignition.

Excellent results have been obtained with the dry cells manufactured by the Siemens and the General Electric Companies, and no doubt there are many other batteries capable of yielding equally good results. It is desirable, if dry cells are to be used, that they should be enclosed in some kind of casing in order to minimise liability to make accidental contact with the firing line.

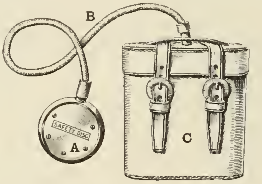


Fig. 13.—Dry Battery Exploder in Case, with Wood's Patent Safety Disc.

One of the best known arrangements is that shown in Fig. 13. It consists of a leather case, C, containing dry cells, to the terminals of which there is an attachment known as Wood's patent safety disc. The latter is designed to ensure that the shot-firing cable shall be totally disconnected from the batteries immediately after the shot has been fired. In the figure referred to, A is a brass terminal plate mounted on a vulcanised fibre disc and in electrical connection with one pole of the battery through one of the wires in the flexible twin conductor B. It will be seen that a predetermined and deliberate action on the part of the operator is necessary to bring the free end of the cable into electrical connection with the safety disc. The apparatus has a shot-firing capacity of about 2,500 shots, and weighs less than 2 lb. Messrs. Theedam of Dudley and Messrs. Hunter & Warren of Glasgow supply their respective areas with this deservedly popular little shot-firer.

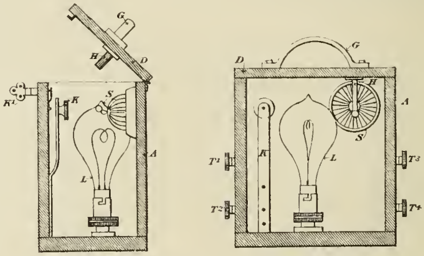
At many collieries one, two or three dry cells are grouped together in a pinewood box with screw-down lid. The outside + and − wires are respectively joined to two terminals bolted through one side of the case, and the exploder completed by the addition of a handle or sling strap. Messrs. John Davis & Son send out sets of dry cells arranged in light japanned cases, with external spring firing contacts and also make a combination exploder and cable reel.

Accumulator cells have not so far been used for shot firing to any appreciable extent. A shot-firing "battery" must withstand rough treatment and perhaps an occasional fall. Portable accumulator cells are more or less of necessity enclosed in easily-damaged cases. Leakage of acid, corrosion of terminals and cost of upkeep add to the difficulties in the way of their adoption.

The extensive popularity of H.T. fuses further renders it unlikely that even a greatly improved form of secondary cell would possess appreciable practical value.

Firing from Electric Light Mains.—It is often convenient when engaged in shaft sinking, drifting or in open quarry work to fire shots by current from electric lighting mains. Charges so fired are probably more effective than when exploded through a magneto machine, but the risk of accidental ignition is so great that this method should only be considered permissible under special conditions. Shot-firing cables rapidly deteriorate, owing to rough handling and injuries caused by falling débris, &c., insulation disappears here and there, with the result that one main may at any time be earthed. Given a leakage on the lighting circuit—and a current of ¼ ampere is amply sufficient to fire a fuse—it will be seen that the margin of safety is not large.

A shot-firing key has been designed by Messrs. John Davis & Son to ensure safe operation when connected with a lighting installation. End and front elevations of this device are shown in Fig. 14 respectively. It consists of a lock-up case, A, provided with a double-pole firing-key, K, incandescent lamp, L, and automatic current disconnecting switch, H. On opposite sides of the case are two pairs of terminals, one pair leading to the fuses, the other to the lighting mains. It is immaterial to which side either pair of wires are attached. When ready to fire, the lid D is opened by screwing in a key, K¹, which should be in the possession of the chargeman or contractor, as the case may be. The switch S is then turned on by pulling up the lever handle, after which pressure on the button K fires the charge. The act of closing the box lid after firing automatically breaks connection with the dynamo circuit by pushing down the lever, as indicated in the figures. To ascertain whether the apparatus is in good order, preparatory to firing, pull up the switch-lever, hold a piece of metal —a pick-blade, lamp vessel or anything handy—against the firing line terminals and press the button. If the circuit is intact the lamp should incandesce.



End Elevation. Front Elevation.

Fig. 14.—Key for Blasting from Electric Power Mains

Mr. Frank Brain devised a system of firing from dynamo mains about 19 years ago. This scheme had for its object the ignition of blasting charges with absolute immunity from the risk of igniting and exploding any inflammable gas that might be present in the mine. The proposal embodied the use of wires carried along the gateways to the coal face and joined at the opposite ends to main cables which extended to any convenient place. A number of shot holes, in a stall, would be joined in series or parallel (as the case might require) to the leads, and the charges would be fired simultaneously either from a main haulage road or from the pit top. Mr. Brain also designed a sparkless firing key, which was arranged to break circuit below the surface of a non-conducting liquid.

(*To be continued.*)

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THE EXCITING CURRENT OF INDUCTION MOTORS.

BY A. S. McALLISTER.

In predetermining the performance of an induction motor, it is essential that the value of the synchronous no-load current and its two components—the power and the wattless—be known with a fair degree of accuracy. The power component of the no-load current is found from the so-called "constant" losses of the machine, including friction, windage, the iron loss and a small amount of primary copper loss. The friction and windage losses can be estimated from the mechanical dimensions, and the copper loss is easily determinable, while little difficulty is experienced in calculating the iron loss when the distribution of the magnetism and the volume of the several parts of the core are known. The method ordinarily employed in determining the wattless component of the no-load current (the exciting current) requires a knowledge of the length and cross section of each magnetic path, the density of the magnetism which follows each path and the mechanical arrangement of the coils through which the current must flow to produce the exciting magnetomotive force. It will be appreciated at once that the task of calculating the wattless component of the no-load current according to this method is much more laborious than that used for determining the power component. The brief outline discussion given below is intended to call attention to the fact that the value of the wattless component may be ascertained directly from the volume of the air-gap and the volume of the core material, without reference to the required magnetomotive force, the number or the distribution of the primary coils.

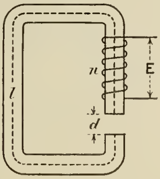

FIG. 1. SINGLE MAGNETIC CIRCUIT.

In Fig. 1 let A = area of a certain magnetic path in square centimetres, l = length of path in iron in centimetres, μ = permeability of iron, d = length of path in air in centimetres, n = number of turns of coil, E = effective value of impressed E.M.F. in volts, ϕ = any chosen value of flux, i = any chosen value of exciting current in amperes, I_q = effective value of exciting current, ϕ_m = maximum value of flux.

From fundamental magnetic relations,

$$\text{Flux} = \frac{\text{magnetomotive force}}{\text{reluctance}}.$$

$$\phi = \frac{4\pi ni}{10} \cdot \frac{A}{d + \frac{l}{\mu}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

As is well known, the reluctance of commercial magnetic material is not constant for all densities, and hence it is not proper to assume that the exciting current is sinusoidal when the flux is sinusoidal. When iron is included in the magnetic path the exciting current wave will be peaked. When the major portion of the reluctance of the path is in air, the effect of the distortion produced by the presence of the variable reluctance of the iron will not in general be very marked, and for all practical purposes it may well be neglected.

Thus, if the maximum value of the exciting current is i_m, the effective value will be slightly different from $i_m/\sqrt{2}$, but since, in any event, the actual value of i_m cannot be predetermined with a high degree of accuracy, due to the fact that the true value of μ is not known, it is safe to assume that for induction motors no measurable error is introduced by representing the effective value of the exciting current by the equation,

$$I_q = i_m/\sqrt{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Then

$$\phi_m = \frac{4\pi}{10} \cdot \sqrt{2} I_q n \frac{A}{\left(d + \frac{l}{\mu}\right)} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and

$$I_q = \frac{10\phi_m\left(d + \frac{l}{\mu}\right)}{4\pi\sqrt{2}nA} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

But

$$E = \frac{\sqrt{2}\pi n f \phi_m}{10^8} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence the exciting watts may be expressed as

$$W_q = EI_q = \frac{2 \cdot 5 f}{10^8} \cdot \frac{\phi_m^2}{A}\left(d + \frac{l}{\mu}\right). \quad . \quad . \quad . \quad . \quad (6)$$

Let $V_i = Al$ = volume of iron, in cubic cm.
and $V_a = Ad$ = volume of air, in cubic cm.

Then

$$\frac{\phi_m^2}{A}\left(d + \frac{l}{\mu}\right) = \frac{\phi_m^2}{A^2}\left(dA + \frac{lA}{\mu}\right) = B_m^2\left(V_a + \frac{V_i}{\mu}\right) \quad . \quad . \quad (7)$$

and

$$W_q = \frac{2 \cdot 5 f}{10^8} B_m^2\left(V_a + \frac{V_i}{\mu}\right). \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Where B_m is the maximum magnetic density, in lines per square centimetre.

The interpretation of equation (8) is that in order to ascertain the (quadrature) exciting watts it is necessary to know only the maximum magnetic density, the volume and the permeability of the iron, and the volume of the air gap. That is to say, the very quantities which are necessary in order to determine the core losses will serve simultaneously for the determination of the (quadrature) exciting watts, when the permeability of the core is known.

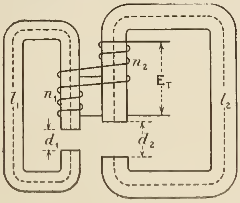

FIG. 2.—COMPOSITE MAGNETIC CIRCUIT.

Although the erratic behaviour of iron with reference to the change in its permeability cannot be reduced to a mathematical expression, it is found that for most practical purposes the permeability of the iron used in transformers and induction motors may be expressed with a fair degree of accuracy throughout the range of density from $B_m = 0$ to $B_m = 15{,}000$, by the equation

$$\mu = 2{,}800 - 3 \cdot 2\left(\frac{7{,}500 - B_m}{10^5}\right)^2.$$

Although the proof given above for equation (8) refers primarily to the magnetic circuits represented in Fig. 1, it can be shown that the facts stated in connection with this equation apply equally as well to the circuits indicated in Fig. 2, and to the more complex circuits existing in both single-phase and polyphase motors.

Thus, making use of proper subscripts, in Fig. 2,

$$W_q = \frac{2 \cdot 5 f}{10^8}\left[B_{1m}^2\left(V_{1a} + \frac{V_{1i}}{\mu_1}\right) + B_{2m}^2\left(V_{2a} + \frac{V_{2i}}{\mu_2}\right)\right] \quad . \quad (9)$$

It may be shown theoretically and verified experimentally, that the (quadrature) exciting watts of a certain polyphase motor are the same in value when all phase windings are used, or when only one winding is subjected to the primary pressure. Thus, when one phase winding of a two-phase motor is open-circuited, the other winding immediately takes double its former value of (quadrature) exciting current, the (quadrature) exciting watts remaining the same. It seems, therefore, that the most logical way to determine the exciting current of an induction motor is to ascertain the density of the magnetism in the core and in the air-gap, and then to calculate the quadrature watts, just as one ordinarily calculates the core loss watts.

THE NEW CARS OF THE SOUTH SIDE ELEVATED RAILWAY OF CHICAGO.

The chief point of interest in the equipment of the new cars of the Chicago South Side Elevated Railway is the special design of the Westinghouse electro-pneumatic control system, which is capable of working in conjunction with the Sprague multiple unit system. The greater number of the old cars on the company's lines are equipped with this latter type of control; in fact, the system was first installed and was developed largely on this railway. At the present time cars having both the Sprague and Westinghouse controllers are made up in trains indiscriminately, no attention whatever being paid to the type of control on the car. This continued working was accomplished without any rearrangement or changes in the Sprague controller circuits. On the new cars the leads from the control or train lines are connected to five relays. These relays close the Westinghouse pneumatic-control storage-battery circuits and thereby operate the controller. The controller is a modification of the well-known Westinghouse turret type, but the unit switches, instead of being arranged on a circular frame, are installed in a long box in such a manner that hinged covers give access to the main contacts on one side and to the interlock fingers on the other. A section of one of the unit switches is shown in Fig. 2. The working of the system is best understood by reference to diagram of connections in Fig. 1, which we reproduce from the *Street Railway Journal* On the first notch of the controller, relay No. 2, and one of the reverser relays are lifted. Should number 4 be the reverser relay lifted, wire 1 of the control circuit is connected to B+. Current then flows through No. 1 wire and over the reverse interlock to R1, through one of the reverser coils to 90, through 90 to the line switch interlock, thence to No. 9 and to B – by means of one of the double point double-throw battery switches. The current energizes the reverser magnet, which admits compressed air to its cylinder and throws the reverser, and when the reverser operates, wire R is connected on the reverser interlock to wire 1. Part of the current is shunted through R over to No. 1 relay to wire 6. This wire leads to the interlocks of unit switches S and J. The branch to S passes on through the operating magnet of M1 unit switch, closing this switch, and to B – over 9. The path to the J interlock continues over wire 13 to the M2 interlock, thence to wire 14 and through the JR operating magnet. By reference to the diagram of the motor and resistance circuits, it will be seen that the closing of the unit switches M1 and JR throws the motors in series with all the resistance in the circuit, and the controller is on the first notch. The closing of these switches also closes a return to B – for wire No. 8, which is supplied with battery current over relay No. 2. Wire 8 leads by way of the limit switch to L, and thence the path continues over M1 interlock (M1 unit switch being closed) to wire 16, over J interlock to 17, over JR interlock to 18, then through the S lifting magnet to 12, and to the line relay, which is located on the relay board with the five relays connected to the control cable, which works the Sprague equipment on other cars on the train. After passing over the relay the path continues through wire 11 to 9 and over the circuit-breaker trip to B –. When S closes, wire 20 is connected to wire 18 over the S interlock, and this starts a progressive lifting of the resistance switches. Wire 20 supplies current to the magnet of RR1 switch and this is closed. Then R1 magnet obtains current over 22 and is closed. Switches RR2, R2, RR3, R3 are closed successively in the order given, and the motors are then connected in series with all the resistance cut out. After these switches have operated they are held closed by current over wire 13.

Moving the master controller to the second step drops No. 2 relay and raises No. 1. This cuts the battery current off of every part of the controller, with the exception of the reverser, and, consequently, all the unit switches are opened. On the third position of the master controller, No. 1 relay drops and No. 3 picks up. The current over No. 1 relay to wire 6 lifts M1 and JR switches, as before. When these are raised current over wire 8 lifts the switches, cutting out the resistance and throwing the motors into full series as before. When R3, the last of the resistance switches, closes, wire M from No. 3 relay supplies current over wires 31 and 32 to the magnet of the J unit switch. This closes and current

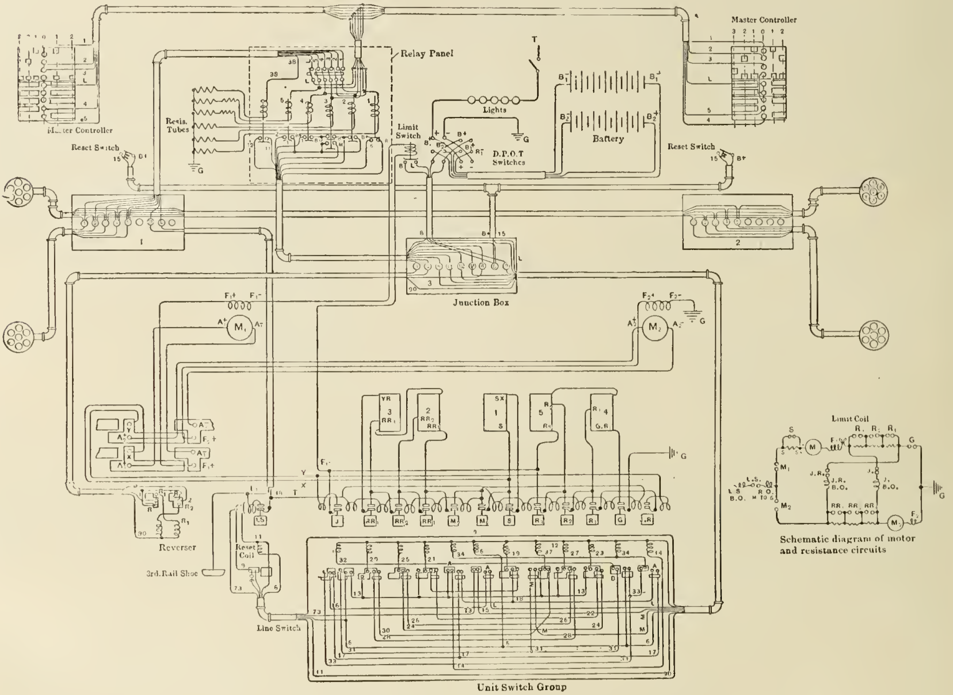

Fig. 1.—Diagram of Connections, Unit Switch System.

is cut off from wire 13. Switch JR and all the resistance switches, with the exception of S, are consequently opened. The closing of J also connects 33 with B+ through wires 16, L and 8. Current through 33 closes unit switches G and M2. When G closes, J drops as the connection between wires 31 and 32 is broken at the G interlock. The only switches closed now are M1, S, M2 and G. The motors are, therefore, connected in parallel with all resistance in. When J drops, however, current is supplied to the magnet at S unit switch through wire 18. M2 interlock wire 17, J interlock wire 16, M1 interlock L and the limit switch. Current is also supplied to wire 13 by the dropping of J. All the resistance switches again close successively in their previous order, and the motors are connected in full parallel.

The return circuit of all the magnets, with the exception of M, passes from 12 to 11 over the line relay and from 11 to 9 by way of the circuit-breaker trip. The magnet of the line relay is connected between the third-rail and the ground. The function of this relay is to drop the controller to the off position when the power is interrupted, because of gaps in the third-rail or any other cause. When power is restored, the switches will automatically notch up again to the former position without the motorman moving his handle.

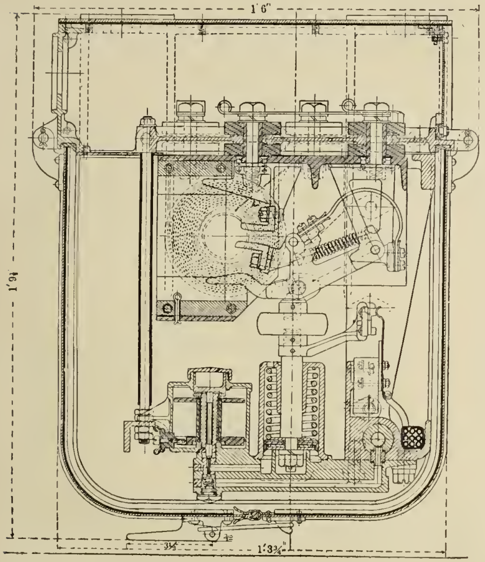

Fig. 2.—Section of Pneumatic Unit Switch.

This prevents the damage that might result if power were suddenly resumed with the controller in the full parallel position. If by reason of a burn-out or from any other cause, an excessive current flows through the circuit breaker, the trip is operated and the contact between wires 11 and 9 is broken so that current is cut off from the line switch operating coil and from all the switch magnets, with the exception of M1. Before the circuit breaker can be thrown in again, the circuit breaker trips must be reset by closing for an instant the reset switch located under a seat in the interior of the car. Closing this switch supplies battery current to wire 15 and over M1 interlock to 73, and to the reset coil, which throws the trip in and restores connection between wires 11 and 9. The circuit through the reset coil is broken at the M1 interlock when this unit switch is closed, and this prevents the circuit breaker being reset, except when the controller handle is in the "off" position.

The limit switch regulates the feeding of the controller. The driver merely places his controller handle at starting, series or parallel position as the case may be. The lifting coil of the limit switch is connected in the circuit of No. 1 motor, and when the current through it exceeds a predetermined amount, contact between wires 8 and L is broken. As previously stated, current through L operates the unit switches, cutting out the resistance. When the circuit is broken, the progressive lifting of the switches is stopped until the current decreases and the limit switch drops. Those resistance switches that have already lifted, however, do not drop, as they are retained by current through wire 13.

The batteries are placed in a box under the car. Two sets of seven cells each are employed. The double-pole double-throw battery switches are mounted on a board under one of the seats. When both switches are thrown in one direction, one battery is connected to the control system while the other set is being charged in series with the car lights. It is customary to change the position of the switches once each day.

It will be noted that the interlocking arrangement is thoroughly worked out. The switch group cannot operate unless the reverser switch is thrown in the proper direction and in the full position, otherwise the R wire will not make contact. Neither can the reverser be operated if the line switch is closed, as the circuit through wire 90 is open. The control equipment consists of the following parts, the line switch upon which the circuit breaker is mounted; the unit switch group, the reverser switch, the limit switch, five resistance grids, two double-pole double-throw battery switches, two master controllers, the relay panel and three junction boxes.

THE EFFECT OF ACID FROSTING AND ENCLOSING GLOBES UPON THE LIFE OF INCANDESCENT ELECTRIC LAMPS.

BY J. R. CRAVATH AND V. R. LANSINGH.

The last few years there has rightly been a tendency in incandescent lighting to lower the intensity of the source of light, either by using enclosed diffusing globes or else by frosting the lamp bulb itself. The diffusion obtained by these methods has not only resulted in more artistic effects, but has also made the light much easier on the eyes, and has undoubtedly aided in popularising the use of the incandescent lamp. In this connection, the question has arisen as to the relative efficiency of the two available methods, which are:—

1. Frosting the lamps themselves and using them without enclosing globes.
2. The use of the bare lamp with a diffusing enclosing globe either ground glass, Holophane or other types.

It has generally been conceded that a frosted lamp, as far as efficiency is concerned, is more economical than a plain lamp with a diffusing globe. Generally speaking, the absorption by such frosting is in the neighbourhood of 10 per cent., while with the use of ground glass, and other types of diffusing globes, the absorption runs from 12 to 25 per cent. or more. The question as to the effect on the life of the lamp has, as far as the authors know, never been satisfactorily answered to date.

The authors, in previous articles in this paper, have advocated the use of some sort of cover or gasket for the neck of an enclosing globe, such a cover being formed of asbestos, mica or some similar material which will keep out all dust, and, in the case of white asbestos, increase the light below the horizontal. In order to determine the effect on the life of the lamp, with these various conditions, tests were made on the following at the electrical testing laboratories:—

1. Frosted lamp, bare.
2. Clear lamp and diffusing globe.
3. Clear lamp, diffusing globe and asbestos cover.

Thirty lamps were selected from among a large number which were purchased direct from the manufacturer. They were of 16 c.p. 115 volt 3·1 watts per candle oval-anchored filament type. These lamps were selected with a view to securing those free from perceptible defects. When received they were divided into three groups. In making this division the only consideration was the efficiency, an endeavour being made to have the same average candle-power and watts consumed for each of the different groups. One of the three groups was then taken to the factory of the manufacturer and was there frosted by the usual acid process. The 10 lamps after frosting were again photometered in order to determine the absorption and modification of the distribution of light, due to the frosting.

The enclosing globes used were of the "Holophane" type, being spheres, 6½ in. in diameter, with 3¼ in. holders. Ten of these were used without any cover, while 10 others were protected with an asbestos disc or washer which practically prevented any dust from entering, and at the same time had a tendency to thrown down any light striking the white surface. This type of globe was selected for the reason that while the glass is heavier than the ordinary type of globe, the increased radiating surface, owing to its numerous prisms, would tend to increase the radiation.

The first tests made were to determine the absorption and modification of the distribution of light, due to the three methods given above. As will be seen from the data given later, the loss of light due to the frosting of the lamp itself was 9 per cent, while the loss due to the absorption of the globe was about 16½ per cent. The dis-

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* From the *Electrical World.*

tribution of light, as thus obtained with the above combination, is shown in Fig. 1, where the photometric curve of the bare lamp is also given for the sake of comparison.

The effect of frosting a lamp is to decrease the candle-power at all angles, with the exception of that directly underneath and directly above the lamp.

The type of globe used in this test is known as one which aims to diffuse the light in all directions below the horizontal rather than re-direct it in any one direction. This is shown by Fig. 1. It will be noticed that the use of an asbestos disc slightly increases the useful light at all angles below the horizontal. Other things being equal, it would seem desirable to use asbestos discs with any form of enclosing globe, thereby preventing the accumulation of dust on the inside and increasing the useful illumination at the same time. In this connection it should be noted that the use of such a disc or washer prevents the dust from settling on the lamp itself as well as on the inside of the globe. The importance of keeping the inside of the globe, and the lamp itself perfectly clean has been well brought out in tests reported on by Messrs. Legg and Townsend at the Chicago Public Library, where in the case of clear lamps and porcelain reflectors the average increase of light, due simply to wiping off the lamps and shades with a cloth, was nearly 30 per cent.

After the absorption test was finished the three groups of lamps were placed on the life test. All were burned pendant upon the same racks and under the same conditions; a frosted lamp, a lamp in a Holophane globe, and a lamp in a diffusing globe with asbestos disc being placed in turn. All were operated on a 60-cycle, constant potential, alternating current system, in which the average pressure fluctuations did not exceed $\frac{1}{4}$ of 1 per cent. above or below normal.

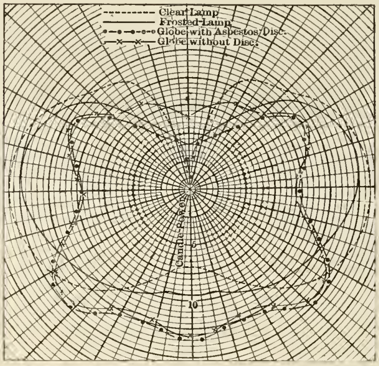


Fig. 1.—Curves of Light Distribution.

The lamps were burned under such conditions throughout their useful lives. Neither the frosted lamps nor the globes were cleaned in any way.

After the test had been in progress 144 hours and 336 hours respectively, the mean spherical candle power of each of the ten frosted lamps was determined. After the test of the lamps burned within the globes had been in progress 288 and 516 hours respectively, their mean spherical candle-power values when used with the globes was determined. At more frequent intervals, the mean horizontal candle-power of the lamps was determined in order to establish the rate of deterioration in candle-power.

——	Group No. 1 frosted.	Group No. 2 in globes.	Group No. 3 in globes & discs.
Initial m. s. c. p. as modified..	12·2	11·1	11·1
Watts per initial m. s. c. p. ..	4·15	4·55	4·55
Per cent. loss of light as compared to clear lamps	9·0	16·5	16·5
Mean zonular c.p.			
Lower 45 deg. zone..........	10·6	12·9	13·4
Lower 60 deg. zone..........	11·3	13·4	13·9
Lower 75 deg. zone..........	11·8	13·2	13 5
Lower hemisphere	12·4	12·4	12 6

Because of the nature of the light units tested the only practicable method of comparison is on the basis of mean spherical candle-power. All candle-power results shown in this report are, therefore, reduced to this basis. The lamps were burned in every case to 80 per cent. of their initial mean spherical candle-power.

The net results of the tests made at the beginning are given in the following table:—

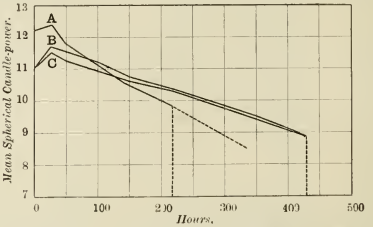
Life Tests of Lamps.

——	Group No. 1 frosted.	Group No. 2 in globes.	Group No. 3 in globes and discs.
Average life to 80 per cent. of initial c.p.................	216 hours	428 hours	423 hours
Corresponding candle-hours ..	2,383 ,,	4,401 ,,	4,384 ,,

In studying the results we note that the loss of light, due to the frosting of the lamp is 9 per cent., while in the case of the type of globe used in this test the loss was 16½ per cent. When, however, the question of life is considered, we find that the life with a frosted lamp is only 216 hours, whereas the globe under test gives 428 hours, or nearly twice the life. If we multiply the average mean spherical candle-power by the number of hours of useful life, we find, in the first case, we have 2,383 candle hours, while in the second place we have 4,401 candle hours—an increase of 85 per cent. Fig. 2* shows the life hours and the candle-power graphically. Care should be taken not to confuse this with horizontal candle hours commonly used in considering the life of incandescent lamps.

The asbestos discs on the necks of the enclosing globes leave the total flux of light practically unaffected. The light in the lower hemisphere is increased about 2 per cent., and the life is only diminished about 1 per cent. There is of course a considerable advantage due to the fact that dust is prevented from falling on the outside of the globe.

The object of frosting lamps is to cut down the intense glare of the bare filament with the least possible loss of light, rendering the lamp more agreeable to the eye and giving a more artistic effect. In many instances, the same results can be obtained by the use of ground glass diffusing globes with a corresponding increase in the life of the lamp. Where a reflector is needed and at the same time diffusion of the light from the lamp filament is advisable, a frosted bulb lamp is still the most easily available device for securing diffusion. It is to be regretted that the tests did not include ground glass as well as diffusing globes, but judging from the tests given in previous articles in these columns by the authors on the absorption by ground glass globes, it is probable that a test on these would show very nearly the same results as here obtained.



A. Frosted lamps alone. B. Clear lamps with globe. C. Clear lamps with globe and asbestos disc.

Fig. 2.—Curves of Average Candle-power Performance.

The usual guaranteed life of bare lamps of this kind with clear glass bulbs is 450 hours. The loss of life by enclosing them in globes is, therefore, about 5·5 per cent., while the loss of life by frosting is about 52 per cent.

VOLTAGE CALIBRATION.

In a recent issue of the *Elektrotechnische Zeitschrift*, Dr. M. Kallmann, electrician to the Municipality of Berlin, describes a simple and ingenious method for calibrating voltmeters and checking the pressure used on supply networks. He makes use of two Nernst lamp ballast resistances, a and b, connected, as shown in the diagram, in series with two resistances, r_1 and r_2, each of about the same value as the mean resistance of a and b, in such a way as to form a Wheatstone bridge, the galvanometer B being connected across the two diagonal points. This Wheatstone bridge system is not subjected to the whole pressure of the mains, but part of the pressure is absorbed by an adjustable resistance, R, and two fixed resistances, W_1 and W_2. The resistances are so adjusted that when the pointer of R shows the correct voltage of the network on the scale the bridge is balanced so that the galvanometer B gives no deflection when the switch U is at the position 1. If now the voltage of the network is higher or lower than the standard, the current through the bridge will vary, and as the resistances *a* and *b* have high temperature coefficients, and are on opposite sides of the bridge, the bridge will be thrown out of balance, and there will be a deflection on the galvanometer. By readjusting the resistance R balance can be restored.

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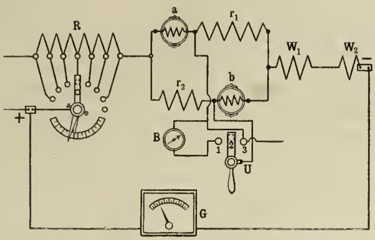
* In reproducing this figure we have corrected an obvious error in the arrangement of the scale of candle-power in the original.—Ed. *E.*

By using a standard voltmeter connected in the position *b*, a scale of R can thus be marked off once for all in volts, so that the arrangement can be used at any time for measuring the voltage of the network or for calibrating a voltmeter connected across the 'bus bars. *a* and *b* are the ordinary ballast resistances of a ½ ampere Nernst lamp, and Dr. Kallmann finds that they can be used for long times at a stretch without rendering them inefficient for this purpose. He uses them at a temperature of about red heat.



For alternating currents a telephone is used instead of the galvanometer B. If a very accurate test is not required, the galvanometer B can be dispensed with, and the observer notices whether the colour of the hot resistances differs when he puts the switch over from position 2 to position 3. In this latter position the diagonal points of the bridge are short-circuited, and if the bridge is balanced there should be no alteration in the current flowing and consequently no alteration in the temperature of the resistances.

A NEW ARC LAMP.

In the *Elektrotechnische Zeitschrift* for May 3rd a new type of electric arc lamp, in which a greater efficiency is obtained by utilising conductors of the "second class," is described by Herr E. Stadelmann. The author begins by pointing out that much attention has been devoted recently to the development of electric lamps having higher efficiency, as is exemplified by flame arc lamps and by Nernst lamps. The conductors of the second class can be utilised for arc lamps as well as for glow lamps, and various attempts have been made to produce a satisfactory lamp on these lines, in which the arc has been burnt between such conductors, or in which such a conductor has been placed in the arc between the carbons.

The attempts to utilise these conductors to increase the illuminating power are fairly old, and notably the Jablochkoff candle and the Soleil lamp of Clerc and Bureau may be mentioned. The Jablochkoff candle owed its efficiency to the volatilisation of a conductor of the second class between the carbons, and its chief defects were the short duration of the burning and the difficulty of relighting after once extinguishing. The Soleil lamp suffered also from the last defect, but had the advantage that the conductor served both to reflect and to increase the light, which resulted in an extremely steady illumination. Both lamps were without any mechanical regulation. The disadvantage of the Soleil lamp was that the light from the carbons was practically entirely cut off, and that the lamp relied for its illuminating power entirely on the light reflected by and radiated from the second-class conductor. When this defect can be overcome one obtains a satisfactory arrangement for a lamp, in which the conductor of the second class is used both to reflect and to intensify the light, but in which also the light from the carbons and that from the arc itself is utilised. In this way the efficiency is made as great as possible. In order to arrange a lamp on this principle, the carbons are made either round or flat in section, and arranged horizontally, and above them is fixed a conductor of the second class, in such a way that it bridges over the gap between the ends of two carbons without actually touching the carbons themselves.

The lamp is started up by bringing the two carbons into contact, as in the ordinary arc lamp. At first the arc burns between the two carbons, but as the second-class conductor is immediately on top of these it becomes heated by the arc and soon is raised to such a temperature that it is conductive. When this condition is reached the arc will strike to the conductor, and the current will then pass for a certain distance along the conductor, and again pass from the conductor to the second carbon. Not all the current will flow in this way, as a part will continue to pass from carbon to carbon through the still burning arc. The arc will be longer when the second-class conductor is hot enough to carry some of the current, as the resistance between the two carbons is thereby diminished. It will be observed that this arrangement gives three sources of light—namely, the craters or white hot tips of the carbons themselves, the arc burning between the carbons, and the incandescent conductor above the carbons. In addition to this, part of the light from the ends of the carbons which would normally be radiated upwards into the top of the lamp is reflected down by the surface of the conductor above the carbons.

The light from this lamp is particularly steady, as the conductor over the arc protects it from draughts, and flickering is practically avoided. An additional advantage of using the second-class conductor as a source of light is that the light from the lamp will not be subject to alteration in intensity resulting from small alterations in the strength of the current, on account of the fact that the second class conductor is a good light accumulator, and a greater percentage of total light given out from the lamp is due to this source.

In this respect the lamp is similar to the Soleil lamp, but in contradistinction to that lamp it possesses the advantage that it has a higher efficiency, as the cooling is considerably less than with the big blocks used in the Soleil lamp. In addition, the efficiency is greater in this lamp, because the Soleil lamp only utilises the light from the second-class conductor and a part of the arc, whereas in this lamp the light from the second-class conductor and the whole of the arc and also from the glowing ends of the carbons is utilised.

The best substances to use as second-class conductors are substances such that their volatilisation is as little as possible; considerably steadier and more even light is thereby obtained, and also naturally the lamp works more economically as the conductors do not have to be so frequently renewed. A further advantage from this arrangement is that the greatest part of the light is radiated under the lamp which is generally an advantage in lighting. The lamp also possesses the possibility of so arranging the axis of the carbons that the light can be directed in any particular direction.

Experiment has shown that fire-clay is a suitable substance to use, but further experiments may reveal a more suitable material. It is naturally necessary that the second-class conductor should be fixed in the lamp in such a way that it can be changed as easily as the carbons.

The author concludes by pointing out that it is not essential to construct the lamp precisely as described, but that other arrangements can be made in which it would be more similar to the ordinary type of arc lamp, and by means of which different distributions of light could be obtained.

The Paper does not give any particulars of actual measurements of efficiency or light distribution with the new lamp.

THE MASSIE WIRELESS TELEGRAPH SYSTEM.

A description of the chief characteristics of the Massie wireless telegraph system appeared in *The Electrician*, Vol. LV., p. 744. The equipment as used at the present time, however, possesses a number of improvements in detail, which are described in a recent issue of *The Electrical World.*

The operating circuits of the Massie system are arranged in three distinct, although somewhat interconnected, groups, which groups may be designated as the transmitting, the detecting and the receiving groups respectively.

A special controlling switch shown in the diagram of connection, Fig. 1, allows either one of the three groups to be used as the operator may desire. When the apparatus at a certain station is in active use, the switch is so constructed that the aerial will be connected to the receiving circuit or disconnected for transmitting, as the case may require. At all other times, however, the aerial is connected with the detecting apparatus, which contains a bell alarm in a relay circuit, so that the operator is relieved from the tedious task of "listening in," and yet no messages intended for the station will be overlooked.

To use the powerful transmitting apparatus the switch must be placed in such a position that the delicate receiving equipment is entirely separated from the aerial and effectively insulated therefrom, the battery circuits must be broken and the detectors short-circuited and grounded; when the switch is changed so as to put the receiving apparatus in an operative condition the transmitting circuit is broken. Thus the switch device effectively protects all the apparatus by making it impossible to send while the receiving circuits are closed and vice versa. The aerial connected to the receiving apparatus is separated from the transmitting apparatus by means of an insulated microscopic air gap termed an "anchor gap," in the transmitter circuits; otherwise the antennæ would be grounded through the inductance of the transmitting apparatus. Although this small gap is sufficient to insulate the vertical when receiving, it is practically a short-circuit for the high-tension oscillations produced when transmitting.

The transmitter equipment includes the usual spark-gap, inductance coil, condenser, high-potential transformer, interrupter, when direct current is used, and source of energy. Each of these parts possesses features of construction deserving special mention. The spark-gap is surrounded by a micanite tube, fitted with a window, which serves to deaden the excessive noise from the disruptures and yet allows the gap to be inspected at any time. It is placed within the inductance coil. The inductance of the coil may be varied by shifting the position of the connecting terminal along the turns, so that, in connection with the proper capacity in the condenser, the transmitting circuits may be adjusted to give forth any desired length of electrical wave. The turns on each coil are carefully calibrated and the inductance for each position of the sliding terminal is indicated on the framework, while the mechanical mounting of the coil is such as to allow any desired inductance to be found at once by merely revolving the coil.

Difficulty has frequently been experienced in causing a spark-gap to operate continuously and to repeat its performances indefinitely, a gradual change usually taking place in the behaviour of the gap. This change has been attributed to the heating and to the ionising of the air surrounding the gap, and a remedy for the difficulty has been found in cooling the terminals of the gap and removing the air from the immediate neighbourhood. In his latest equipments Mr. Massie builds the air-gap terminals of tubing through which air is forced under pressure. The terminals themselves are cooled by the expansive action of the compressed air, while the ionised particles are removed before they have accumulated in sufficient quantities to affect the operation of the gap by exhausting the expanded air through small openings in the ends of the rods. The expanding compressed air is also allowed to flow through the hollow turns of the inductance coil in order that the coil may be kept at a temperature lower than that which would otherwise be produced in the windings by the high-frequency currents. Needle valves control the admission of the compressed air to the inductance coil and the spark-gap rods an electromechanically-operated valve in the main supply pipe is connected to the main controlling switch, so that the valve is opened when the transmitting circuits are in use and is closed at all other times.

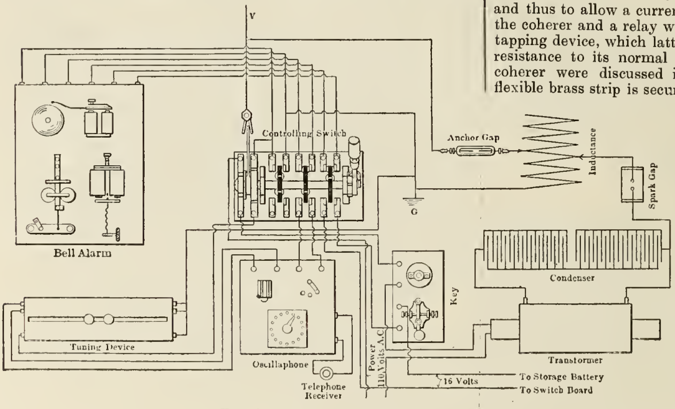


Fig. 1.—Diagram of Connections.

The condenser is built up of plates of glass on which are secured sheets of tin foil. The connections are so made that the glass itself becomes the dielectric, and the air is not depended upon either for insulation or for inductive capacity. Each glass plate with its two sheets, therefore, possesses a definite capacity, and the capacity in circuit depends upon the number of plates in use. The immediately near sheets of adjacent plates are connected together by means of a spring contact inserted between them.

These contacts are mounted on rods, and the alternate rods are joined in groups to 'bus bars, so that the active capacity of the condenser depends upon the number of rods which are "in" or "out." Since the air space separating adjacent plates is not subjected to any difference of potential, there is no possibility of a disruptive discharge between these plates. A leakage path through air is found, however, over the exposed sides and edges of each glass plate. For the purpose of improving the insulation and preventing the formation of corona, all of that portion of the glass not covered by the tin-foil and a limited section of the coil is given a coating of asphaltum varnish. This material is intended solely as an insulator and it contributes in no way to the inductive capacity of the condenser. It is used in preference to other varnishes as brush discharge is reduced to a minimum, thus producing a more defined period of oscillation and, therefore, sharp and true wave lengths.

The transmitting key is in each case similar to a telegraph-sender key, and the apparatus is of such a nature that anyone familiar with the Morse alphabet can send messages without additional instructions. With a small portable or boat set the key is connected directly in circuit with the primary of the high-potential transformer. When the energy is obtained from a battery or a direct-current generator a mechanical interrupter is also inserted in the primary circuit, but when alternating current is used the interrupter is omitted. In a high-power land station where the heavy currents would tend to destroy the key, unless an extremely large and unweildy one were used, the key is used merely to close a battery circuit to an electromagnetically-operated oil switch in the primary circuit of the high-potential transformer, as shown in Fig. 1.

The Massie detector is of the filings coherer type. The main axis of the device is placed in the vertical direction, so that the force of gravity assists in the action of the coherer. The coherer consists of a magnetised needle with its lower end supporting magnetic filings immediately above a mixture of non-magnetic filings—the former being of iron and the latter of silver. The filings are placed in a silver-lined cup which forms one terminal of the coherer, the magnetised needle being used as the other terminal. The needle causes the iron filings to be arranged in line just above the silver filings, with a minute film of air between them, thus forming an electrical path of high resistance. The effect of an electrical oscillation is to cohere the filings and to decrease the resistance and thus to allow a current to flow from a battery circuit through the coherer and a relay which in turn operates a bell alarm and a tapping device, which latter decoheres the filings and restores the resistance to its normal high value. The main features of this coherer were discussed in the article referred to above. On a flexible brass strip is securely mounted the silver-lined cup, and to this is fastened a substantial glass tube which serves for holding the needle in place. The tapper strikes against the brass strip, but does not come in contact with the glass tube so that the breaking of a tube by the tapper is unknown. The filings are completely enclosed and the performance of the coherer is not affected by atmospheric changes, while the effect of external mechanical disturbances is negligible. When cohered the resistance is less than 50 ohms, often being less than 1 ohm, thus an inexpensive relay can be used, which is an important factor in the cost of manufacture. The coherer with its bell alarm remains in circuit at all times when messages are not being transmitted or received, and to it is given the task of announcing when a distant operator wishes to communicate with the home station.

After the coherer has announced that a message is to be sent from some distant station, the operator at the home station moves the main circuit-controlling switch so as to connect the aerial to the receiving apparatus. The predominating feature of the receiver is its ability to withstand rough treatment. It is of the microphonic type, and, mechanically considered, is extremely simple. The "oscillaphone," as the inventor terms the device, consists of a steel needle held in contact with two sharp edges of carbon by means of a small permanent magnet. The terminals of the oscillaphone are formed by the two carbon compound (carbon and paraffin) strips. The resistance of the two contacts between the carbon edges and the needle is normally about 40,000 ohms. When the contacts are included in the aerial circuit the resistance decreases to less than 1,000 ohms while electrical oscillations are being received, and it then automatically increases to its initial value when the oscillations cease. The oscillaphone is connected simultaneously in series in the aerial circuit and in a local battery circuit containing an ordinary telephone receiver wound to 1,400 ohms resistance, in order that the signals may easily be interpreted. The loudness of the signals received is adjusted by means of variable resistance inserted in series in the local battery circuit or in shunt to the oscillaphone; the effectiveness of the adjustment is ascertained by the use of a miniature electric wave producer, which consists of a pocket-size primary cell connected to a magnetic make-and-break contact device, so that the operator need not depend upon signals from other stations for testing the effectiveness and sensitiveness of the oscillaphone.

For the purpose of eliminating from the oscillaphone such messages as may not be intended for the particular station in question, an inductance coil is used in series with a condenser, the inductance and the capacity being so adjusted as to render the combined circuits resonant at the single frequency selected for this station. It is stated that messages which differ in frequency as much as 20 per cent. from that for which the receiving apparatus is adjusted will not affect the oscillaphone. The resonant frequency depends largely upon the inductance and the capacity, and it varies only slightly with the resistance in circuit; the sharpness of the tuning, however, depends to a great extent upon the resistance. It is desirable, therefore, that the resistance be constant in order that the resonant frequency may not change, and it is necessary that the resistance be small in value if the selectivity is to be absolute. In some of his latest equipments Mr. Massie has used a magnetic type of receiver in which the resistance in the oscillating circuit is constant and of a negligible value. In this device the telephone receiver circuit is inductively related to the oscillatory circuit. Through the common magnetic paths of the two circuits is moved slowly an iron wire which has been subjected to the influence of a permanent magnet. When a high-frequency current flows in the oscillatory circuit the iron wire suddenly loses its magnetism, and the great rate of change of magnetic lines interlinked with the telephone receiver circuit generates therein an E.M.F., which causes the production of a sound in the receiver. The "iron wire," which is built up of overlapping and concentrically arranged spirals of wire, is moved along the face of the permanent magnets and through the coils by means of a driving mechanism similar to that used in a phonograph. The tuning obtained is claimed to be remarkably sharp and complete.

The Massie apparatus is used to some extent in the United States Navy and other American Government departments.

PHYSICAL SOCIETY.

At a meeting of the Physical Society held on May 25th, Dr. C. Chree, F.R.S., Vice-president, in the chair, a Paper on

"Colour Phenomena in Photometry"

was read by Mr. J. S. Dow. The question has often been raised whether it is physiologically possible to compare lights of different colours. The author has found that it is chiefly a matter of practice. A great difficulty arises from the fact that the central portion of the retina is more sensitive to red, and less sensitive to green, than the surrounding portion. Therefore, when we attempt to photometer lights of different colour, enormous differences are found as the distance of the eye from the photometer-screen is altered, and utterly different results are obtained with different photometers. Curves are given in the Paper showing the effect of altering the distance of the eye when an incandescent mantle is compared against a gas standard with the Joly photometer. Differences of 5 per cent. can easily be obtained. An experiment was shown at the meeting to demonstrate that the Purkinje phenomenon, generally regarded as a great cause of uncertainty in ordinary work, only becomes noticeable at very small illuminations and with comparatively large fields of view. The Purkinje effect can be physiologically explained by the action of the "rods" and "cones" on the retina. The comparative weakness of the Purkinje effect with small fields can be explained by the fact that the central portion of the eye contains practically no rods but only cones. The Paper also describes experiments to show that Flicker photometers seem to be affected by colour phenomena, but to a smaller extent than ordinary ones. In any case, whether Flicker or an ordinary photometer is adopted, it is necessary to specify the size of the field, the distance of the eye and the order of illumination used, in order to get consistent results.

Mr. A. P. TROTTER expressed his interest in the Paper, and said he thought the difficulty of comparing the intensities of two lights of different colours was an imaginary one. It was possible for anyone accustomed to photometric measurements to get reliable comparisons of lights of different colours. The author, for the sake of precision, had dealt with the comparison of red and green, but he pointed out that in practice the variation in colour between the lights under test was not so great as this; ranging from the light of the Hefner lamp to that of the arc light or daylight. He agreed with the author that when taking photometrical measurements it was best to get as far away as possible from the comparison disc.

Mr. A. RUSSELL considered Mr. Dow's explanation of the phenomena of heterochrome photometry by means of the irregular distribution of rods and cones on the retina quite satisfactory. Whatever theory we adopt as to the difference between the functions of the rods and cones, it is obvious that their relative numbers on the portion of the retina covered by the image of the photometer disc is a factor of primary importance in determining the balance. It is a physiological fact that there are no rods on the yellow spot, and this had led Prof. Blondel to suggest that if we arranged so that the image always fell on the yellow spot, consistent results might be obtained. Reference was also made to M. Lauriol's Paper in the *Bulletin* of the Société Internationale des Électriciens on the effect of the speed of the rotating part of the Flicker photometer on the balance obtained. The experiments proved that many of the results obtained depended merely on the speed of rotation. When comparing green with red, the numbers obtained varied between the wide limits of 1 to 5. Even when comparing a Nernst with an ordinary glow lamp, a variation of 20 per cent. with speed was noticed. It was pointed out that it was easier to obtain a balance when comparing red with green by using a grease-spot photometer than by using a Lummer-Brodhun contrast photometer. The colours of the two sides of the grease spot in the position of balance, owing to the transmitted light, were not pure red and green, but were mixtures which it was much easier to compare. The experience of the speaker was that the Lummer-Brodhun photometer was the one most favoured by those engaged in accurate photometric work. For comparing lights of different colours, however, a modified form of grease-spot photometer would have many advantages.

Mr. S. SKINNER described an

Automatic Arc Lamp

exhibited by Mr. H. Tomlinson and Rev. G. T. Johnston. This is a simple form of automatic arc lamp which can be constructed by any amateur at small expense. A vertical brass tube supported by a wooden framework carries the upper carbon, which can be raised or lowered by hand and clamped in any position in the tube. The lower carbon fits into a hollow brass tube, and into the lower part of the tube is fitted an iron plunger. The plunger is surrounded by a solenoid, consisting of a single layer of No. 14 copper wire, the internal diameter of the solenoid being slightly greater than the diameter of the plunger. The plunger dips into a small box of mercury, and is made to float upright by means of a brass collar and by the rounded ends of three nails forming an equilateral triangle. The current enters the upper carbon through the brass cylinder, passes through the lower carbon into the mercury, and then through the solenoid. To "strike the arc" the lower carbon is raised by hand to touch the upper one, and the plunger is then permitted to sink into the mercury until the suction of the solenoid balances the buoyancy of the mercury. With currents from 2 to 6 amperes the light is very steady, but for currents above 4 amperes it is suggested that the solenoid should have two layers of wire arranged in parallel. For currents less than 3 amperes these layers could be arranged in series.

A Paper on

"The Theory of Moving Coil and other kinds of Ballistic Galvanometers"

was read by Prof. H. A. WILSON. In this Paper the exact formulæ giving the quantity of electricity passed through various types of ballistic galvanometers in common use are obtained. It is shown that the different types require different formulæ, all of which, however, reduce to the same formula when the angle of deflection is very small. In the case of a moving coil galvanometer having a rectangular coil, iron core, and pole pieces arranged so as to give a radial magnetic field, the formulæ take a simple and convenient form.

Mr. A. CAMPBELL exhibited a

Bifilar Galvanometer free from Zero Creep.

For measuring direct currents and voltages of ordinary range (from 0·1 ampere or volt and upwards) moving coil galvanometers with shunts or added resistances are convenient. The usual instruments, however, are affected by gradual displacement of zero (due to elastic set) when a deflection is maintained for some time. This difficulty is got over by replacing the ordinary torsional suspension by a bifilar system in which the two wires are so far apart that the gravity control quite swamps that due to the torsion of the wires. In the instrument shown, the wires are more than 1 cm. apart, and the sensitivity with 40 ohms resistance is 400 mm. at 1 metre for 0 001 ampere; this is sufficient for many purposes. The full deflection may be maintained for hours without causing a zero creep of 1 part in 2,000. To attain good damping a very powerful magnet is used. The arrangement of this and the general design are due to Mr. R. W. Paul, who has adapted to the purpose Mr. Evershed's system of coil and magnet.

Prof. H. A. WILSON asked if the zero creep might not be due to magnetic material in the coil. If the field was unsymmetrical the presence of magnetic material would produce a creep.

Mr. CAMPBELL replied that in very sensitive moving-coil galvanometers the presence of magnetic dirt was a source of trouble, but in the instrument which he had exhibited the control was so strong that the creep due to this cause was practically nothing.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"Adressbuch der Elektricitätsbranche von Europa." Vol. I. (Germany). 6th Edition. 1906-7. (Leipzig: Schulze & Co.)

"Turbodynamos und Verwandte Maschinen." By Dr. F. Niethammer. (Zurich: Fritz Amberger.) M8.

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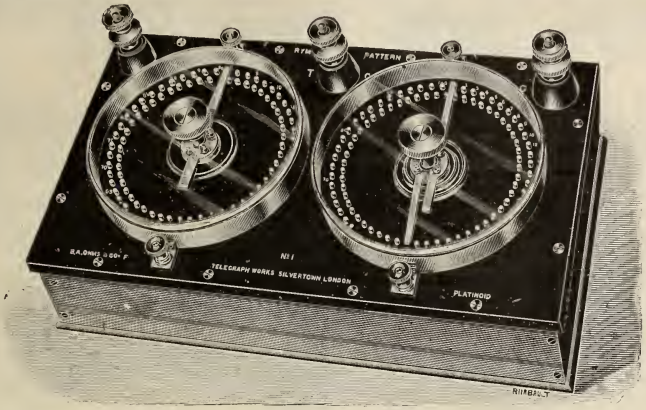

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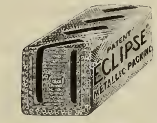

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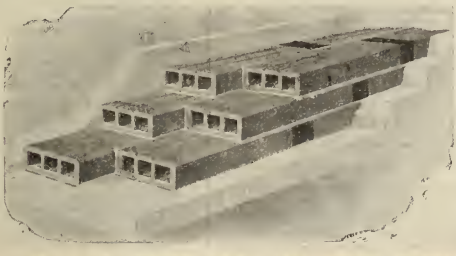

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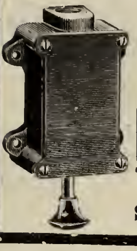
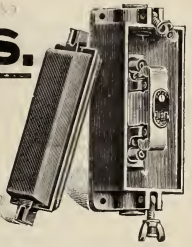
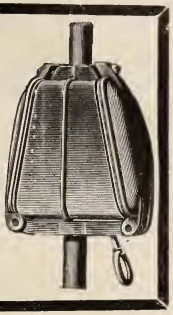

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In addition to the tables, instructions and other detailed information as to cables, ducts, junction boxes, &c., contained in the section on Underground Mains, it has been deemed advisable to add a chapter briefly describing the various systems employed for public distributing networks. In this, essential practical information is alone given; two and three-phase systems are dealt with, as well as continuous current and single phase, and the method of calculating the size of the conductors and the fall of pressure from the number of lamps or horse-power of motors is made clear without the elaboration of clock-face diagrams or algebraical exercises.

Diagrams for the connections of telephones are given in Section D, including those for subscribers' instruments on the British Post Office exchange system in London; and it is believed that neither these diagrams nor those for bell connections have hitherto been published together in convenient pocket-book form. The various conversion factors in the Miscellaneous Section and the arrangement of the wages table are those which the Editor has himself found the most useful in practice.

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(Included on this Sheet is a Table of Towns not owning Electricity Works, but taking a supply "In Bulk." This Table (No. 1a) contains information as to the source of supply, with equipment of sub-stations and system of distribution. Also other information as in Table I.)

TABLE III.—Electric Power Undertakings of the United Kingdom.

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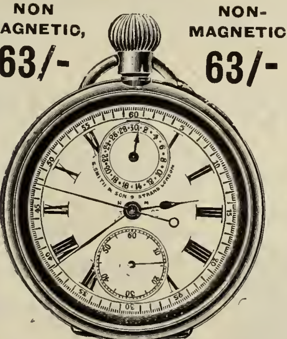
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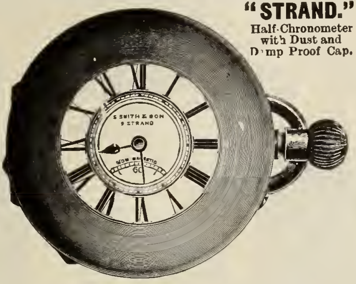

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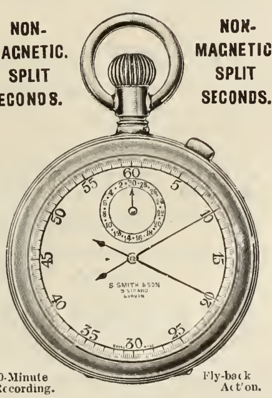

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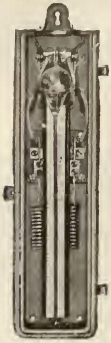

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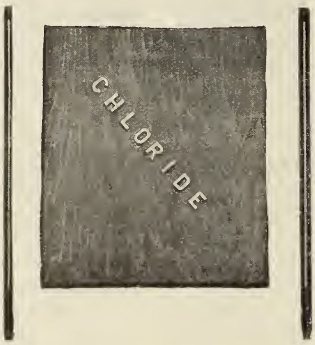

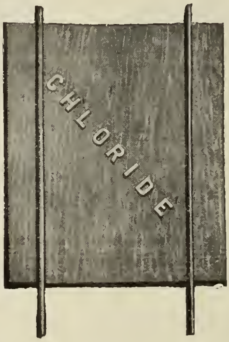

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in this direction alone has been enormous in some cases. At present, however, electrical engineers are severely handicapped, when they endeavour to effect these improvements, by the high price of electric power in London. The existing companies spent much money in the early days on the necessary pioneering work, and as their concessions expire in 25 years' time they can hardly be blamed for endeavouring to make large profits during the remainder of their tenure. Not only must they pay a return on money invested, but they must also redeem a large proportion of their capital which they will fail to recover at the end of this period when they are liable to be bought out on "tramway terms." We can, therefore, not look to the present supply companies in London to save the situation unless they are given some assistance. It has now been generally recognised that, in addition to giving them facilities to link up their stations and removing some of the minor hardships which they have to bear under the Electric Lighting Acts, the best assistance that can be afforded them is by means of a "bulk" supply system. By such a system they might be relieved of the necessity of extending their existing stations, and they would be supplied with electrical energy from enormous works, in which full advantage can be taken of the large output and good diversity and load factors to enable the attainment of far greater economies in production than have hitherto been possible.

There are four manners in which such a scheme can be carried out. The method which suggests itself as most obvious is an amalgamation of the companies and the building of two or three joint power houses of large dimensions and on suitable sites for economical working. Unfortunately the existing companies would not be able to obtain sanction for such an amalgamation, and, moreover, unless they obtained a prolongation of their powers so far as the new works were concerned and something almost equivalent to a guarantee that electrical energy would be bought from these new works for a number of years after the expiry of the Provisional Orders in 1931, they would hardly consider themselves justified in carrying out a project of this magnitude. The second alternative is the formation of a new company such as the Administrative County of London Electric Power Co. under more favourable conditions than the existing ones. To allow such a company to compete with the existing companies, who have to work under the disadvantages we have mentioned, would obviously be unfair; but a working arrangement was arrived at between the old companies and the new one last year, by which these difficulties were evaded. The failure of the Administrative County of London Co. to get its bill through the House of Commons before the end of the session enabled the London County Council to formulate its scheme, which is the third of four alternatives we are considering. Briefly, the London County Council proposes to complete its present tramway generating station at Greenwich, and to erect in the course of a few years an additional works at Battersea. From these two power houses it would supply any of the existing electricity undertakings (companies as well as local Borough Councils) in bulk, leaving it entirely to them to cater for the power users. But if a central authority for electric power supply is established, it must be in a position to supply not only to retailers but also to the larger manufacturers direct, and to the large suburban railway companies as well as to the tramways. In addition to this there must be some method to prevent the retail distributor from charging too high a price to the power user. In the L.C.C. bill an attempt was made to meet the last difficulty by giving it power to appeal to the Board of Trade to consider whether any particular "authorised distributor" was not charging too high a price; but it is not the actual scheduled prices but the lower prices and discounts for power contracts which should be in question, and, moreover, the obligation to supply at a reasonably low price in any part of the area should extend to the bulk supplier as well as to the distributor. Certain modifications in this sense have been agreed to, but they still leave this one of the weakest points in the scheme, and it can hardly be remedied, for the Council have insisted from the outset that an essential feature of the Bill is that its provisions are merely "permissive" so far as their exercise by the Council itself is concerned. Another grave objection to the scheme is the general character of slowness and costliness that has always attached to work undertaken by the London County Council, for its whole organisation, hedged in with standing orders and formalities, cannot possibly act with the promptness and decision necessary for the conduct of a big commercial undertaking of a new character.

This objection applies also to the fourth alternative which has been proposed in some quarters, and would be the most rational solution of the problem if the electric power supply industry were an old one instead of a new one. We refer to the suggestion that an Electricity Board should be formed on much the same lines as the Metropolitan Water Board, and that it should control the whole supply of electricity in London. Such a scheme would take years to put into force, however, for first would come lengthy arbitration to decide on the value of each of the existing undertakings—29 in London itself and 23 in the surrounding area—and, by the time the necessary formalities were completed and the building of the new large power houses had been commenced the power consumers would have been compelled to move their works to a more progressive district where they could obtain what they wanted at once.

We await with interest the conclusion of the proceedings before the House of Commons Committee and the presentation of the Committee's report. This will only be of utility, however, if it really deals, as it should, with the whole broad question of electricity supply in London, and not merely with the question, which has now become rather a political than an engineering one, whether the London County Council Electric Power Bill shall be sent up to the House of Lords for rejection.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electric Machine Design. By H. F. Parshall and H. M. Hobart. (London: Offices of *Engineering*.) £2. 2s.

The volume before us needs no higher recommendation than the statement that it is a revision and an enlargement of the same authors' well-known standard work entitled "Electric Generators." The general scheme of arrangement is the same, but many additions have been made in all parts of the book, introducing examples of progress in electric machine design which have made their influence felt since the appearance of the original book. As the new title indicates, there has been some widening in the scope covered, as the broad principles of design investigated extend into subject matter not strictly comprehended by the former designation. In the earlier part of the book due weight is given to the importance of the testing and examination of the properties of the materials employed in dynamo construction and a good résumé of some of the magnetic testing work of Ewing and other investigators is given, including some interesting notes on the mysterious effects of "ageing" on sheet iron. Of no less vital importance are the properties of different insulating materials and the effects of variations in temperature and in the time of application of the impressed voltage, which are dealt with to some length in a succeeding section. The general principles of the disposition of armature windings follow, the often seemingly complicated arrangements being made easily intelligible by the clear nomenclature adopted. Machines are afterwards considered in relation to thermal limitations and the estimation of the different losses thoroughly investigated. The design of the magnetic circuit is then followed out, transformers and induction motors being included. Many designers will regret the use of "kilolines per square inch" in this part of the book instead of the more familiar C.G.S. units adopted by most writers. One of the most valuable chapters is that entitled "Constant Potential: Continuous Current Dynamos," which contains a masterly treatment of armature reaction and commutation from the point of view of reactance voltage, including a useful bibliography of Papers on this part of the subject. In the examples of actual designs of machines very full data are given, from a careful study of which much can be learnt. The examples, on the whole, represent up-to-date practice; but one or two of the traction motors selected exhibit features not now adopted in new designs. The treatment of rotary convertors is very full, and deals clearly with the problems which puzzled designers in the early days of these machines. The design of alternators occupies a considerably shorter space than continuous current machines, and two very brief chapters on generators for steam turbine speeds conclude this monumental work. The object which the authors have had in view has been to provide the designer with material useful in his everyday work, and place the results of solid experience at his disposal, rather than to describe new developments and tendencies, and they have produced a volume which, if not a complete record of all the ramifications of modern practice, is a fund of reliable information relating to the materials with which the whole vast structure of present-day electric machine design is built up.

Steam Turbine Engineering. By T. Stevens and H. M. Hobart. (London: Whittaker & Co.) 1906. 21s.

The authors of the many books on steam turbines which have recently appeared have generally aimed at the presentation of the scientific principles on which turbine practice is based. The authors of the book before us have quite a different object. They have made an exhaustive compilation of the results of trials from various periodicals, magazines and reports in order to present fairly what a steam turbine can do. The book will have more interest for the steam turbine user, therefore, than for the student or designer. The latter are, however, well provided for by existing literature on the subject, whilst the special interests of purchaser and user have up to now been somewhat neglected.

The authors first give data of cost and weight collected from existing installations, and from these it appears that the initial cost of the turbine plants is slightly more per kilowatt than the cost of piston engines. A necessary chapter on nomenclature and units follows this, because the authors express results generally in units, which are unusual with English steam engineers. For instance, the comparative weights of piston engines and turbine engines are given in "metric tons," a metric ton being equal to 2,204 lb. or 1,000 kg. The results of steam consumption in some cases are given in pounds per kilowatt-hour, in other in kilogrammes per kilowatt-hour. The tables of constants and conversion ratios are so complete in this chapter, however, that no difficulty will be experienced in finding the proper factor to convert the results to any system the reader may desire.

The next 10 chapters are devoted respectively to the Laval, Parsons, Curtis, Rateau, Zoelly, Riedler-Stumpf, A.E.G., Hamilton-Holzwarth, Elektra and the Union steam turbines. In each case a description is given of the mechanical features of the turbines, with illustrations of details, drawings of the blades, methods of governing, &c., and then data of steam consumption under various conditions of load, initial pressure, vacuum and superheat, collected from various published tests, are discussed and exhibited in tables and in curves. Naturally the information regarding performance is more complete in the cases of the Laval and the Parsons turbines, and in both these cases the figures given are exhaustive. No test of value has escaped the scrutiny of the authors. One of the most interesting chapters of the book follows next. Average results of steam turbine performance are here contrasted with average results of piston-engine performance, and the curves illustrating the discussion bring out clearly the peculiarities of the two types. Thus it is easy to deduce from the results shown that the economy of the steam turbine is not much affected by variations of the initial pressure. It is stated, for example, that in the case of the Parsons turbine a decrease of the initial pressure from about 225 lb. per square inch absolute to 185 lb. per square inch absolute only increases the consumption of steam 1 per cent. Such a change in the initial pressure in the case of a piston engine would be accompanied by a much greater change in the consumption. On the other hand, the influence of a good vacuum is paramount in the case of the turbine, and is not so great in the case of the piston engine.

The steam pressure, superheat, and vacuum in plants in actual operation are discussed in Chapter XVII., and then follow short chapters on condensers, foundations, buildings, Chapter XXI. giving some account of boiler and superheater surface used in actual installations. Some examples of existing steam turbine plants are illustrated, and then follows a chapter on marine steam turbine. The authors here give all the published results available in this interesting development of the subject. It is impossible to write a chapter which shall be adequate to the importance of the marine steam turbine at the present time because of the difficulty of obtaining information. The authors clearly define their position by the statement that their "purpose is to bring together as much data on the application of the steam turbine to marine work as those who have the information are willing to have published," and this they have done. There is a final chapter on the bibliography of the subject, arranged in five sections—namely, A, Steam turbine engineering in general; B, Particular plants; C, Superheated steam; D, Condensing plants; E, Marine installations, the references being arranged in order of their dates. This chapter will be found most useful to all interested in the subject, being the most complete of its kind which has yet appeared. The book has many illustrations, some of them being reductions from working drawings and some being photographs of actual plant. The authors have succeeded at infinite labour in collecting data and in placing before engineers what can be accomplished by the steam turbine at the present time.

Electric Transmission of Water Power. By Alton B. Adams. (New York: McGraw Publishing Co.) $3 net.

We have in this work another consignment of records of American practice with some discussion thereon from the point of view of the American engineer. With little experience of this important branch of electric power development and transmission work at home, we must perforce look abroad to learn the experience of others, but the varying climatic conditions and the more stringent official regulations of this country must be carefully considered in conjunction with the practice across the water.

The author gives us little that is useful towards the initial development of water-power schemes, with reference to the civil engineering side of the question and the design and equipment of generating plants, and concerns himself more with transmission lines. The volume certainly commences with several chapters on the more general aspects of hydro-electric schemes, such as their utility, development and location, and the more physical questions of cost of conductors, station and alternator design and transformers, but, beyond two chapters on the physical limits of electric power transmission and continuous current *v.* alternating, we fail to find anything in this earlier part of the book beyond the mere record of some interesting and more or less vital statistics of some dozen and a half existing plants. This information might well have been included in a few well-chosen tables, and much space and rather tiresome repetition avoided. Not so, however, with the latter part of the publication. When the author comes to line equipment some useful discussion takes place, and interesting records are given of experiments and observations from working results. Guard wires *v.* lightning arresters or combination of both are discussed and instances of their use and results quoted.

As regards materials for line conductors, the author favours aluminium to such an extent as to refer to the "victory of aluminium." Insulator pins and their design are treated thoroughly, but the comments are confined mainly to wooden pins. The chapter on insulators deals rather with their requirements and testing than their manufacture and construction, and interesting facts and observations are given on arcing and silent discharge in snow and rain and over damp surfaces. The volume concludes with a chapter on steel towers.

A point to be noted about this latest addition to works on long distance transmission is the entire absence of even the most elementary mathematics and formulæ. Yet many crucial points on induction, the distance apart and cost of conductors, inductance and impedance of choking coils and resistances in connection with lightning arrestors, and a host of others may be presented more truly and simply to the mind by simple formulæ than by lengthy description, and may be utilised to verify or explain experimental results with advantage. As a record of practical experiment and working results, however, the volume contains much that should interest designers of long-distance transmission systems, and as a discussion on extra-high-tension phenomena with respect to the working of the system it should prove of assistance to those who run such plants

Physical Chemistry for Electrical Engineers. By Dr. J. L. R. Morgan. (London: Chapman & Hall,) 1906.

The author says in his preface that the book before us is not only for the professional electrical engineer, but also for the use of all those who have the same object in view—namely, the attainment of a knowledge of physical chemistry which shall be sufficient in its scope for the understanding of current work in electro-chemistry.

Chapter I. deals with such fundamentals as atomic and molecular weights, factors of energy, &c. We feel it necessary to register our objection to the gratuitous changes of names which physical chemists are adopting. Why should the word gram-molecule be abbreviated to mole and gram-molecular to molar? Dr. Morgan commences his subject with molecules and then uses Ostwald's abbreviated mole and molar. At any rate the word should not have a terminal "e." Surely it is time that this coining and altering of names ceased. One of the most useful sections in the book is Chapter V., entitled Chemical Mechanics, and deals very fully with the law of mass action.

Chapter VII. deals with electro-chemistry. The study is taken up from a rather mathematical point of view, but this should not matter to an engineer who must have a fair acquaintance with mathematics. The book will undoubtedly be of value to engineers who desire to gain an acquaintance of the practice of electro-chemistry, but at the same time it will be necessary to study pure chemistry. Our own opinion, however, is that for the carrying out of electro-chemistry on a manufacturing scale, an electrical engineer with a certain knowledge of chemistry should collabotate with a chemist who is not unacquainted with electrical engineering.

Die Oxydation des Stickstoffes in der Hochspannungsflamme. By Dr. Johannes Brode. (Halle a.S.: Wilhelm Knapp.) 2.50m.

In view of the impending exhaustion of the Chili nitre fields, the increased activity of chemical and electrical research in connection with the artificial oxidation of nitrogen is natural and opportune. Some progress has recently been made in purely chemical methods by the combustion of hydrogen, followed by a sudden cooling. In the present treatise the efficacy of the high-pressure alternating arc is studied. The author transformed a single-phase current of 50 ∾ per second to 6,000 volts by means of two transformers. His electrodes were hollow Nernst filaments 2mm. in external diameter, mounted in a glass globe of four quarts capacity. In one experiment, with a distance of 5·5mm. between the electrodes, a current of 0·055 amperes, and a power of 25 watts, the percentage of NO in the flame was 6·4. This fell to 4·7 on increasing the current to 0·17 ampere. This fall must not be attributed to the increase of temperature, since a higher maximum temperature in the green portion of the flame means a greater evolution of NO. It is due to increased reversal of the oxidation in the other portions of the flame. The cost of power amounts to about double that involved in the electrolysis of the nitrides of lithium or sodium, where the kilowatt-hour is calculated to yield 195 grammes of nitric acid. But in this process the cost of handling is very considerable. The most formidable rival of the electric method is, so far, the carbide process, notably Frank's cyanamide carbide, a ton of which binds 250 kg. of nitrogen. This gives a yield of 175 grammes of nitric acid per kilowatt-hour. Both processes are well able to compete with commercial nitre as regards the absolute chemical value of the products, but this may be very different from their agricultural value. A mixture of nitrous gases does not become useful to the agriculturist until he can handle it conveniently. Attempts have been made to absorb the gases with lime water, but the resulting mixture is very hygroscopic. A similar problem has been brilliantly solved in the manufacture of sulphuric acid, and it will probably be solved also for nitrogen long before 1923, the date assigned to the exhaustion of Chili saltpetre.

ATMOSPHERIC ELECTRICITY AND TREES.

A recent number of the *Electrical World* contains an interesting article by Prof. A. G. Mc Adie, of the United States Weather Bereau, on "Atmospheric Electricity and Trees." The first part of the article deals with the effect of sunshine on transmission of wireless messages. In Marconi's long distance experiments in 1902, it was evident that transmission at night was more effective than during the day. This difference was attributed to the discharging effect of sunlight upon the vertical wires. The effect was also noticed by Solari in the experiments on board the "Carlo Alberta," and is, of course, of a similar nature to the influence of light upon the polished discharge knobs of his apparatus noticed by Hertz. The subject has also been studied by Major G. O. Squier, of the United States Signal Corps, who conducted a series of experiments, using trees as receiving stations. (See *The Electrician* Vol. LIV., p. 836.)

It was shown that a marked difference in efficiency was noticeable in the various trees, and that a tree with a small amount of leaf surface gave poor results, a dead tree acting almost as an insulator. A curve showing the variations in resistance of a large eucalyptus tree was obtained which showed that the maximum changes occurred at times when the general influence of the sun is withdrawn in the evening and appeared again in the morning. It is suggested that such changes might well be studied with the aid of recording instruments, and the fact established whether or not during the night hours there is a minimum of electrical activity in the atmosphere, while during sunlight a rapid ionisation takes place, resulting in a marked disturbance of the electrons and a consequent dissipation of electrical energy. Making use of this principle, it might be possible to devise a sunshine recorder more sensitive than those now in use.

The second section of the article is devoted to the behaviour of trees during thunderstorms, and is illustrated with some photographs of trees which have been struck by lightning. Satisfactory explanations of the reason why some trees are apparently so much more liable to be struck by lightning than others have not as yet been given. The oak, for example, is especially liable to injury; but, on the other hand, the beech is only infrequently affected. The character of the root is doubtless an important factor. Living trees behave differently from those which are decaying or dead. Dead trees when struck exhibit similar effects to flagstaffs, and are chiefly splintered at the top. In a living tree, however, it would appear that the shattering effect is more pronounced in the trunk about midway between the ground and the foliage. It is pointed out that in the case of electrical oscillations of high frequency conductivity becomes a matter of the amount of surface area rather than of the volume, and it is likely, therefore, that in the case of lightning the conducting layer penetrates little further than the outer bark. Some of the illustrations show very remarkable effects, a noticeable point being the frequent lack of any vestige of the effect of the lightning stroke on the trunk of a tree struck above the point of splintering or fracture, and also the absence of disturbance of the ground at the roots of the tree. Attention is called to the excellent "earth" made by the roots of a tree, and indeed it has been found in a wooded country that a much better earth could be obtained by driving an iron nail into the trunk of a tree or shrub than by the ordinary method of burying a conductor plate. It is suggested that it might also be practicable to study the differences of potential between the tops of trees and the roots; and to determine whether the trunk portion of a tree maintains the potential of the ground during a thunderstorm, or whether there are momentary marked differences of potential at points on the trunk system, and corresponding nodal points increasing liability to side flashes. The effect of lightning upon trees might also be studied by microscopic analysis of wood specimens.

Some interesting observations upon trees struck by lightning are given by K. E. F. Schmidt in *Elektrotechnische Zeitschrift* for September 7, 1905. The track of the discharge seemed to be along certain grooves, following the grain of the wood. By injecting staining fluid in the roots of some maples and oaks it appeared that this was carried slowly up the trunk in certain narrow paths. It was therefore argued that the electric discharge probably passes from the top branches to the roots along these paths. For wireless work one connection should be made at that portion of the trunk where one of these lines of communication can be tapped, and the other connection with the branches corresponding.

The latter part of the article contains a detailed account of some experiments carried out by Mr. W. W. Thomas, in charge of the Weather Bureau Office at Mount Tamalpais, on wireless telegraphy with trees, bearing chiefly upon the conductivity of freshly cut trees. The apparatus used consisted of two aerials, each 20 ft. in length and composed of seven strands of No. 14 copper wire. The receiving set consisted of a portable outfit, comprising a wave detector and necessary adjuncts. The sending set consisted of the usual coil and aerial and a special device for making and breaking.

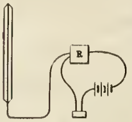

Fig. 1.

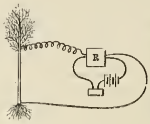

Fig. 2.

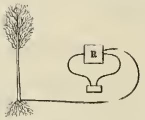

Fig. 3.

The object of the experiment indicated in Fig. 1 was to test the effectiveness of the apparatus. A portable receiver, R, was connected with the vertical, there being no ground connection. The signals could be plainly heard in the telephone. The experiment of Fig. 2 was to test Squier's statement that electromagnetic waves are received by a living tree. Receiver R was connected with a living bush having luxuriant foliage, 15 ft. high and 200 ft. from the sending station. The signals were heard easily, thus confirming Squier's view.

In the experiment indicated in Fig. 3, the foliage and the trunk of the tree was eliminated to test electromagnetic effects through the ground. The signals were heard, but less distinctly. The object of the experiment shown in Fig. 4 was the elimination of trunk and roots, and to test whether signals could be heard with the receiver insulated. Neither ground wire nor vertical was used. The signals were heard.

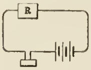

Fig. 4.

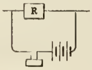

Fig. 5.

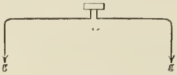

Fig. 6.

Fig. 5 shows the circuits used to test the capacity of two insulated wires, each 25 ft. in length, connected with the receiver only. The signals were heard distinctly from a distance of 600 ft. In Fig. 6, two wires were connected with a telephone receiver and the loose ends earthed 30 ft. apart. No battery was used. The vertical was removed from the induction coil, but one terminal of the coil remained connected with the earth. The signals were heard distinctly. It is seen, therefore, that electromagnetic effects can be detected regardless of trees and roots, unless it be that the surrounding trees and root systems act as antennæ.

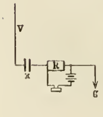

Fig. 7.

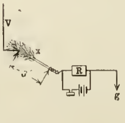

Fig. 8.

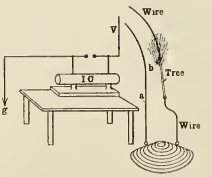

Fig. 9.

The receiving apparatus was then set up as shown in Fig. 7, 600 ft. from the transmitting station, and the strength of the signals (which were clear and very distinct) were carefully noted. The vertical was parted at X, and a live bush, full of sap, and about 10 ft. in length, which had just been cut off at the roots, was introduced into the break, as shown in Fig. 8, at B; the bush thus became a part of the aerial; not the faintest signal could be heard. The arrangements were alternated a number of times with the result that signals were always heard with the former and never heard with the latter arrangement. The bush failed to conduct the oscillations. The effect is the same as introducing impedance.

The sending apparatus was next set up near a large coil of cable (lead-covered). The spark-gap was set at about ⅛ in. Two wires, *a* and *b* (Fig. 9), were attached to the sheathing of the cable and the loose ends placed conveniently near the vertical; *b* was parted and a live bush was introduced into the break. Upon touching the vertical with *a*, while the coil was in operation, sparks ceased to cross the gap, but touching the vertical with *b* made no apparent reduction in the amount of spark crossing the gap.

In the experiment shown in Fig. 10 the vertical was erected at a railroad track 300 ft. from the wireless station. A capacity was used as a ground for the receiver. An insulated wire, O, was connected with one of the rails of the track, and the loose end was placed conveniently near the receiver. An insulated wire, M, was connected 10 ft. above ground to a young tree 30 ft. in height, and the loose end of the wire placed near the receiver. Loud and clear signals were heard through the receiver without either O or M being connected with the receiver. Upon holding O against the vertical at X the signals disappeared at once. On removing O and connecting M with the vertical at X the signals reappeared as clearly and distinctly as at first; O and M were alternately connected at X several times with the same results in each case, as first shown. The contact M was then moved down the tree and again alternated with O in connections with V at X, but with the same results. The wire O would readily conduct the electrical oscillations from the vertical to the ground at the rail, thus cutting out the receiver entirely, but the tree would not so conduct the oscillations from the vertical to the ground. Changing the position of M on the tree made no apparent difference in the results obtained.

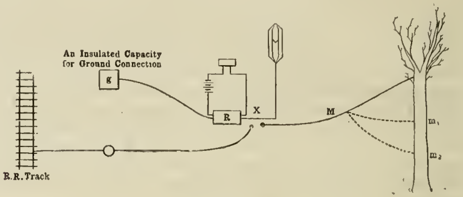

Fig. 10.

While making experiment shown in Fig. 11 it was found that a long insulated wire hanging over an embankment acted as a vertical; hence the arrangement in this experiment. The upper end of the wire M was connected to the receiver, and signals were heard distinctly. Connecting M to a small tree 30 ft. below made no apparent difference in the strength of the signals; M was connected further and further down the tree, but the results remain unchanged.

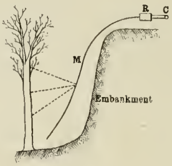

Fig. 11.

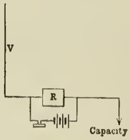

Fig. 12.

The receiving apparatus in the next experiment was arranged as shown in Fig. 12. The signals were loud and clear. The vertical was then released from the receiver and connected to a small tree at a point, X, 3 ft. or 4 ft. from the ground (Fig. 13), while the receiver was connected by a short wire to the same tree at a point, Y, about 1 ft. from the ground. Not the faintest signal could be heard. The contact X was made closer and closer to Y, but still no signals were heard. When X and Y were finally brought in contact the signals reappeared with the same strength as when the

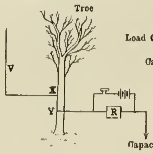

Fig. 13.

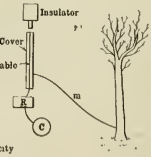

Fig. 14.

vertical was connected as shown in Fig. 12. This is similar to the second part of the experiment in Fig. 8, and proves that the tree trunk acts as an impedance. The same result would follow by the introduction of a choke coil. Squier notes that even 100 ohms will materially modify the signals.

In the experiment represented by Fig. 14 a section of nine conductor lead-covered cable, 15 ft. long, was suspended in free air from an insulator. The sheathing was ground by a wire, *m*, leading to the root of a tree. On connecting the cable wires to the vertical pole of the receiver, the signals were heard distinctly. The distance was 600 ft

The vertical used in the next experiment was 50 ft. long and cage-shaped. A primary ground wire of insulated copper wire with several branches was connected to green scrub oaks at the earth line, as indicated in Fig. 15 A secondary ground, consisting of a single copper wire, was connected to the top of a green scrub oak. Signals from the sending station, 400 yds. distant, were plainly heard without any ground connection and receiving box insulated from earth. The signals were slightly increased on introducing a primary ground. When both the vertical and the primary ground were connected to the vertical post the signals were greatly reduced, but were not entirely eliminated. The secondary ground wire had no effect whatever upon the strength of the signals.

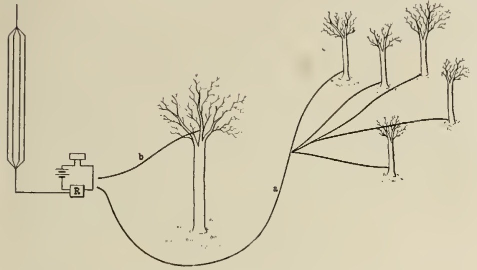

Fig. 15.

The two wires of a head telephone A and B (in the arrangement shown in Fig. 16) were connected near each other at the base of a tree. No signal was heard. When B was moved higher, as shown at B_1, B_2, B_3, the signals increased in strength until B_4 was reached. When the terminals were left at A and B_4 and the vertical was disconnected from the induction coil, signals were heard as before. When the vertical was replaced and the ground wire of the coil was disconnected no signals were heard. The distance was about 50 ft.

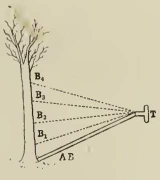

Fig. 16.

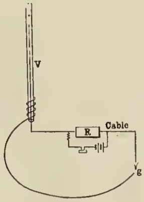

Fig. 17.

In the last experiment, there was used a section of lead-covered cable (Fig. 17), 15 ft. in length, having its sheathing earthed, and its inner wire connected to R, and no electrical connection between the sheathing and the inner wire. A roll of wire netting having a fine mesh was wrapped round R, completely covering it, top, bottom and sides. The telephone wires were kept entirely within the wire covering. Signals were heard, and they were scarcely less distinct than those heard when the netting was removed. The only openings in the wire covering were those just sufficient to admit the aerial and the ground wire. These openings, however, although small, were sufficient to admit enough radiations to distinctly affect the receiver.

Royal Society.—Among the Papers down for reading yesterday was one by Prof. E. Wilson (communicated by Sir W. H. Preece, K.C.B., F.R.S.) on "The Effects of Self-Induction in an Iron Cylinder."

DIRECTED WIRELESS TELEGRAPHY.

The patent, No. 16,655 of 1905, relating to the system of directed wireless telegraphy described by Mr. Marconi in his recent Royal Society Paper, has now been issued by the Patent Office. The complete specification is as follows :—

The object of this invention is to provide improved apparatus for use in wireless telegraphy, whereby the efficiency of the apparatus can be largely increased, 1st, by limiting the receptivity of the receiver to electric influences coming in a certain assigned direction only, and 2nd, by eliminating from the receivers, the undesired and disturbing effects of atmospheric or other electric waves.

The invention is based on the discovery that a horizontal wire, having a length equal to one half the wave length sent out by the transmitter, if laid parallel to the earth but insulated from it has electric oscillations set up in it only when it is placed substantially in a radial direction with respect to the transmitting centre and also is quite unaffected by atmospheric electrical disturbances.

According to this invention in place of an earth connection and an elevated conductor at the receiving end, we employ an insulated or practically insulated conductor lying in a horizontal or substantially horizontal straight line, preferably raised above the surface of the ground or water. The said conductor is divided into two parts preferably at the centre, and between the two parts is placed and connected any suitable receiver or dectector of electrical waves, such as a magnetic receiver.

It is found that such a receiver is practically only operated by oscillations produced at a station situated in the vertical plane passing through the receiving antenna.

The high frequency electric wave transmitter we employ is one consisting of a long horizontal conductor in the same vertical plane as the receiver and preferably arranged with its generator end the nearer to and its tail end farther from such receiver, as described in our Specification dated the 14th of July, 1905, No. 14788.

When using the above described horizontal antenna as a receiver, it is desirable that the total length of its two parts should be approximately half a wave length of the transmitted oscillations, or its length may be half a wave length multiplied by an odd number, and several conductors laid side by side and connected together may be advantageously employed.

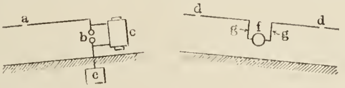

Fig. 1.

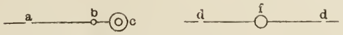

Fig. 2.

If the conductors should not be of the desired lengths they can be tuned to respond to the desired frequency by the introduction of suitable amounts of inductance or capacity or both.

As the receiver will give the best results only when placed in a radial position as regards the transmitting centre, it may be used with great advantage to determine the direction of a transmitter, such as, for instance, on a ship at sea.

The receiving antenna above described may be completely insulated from earth, or may, under some circumstances, be connected to earth through suitable choking coils or resistances which will prevent any undue accumulation of tension caused by atmospheric electricity.

The antenna may also be connected to the spark-gap or detector as the case may be through condensers or inductances—in fact, any of the usual adjuncts to the vertical aerial or antenna may be used.

Figs. 1 and 2 are a diagrammatic elevation and plan respectively of transmitting and receiving stations at a considerable distance apart and equipped with horizontal transmitting and receiving antenna as above described. In these figures the transmitting station is on the left *a* being the horizontal antenna which is connected to the earth *e* at its generator end, a pair of spark balls *b* being inserted in the earth connection and these are shown as usual connected directly to an induction coil *c*, but in place of the spark balls and inductance may be inserted or the coil of an oscillation transformer so as to create in the antenna *a* electric oscillations by inductive action in the usual manner.

In correspondence with this transmitting station is the receiving station on the right in which *d* is the horizontal receiving antenna divided into two parts each connected to the detector *f*.

Two slanting or vertical wires *g* may be employed to connect the detector to the two parts of the antenna *d* when these are placed at a height above the earth.

There are two claims : (1) In a system of wireless telegraphy a substantially horizontal receiving antenna, divided into two parts each connected to a detector between them in correspondence with a substantially horizontal transmitting antenna in the same vertical plane substantially as described. (2) In a system of wireless telegraphy a substantially horizontal receiving antenna, divided into two parts each connected to a detector between them, in correspondence with a substantially horizontal transmitting antenna in the same vertical plane and having its generator end nearer to the receiver than its tail end substantially as described.

THE EBULLITION OF METALS.

M. Moissan delivered a pleasing discourse on this subject at the Royal Institution last Friday, and, in spite of the approach of the Whitsun holiday and the fact that the lecture was in French, there was a large attendance. The chief feature of the lecture was the distillation of gold before the audience by means of a furnace in which an arc taking 700 to 800 amperes at 110 volts was employed. Some of the vapour arising from the furnace was allowed to condense on a glass globe, and showed the distinctive colour possessed by the "purple of Cassius." 150 grammes of gold were used for this experiment. M. Moissan explained how it was that the furnace could be used to reduce refractory oxides which it was impossible to reduce in the oxyhydrogen flame. He also recapitulated the results of his series of experiments with other metals. By taking 150 grammes of each of the following rare metals in turn and subjecting them to the heat of a 500 ampere 110 volt arc in his furnace for three minutes he distilled the following quantities: Ruthenium, 10 grammes; platinum, 12 grammes; palladium, 9·6 grammes; iridium, 9 grammes; rhodium, 10·2 grammes. Osmium is more refractory, but a 700 ampere arc for three minutes distilled 29 grammes. He had been able to experiment with comparatively large quantities of rare metals through the kindness of Mr. Matthey, and he related with a smile that a spectroscopic analysis of the dust of his laboratory revealed a brilliant mixture of these owing to the escape of the metal vapour from his furnace. Iron was one of the most difficult metals to boil and distil. Using 300 amperes at 110 volts he had succeeded in boiling off 14 out of 150 grammes in five minutes. With 1,000 amperes at 55 volts, applied to 825 grammes of the metal for 10 minutes, 150 grammes had been distilled; and with 1,000 amperes at 110 volts for 20 minutes, 400 grammes out of 800 grammes. With molybdenum, no effect could be obtained with 700 amperes at 110 volts applied for 10 minutes, but, after 20 minutes in the furnace, 36 grammes out of 150 grammes were volatilised. A 500 ampere arc at 110 volts applied to 150 grammes of uranium for three minutes had no effect at all, but on increasing the current to 700 amperes and applying it for five minutes 15 grammes were distilled. Finally 200 grammes of uranium were completely volatilised in nine minutes by a 900 ampere arc at 110 volts. By making such experiments as these with different metals under precisely similar conditions he was able to compare their boiling points and thus get a rough idea of the actual temperatures at which they boiled. This enabled an estimate to be formed of the temperature of the sun, for it was known by the spectroscope what metals the sun contained. He estimated the temperature at about 3,500 deg. abs., which approximated most closely to the figures given by Violle, and was considerably less than the high values estimated by other physicists who had worked at the problem. No material had proved absolutely refractory to the electric arc, and he had succeeded in melting every metal within a few minutes. In none of the experiments had any allotropic forms of the metals been found; but gold had dissolved carbon, and other carbides had also been obtained. Among the interesting facts mentioned was that the carbon rods were purified by the high temperature are. On cutting sections at various distances from the ends and examining them spectroscopically, it was found that, near the ends, the carbon had become perfectly pure, but as he proceeded further from the ends traces of iron, manganese, silicon, &c., were met with in increasing quantities.

ELECTRICAL EQUIPMENT OF A GAS ENGINE FACTORY.

A novel feature of the works of the Olds Gas Power Co. of Lansing, Michigan, is that nearly all the power used is generated by engines under test. After assembling, the engines are placed upon a foundation with slotted rails, called the working-down stand, on which the bearings, cylinders and other wearing parts are worn down to good bearing surfaces, the power being derived from a line shaft driven by other power. When in condition for operation they are taken to the testing stand, and after test to the paint and packing rooms.

On a long foundation adjacent to the testing stand there are located eight generators with an aggregate capacity of 168 kw., and ranging from 35 kw. to 10 kw. Each generator has its individual switchboard. These generators are compound wound for 250 volts, direct current, constant potential. Generators of different capacities were installed to provide one of suitable size to load each engine manufactured by the company, the engines ranging from 18 H.P. to 50 H.P.

The method used in testing the engines is considered much more accurate than a Prony brake. After each engine is taken from the working-down stand it is placed on the testing stand and run for a short time with its own power. It is then belted to a generator of suitable capacity and run on a water rheostat until it is capable of carrying sufficient load to warrant connecting its generator in parallel with the other machines, at which time it is connected in parallel with the others by throwing over a three-pole double-throw switch on its switchboard. A pilot light is provided upon each generator switchboard which is lighted whenever a generator is carrying a water rheostat load, thus preventing the accidental connection of two generators in parallel on the rheostat without notice.

After the engine has run for a sufficient length of time to enable it to develop 10 per cent. more than its rated brake horse-power the generator is again connected to the water rheostat and the engine is given its test run. The power developed by the engines is at all times shown by indicating wattmeters, one of which is mounted on each switchboard. These instruments are of the horizontal edgewise type with two scales, one above the needle and one below. One scale is graduated to read directly the kilowatt output of the generator with which it is connected, and the other scale to read the corresponding horse-power delivered to the generator pulley. To obtain the various points of this second scale, the various kilowatts output were reduced to corresponding horse-power and then multiplied by the efficiency of the generator with which the instrument was to be used. The generators were all tested at the factory by the Westinghouse Company, and copies of the efficiency curves were furnished to the instrument makers for use in calibration. By the use of one of these instruments the brake horse-power delivered to a generator which is being driven by an engine under test is accurately indicated at all times. If there should be much slipping of the belts, this power, of course, would be less than that generated by the engines; but, as all the generators have belt-tightening bases, this slipping can be made so small as to be practically negligible. At all events the reading will not favour the engine, and the power delivered at the engine pulley will be equal to or greater than the reading of the instrument.

Again, should a generator be operating at a lower efficiency at the time of the test of an engine than at the time of the factory test of the generator, the reading of the wattmeter will be less than the horse-power delivered to the generator. Consequently, the maker of the engine is always abundantly safe in guaranteeing the output as obtained by the readings of one of these wattmeters.

In addition to the three-pole double-throw generator switch, the water rheostat pilot lamp and the indicating wattmeter already mentioned, each generator switchboard is equipped with a circuit-breaker, an ammeter, a voltmeter, the field rheostat for the generator, an earth detector and two lamps, one connected to the main 'bus bars and located over the voltmeter and one connected to the generator leads and located over the ammeter.

The equalisers for the generators are all connected through the middle blades of the three-pole switches to a short equaliser 'bus bar near the 35 kw. machines, the endeavour being made to keep the connection to the generators of such size and length that the drop in potential over them will be the same in each case if the equaliser connection carry the full load of the generator.

A room has been provided in the basement under the testing department for the future installation of a storage battery so that, if there should come a time when the ordinary shop load would not be sufficient to provide loads for testing, the storage battery can be charged and then discharged on night loads for lighting and the operation of heating fans and for extra heavy day loads. As a further provision for additional load, a second water rheostat has been provided with a connection from the 'bus bars on the distributing switchboard. This water rheostat is controlled by a switch on the distributing switchboard and a single-pole circuit-breaker is connected in one side of the circuit. Up to the present time, however, the shop load has been more than sufficient to provide loads for testing purposes, and there has been no need for the use of a storage battery or the second water rheostat.

It may be interesting also to note the method of operation of the water rheostats. Each rheostat consists of an open steel tank, which forms the negative electrode, and a steel plate suspended inside and insulated from the tank, which forms the positive electrode. The tank is also insulated from the ground. The electrical connections to the two electrodes are made by means of lead-covered cables.

The saline solution, which may be made of any desirable strength by the use of variable quantities of salt and water, is forced by means of compressed air into the tank from a closed supply tank in the basement. The connection from this tank to the rheostat is of lead pipe incased in extra heavy rubber hose, and the supply tank is mounted on insulating supports. An air line containing compressed air is run along the basement ceiling under the switchboard, and a connection is made to two three-way cocks at each switchboard, from each of which an air pipe runs to the top of each supply tank. A scale has been provided on the inside of the wall of the building opposite each rheostat, and a pointer operated by a float in the rheostat tank indicates the level of the water in the tank. The operator can then stand at the switchboard and, by throwing a three-way cock in one direction, admit compressed air to the supply tank, and the level of the solution in the rheostat tank will be raised and the load increased. By throwing the handle of the three-way cock in the opposite direction the air in the supply tank is released to the atmosphere, the water in the rheostat tank runs back into the supply tank and the load is decreased. Thus, by the operation of the three-way cock, the load may be adjusted to any desired quantity. One three-way cock is used for each of the rheostats above mentioned.

In conclusion, it may be noted that practically all the time since its installation the plant above described, with the assistance of one 50 H.P. unit, has carried its load of 250 to 450 amperes with but few interruptions and with but minor difficulties.

FARADAY SOCIETY.

At a meeting of the Faraday Society on May 15th, Dr. F. Mollwo Perkin in the chair,

Mr. H. D. Law read a Paper entitled

"Behaviour of Platinised Electrodes."

The author desired to find an electrode on which the reduction of the aromatic-aldehydes and similar easily reducible compounds could not be effected. Platinised platinum, as being the metal from which hydrogen is liberated at the lowest potential, was tried as the cathode in an acidified alcoholic solution of benzaldehyde. At first, energetic reduction took place; the activity of this, however, diminished in successive experiments, and was extremely small after 12 hours' polarisation. The cause of the reaction is obscure; it is probably catalytic in its origin.

Dr. N. T. M. WILSMORE drew attention to Tafel's work, which the author's results appeared to contradict.

Dr. PERKIN remarked on the differences between lead and platinum electrodes, and discussed the general bearing of the author's experiments.

Mr. Julius L. F. Vogel read a Paper on

"The Electrolysis of Fused Zinc Chloride in Cells Heated Externally."

The author begins by explaining that the work which formed the subject of the Paper was carried out for the most part between 1898 and 1901, and could be conveniently divided into three periods. He then explains how the investigation came to be undertaken; the original inception of the process was due to the late F. Maxwell Lyte, who took out patents for a complex ore process involving the electrolysis of fused zinc chloride and for the dehydration of zinc chloride. The process as such was never investigated practically. The second period deals with the investigation of the dehydration of zinc chloride by evaporating under reduced pressure, and the electrolysis of the salt in a fused state in externally heated cells by Dr. O. J. Steinhart and the author jointly on behalf of the Smelting Corpn. (Ltd.) The various experiments and the apparatus employed for these experiments are described. The third period deals with the further investigations made after the United Alkali Co. had joined the Smelting Corpn. in testing the process, and details are given of the work as carried out under the joint supervision of the author's firm and the chemical staff of the United Alkali Co. The author describes how the process was carried successfully to a stage when continuous electrolysis was carried on for 11 days and nights, and 3 cwt. of pure zinc was produced. He then explains how, on the failure of the Smelting Corpn., the work was suspended, and finally abandoned, although further elaborate investigations were undertaken by the United Alkali Co. utilising cells heated internally by the current. The author finally reviews the work done in cells heated externally, and expresses his opinion that the process was "non-proven," and that it still offers possibilities of being carried to commercial success. The Paper is illustrated with sectional drawings of apparatus, and lantern slides, prepared from photographs of the actual plant, were exhibited.

Dr. O. J. STEINHART referred to the production of zinc from zinc oxide by feeding the latter into a molten bath of chloride, after the fashion of aluminium electrolysis.

Mr. W. MURRAY MORRISON mentioned some of the advantages of internal heating with regard to local inequalities of temperature.

Dr. H. BORNS referred to the formation of zinc clouds diffused in the electrolyte under certain conditions, and consequent reduction of efficiency, observed by Lorenz. He asked whether the addition of impurities, such as ammonium chloride, had been tried. Evaporating with HCl was a method of dehydrating the chloride.

Mr. L. GASTER asked for information regarding comparative energy losses in externally and internally heated cells, and also regarding the consumption of carbon.

Dr. G. RUDORF (communicated), after reviewing the various methods proposed for dehydrating the chloride, affirmed that the author's was the only practicable one. He asked for information regarding the effect on the enamel of continuous heating with zinc chloride; his experience was that a perfect enamel was not obtainable.

Mr. J. L. F. VOGEL, in reply, said that the use of a fused metallic cathode and proper temperature and other conditions prevented the formation of zinc cloud. Carbon losses depended greatly on the dehydration; they had not had opportunities of trying Acheson graphite. It was undesirable to add foreign substances, as these would accumulate in time; it was likewise impracticable to dehydrate in the fashion referred to by Dr. Borns. The difficulty in electrolysing a solution of ZnO in fused chloride was that the solubility was slight, and at the high-current densities demanded by practice not sufficient oxide would pass into solution.

ELECTRICITY IN MARKET GARDENING.*

Experiments of much interest in relation to the electrical stimulation of vegetable growth are now being carried on by Hon. Warren H. Rawson, of Boston, at his large market gardening establishment in the suburban town of Arlington, Mass. Mr. Rawson is one of the best-known market gardeners in the vicinity of Boston, and for a long time he has been greatly interested in the problem of accelerating vegetable production by electrical means. He has employed the arc light with success in expediting the growth of vegetables, and the latest development in Mr. Rawson's study of how best to promote thoroughly scientific market gardening consists in the introduction of electric currents into the vegetable beds themselves, and thus far the results obtained have been sufficiently successful to render them full of significant interest.

In November, 1905, Mr. Rawson, acting in connection with Mr. Reuben Le Baron, supervisor of wires, and a practising electrician in the town of Arlington, began to experiment with currents of exceedingly small magnitude in the lettuce beds of one of the largest greenhouses on his Arlington estate. The soil had been previously sterilised by heating. It was found that if a copper plate was sunk in the loam and fertiliser of the bed at one end of the house, and connected by an overhead wire to a zinc plate sunk in the bed at the other end, a current measurable on a milliammeter flowed constantly through the wire, and a P.D. of about 0·5 volt was found to exist between the terminals. No current was supplied from any outside source; the entire flow occurred as a result of the chemical action of the ammonia and other salts in the bed upon the zinc plate. The bed acted simply like a large battery cell, and the current measured varied in value from about 0·4 milliampere to almost 15 milliamperes.

One of the beds in the house was separated from the bed in which the plates were sunk, in order to compare the growth of the electrically-stimulated plants with the growth of plants subjected merely to the usual gardening care. It was found that the electrically-treated lettuce grew enough faster to be ready for market a week ahead of that in the ordinary bed, and the heads were also larger in size. The saving of a week's time in this way means a considerable financial gain to a large market garden, where a single greenhouse may contain from 30,000 to 40,000 heads and have an operating value of $40 or $50 a day. The earlier completion of a crop also releases the bed just that much sooner for further production.

The same general treatment is being applied to the production of cucumbers, and while the experiments are still in a rather early stage, it has been found that the yield of the bed has been considerably increased and the foliage of the vines has been much augmented.

Care has been taken to treat the compared beds alike, with the single exception of electrical application. The experiments have been tried in three different sized greenhouses, the largest being 400 ft. long and the smallest about 100 ft. The width of the beds is about 13 ft. each, and the depth approximately 2 ft. Of this depth about 1 ft. consists of manure, which is strongly ammoniacal. The size of the plates used has been varied more or less, and the composition of the soil has been found to have considerable influence upon the results. At the time of the writer's visit the 400 ft. house was equipped with a ½ in. zinc strip at the end of one bed, connected to a No. 16 wire running through the house to a copper terminal which consisted simply of a single bare wire of No. 16 size sunk in the bed at the opposite end from the zinc terminal. An ammeter gave a reading of 4 milliamperes. Cucumbers are being raised in this bed. In some cases it has become necessary to cut down the current by decreasing the plate area, in order to avoid stimulating the crop to a rank growth. In other cases plates 12 in. by 10 in. in area have been used. It is certainly interesting to observe the current flow under the conditions prevailing.

Prof. George E. Stone, of the Amherst Agricultural College, has become greatly interested in the experiments at Arlington, and a thoroughly scientific study of all the conditions and phenomena is now in progress. Readings are being taken of the current flow, the size of the crop is being recorded, and all the important facts which might have a bearing upon the production rate and comparative results are being recorded with care. The whole subject is in this country in its infancy, and there is room for an exhaustive study of the different factors which influence the vegetable growth. In many quarters the idea prevails that current is applied externally from the mains of the local electric light and power circuits, but such is not the case. A great deal remains to be found out as to the proper size of plates for various soils and kinds of product, the best current to use, the effect of temperature, moisture, &c.

At first blush it seems almost impossible that a current of a few milliamperes spread out in sheets over a cross-sectional area of about 26 sq. ft. and a bed 400 ft. in length could produce enough chemical action or stimulation of the roots of the plants to make any perceptible difference in the results. The experiments have gone far enough to satisfy the investigators that there is a stimulus to the growth, however, and it is highly probable that in the not distant future a notable gain in the knowledge of forced market garden production will be enjoyed by the agricultural world. The only expense seems to be the cost of installation, which is a very small matter as thus far practised.

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* From the *Electrical World.*

CORRESPONDENCE.

"THE ORIGIN OF LIFE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your Notes of last week on the above subject you make two statements which are, I think, founded on erroneous conclusions. Firstly, you refer to Mr. Burke's claim "to have created living matter" by the action of radium on bouillon. In his book Mr. Burke makes no such claim; he is most careful to insist that, whilst radiobes exhibit the attributes generally associated with living matter, they are really only artificial imitations brought about by agencies of the same order as those that *may* have produced living matter. The difference is important.

Secondly, because Mr. Rudge has discovered that a sulphur contamination in presence of barium is necessary to produce radiobes, you infer that the latter are dead "in more senses than one." If the observations regarding the vital cycle of radiobes are admitted as correct, surely the fact that other constituents besides radium and bouillon are present or necessary in nowise points to your conclusion. Protoplasm contains a percentage of sulphur; and, if it did not, the artificial growths produced by Mr. Burke would still "point the way," which is all that he claims.—Yours, &c.,
V. ZINGLER.

London, June 6.

[So far as we know, the "vital cycle of radiobes" has never been put beyond doubt, and we cannot remember to have seen our correspondent's name in connection with any corroborative experiments.—ED. *E.*]

LEGAL INTELLIGENCE.

Osburne and Others v. Lea, Son & Co.

At Norwich County Court last week Judge Willis, K.C. (with Mr. S. G. C. Russell, A.M.I.E.E., as assessor) heard an action, brought by Dr. Osburne and Misses McClintock, proprietors of a private asylum, against defendants for recovery of £100 for alleged breach of contract and negligence.

Mr. E. E. WILD, for plaintiffs, said that in 1896 defendants installed electric lighting plant at the asylum, which consisted of a Crossley oil engine, a dynamo and a battery of accumulators. The plant worked more or less satisfactorily until about 1903. In that year plaintiffs negotiated with Norwich Corporation for a supply of electricity. These negotiations came to nothing, and then correspondence ensued between the parties to this action, defendants suggesting certain atlerations at a cost of from £130 to £140. Defendants said that if those alterations were carried out the plant would run smoothly for several years without additional cost. They charged £135. 10s. for the installation and £15 for an ammeter, and this amount had been paid with the exception of £12. 8s., and he should ask the Court at a later stage to say it was an excessive charge. The important point was, however, the claim for damages. Defendants counterclaimed for the balance of £12. 8s., and also for £4. 4s. for a commutator for the dynamo. The latter item was not disputed, but the evidence would show that the total cost of the work should not have been more than £80. Mr. Wild said defendants subcontracted for the accumulator cells. Complaint was also made that the plates in the glass boxes should not be allowed to touch. The sections were not properly held together, and the glass insulator rods were not sufficient in number. The plates buckled, the glass rods fell down, there was a short circuit, and the light went out. The ammeter was not properly fixed, and did not record the amount of electricity passing from the cells to the lamps. Complaint was also made of the oil engine, and it was imposssible to supply the lamps from the dynamo.

The JUDGE said the contract was completed by Feb. 1, 1904. The question was whether the work had been done in a satisfactory way. He should ask the assessor to say whether defendant firm supplied everything they should do.

Mr. GRAHAM, for defendants, said batteries were delicate things, and wanted constant attention. If a battery was working successfully for two years he should ask the Court to come to the conclusion that the collapse of the battery was not due to any fault in it when it was put in, but through want of attention.

Mr. WILD replied that plaintiffs' experts considered the failure due to the manner in which the plant was put up. In August last the light went out, and then Mr. Woolnough, of Norwich, was called in to see if be could not make the plant work. He would say that the batteries were in such a state as one would expect after 10 years' working. Mr. Woolnough did the work that was absolutely necessary, and in November delivered his report, which was sent to defendants, who replied that they did not think the battery was in so bad a condition as he had asserted. In February Mr. Broadbent, who was called in by plaintiffs, found that the cells had not been properly erected, and no care on the part of the attendant could have prevented the destruction of the plates.

Dr. OSBURNE said the electric light plant was erected in 1896, and in 1903 he put himself unreservedly in the hands of defendants. The installation was completed about the end of January, 1904, and when his man left in March defendants sent down the man in charge of the erection of the plant (named Herdley) to instruct a man named Chaplin in its working. Chaplin continued in witness's employ up to the end of the year, and kept everything in good order. In January, 1905, Herdley visited the place at defendants' suggestion, but made no complaint as to the way in which things were kept. In August the light went out once or twice, and in September Mr. Woolnough was called in and instructed to patch up matters temporarily. Eventually Mr. Broadbent was called in, and upon his report plaintiff had acted.

In cross-examination Witness said that between January, 1904, and November, 1905, there was no written complaint that the light was bad. He did not complain because it was a little better after Herdley came in January. Witness paid for the work by instalments, but made no complaint when the instalments were sent. In August last defendants wrote to Miss McClintock hoping that the light was going satisfactorily. It was not then going satisfactorily, but witness did not complain.

Evidence of the attendants having been given,

Mr. FRANK WOOLNOUGH, electrical engineer, said that in March, 905, he noticed that the plates of the cells had thencommenced 1to spread, and had allowed the glass separators to fall to the bottom and that the plates at the extreme edge were touching. Witness considered that the plates ought not to have been put into such large boxes. If plate sections of right size had been put in, or a box bought to fit the sections, no harm would have happened. Assuming that the work had been properly done, the plate sections and box would have lasted four years at least. In August, 1905, witness found that no light could be obtained, and that the cells were wasting electrical energy. The battery was useless, and in his opinion this was due to bad arrangement. To put the cells and sections into proper working order would cost £80. Defendants undertook to renew the sections, and it would have been all right if they had done that, but they put in plates too small. An entirely new system such as defendants undertook to put in would cost about £75.

Mr. FRANK BROADBENT said he had inspected the accumulators. Assuming the work had been properly done, the battery ought to have lasted five years. In witness's judgment, new sets of plates had been put into existing glass boxes without supports, and there was no mechanical appliance for holding the plates together. In consequence of there being no supports the glass separators dropped out when the plates began to expand. Having regard to the price paid, witness did not think it was proper value given. The trouble would take some time to show itself to an outside observer, and no amount of care could have stopped the buckling. This was due to faulty erection.

For the defence Mr. F. J. LEA said that during the course of the work at plaintiffs' asylum he found that they could not get an absolutely satisfactory arrangement with the existing engine. He told Dr. Osburne it would not be safe to run direct from the dynamo, for, although it was rather more economical, there was a certain amount of risk, and if the engine stopped, or the belt broke, the whole place would be left in darkness. Dr. Osburne left it to him to do what he considered best. The recording ammeter was put up so as to be a check on the workman, and the cost of it and the erection would be about £12. 10s. With regard to the accumulators, it was an every-day practice to put new plates into old boxes. The plates he used were of sufficient mechanical strength to do without supports; he had many times used them in a similar way. Witness saw the installation when it was finished, and it was delivered over in thorough working order. In March, 1904, one of witness's men was sent over to instruct another man in working the plant, but nothing was then spent upon the battery. After a year's run £1. 16s. 10d. was spent upon the battery, which was a small amount, especially as the apparatus had been in the hands of an unskilled man. Buckling of plates was a gradual process up to a certain point, when it became very rapid, and plates always required careful watching. About a month ago witness saw the battery, and it appeared to have been terribly overrun. Witness was satisfied that his was good, sound work, and it was on the same lines as work he had carried out successfully in many places.

In cross examination he said he explained to plaintiffs' man how to use and look after the cells. He went to the manufacturer's to get the various articles he required, and purchased the lowest price plates quoted to him, as he thought they were as good as the highest price. The total cost of the job without witness's expenses came to £96. Time accounted for £23, and witness had three journeys, which would not go through the books. Practically the net cost of the job was £100 to £105. If the plant had been properly attended to it would have been in good order to-day.

HERDLEY, defendants' foreman, said that besides putting in the installation he took the engine to pieces and cleaned it. He was at the asylum about a month, and instructed Barrett as to what he should do. Later on, when he was sent over to instruct another man, he noticed nothing wrong with the battery. In Jan., 1905, he again went to Catton, and then put in two new plates, as the others had been buckling. Apart from that the battery was in good condition.

Mr. GEORGE LAWSON, a representative of the A.B.P. Accumulator Co. (who supplied the accumulators) said that no frames were sent, as they evidently thought the plates were mechanically strong enough to do without supports. Witness sent everything he considered necessary to make a good job.

Mr. FREDERICK JENKINS, an inspector in the employ of the same company, thought the plates were sufficiently mechanically strong to do without supports, and he attributed the buckling to chemical action, and his opinion was that unless there was a competent man to look after a battery its life was very short.

Mr. ROBERT WILLIAM VICAREY had seen the installation and was of opinion it had not received attention. The acid in the water had undoubtedly caused the mischief. The A.B.P. accumulator plate was as strong as any plate, and from what he saw he thought there was nothing wrong when defendants left the work.

After counsel had addressed the Court, the JUDGE said he was of opinion that plaintiffs were entitled to succeed. He thought the price to be paid by plaintiffs was a liberal price for the work to be done, and called for skilful work on the part of defendants, and also material of good character. £130 to £140 was the price which Mr. Lea himself suggested, and plaintiffs without attempting to procure a modification, accepted the price offered. Through the assistance of the assessor, he had come to the conclusion that defendants failed to perform the contract. It appeared that the plates supplied were not of the quality which ought to have been supplied, and also that the plates, considering the size of the boxes, were not sufficiently supported when the work was done. He thought the failure of the light was due to the plates having spread and short circuited, and he thought that state of things was brought about by there not being sufficient support when the plates were placed in the box, and the plates not being of the quality defendants ought to have supplied. That being so, the question arose what compensation (if any) defendants ought to make for the breach of contract. He did not think he ought to deduct from the damages anything because plaintiffs did not communicate with defendants, as plaintiffs could not be expected to understand electrical appliances. He thought the £80 claimed was not too much in order to restore machinery; but as plaintiffs had enjoyed the light for nearly a year and a half he put the damage at £60. He did not allow anything in respect of the temporary work done by Mr. Woolnough, but allowed £1 for re-fixing the ammeter and £4 for the extra expense in running the dynamo. There would, therefore, be judgment for plaintiffs on the claim for £65, with costs, and for defendants on the set-off for £12. 2s. 1d., with such costs as the registrar could allow.

Criggleston Coal Co. (Ltd.) (Petition of British Insulated & Helsby Cables, Ltd.)

Last week the Court of Appeal (the Master of the Rolls and Lords Justices Romer and Cozens-Hardy) dismissed the appeal of the debenture holders and of the company against an order of Mr. Justice Buckley for the winding-up of the company. Petitioners were judgment creditors for cables supplied. The facts were reported in our issue for May 18.

Re London Electrobus Co. (Ltd.)—Last week Mr. Justice Joyce made an order for the removal of an applicant's name from the register of shareholders on the ground of misstatements in the prospectus. Mr. Justice Buckley made a similar order in an application by seven shareholders to have their names removed from the register.

LIGHT RAILWAYS.

During the past month 10 applications were lodged with the Light Railway Commission for Light Railway Orders, compared with 17 in November last and 18 in May, 1905. The total length of the projected lines is $49\frac{1}{2}$ miles and the estimated cost is £457,366, exclusive of equipment. We give below a list of the new electrical schemes :—

Title.	Promoters.	Engineers.	Miles.	Gauge.	Agents.
Aldershot and Farnborough	J. Browne Martin, A. Greenwood & others	R. A. Smith	$10\frac{1}{2}$	3ft. 6in.	Lees & Butterworth.
*Callington (Cornwall).............	G. W. Ry. Co.	W. W. Grierson and J. C. Inglis	10	4ft. $8\frac{1}{2}$in.	R. R. Nelson.
Hertford (Watford, Barnet & Bushey)	Hertford County Council	Urban A. Smith ..	$2\frac{1}{2}$	4ft. $8\frac{1}{2}$in.	R. A. Read.
Gainsborough and District	S. W. Luttrell & Co. & Major W. R. McKay	Godden & Co.......	$4\frac{3}{4}$	3ft. 6in.	F. G. Tweed.
Highgate Hill	Highgate Hill Trams Co.	M. N. Ridley	$1\frac{1}{2}$	4ft. $8\frac{1}{2}$in.	Weeks & Co.
*Kirkby Malzeard (W. R. Yorks)	G. Bland, D. Ellis and others...........	E. W. Dixon	6	3ft. 0in.	Torr & Co.

* Electric or steam.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Manchester Tramways committee invite applications for the positions of rolling-stock superintendent and works manager. The superintendent must be a qualified electrical and mechanical engineer, with practical experience; and the works manager will be in charge (under the rolling-stock superintendent) of the car repairing works. Applications to the committee, 55, Piccadilly, Manchester, by June 11. Further particulars are given in an advertisement.

Ipswich Corporation Electric Supply & Tramways committee invite applications for the positions of mains superintendent and general engineering assistant (commencing salary £150 per annum) and installation department assistant and canvasser (commencing wages £2 per week). Further particulars are given in an advertisement. Applications to the chief engineer and manager (Mr. Frank Ayton) by June 18.

The Sanitary Commissioners of Gibraltar require the services of an assistant electrical engineer. Commencing salary £200 per annum, rising by annual increments of £10 to £250 per annum. Applicants must have had experience in high-tension alternating distribution with transformer stations, in laying h. and l.-t. concentric cables, installing a.-c. and c.-c. motors, street and private lighting, &c. Applications to the secretary and engineer to the Sanitary Commissioners (Mr. Wm. Wallace Copland), Gibraltar, by June 30. See also an advertisement.

The Governing Body of Battersea Polytechnic, London, S.W., will require from September next the services of an instructor in the drawing office. Salary £150 to £200 per annum. Particulars from Secretary. See an advertisement.

An electrician, conversant with three-phase work and telephones, is required immediately for the West Coast of Africa. See an advertisement.

An assistant master, to teach electrical and mechanical engineering, is wanted for the Municipal Technical Schools, Limerick. Applications by 25th inst.

Mr. E. F. Jones, of Southport, has been appointed chief assistant electrical engineer at Hoylake and West Kirby Electricity Works.

Derby Electric Lighting committee have appointed Mr. E. G. Boissier mains superintendent at a salary of £100 per annum (rising by £25 a year to £150), and Mr. G. Dearle assistant superintendent at £75 (rising in a year to £100).

Mr. Valentine A. Browne has been appointed sub-manager of La Capital and Grand National electric tramway systems.

Mr. A. F. Bound has been appointed signal superintendent to the Great Central Railway, vice Mr. T. Wharmley, retired.

EDUCATIONAL NOTICES.

Bradford Technical College.—In the report for 1904-5 session it is stated that the total number of students in attendance was 1,033, against 1,110 in 1903-4. In the engineering department the numbers of both day and evening students were well maintained. It is intended to provide a new junior drawing office, a drawing office for second and third year electrical engineering students, an additional lecture room, an extension of the mathematics lecture room, and a mechanics laboratory. The new course in motor car engineering is expected to be popular. The effort made to bring the equipment of the dynamo and motor room up to modern requirements has produced excellent results, as the classes have been well attended.

The Proposed South Kensington High School of Technology.—The Council of the Association of Teachers in Technical Institutes recently passed a resolution welcoming the establishment of a Technological High School at South Kensington on the lines laid down in the Departmental committee's recent report, but suggesting that various points be considered before a complete scheme is drawn up. The Council considers that—

1. The work of the Institution should be confined to technical investi-

gation, research and post graduate studies, and that no training preliminary to the true work of the Institution should be undertaken in the new College. Some of the highly specialised departments should be situated at more convenient centres in the provinces, and full use should be made of the staff and equipment already existing in such towns as Manchester, Leeds, Sheffield, Newcastle-on-Tyne, &c. There should be due co-ordination between the work of existing technical institutions and that of the new suggested Institution, especially in regard to the earlier training of students to fit them to profit fully by the advantages offered in the highly specialised departments of the school at South Kensington and elsewhere.

2. The conditions of admission should be so framed that the minimum age of students entering the school should be 19, and all students should be required to give evidence of previous satisfactory training for three years after having reached the standard of general education marked by university matriculation. An honours degree in science of a British or Colonial University should also be accepted as qualifying for admission.

3. There should be representatives from associations connected with technical education, in order that the continuity of a student's work can be secured.

4. This association is of opinion that the new Institution should be permanently independent of University Control.

Arbroath.—The Council have decided to support the application of Mr. Geo. Balfour for a provisional electric lighting order.

Argentina—In a report on the trade of the Rosario district Mr. Consul H. A. Mallet states that a Belgian firm secured the concession for the construction and operation of the electric tramways in Rosario, and that the work is well advanced. The concession includes 55 miles of route, and provides for the electrification of the present horse-drawn tramways, which were purchased by the Belgian company. It is expected that the first section of the electric system will be in operation next month. The electrical plant and apparatus and the steel poles were obtained from the United States, Belgium supplying the rails, the steam plant and some of the apparatus coming from Great Britain.

Mr. Mallett calls attention to the market offered in Rosario for electrical appliances.

The contract with the Rosario Electric Lighting Co. having expired, the municipality are inviting tenders for lighting the city by electricity.

The Buenos Aires & Belgrano Tramway Co.'s local service in Belgrano and also their line between Belgrano and Nuñez were opened on 5th ult.

Buenos Aires Council have received an application for a concession to run a service of electric freight cars on the trackless trolley system.

Buenos Aires Municipality having, owing to opposition by the Mayor, hitherto refused permission to the Cia Alemaña Transatlantica de Electricidad to extend their mains in portions of the town which are at present lighted by kerosine, the inhabitants of the districts affected have now petitioned the mayor to accept the company's proposal.

Aston.—The Electricity committee's report for the past year states that there has been a greatly increased demand for electric current for lighting and power, and that the income was £14,109. 9s. 4d., against £8,906. 19s. 8d. After paying all expenses, including interest and sinking fund, there was a deficit of £1,621. 8s. 4d., against £4,380. 1s. 6d. in the previous year. 1,734,441 units were generated, an increase of over 50 per cent. on the previous year.

On Wednesday, the Chairman of the Tramways committee (Ald. Evans) announced that the whole of the tramways in the district had now been electrified.

Australasia.—The "Australian Mining Standard" says Brunswick (Victoria) Council are negotiating with firms for the erection and equipment of electricity works.

Mr. T. Rooke, the city electrical engineer, has returned to Sydney after visiting England, Germany, America and India to collect information as to the latest practice in electricity supply. Mr. Rooke will present a report to the Council on the subject.

Our Australian correspondent informs us that the Newtown (near Sydney) Council have refused to permit Messrs. Hatte & Edwards to establish electricity works in the district, and have also decided not to erect a municipal station or to allow the Sydney Corporation's mains to be extended into the district. A deputation of 50 local firms urged the Council to adopt electric lighting, and a public meeting has been called to discuss a proposal to form a company to carry out an electricity supply scheme.

The Brighton–St. Kilda State-owned electric tramway is open for traffic.

The Victorian Minister for Works held a conference on 23rd ult. with representatives of the Councils interested and discussed the Prahran–Malvern and Kew–St. Kilda electric tramway projects.

A referendum of ratepayers upon the proposed purchase by Zeehan (Tasmania) Town Board of the undertaking of the Zechan Electric Light & Power Co. for £5,500 has resulted in a majority of nearly four to one in favour of purchase.

Tenders were recently invited for electric motors for the Government Printing Office, and also for re-wiring the House of Parliament, Brisbane.

Bangor.—On Wednesday the Council adopted a recommendation of the Lighting committee to provide additional plant at the electricity generating station at an estimated cost of £1,700. The revenue of the electric lighting department for the past year was £3,134 and the gross profit £1,155. After providing for interest, &c., the deficit is £323.

Barton & Ashby Light Railway.—The official inspection of the permanent way took place last week, and the line, which is nearly 10 miles long, will be opened for traffic on Wednesday next.

Belfast.—At the adjourned meeting of the Corporation on Tuesday, the report of the city electrical engineer, Mr. Victor A. H. McCowen, abstracted in our issue of June 1, was approved.

Bermondsey (London).—During year ended March 31 the electricity department sold 1,564,462 units (against 932,099 in the preceding year), including 387,183 units for private lighting (at 3·4d. per unit), 659,064 units for power (at 1·47d.) and 361,662 units for street lighting.

Owing to the success of the undertaking, the Electricity and Street Lighting committee recommended the Council to fix the charge for street lighting for the past year at 2¼d. per unit, and also to apply £449 in aid of rates, being the amount charged to the rates for the years 1901-2-3-4 in respect of that part of the depot which had been appropriated for electrical purposes. Of the gross profit (£7,906) for the year the committee proposed to carry forward £1,010 and to put £6,896 to net revenue account. £140 was allocated out of revenue for an electric pump, which would obviate the necessity of firing the destructor house boiler and £500 for strengthening the mains. After providing for redemption of debt and interest, the balance was £3,000, and this has been transferred to reserve. Existing prices for current are to be continued, except the flat rate, which has been reduced from 4½d. to 3¾d. per unit as from July 1.

The generation costs for the past year was 0·67d. per unit, against 1·16d. The committee record their appreciation of the services which the chief engineer (Mr. W. E. J. Heenan) and his assistants have rendered to the council during the year.

The committee's recommendations were adopted.

The committee has been authorised to arrange special terms for the supply of energy to the Tilbury Contracting & Dredging Co. and the S.E. & C. Railway Co. Application is to be made for sanction to borrow £2,000 for strengthening and extending of mains.

Bolivia.—Mr. Consul G. Harrison has recently written an interesting report on the trade of Bolivia for 1904-5, and especially records the continued prosperity of the mining industry in that country. One of the principal difficulties in the development of this industry is the want of cheap motive power, and it appears that a partial solution of the difficulty has been found in the employment of anthracite gas engines. Mr. Harrison invites makers of this class of gas plant to give special attention to the question of altitude on the efficiency of these engines in countries where work has to be conducted at such altitudes as 12,000 ft. to 14,000 ft. above sea level. On the eastern and north-eastern flanks of the great Bolivian tableland the rivers that form the head waters of the Amazon and River Plate systems offer great possibilities for the establishment of works for the generation and transmission of electric power. To be of service in the principal mining districts of Bolivia current would have to be transmitted over distances varying from 50 to 120 miles. Already one survey of the rivers above mentioned has been made, and it is calculated that many thousands of horse-power could be made available for use in the mines of the Oruro district. Already the Huanchaca Co. have an electric transmission plant of about 2,000 H.P. supplying energy at a distance of over 78 kiloms from the source of power. This company's plant is of French make, but the majority of such electrical installations as exist in the country are of German origin. It is said that American manufacturing firms are becoming interested in this trade. There is springing up a considerable demand for gas-producer plant, oil engines, electric power transmission and lighting plants, electric mine hoists, electric rock drills, &c.

A supply of electric current for lighting and power purposes has already been decided upon in connection with a water-supply scheme for Sucre.

Brighton.—For the year ended March 31 the total income was £91,330, an increase of £1,626. Interest absorbed £37,432, an increase of £867, and sinking fund charges £20,261 (increase £3,677), and the deficiency was £980 on the year. 8,000,200 units of electricity were sold, compared with 7,780,220, and the equivalent of 296,182 8 c.p. is connected to the mains, compared with 283,741.

Chili.—Don Roberto L. Beausire, president of the Sociedad Fabrico de Sacos, has been authorised to establish electricity works for Llai Llai and the vicinity.

Clacton.—The Council's electricity supply works were started on Saturday when current was switched on to the Palace Theatre and grounds. The initial capital expenditure is £13,000. The three-wire low tension direct-current system of distribution has been adopted, and the plant includes two 110 kw. generators, each giving

220 amperes at 500 volts and driven by two 180 B.H.P. Davey, Paxman gas engines. The charges for current to private consumers are 5d. per unit for lighting and 3d. for power.

Commercial Development of Electricity Supply.—Though the organisation of sales departments in connection with electricity supply is a comparatively modern growth, yet in many cases the commercial and sales branch has already reached a high state of development. Not only the electric power companies but also the large electricity undertakings (municipal and company-owned) are setting an example in this respect. One of the most interesting instances is that of the Yorkshire Electric Power Co., which has established, as an auxiliary to its sales department, an estate department where information is collected and distributed on the subject of vacant land and buildings suitable for works, and the department is ready to give information to any probable power user on the subject of rents, rates, railway and canal facilities, &c. The movement of manufacturers from highly-rated districts, where a cheap public supply of power is not available, into the districts where such a supply is available continues steadily. Two recent connections to the Yorkshire Co.'s mains include the Leeds Engineering & Hydraulic Co., which has abandoned its old works in Leeds and erected new works at Calverley, these new works being electrically-driven from the Power Co.'s mains. Glover & Co., mungo and shoddy manufacturers, formerly carried on business in Batley, but have removed to Ravensthorpe, so that they may drive their machinery electrically. Cases of this kind are occurring more and more frequently, and there is no doubt that electric power companies are important factors in the industrial redistribution which is now taking place.

Country House Lighting.—The house of the Leader of the Opposition (the Right Hon. A. J. Balfour, M.P.) at Whittinghame, N.B., is being fitted up with an electric lighting installation.

Croydon.—The local tramways were taken over by the Corporation at midnight on Thursday last. The manager (Mr. Goodyer) and the staff pass into the Council's service.

Derby.—The Electricity committee has been authorised to substitute electric for gas lighting on a new tramway route at an estimated capital cost of £360.

Dudley.—The Council are recommended to reduce the charge for electric current for power to 1d. per unit for 22 hours per day and 6d. for the two hours of heavy load.

The Tramways committee have provisionally approved the plans of the Birmingham & Midland Tramways Joint Committee for the reconstruction of the Tipton tramway.

Exhibition.—A number of practical and interesting exhibits are tastefully arranged at an exhibition now being held under the auspices of the Westminster Electric Supply Corpn. at 96, Victoria-street, Westminster, London, S.W. A large ground floor and basement are occupied with a display of up-to-date fittings and accessories for electric light and power. A useful booklet enables visitors to concentrate their attention on certain exhibits, and other literature, freely distributed, gives non-technical visitors all the information necessary to enable them to appreciate the advantages of electric lighting and electrically-driven fans, motors, &c., over gas, oil and other methods. There are over 30 exhibits, and these include several novelties. The exhibition should prove particularly attractive to all interested in domestic appliances, hotel and restaurant keepers, and tradesmen whose commodities require brilliant illumination accompanied with safety and cleanliness, such as the jeweller, the florist, the confectioner, the tailor, the stationer, the upholsterer and cabinet maker, and many others. Exterior lighting by arc and special types of incandescent lamps for shops and other business premises is particularly well catered for, and, in fact, the exhibition has been arranged to meet the requirements of a large range of users of electrically-operated appliances, &c. The exhibitors include many of the leading firms in the electrical industry. Of these we may mention Messrs. Crompton & Co., Lundberg & Sons, the Jas. Keith & Blackman Co., the General Electric Co., the British Westinghouse Co., the Dowsing Radiant Heat Co., the British Thomson-Houston Co., the Langdon-Davies Motor Co., and others.

Fatalities.—The inquiry into the circumstances attending the death of a workman named Harrison which, as reported in our last issue, occurred from an accident at Callender's Cable & Construction Co.'s works, Erith, resulted in a verdict of "Accidental death."

The evidence showed that deceased and other men were engaged in moving a large drum of cable and were warned to stop their operations and leave the spot on which they were working which was a "danger bay" (*i.e.*, a place at which the testing of a cable at about 8,000 volts was taking place). The deceased and another man, the latter of whom admitted having received the warning, did not leave as instructed, and deceased received the shock which caused his death by rolling the iron-rimmed cable drum on to the live cable which was in process of being tested.

An unfortunate accident occurred on the Swindon Municipal tramways on Friday evening, resulting in the death of four persons and in several others being injured. A car containing between 70 and 80 passengers while descending a hill got out of control, and at the foot of the incline ran on to the up rails at a crossing and overturned.

Finchley.—At the last meeting of the Council the Electricity committee reported that, owing to the great increase in the price of cables, it had been found that the sum included in the extensions loan of £23,360 had been insufficient to carry out the works. The estimated cost of proposed extensions was £6,000, but the committee desire to make provision for further extensions, and they recommended that application be made for sanction to borrow £12,000—for a new feeder for the Western district, £2,750; distributing mains upon certain estates, £6,000; and anticipated further extensions of distributing mains, £3,250.

Glasgow.—The Corporation Tramways department report that for the year ended 31st ult., the average track mileage open was 153¼ miles, increase 8½ miles; the car mileage run was 18,886,910 miles, increase 943,315 miles. The traffic receipts were £813,768. 11s. 1d., increase £57,288. 2s. 6d. 208,058,348 passengers were carried, increase 12,290,829. Since the beginning of the year the Giffnock, Pollokshields, Baillieston, Springfield-road, Rouken Glen, Killermont and Barlinnie extensions of a total length of 6¾ miles of route were opened.

Greenock.—The Corporation, who have decided to erect a refuse destructor in connection with a second electricity generating station, have obtained sanction to a further loan of £50,000.

Hastings.—An inquiry was held on Friday last into the Council's application for sanction to borrow £563 for street electric lighting.

The town clerk (Mr. B. F. Meadows) said it was intended to erect arc lamps of 2,000 c.p. aggregate for the existing gas lamps. It was proposed to utilise the standards of the tramway company. The number of old lamps would be considerably reduced by this alteration, and the total cost would be slightly larger than at present.

The borough electrical engineer (Mr. R. F. Ferguson) supplied technical details, and evidence was given that some of the streets proposed to be lighted electrically were at present badly illuminated.

The inspector (Mr. H. R. Hooper) said he was not satisfied as to the necessity for the change. The comparisons affecting gas and electric light were not on parallel lines. He asked what was the money advantage under the proposed improvements.

Mr. Ferguson replied that there was no money advantage, but they would get improved lighting.

The Inspector said no evidence of the inefficiency of the present lighting had been put before him, and he wanted to know whether it was necessary for them to increase their capital account by making it more efficient.

Mr. Ferguson said they were not making a profit by their lighting, but were covering working expenses. They were not paying their fixed charges. The new lamps would be Oliver arc lamps.

The Inspector subsequently visited the electrical works with Mr. Ferguson.

Application has also been made by the Council for sanction to a further loan of £8,760. 11s. 3d. for extensions to the electricity undertaking.

Hanley.—The receipts of the electricity department last year were £14,738 (3·89d. per unit sold), including £12,053 net from supply of current to private consumers, £2,226 for public lighting, £260 meter rents, £62 from sale of lamps, &c., £73 for wiring, and £62 for hire of motors.

The gross expenses, including £5,746 (against £5,085 in 1904) for interest and redemption of loans, were £13,289 (3·51d. per unit sold), against £13,083 (3·72d.), and the coal bill was reduced by £159. The net profit was £1,449 (against £1,808), 627,168 units were supplied for private lighting (against 591,619), 85,692 for power (against 70,183), and 196,737 for public lighting (against 182,470). The maximum load was 870 kw. (increase 75 kw.). Motors connected, exclusive of small fan motors, were 67 (270 H.P.) against 47 (155½ H.P.). The average price received per unit was 3·77d. against 4·02d., the decrease being due to the reduction of the number of hours charged at the maximum price from 150 to 91 per quarter, and by taking the maximum demand in each quarter instead of calculating all quarters according to the winter maximum.

The borough electrical engineer (Mr. C. H. Yeaman) points out in his report that £548 was saved in engineering and management expenses, and that the profit would have been larger than in the previous year but for the fact that rates and taxes and capital charges showed an increase of £754 The portions of Mr. Yeaman's report dealing with the present condition of the generating plant, the question of depreciation, &c., were abstracted in our issues of May 11 and 18.

The Electricity committee recommended that the year's net profit be transferred to a depreciation and contingency fund, but the Council resolved (as stated in our issue of May 25) to apply only half the net profit to this purpose, and to allocate the other half to relief of rates, after allowing £63 for depreciation of motors and £120 for transformers discarded. As the Local Government Board refused sanction to a loan for the purchase of motors for letting on hire, the motors required for this purpose have so far been paid for out of revenue, and Mr. Yeaman proposed that the profit (£62. 9s. 11d.) on their hire be applied to writing down their stock value, which was agreed to.

In view of Mr. Yeaman's remarks on depreciation and obsolescence of plant, it may be interesting to note that the plant running at Hanley consists of

1. Howden-Westinghouse set, 500/650 kw., 333 r.p.m., triple direct coupled. Date, 1904.

2. Raworth-Mordey Victoria, 50 kw., compound, rope-driven. 1894.
3. Raworth-Mordey Victoria, 100 kw., compound, rope driven. 1894.
4. Raworth-Mordey Victoria, 100 kw., compound, rope-driven. 1894.
5. McLaren-Ferranti 170 r.p.m., 300 kw., compound cross-coupled. 1895.
6. Ferranti steam engine and Ferranti generator, 150 r.p.m., 600 kw., compound cross-coupled. 1897.
7 And one Raworth-Mordey Victoria, 50 kw., like No. 2, erected at the destructor works, but not yet running there.

The whole of the plant is run condensing. Steam pressure, 120 lb. per square inch. Capacity of plant purchased as used on peak load, 1,850 kw. There are also two 30-light series Brush arc lighters installed, but the arcs are usually run on Ferranti rectifiers.

Mr. Yeaman is doing his utmost to stimulate the use of electricity for power, heating and cooking, &c., and supply is to be given at 1d. per unit net to (1) large power consumers who agree to use electrical energy as the sole power for three years and to pay not less than 12s. 6d. per quarter per brake-horse-power of motors installed, and (2) to consumers agreeing to restricted hour supply and providing a time switch to be so arranged that no current can be taken for power from sunset to 10 p.m. daily. The general rates for power supply have been fixed to meet the needs of the local power users—viz., 3d. per unit for first 91 hours quarterly of the maximum demand and 1d. per unit. for all further consumption. Mr. Yeaman points out that this gives an average of 1·28d. per unit for a motor running continuously at the maximum load required and 1·56d. per unit if the average load is half the maximum taken, as is usually the case in factories and workshops.

Increase in Prices.—Dated June 1, the General Electric Co. give notice of a general advance in prices, necessitated by the continued rise in the price of raw materials. The advance applies to nearly all the items in the company's bound catalogue 1905-6, and varies from 5 to 20 per cent.

International Exhibitions.—The International Exhibitions' committee of the London Chamber of Commerce resolved last week to recommend the Chamber to support the Irish International Exhibition (1907), as far as possible. The committee also passed a resolution that the time has arrived when there should be another International Exhibition held in London; and resolutions in support of the New Zealand (Christchurch) Exhibition 1906-7, and of the project to hold an Anglo-Portuguese Exhibition in 1908 were also adopted.

Ipswich.—The Electric Supply and Tramways committee, in response to several requests from residents in the town, have decided to establish an installation department in connection with the electric supply undertaking. The chief engineer (Mr. Frank Ayton) will be glad to receive price lists of apparatus and fittings from those firms who have not already sent them.

Italy.—A law has been issued authorising the Societa Romana Tramways-Omnibus to double a portion of their existing electric tramway route in the city.

Lancashire and Yorkshire Railway.—On Friday the Lancashire & Yorkshire Railway Co. opened the first section of the extension of the electrical line to Aintree.

Lancaster.—The total income of the electricity department for the year ended March 25 was £9,050. 5s. 11d., including £5,536. 16. 7d. net for private lighting, £554. 13s. 3d. for power, £2,031. 2s. for traction and £770. 10s. for public lighting.

Total expenses were £4,802. 14s. 1d., including £2,781. 2s. 8d. for generation, £568. 4s. for distribution, £409. 9s. for rent, rates and taxes and £745. 8s. 7d. for management expenses, leaving a gross profit of £4,247. 11s. 10d. After providing for interest, redemption of loans, &c., the net balance (£1,007. 10s. 2d.) has been placed to reserve. The total capital expenditure is £62,290. 14s. 6d., an increase of £904. 13s. 3d. on the year. 728,790 units of electrical energy were generated, 62,000 were supplied to public lamps, 365,257 to private consumers and 256,559 to the Tramways committee. There are 40 arc and 80 incandescent lamps for street lighting, and the total lamp connections is equivalent to 39,000 8 c.p. The maximum supply demanded was 700 kw. (500 kw. for lighting and power and 200 kw. for tramways).

The traffic revenue of the tramways department was £5,236. 13s., traffic expenses £2,404. 18s. 5d., general expenses (including salaries and wages, rents, rates and taxes, &c.) £899. 8s. 5d., general repairs and maintenance came to £511. 8s. 9d. and power (251,180 units at 1·9d. per unit) cost £1,988. 10s. 2d. After paying interest and sinking fund the deficit was £3,143. 12s. 10d., against £3,180. 0s. 6d. for 1904-5 and £2,833. 3s. 4d. for 1903-4. The total capital expenditure is £39,306 10s. 3d., an increase of £3,025. 7s. 2d. on the year. 213,277 car-miles were run, 1,482,820 passengers were carried and the average receipts per car-mile were 5·89d. Working expenses per car-mile were 6·53d., interest and debt redemption charges 3·23d., making total expenses per car-mile 9.67d.

Leyton.—The Council have received sanction to a loan of £23,350 for tramcar sheds, repairing shops and electrical equipment, and £17,819 for additional plant at the power station.

Lincoln.—The profit of the electricity undertaking for the past year was £2,165, compared with £1,161 in 1905. The Chairman of the Electricity committee (Councillor Pratt) announced at the Council meeting on Wednesday that the past year had been the most successful one they had had. There was an increase in the number of units sold of about 200,000. The city electrical engineer (Mr. Stanley Clegg) was to be congratulated upon his success in putting the undertaking upon a sound basis.

Llanelly.—The Council have received sanction to a loan of £6,000 for electricity supply. Electrical energy is to be taken in bulk from the South Wales Electrical Power Distribution Co.

Malvern.—An unopposed inquiry was held here last week into the Council's application for sanction to borrow £475 for the provision, in duplicate, of an electrically-driven compressor at the Link Mill, in connection with the sewerage system.

Manufacturers' Association.—It is announced that a provisional committee has been formed to organise an association for protecting the interests of manufacturers generally in Great Britain.

The committee includes Sir John Bingham (Messrs. Walker & Hall), Sir Joseph Lawrence (Linotype & Machinery), Mr. G. Byng (General Electric Co.), Mr. R. K. Morcom (Bellis & Morcom), Mr. Hugo Hirst (Robertson Lamp Co.), Mr. W. C. Mountain (Ernest Scott & Mountain) and Mr. H. H. D. Anderson (Associated Portland Cement Manufacturers). The association will be called the Manufacturers' Association of Great Britain. The secretary is Mr. B. H. Morgan.

Marriage.—At Bingley, on Wednesday, Mr. R. L. Horsfield, manager of Walsall tramways, was married to Miss Susannah Lister.

New Cable Steamer.—On Wednesday the new c.s. "Cormorant," built for the Western Telegraph Co., was launched from Messrs. Bow, M'Lachlan & Co.'s yard, Paisley. The new vessel is a strongly-constructed single-screw steel steamer built throughout to Lloyd's highest requirements. The machinery, supplied by the builders, is placed amidships and is of triple expansion type with usual auxiliaries. Forward and aft of machinery space large cable tanks are fitted. The bow gear is neatly wrought into the fiddle bow, and a steam cable winch is fitted forward, also a special steam winch aft. The decks and woodwork throughout the steamer are of teak.

Nottingham.—In the annual report of the Electricity committee it is stated that the demand for electrical energy continues to increase.

Additional plant has been installed at St. Ann's power station and various extensions of mains have been carried out during the year. The total capacity of the plant installed at the three stations is 15,245 H.P. (Talbot-street station, 8.925 H.P., St. Ann's, 5,660 and East Croft, 720). The number of consumers is 3,040, compared with 2,793 in 1905, and the equivalent of 297,553 8 c.p. lamps is connected, compared with 267,401. There has been an addition of 79 motors during the year, representing an increase of 249 H.P., the total being 653 motors and 2,263 H.P.; 9,052,562 units were sold (lighting 3,670,554, power 1,284,956, traction 4,097,052), an increase of 582,641 units. 47·19 per cent. of the units sold for private lighting were at 1½d. per unit. The total receipts were £80,247, and the expenditure £38,569, leaving a gross profit of £41,677.

Obituary.—We regret to record the painfully sudden and unexpected death of Capt. R. G. Halpin, late of the c.s. "Britannia," which occurred at Falmouth on Friday last. Capt. Halpin entered the Eastern Telegraph Co.'s service in December, 1888, and was at the time of his death only 37 years of age. He had been invalided for the past eight months, and had just returned to duty apparently fit and well. He left England in the tug "Cruiser" on a sounding expedition off the Azores. While on the way out it appears that Capt. Halpin ran a copper wire into one of his fingers and blood poisoning set it. Dr. A. B. Harris, who was on board, had the captain landed at Falmouth, and for a time he seemed to improve in health, but gradually became worse and died. Dr. Halpin, the captain's brother, came over from Ireland and removed the body to Wicklow, his native place, where he was buried on Tuesday, deeply regretted by a large circle of friends in the telegraph service.

The death occurred on 31st ult at Altrincham, Cheshire, of Jeremiah Eugene Mathewson, managing director of Geo. Richards & Co. (Ltd.) and Tilghman's Patent Sand Blast Co. (Ltd.).

The death occurred on Wednesday of the Right Hon. Sir F. Peel, K.C.M.G., senior member of the Railway and Canal Commission.

Peru.—A company has recently undertaken the lighting of the town of Ignitos by electricity, and most of the principal streets are lighted by this illuminant. The plant and apparatus for the installation were imported from the United States.

Presentation.—The Ilford tramway and electricity staff have presented a silver salver to Mr. G. R. Spurr, late tramways manager, on his departure to take up the position of electrical engineer at Walthamstow.

Proposed German Cable to Morocco.—We understand that at the recent conference at Algeciras the German Government received authority to land a submarine telegraph cable at Tangier.

Rhodesia.—The gradual, if quiet, development of Rhodesia, lends interest to any literature which may be published concerning this division of the British Empire. Mr. Percy Lindley, who is well known in connection with literary ventures, is editor of the "Rhodesia Review," a copy of which we have received, with a note calling special attention to the baneful practice of registering companies under "reconstruction" schemes in Rhodesia, with the result that shareholders in such companies become liable to suffer serious losses in connection with their investments and speculations in Rhodesian stocks and shares. This point may have some passing interest for our readers. The "Rhodesia Review" contains, however, matter much more likely to be of interest to them, and we may refer to the sections dealing with Rhodesian railways, Rhodesian copper prospects, labour troubles and such like matters, which prove that Rhodesia is not less concerned than ourselves with the questions of the hour.

Rochester.—The Star Hill to Deloe Grange tramway route was opened for traffic last week. The construction of the extension to Rainham is being rapidly proceeded with.

Rubber Cultivation in Brazil.—To encourage the cultivation of the rubber tree the Brazilian Government has instituted four prizes of $40,000, $20,000, $13,000 and $6,000, which will be awarded to those who have planted the greatest number of trees within 18 months

St. Helens.—The income of the electricity department for the past year was £18,772. 12s. 1d., and the total expenditure £17,449. 5s. 11d., leaving a profit of £1,323. 6s. 2d., of which £500 has been placed to credit of plant and machinery account, £100 to accident fund, and the balance (£723. 6s. 2d.) to reserve

Seaham.—The Board of Trade have rejected the claim of the S M.H. Tramways Synd. to dispense with the Council's consent to their application for a provisional electric lighting order.

Ship Lighting.—The new Cunard steamship Co.'s s.s. "Lusitania," which was launched yesterday (Thursday) at Clydebank. will be the biggest ship afloat, and, of course, has a very complete electric lighting and power installation. There are altogether 4,500 electric lights, and electricity is employed for ventilating and for various power purposes.

South Africa.—The "British & South African Export Gazette" states that, in consequence of the report by the borough electrical engineer (Mr. J. Mordey Lambe) as to the present unsatisfactory condition of the municipal electricity works (plant and distribution system) and tramway undertaking, East London Corporation have decided to consult the municipal electrical engineers of Cape Town and Durban (Mr. W. F. Long and Mr. John Roberts) on the subject.

Mr. Lambe advocates the erection of a new station, the renewal of certain machinery, the installation of coal-handling plant and doubling portion of the tramway track at an estimated cost of £45,120, a profit of £7,665 per annum being anticipated from this expenditure.

The small supply station at Zomba, which has been established two years and which supplies electric current to only about 350 incandescent lamps, is said to be paying its way. Current is generated by three 220 volt 35 ampere Staffordshire dynamos driven by a Pelton water wheel from the Mlungusi river, about ½ mile distant.

South Shields.—On Wednesday the Council authorised the Tramways committee to construct a line of tramways from Boldon-lane terminus to Slake-terrace, so as to complete another circular route, at an estimated cost of £10,789. When the new line is completed there will be 12½ miles of single track. The total expended on the tramways undertaking to date is £150,789.

Spain.—Mr. Consul A. Keyser's interesting report on the trade of Cadiz and district for 1905 refers to the construction of the electric tramway from Cadiz to San Fernando, a distance of 14 miles. This line is nearly completed. The scheme of the tramway company which is constructing and operating the service includes the lighting of San Fernando by electricity. The tramway (upon which work is steadily progressing) will ultimately be extended to Algeciras, taking the route from San Fernando, Chiclana, Tarifa and Algeciras Much is anticipated from this important electric line, which will enable the population of Cadiz to travel much further afield than is its wont. The peculiar natural formation of Cadiz has in the past tended to confine its inhabitants within the confines of what is practically an island city. It is pointed out that there is a good opening for a light railway to put the coast towns in this part of Spain in communication with many populous centres inland, and the introduction of a good motor vehicle service between Cadiz and Algeciras (about 60 miles) is suggested as a good opening for British enterprise. The importance which Cadiz may one day attain as a European port for South Africa, in much the same manner as Brindisi has become for the East, lends additional interest to Mr. Keyser's report, to which those of our readers who are interested in the development of oversea trade may be referred at the present time, when British interests in Spain may be regarded as in the ascendant. The nearness of Cadiz to Gibraltar gives this district an additional interest to Britishers.

Stepney (London).—The capital outlay on electricity supply at March 31 was £250,501, an increase of £28,760 during the past year.

The Electric Lighting committee propose to write off out of the year's profits £1,045, which, with the amount already written off, reduces the capital expended to £243,982. The result of the year's working was a gross profit of £13,985, and an increase in the units sold from 3,425,153 to 4,046,205 (382,880 at 8d., 212,491 at 6d., 2,193,635 at 1d. and 1,257,197 at 0·9d.) producing £31,595, an increase of £1,648. Although the total expenditure increased by £2,499, the cost per unit had decreased, being 1·07d. per unit, against 1·10d. After paying interest and instalments of loans, the net profit was £1,988, against £5,815. It was intended to write off £1,045 from capital expenditure and to carry forward £943. The depreciation and renewal fund amounted to £19,026 on March 31. The Electric Light committee say that, with a reserve of £9,500 and £2,237 carried forward, the Council need have no apprehension of the continued prosperity of the undertaking.

Application is to be made for sanction to borrow £10,500 for extensions of mains.

Sunderland.—The total revenue of the electricity department for the year ended March was £47,964, and the expenses were £26,560 leaving a gross profit of £21,404, equal to 7·02 per cent. on capital outlay.

After paying £10,063 for interest and £9,912 for sinking fund, the net profit is £1,429, against £954. Since the undertaking was commenced in 1895, the total net profit has been £4,575. The number of equivalent 8 c.p. lamps connected was 367,893, compared with 289,226; the units sold were 6,159,954, against 4,772,913, and the number of consumers was 1,120, against 1,041. Capital expenditure per kilowatt was £51·8, against an average of £79·1 for municipal undertakings throughout the kingdom. The works cost per unit sold now stand at 0·736d., against 0·851d., and the total engineering costs bring it up to 1·005d., against 1·154d. With sinking fund and interest the total works cost come to 1·784d., against 2·083d. For public lighting there are 165 arcs, 24 incandescents and 24 Nernst lamps. Important extensions have recently been completed for the River Wear Commission and Sir James Lang & Son's shipyard. The charges for current for lighting will be considerably reduced from Oct. 1, and it is believed that the result will be a large increase in lighting consumers. Reductions have already been made in the charges to the tramways and to power users. The loans sanctioned amount to £337,558, and £328,039 has been borrowed, the total sum expended being £326,494.

The total income of the municipal tramways for the past year was £68,174, and the expenditure £38,737, leaving £29,436. After paying interest and sinking fund charges, the net balance is £3,541, which it is proposed to contribute in aid of the rates.

Swansea.—The Tramways committee on Wednesday decided to give notice to the Swansea Improvements & Tramways Co. of intention to purchase the tramways (Docks–Alexandra-road route) authorised by their 1882 Act. The cost of the lines recently constructed by the Corporation and leased to the company has been agreed at £108,363. 10s. 2d.

The net profit on the past year's working of the electricity department was £339. 5s. 10d.

Tunbridge Wells.—A uniform charge of 4½d. per unit is to be made in future for electric current for private lighting, as an alternative to the present maximum demand system.

Walsall.—An unopposed inquiry was held last week into the application of the Council to borrow £13,000 for extensions of the electricity undertaking to meet the demand for electric current during the winter 1906-7.

Evidence was given that the sum was required for—engine-room plant £3,100, boiler-house plant £1,040, additional plant at Pleck sub-station £1,517, new sub-station at Green-lane £2,000, new sub-station for Highgate and Mellish-road £2,099, additional plant at Hospital-street sub-station £878, low-tension distributors £1,471, meters and services £900. The present capacity of the plant is 1,300 kw., and 1,070 kw. was now required to meet the maximum demand for lighting and traction. Total capital outlay to Dec. last was £91,427, £17,000 was for traction. In 1896 the gross profit was 2¼ per cent. on capital invested, and this had increased to 6½ per cent. in 1904, but fell to 5⅛ per cent. in 1905 owing to reduced charges for current.

West Bromwich.—For the year ended March 2,011,636 units of electricity were generated, against 1,631,326 units last year.

For private lighting 234,384 units were supplied, for power 210,810 units, 1,102,749 units for electric traction, and 107,984 units for public lighting, making 1,655,927 units sold, against 1,411,884. The total income was £12,206, and expenditure £6,437, leaving a gross profit of £5,769, and after allowing for interest, redemption of debt, &c., the net profit was £1,930 on all departments, but the profit on the sale of electrical energy was £2,260. There are 82 public lamps, and the total maximum supply demanded was 953 kw. (476 kw. for lighting and power and 477 kw. for traction).

In the report of the borough electrical engineer (Mr. W. A. Jackson) it is stated that the increase of 55,244 units sold for private supply was due to the cultivation of the motor load. The combined load factor for lighting and traction was 19·8 per cent., against 19·33 per cent., the lighting and power and traction load factors being 13·3 and 26·5 per cent. respectively. During the year 25 new consumers, representing 9,749 8 c.p. lamps (against 3,555 8 c.p.), were connected, making the total connections 30,432 8 c.p. lamps. The total equivalent of 8 c.p. lamps connected on the hire-purchase system was 799. There are 59 arc and 49 Nernst lamps and 55 motors (representing 268 H.P.) on hire. The total works costs have been reduced from 0·74d. to 0·6d. per unit. The average price obtained from sale of current was 1·71d. There was a loss of £330 on the outdoor departments, due mainly to quarterly hire-purchase or hire instalments being insufficient to cover interest, sinking fund and maintenance charges. The stock in hand at the installation stores has been largely depreciated, and it is now stated that the valuation stands at a low figure at which the stock is realisable.

A Board of Trade inquiry was held last week into the recent accident on the West Bromwich Tramways which resulted in the death of a girl, who was run over by a tramcar and killed.

Evidence was given by the driver of the car, which was one of the Brush type, and was fitted with a trigger lifeguard. The deceased child, in crossing the road, tripped up and fell lengthways across the track. Before he could pull up the car went on to the child, who got entangled between the booster beam and the leading driving wheel. The car was travelling at six or eight miles an hour, and he applied the electric brake and pulled it up within a car's length. The child was not struck by the step of the car and the lifeguard acted well. The car was lifted by three jacks, and it was not until half an hour after the accident that the body was got out.

Mr. G. Conaty, tramways manager, said the possibility of getting people from under tramcars alive by the aid of jacks was remote. There were no regulations with regard to the distance of the gate of the lifeguard from the road, but they were usually from 4 in. to 6 in.

The Inspector (Col. Yorke) failed to see how jacks could save life. It was better to attend to the lifeguard, as prevention was better than cure. He should recommend that the gate of the lifeguards should not be as high as 6 in.

Westminster.—The City Council have referred back a recommendation of the works committee to illuminate Parliament-street and Whitehall by gas lamps.

Two companies tendered—viz., the Gas Light & Coke Co. and the Westminster Electric Supply Corpn. The former offered to supply new lamps and maintain them for £15. 1s. per lamp per annum. The Westminster Corporation made two offers, in each of which it was stipulated that there should be no charge for the first 18 months. The average cost of lamps in the first offer was to be £14. 16s. 10d., and in the second (with 9-ampere flame arc lamps) £11. 19s. 5d., the Council in the second case paying for the installation. The committee reported that while the Westminster company's offer would be cheaper than that of the gas company for the 5 years of the contract, it would be dearer if the contract were extended to 10 years, as the electric company proposed to raise the price at the end of 5 years.

Wimbledon.—Application has been made for sanction to a loan of £20,650, the estimated capital expenditure upon mains, meters, transformers and sub-stations for the next three years.

Wireless Telegraphy.—The flagship of Prince Louis of Battenberg, the "Drake," which has just arrived at Berehaven, had, it is announced, been in wireless telegraphic communication with Gibraltar during her entire voyage. The "Cumberland" and the "Duke of Edinburgh," following the flagship, acted as intermediaries with Gibraltar. The distance from Berehaven to Gibraltar is about 1,800 miles.

Wireless telegraph installations are being erected up the river Pachieta, one of the affluents of the river Ucayali (Peru), the principal station being at Puerto Bermudez, and the object being to bring Iquitos into direct wireless communication with Lima The "Telefunken" system is being installed.

Dinner.—The fourth annual dinner of Middlesbrough Corporation electricity department staff and employés took place on Friday last. The borough electrical engineer, Mr. H. M. Taylor, said the undertaking was making good progress, and, notwithstanding increased expenditure, there was a profit on the year.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

The Electricity committee of *Stepney* (London) Council invite tenders for supply of meters, demand indicators and arc lamp carbons. Specifications, &c., from the engineer and manager (Mr. Wm. C. P. Tapper) 27, Osborn-street, Whitechapel, E., where tenders by noon June 18. See also an advertisement.

The Electricity committee of *Stepney* (London) Council also invite tenders for supply and erection of flame arc lamps and cast-iron columns, switches, &c., for the lighting of certain streets in the borough. Specifications at the offices of the electricity department, 27, Osborn-street, Whitechapel, E. Tenders, addressed to the Chairman of the Committee, by noon of June 18. See also an advertisement.

The Powell Duffryn Steam Coal Co., *Aberaman*, near Aberdare, want tenders by 10 a.m. 18th inst., for stores, including electrical fittings, ironmongery, steam tubes, &c. Particulars from the Stores Manager, Aberaman Offices.

Stoke-on-Trent Electricity committee require tenders by 18th inst. for supply of piping. Specification, &c., from the Electricity Works.

Colchester Corporation want tenders by 18th inst. for extension of Magdalen-street tramcar shed, and by 4 p.m. 20th inst. for 12 months' supply of coal to the electricity department.

Finchley Council invite tenders for feeders, distributing mains and other cables, network and joint boxes, &c. Tenders by 5 p.m. June 18.

Salford Education committee require tenders by 22nd inst. for four d.c. motors (one 40 H.P., two 15 H.P., and one 1 H.P.).

Allahabad (United Provinces, India), Municipality invite applications from firms willing to undertake electricity supply for lighting and fans, and the construction of tramways. Further information from the Secretary.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Council received 23 tenders from 15 firms for condenser and cooling tower, and the tender of Isaac Storey & Sons at £2,635 was accepted.

The tender of W. T. Glover & Co. for 880 yds. of cable at £534 was also accepted. Six firms tendered for this contract, including Johnson & Phillips (Ltd.), St. Helens Cable Co., Callender's Co., British Insulated & Helsby Cables and Siemens Bros. & Co. The lowest tender was accepted, the highest being £560. 2s.

For arc lamp lowering gear 13 tenders were received, but no tender has yet been accepted. The Electricity committee have, however, arranged with the Improved Electric Supplies, Johnson & Phillips and Veritys Limited for a trial of their respective gears.

For wiring the Rotherhithe Baths six tenders were received by the Council, and the lowest, that of the Salisbury Electrical Engineering Co. was accepted at £218. 15s. The highest tender was £541. 4s.

The tender of Messrs. Duke & Ockenden has been accepted for repair and maintenance of artesian well and pump at the generating station for three years, the pricesbeing, repairs £55 net, maintenance £30 per annum.

Barnstaple Town Council have accepted the tender of the St. Helens Cable Co. for cables, &c., at £336. 18s. (W. T. Henley's Co. tendered at £348. 6s. 1d., and the British Insulated & Helsby Cables at £344. 13s.); that of F. Jewel for troughing at £18 18s. (Rawle, Gammon & Baker tendered at £27. 7s. 6d., and Devon Rustic Wood Co. at £22. 10s.); that of W. H. Kays, Ltd., for bitumen and box compound at £5. 10s. per ton, and 4d. per lb. respectively (Rowland Carr & Co. tendered at £5. 15s., and 6d. respectively); and that of the British Thomson-Houston Co. for meters.

The following contracts have recently been secured by Mr. P. J. Mitchell for Rateau patent exhaust steam utilisation turbo plants :—

One 500 kw. three-phase turbo alternator, condensing plant, pipework, and watertype accumulator for the Powell Duffryn Steam Coal Co.; one ditto for the Sneyd Collieries, Burslem; one 250 kw. three-phase turbo alternator, pipework, and water type accumulator, for the Tredegar Iron and Coal Co.; and one 450 kw. continuous-current turbo generator, for the Steel Co. of Scotland, the latter being a repeat order.

Hull Corporation have accepted the tender of Clayton, Son & Co., for two Lancashire boilers for the tramway power station at £1,177. 1s. 6d., that of Harrison & Turner for altering condensing pipes at £157, that of G. Green & Son for an economiser at £500 and that of T. T. Vicars & Co. for mechanical stokers at £270.

Andrew Barclay, Sons & Co., Kilmarnock, have recently delivered to the General Electric Co. an Oddie-Barclay high speed pump, fitted with rams 4¼ in. and 6 in. dia. by 6 in. stroke. When running at a speed of 223 revs. per min. the pump is to deliver 133 gallons against 800 ft. head.

The Postmaster-General's Department, Adelaide, has accepted the tenders of Todd & Samuel for copper wire and tapes, copper binders and insulators; of Rabone, Feez & Co. for galvanised iron binding wire; and of Zwicker, Tod & Co. and Dalgety & Co. for porcelain insulators.

Derby Corporation have accepted the tender of Callender's Cable & Construction Co. for lighting cable at £662. 5s. 6d., and that of the Electric Tramway Equipment Co. for overhead tramway material and pinion wheels.

The Governing Body of the National Physical Laboratory has placed an order with Pritchetts & Gold for a battery of 60 cells giving discharges of 3,000 amperes, and for a battery of 56 cells for lighting and power.

The contract for the main switchboard and distributing boards required for the Berry Yard Sugar Refineries, Greenock, has been placed with Messrs. Kelvin & James White.

Ed. Bennis & Co. have received a contract for 10 complete stokers and compressed air furnaces for Bloemfontein municipal electricity works.

Sydney (N.S.W.) Water and Sewerage Board have accepted the tender of the India Rubber, Gutta Percha & Telegraph Works Co. for electrical supplies.

Rotherham Council have accepted the tender of Steel, Peech & Tozer for steel rails and fish plates for the Whinney Hill tramway route at £852. 7s. 6d.

North Staffs Joint Hospital Board have accepted the tender of Blackburn, Starling & Co. for wiring the mortuary.

Accrington Electricity committee have accepted the tender of Yates & Thom for Lancashire boiler plant at the electricity works.

Robert W. Blackwell & Co. have received an order for a further supply of tramway poles for Johannesburg.

Birkenhead Education committee have accepted the tender of Heaney & Co., for wiring the Woodlands Schools at £147. 5s.

Greenock Corporation have accepted the tender of the Horsfall Destructor Co. for refuse destructor plant at £14,315.

Stepney (London) Council has placed an order with the Underfeed Stoker Co. for an additional stoker at £216. 13s. 4d.

Steam Turbines.—Leeds Corporation recently decided to extend the plant at their electricity works by the adoption of steam turbines, and advertisements (which appeared in *The Electrician*) were duly issued inviting tenders for two 3,000 kw. sets. After making a tour of inspection, during which most of the more modern turbine stations in this country were visited, the committee have recommended the adoption of the Willans-Parsons type of turbine, with shrouded blades, and (as stated in our last issue) they recommend the Council to place the complete contract, including the generator portion and condensing plant, in the hands of Messrs. Willans & Robinson, Rugby.

BUSINESS NOTICES.

Geo. Wm. Jubb and Ernest Darley Stakes, electrical engineers, Market street, Wakefield, have dissolved partnership. Debts by Mr. E. D. Stakes.

The offices of the Anglo-Portuguese Telephone Co., Ltd., have been removed to 31, Budge-row, Cannon-street, London, E.C.

The Phœnix Electric Heating Co. (Ltd.) notify that they have acquired the business of the Electric Heating Co., sole makers of the Phœnix electric heating and cooking appliances. The technical management remains as before. Showroom accommodation is being provided at 116, Great Portland-street, W.

Messrs. Wallington Jones & Co., 13, Crutched Friars, London, E.C., are making a speciality of complete isolated generating plants for light and power, and have appointed Mr. Leonard Stallybrass, late of the District Electric Co., Wolverhampton, to be manager of their electrical department.

BANKRUPTCIES, &c.

Thos. Hudson Hunter, electrical engineer, &c., lately trading at York-road, West Hartlepool, has been adjudicated bankrupt.

The trustee (Mr. F. Stone, 47, Full-street, Derby) in the bankruptcy of Sidney Gardner, electrical engineer, Horninglow-street, Burton-on-Trent, has been released.

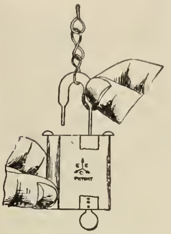
Sale by Auction.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, London, S.W., will sell by public auction, at the Royal Arsenal, Woolwich, on the 22nd inst., at 11 a.m. some obsolete and unserviceable stores, including steel, copper, gunmetal, lead, zinc, brass, aluminium, &c.; two lathes, some electric cable, telegraph instruments, indiarubber, tools, &c. The lots may be viewed at the Royal Arsenal, as set out in an advertisement on another page. Catalogues from the War Office, Pall-mall, S.W.; the Ordnance Office, Tower, E.C.; and the Ordnance Office, Royal Arsenal, Woolwich.

Factory Premises, &c., for Sale and to Let.—Messrs. George W. Dawes & Co., 12, Basinghall-street, London, E.C., advertise that they have available many factories, workshops, &c., suitable for the engineering trades, &c.

Messrs. Fuller, Horsey, Sons & Cassell have a large number of eligible factories, warehouses, &c., for sale and to let detailed in their register.

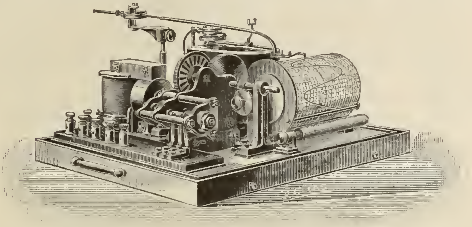
Mr. Sills, architect, 30, Norfolk-street, Strand, London, W.C., has for sale foundry works at Bury St. Edmunds, suitable for engineers or other works.

Lock Seal for Meters, &c.—Messrs. Everett, Edgcumbe & Co., of 87, Victoria-street, Westminster, S.W., and Hendon, N.W., are placing upon the market the "Shurlock" seal for sealing prepayment and other gas and electricity meters, mail bags, &c. The accompanying illustration shows the method of affixing the lock-seal, and it is believed that it is impossible to tamper with the "Shurlock" seal without the fact being apparent, not only on minute examination but even on casual inspection. Although it takes the place of either a padlock or lead seal, there is no necessity for any authorised person wishing to break the seal in case of emergency to use force, as no key is required to open it. The seals are supplied in a convenient form for the pocket, and can be applied without any tool. Other facilities are offered with the "Shurlock" seal which users will readily appreciate. An illustrated sheet of particulars is available.

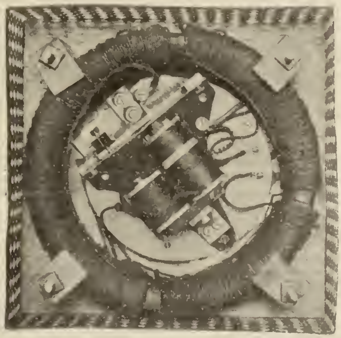


THE "SHURLOCK" SEAL.

Bat Electrical Co.'s Specialities.—Two sheet lists (Nos. 14 and 88) have been issued by the Bat Electrical Co., 23 and 25, North-street, King's Cross, London, N., describing (1) Hospitalier's patent wave recorder and (2) the company's patent "Rex" transformer. In the accompanying Fig. 1 a general view of the wave recorder is shown. The object is to inscribe directly upon a sheet or roll of paper, by means of ink the representative curves of periodically and rapidly variable electrical phenomena. The apparatus is made up of a small synchronous single-phase motor connected to the electric supply, to be studded on to some other supply by means of one of the sets of terminals shown. A condenser of suitable capacity is connected through a resistance to another set of terminals, and the electric supply to be studded in is brought on to a third set. The motor causes the automatic commutator and the recording cylinder to revolve by means of the gear wheels shown.



E. HOSPITALIER'S WAVE RECORDER.



THE REX TRANSFORMER. Back view, with cover removed.

One complete revolution of the drum allows the inscription of three curves, each corresponding to 1,000 periods. The wave recorder will be found useful in recording the volts wave form, the amps. wave form, the determination of power factors, and the determination of frequency. There are many other uses to which the recorder can be put. Fig. 2 shows a back view of the "Rex" transformer without cover. This apparatus will transform alternating into continuous current for charging from 2 to 15 accumulator cells and for various other purposes. Pamphlets now obtainable from the company give fuller particulars.

Catalogues, &c.—Electrical speed indicators form the subject of a new pamphlet (S. I. 66), issued by Elliott Bros., of Lewisham, London, S.E.

Lists of electric light fittings and fixtures are published by the General Electric Co. showing goods that are offered at reduced prices. These lists are respectively F 1,125 and F 1,026. In connection with the goods offered in list F 1,125, the company point out that these reduced prices relate to patterns of fittings which they do not illustrate in the present edition of their catalogue, and consequently the demand does not warrant their being held in stock. The fittings are, however, quite new and of best quality. In regard to list F 1,026, these fixtures are being offered at specially reduced prices for quantity orders, the company's object being to encourage installation contractors to stock certain of their leading lines in electric light fixtures. There are some good things in both lists.

A series of Siemens' publications has just been issued, including lists 1A, 3B, 3E, 5B, 7A, and sheets 16 and 17. These lists, &c., deal respectively with continuous-current generators and motors, Lilliput arc lamps and accessories, Siemens' arc lamp carbons, switchboard instruments, vulcanised india rubber wires and cables, type EK switchboard instruments, and fittings for Lilliput arc lamps. The list of continuous-current generators and motors deals with medium sized machines, classes F and G. These machines have been listed in such a way that all the data may be read across two pages, so that outputs and prices are easily comparable. The method of coding adopted is simple and effective, and the lists will be found useful by the busy contractor, more especially as the information given concerning the machines is very complete. In the Lilliput arc lamp list a new type of lamp for 3, 4 and 5 amperes is included. Accompanying these lists is a handy binder which has pasted in at the end a Contents Card showing the company's scheme of price lists, and enabling those who wish to consult these lists to make them up in the most suitable way for easy reference.

Ernest F. Moy (Ltd.), Camden Town, N.W., have ready list No. 17, giving illustrated particulars and prices of screws, bolts, nuts, washers, &c., of their manufacture.

Mr. Percy Pitman of Bosbury, Ledbury, has ready two sheet lists of "Hector" water motors, one illustrating and describing a type of this machine supplied for ordinary domestic work, and another describing a combined water motor and dynamo for charging accumulators. The particular machine illustrated in this list will charge two motor cars or four motor bicycles.

A price sheet (No. 15 C), describing and illustrating the two forms of tantalum lamps now available, and some accessories used in installing these lamps can be obtained by the trade from Siemens Bros. & Co., York-mansion, York-street, Westminster, S.W. Both forms of lamp (Standard and "Sun") are illustrated.

Mr. C. S. Knowles, 7, Victoria-street, London, S.W., has ready a number of sheet lists of electrical supplies, including battery connectors, insulating tape, soldering paste and unglazed porcelain leading-in tubes.

The Howard Asphalt Troughing Co., of Trafford Park, Manchester, have issued a well illustrated pamphlet giving useful information in regard to the Howard troughing and a set of instructions how to lay the troughs.

In a catalogue just issued by E. P. Allam & Co., Red Lion-street, Clerkenwell, London, E.C., motor starters, controllers and reversing switches, and iron clad switches, cut outs, house service boxes and circuit-breakers are listed, and specimen examples of this apparatus are shown.

The Edison and Swan Co. have ready their 1906 fan catalogue, also a leaflet of Ediswan fancy switch plates (flush patterns).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from May 30 to June 6, with the ports of destination :—

Africa—Alexandria, £794 (including £241 telegraph material) ; Delagoa Bay, £382 and 213 tons iron telegraph poles ; Durban, £103 ; East London, £51 ; Port Elizabeth, £238. *Argentina*—Buenos Ayres, £2,187 (including £1,582 telegraph material) ; Rosario, £55. *Australasia*—Adelaide, £65 ; Brisbane, £60 ; Fremantle, £1,562 (telegraph cable) ; Melbourne, £195 ; Perth, £170 ; Sydney, £1,979 ; Wellington, £410 (including £375 telegraph material). *Azores*, £800 (telegraph material). *Belgium*—Brussels, £120 ; Ghent, £40. *Brazil*—Rio Janeiro, £389 (including £357 telegraph material) ; Santos, £870. *British Guiana*—Demerara, £38. *Burma*—Rangoon, £17. *Canada*—Montreal, £200. *Ceylon*—Colombo, £8. *China*—Canton, £456 (including £258 telegraph material) ; Shanghai, £249 (including £71 telegraph material). *Cochin China*—Saigon, £33. *Denmark*—Copenhagen, £256 (including £250 telegraph cable). *France*—Boulogne, £40. *Germany*—Hamburg, £2,000 (telegraph material). *Gibraltar*, £29. *Holland*—Amsterdam, £119 (including £19 telegraph material). *Hong Kong*, £304. *India*—Bombay, £561 ; Calcutta, £666 ; Karachi, £151 ; Madras, £152. *Italy*—Genoa, £36 (telegraph material). *Japan*—Yokohama, £2,882 ; Yokosuka, £2,656. *Mexico*—Coatzacoalcos. £937. *Philippines*—Manila, £18 (telegraph material). *Portugal*—Oporto, £95. *Roumania*—Galatz, £40. *Russia*—Kurch, £2,798 ; St. Petersburg, £1,753 (including £1,720 telegraph material). *Siam*—Bangkok, £137. *Spain*—Malaga, £90. *Straits Settlements*—Penang, £166 (including £18 telegraph material) ; Singapore, £600. *Surinam*, £37. *Sweden*—Gothenburg, £26 ; Stockholm, £43 (including £29 telegraph material). *U.S.A.*—Boston, £11 ; New Plymouth, £50 ; New York, £127. Total, £28,251 (for eight days), against £143,742 for seven days last year (May 31 to June 6).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

April 23, 1906.

9,445 ROBERTSON. Securing glass bulbs of incandescent lamps to caps.
9,488 SIEMENS BROS. & CO. (Siemens-Schuckertwerke G.m.b.H., Germany.) Rotating field magnets of electric machines.*
9,498 ADAMS. Apparatus for lubricationg rails of tramways.
9,504 JORDAN. Underground conduit system of electric traction.
9,509 ELEKTRIZITÄTS A.-G. VORM. W. LAHMEYER & CO. Electrically-operated valves. (Date applied for, May 3, 1905.)*†
9,515 THESTRUP. Switches for tramways and the like.

April 24, 1906

9,544 B.T.-H. CO. (G.E. Co., U.S.) Motor control systems.
9,550 MCCORMICK. Electric controller contact.
9,556 JOHNSTON & ACKERMANN. Automatic block signal system for electric railways. (Date applied for, April 25, 1905.)*†
9,563 MUNRO. Automatic fire alarms.
9,568 SMITH, SMITH & HOOPER. Means for use with tramcars and other vehicles to suppress dust.
9,594 LAKE. (Ingersoll-Rand Co., U.S.) Electro-pneumatic channelers.*
9,606 MURDOCK. Rotary converters.
9,612 WEGNER & WENDLEBURG. Electric hammers.*
9,630 CIE. DE L'INDUSTRIE ÉLECTRIQUE ET MÉCANIQUE. Electrical devices simultaneously actuating controllers of several railway vehicles from any one of these vehicles. (Date applied for, April 25, 1905.)*†
9,633 B.T.-H. CO. (G.E. Co., U.S.) Dynamo electric machines.

April 25, 1906.

9,688 BROWN. Alternating-current motors.*
9,693 CROMPTON & CO. & TUBBS. Horizontal arc lamps.
9,706 ATKINS. Electrolytic apparatus.
9,714 KINGSBURY. (Western Electric Co., U.S.) Coin collecting mechanism.*

April 26, 1906.

9,737 VON KRAMER. Electrically-driven pulley blocks.
9,763 CONNELL. Combined switch and lampholder.
9,767, 9,768 and 9,769 WESTINGHOUSE. Turbines. (Date applied for, May 2, 1905.)*†
9,772 SIEMENS & HALSKE A.-G. Glow lamps. (Date applied for, May 31, 1905.)*†
9,781 and 9,788 STONE. Space telegraphy. (Date applied for, 20/6/05.)*†
9,784 GROTE & ELY. Arc lamps.
9,786 MCKENZIE & HOLLAND, & EDMONDS. Electrical detection between railway or tramway signals, points, &c.
9,789 PEARD. Electric fusible cut-outs.
9,792 GARDNER & GARDNER. Electric ignition devices.
9,794 MORGAN CRUCIBLE CO. & SPEIRS. Brushes for dynamo electric machinery.

April 27, 1906.

9,812 SÜSSMIT & HULD. Station indicators.*
9,823 WILKINSON & WILKINSON. Compound rails for tramways and the like.
9,838 MAJOR, STEVENS & STEVENS. Gates for electric and other lifts.
9,846 SIEMENS-SCHUCKERTWERKE G.M.B.H. Alternating-current traction systems. (Date applied for, June 16, 1905.)*†
9,858 JACOBY. Alternating-current commutator motors.
9,859 JACOBY. Motor starting and regulation switches for organ blowing, pumping, &c.
9,904 WEISS. Electric motor mechanism for automobiles. (Date applied for, Jan. 16, 1906.)*†
9,915 ATKINSON. Operating switches, frogs and signals of electric tramways.*
9,916 WISE. (Moore Electrical Co , U.S.) Vacuum tube apparatus.*

April 28, 1906.

9,921 BOOTH, BROOK & HIRST. Electric controller for organ blowing.
9,926 BREW-MULHALLEN. Electric switches worked from any place.
9,951 JOHNSON. (Frederico de Blanco y Perez de Vara, Spain.) Electro-automatic mechanisms for displaying advertisements *
9,958 GOODWIN. Deadening noises in electric conductors.
9,973 QUERTIER. Rail cleaners for tramways. (Date applied for, 16/1/06.)*†
9,980 LEE. Metallic vapour electric lamps.

9,990 **Siemens-Schuckertwerke G.m.b.H.** Electric-mercury vapour lamps. (Date applied for, May 31, 1905.)*†

April 30, 1906.

10,016 **B.T.-Co.** (G.E. Co., U.S.) Dynamo-electric machines.

10,020 **B.T.-H. Co.** (G.E. Co., U.S.) Fluid pressure-brake systems.

10,024 **Laurent.** Arc light carbons.

10,054 **Von Bronk & Pieper.** Production of high-tension currents.*

10,061 **Mitchell.** Insulators for electric traction.

10,097 **Frick.** Reduction of ores by electric transformer furnaces.

10,114 **B.T.-H. Co.** (G.E. Co., U.S.) Electric controllers.

May 1, 1906.

10,125 **Bowron.** Wireless telegraphy, electro-therapy and the like.

10,138 **Bennett.** Dynamo-electric machines.

10,148 **Wood & Wood.** Rendering overhead wires "dead" in case of fracture.

10,156 **Hartenstein.** Electric furnaces.*

10,161 **Hartenstein.** Lining for electric furnaces and preparing same.*

10,172 **Conrad.** Overload and reverse-current relay devices. (Date applied for, May 8, 1905.)*†

10,188 **Evans.** Electrical advertising novelty.

10,208 **B.T.-H. Co.** (G.E. Co., U.S.) Insulating conductors.*

10,218 **Roberts.** Party line telephone systems. (Date applied for, May 1, 1905.)*†

10,219 **Rink.** Electrolytic decomposition of alkaline chloride solution by mercury cathodes.*

10,220 **Morgan Crucible Co. & Speirs.** Brush-holders for dynamo-electric machines.

10,224 **Gaudin & Tellier.** Electro-magnetically operated valves.*

May 2, 1906.

10,249 **Kitsee.** Transmission of electric telegraphy.*

10,268 **Hargraves & Keefe.** Brushes for electrical machinery.

10,274 **Cunningham.** Railways, tramways and the like.*

10,283 **Schwan.** Circuit-closing device for electric clocks and watches. (Date applied for, May 2, 1905.)*†

10,297 **Berry & Berry.** Electric switch and indicating apparatus.

10,310 **Reilly.** Electric heaters.*

10,327 **Orling.** Electro-capillary apparatus.

10,339 **Clarke.** Interrupters for operating induction coils.

May 3, 1906.

10,364 **Hope.** Fuse carriers for high-voltage circuits.

10,367 **Gibson & Brooker.** Electrical advertising devices.

10,396 **Gin.** Electric furnaces for the manufacture of steel. (Date applied for, May 3, 1905.)*†

10,404 **Leidl.** Masts for wireless telegraphy.

May 4, 1906.

10,457 **Hopfelt.** Manufacturing coils for electric purposes.*

10,462 **Merritt.** Collecting fixed charges in connection with electric installations and supplying current and apparatus therefor.

10,464 **Hodgson & Harvey.** Electrical tramway-type controller finger.

10,465 **Furse & Woollatt.** Switches.

10,467 **Stewart.** Automatic switch for preventing excessive current.

10,472 **Hyde.** Leading-in conductors for incandescent lamps.

10,493 **Mitchell, Gartland & Shone.** Incandescent lamps.

May 5, 1906.

10,543 **Smith.** Terminals for accumulators.

10,549 **Lake** (Stromberg-Carlson Telephone Mfg. Co., U.S.). Electrical switching devices.

10,552 **Spence.** Conversion of alternating to continuous current.

10,554 **Lake** (Stromberg-Carlson Telephone Mfg. Co., U.S.). Telephone switchboards.

10,558 **Lake** (Stromberg-Carlson Telephone Mfg. Co., U.S.). Telephone wall boxes.

10,565, 10,580, 10,598, 10,599, 10,600, 10,601, and 10,602 **Lake** (Stromberg-Carlson Telephone Mfg. Co., U.S.). Telephone exchange systems and apparatus.

10,576 **Hanson.** Connecting cables inside trolley standard brasses.

10,585 **Punga.** Alternating-current motors. (Date applied for, May 5, 1905).*†

10,603 **Lake** (Stromberg-Carlson Telephone Mfg. Co., U.S.). Telephone transmitters.

10,605 **Buckeridge & Buckeridge.** Electrical signalling.

10,610 **Brockie.** Arc lamps.

10,613 **Jansen, Norballe & Lawson.** Starting and reversing electromotors actuating elevators and the like.

May 7, 1906.

10,622 **Cowper-Coles.** Leading-in wires for incandescent lamps.

10,639 **Bruce Peebles & Co. and La Cour.** Apparatus for starting up synchronous alternating current dynamo-electric machines.

10,655 **Sibley & Luty.** Elbows for conduits for electric waves.*

10,674 **Settegast.** Electric trumpets and the like.*

10,684 **B.T.-H. Co.** (G.E. Co., U.S.) Dynamo-electric machines.

10,702 **Sefton-Jones.** (Boas, Germany.) Supporting devices for telephone apparatus.*

10,702 **Berry.** Adjustable suspenders for electrical devices. (Date applied for, July 11, 1905.)*†

May 8, 1906.

10,719 **Greves.** Sparking plugs for internal-combustion engines.

10,740 **Fletcher.** Station indicators for railway carriages, tramcars, &c.

10,747 **Chameleon Signs (Ltd.), Avery & Pearce.** Luminous signs.

10,748 **Howard.** Apparatus for penetrating through conduits.

10,778 **Siemens & Halske A.G.** Electrical safeguard indicator for railway points, signals and the like. (Date applied for, Sept. 2, 1905.)*†

10,795 **B.T.-H. Co.** (G.E. Co., U.S. Commutators for dynamo-electric machines.

10,802 **Cowper-Coles.** Electrolytic deposition of metals.

May 9, 1906.

10,812 **Meldrum.** Dynamo-electric generators, motors and apparatus.

10,825 **Dempsey.** Water wheels or turbines.

10,826 **Winter.** Girder clip for electrical conduits.

10,842 **Lewis & Davis.** Electric bells providing automatic fire alarm.

10,861 **Féry & Grassot.** Electric meters.*

May 10, 1906.

10,904 B.T.-H. Co. (G.E. Co., U.S.) Machines for manufacture of incandescent lamps.

10,930 **Farrar.** Cable finder and pulley guide for electrical traction.

10,957 **Thomas.** Vapour electric apparatus. (Date applied for, 5/11/1905.)*†

10,966 **Gardner & Gardner.** Purification of sea water for use with power plants.

10,976 **Lake.** (Parker Clark Electric Co., U.S.) Electric conductors.*

10,987 **Stanley & Anger.** Route indicators for tramcars.*

10,993 **E.-A.-G. vorm W. Lahmeyer & Co.** Dynamo-electric machines. (Date applied for, May 11, 1905.)*†

10,996 **Lineback.** Electric signals for railways.*

11,001 **Graetz.** Incandescent lamps and burners.*

May 11, 1906.

11,028 **Jackson.** Electric tail lamps for motor cars.

11,042 **Clarke.** Electric heating apparatus.

11,058 **Stout.** Circuit-breakers.*

11,067 **Sleep & Everson.** Brake gear for tramcars, &c.

11,075 **Geist & Ernst Heinrich Geist E.-A.-G.** Braking device for motor cars. (Date applied for, May 12, 1905.)*†

11,081 **E.-A.-G. vorm W. Lahmeyer & Co.** Dynamo-electric machines. (Date applied for, May 12, 1905.)*†

11,102 **B.T.-H. Co.** (G.E. Co., U.S.) Insulating material.

11,114 **Clarke.** Wireless telegraphy and telephony.

May 12, 1906.

11,149 **British Insulated & Helsby Cables & Nisbett.** Cables.*

11,167 **Holman.** Telephone and other electrical equipments for divers.

11,177 **Fellowes-Gordon.** Electric fuzes for firing guns.

11,181 **Siemens Bros. & Co.** (Siemens & Halske A.-G., Germany.) Electromagnetic automatic interrupter.*

11,182 **Bray & Bray, Markham & Reiss.** Switches.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

8,891 **Frenot.** Filaments for incandescent lamps. (Date applied for, May 7, 1904.)

9,162 **Feather, Feather, Feather, Feather & Astley.** Trolley heads.

9,279 **Wood.** Controlling supply of energy from alternating current generators to alternating current motors.

9,303 **Gleason.** Electric switch or protective circuit breaker.

9,467 **Braun.** Equalising electrical power with intermittent demand.

9,508 **Brown.** Collectors for electric vehicles on surface contact stud system.

9,565 **Smith.** Making and breaking electric circuits.

9,577 **Seacombe.** Combined portable electric battery and induction coil.

9,702 **Kenny.** (Molyneux.) Field telephone and telegraph apparatus.

9,739 **Wood.** Controlling supply of energy from alternating current generators to alternating current motors.

9,815 **Sangster.** Appliances for use in connection with the electric ignition systems for internal combustion engines.

9,839 **Bruce, Peebles & Co., & La Cour.** Means for the regulation of speed of compensated single phase motors.

11,415 **Evrershed & Vignoles, & Evershed.** Measuring resistances.

11,626 **B. T.-H. Co.** (G.E. Co., U.S.) Protective devices for alternating current systems.

13,954A **Harrison.** (Electric Railway Improvement Co.) Adjustable resistances. (Date applied for, July 6, 1905.)

14,033 **Harrison.** Mercurial and other metallic vapour electric lamps.

15,859 **B. T.-H. Co.** (G.E. Co., U.S.) Prepayment meters.

16,471 **Kamm.** Projecting lamps using Nernst filaments.

16,655 **Marconi & Marconi's Wireless Telegraph Co.** Wireless telegraphy.

16,943 **B. T.-H. Co.** (G.E. Co., U.S.) Electric resistances.

18,051 **Hoffmann.** Trolleys. (Date applied for, Sept. 9, 1904.)

18,264 **Heraeus & Heraeus.** Gas or vapour electric lamps. (Date applied for, Oct. 14, 1904.)

19,989 **Craven.** Electrically operating railway carriage doors and locks.

21,268 **De Saint-Romain.** Igniting charge in internal combustion motors. (Date applied for, April 27, 1905.)

21,707 **Edge.** Protecting device for shunt field windings.

25,174 **Soc. Anon. Electrometallurgique.** (Procedés Paul Girod.) Electric furnaces. (Date applied for, Jan. 4, 1905.)

25,175 **Kriéger & Compagnie Parisienne des Voitures Electriques** (Procédés Kriéger.) Electrical propulsion of vehicles. (Date applied for, May 24, 1905.)

25,550 **Large.** Electromagnetic power hammer, drop stamp, or press.

25,612 **Fairweather.** (Firm C. H. F. Müller.) Röntgen ray apparatus.

26,036 **Electric & Ordnance Accessories Co., Hancock & Hall.** Fans of the rotary propellor type.

26,149 **Palmer.** System of electrical distribution. (Date applied for, Dec. 22, 1904.)

26,237 **Fox.** Ignition devices for explosion engines. (Date applied for, Oct. 25, 1905.)

27,242 **Clatworthy, Holmes, Holmes, Holmes & Holmes.** Control of electric motors.

1906 Specifications.

615 Borden. Telephone holders. (Date applied for, March 1, 1905.)
706 Hewitt. Controlling vapour electric apparatus. (Date applied for, Jan. 20, 1905.)
1,507 Simms & Bosch. Magnetoelectric ignition apparatus.
1,699 Pieper. Electrically-fired internal combustion engines. (Date applied for, Jan, 24, 1905.)
1,820 Passburg. Devices for drying electric cables.
1,830 Raworth. Control of circuits in electric traction.
2,209 Leake. Trolleys or collectors for electricity.
2,317 Küppers. Electric welding of chains, rings and the like.
2,322 Justice. (Bullock Electric Mfg. Co.) Shaft bearings.
2,794 Siemens Bros. & Co. (Siemens Schuckertwerke Ges.) Protection of electric circuits from excessive voltages.
3,541 Siemens Bros. & Co. (Siemens Schuckertwerke, G.m.b.H.). Safety appliances for electric circuits.
4,221 Massie. Oscillaphones or Hertzian wave responsive devices.
4,773 Holmes, Holmes, Holmes, Holmes & Ralph. Starting switches, rheostats, or controllers for electric motors.
6,079 Vontobel. Automatic regulating device for pneumatically controlled collectors supplying current to trains or road cars. (Date applied for, March 14, 1905.)
7,490 Conrad. Alternating-current electro-magnets. (Date applied for, April 3, 1905.)
7,491 Jackson. Electro-magnets. (Date applied for, April 3, 1905.)
8,352 Accumulatoren-Fabrik A.-G. Accumulators. (Date applied for, April 7, 1905.)

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The report for 1905 states that the gross revenue was £29,808; gross profits £12,284 and net profits £9,702. After payment of interest, interim dividend, &c. (representing part of the accumulated profits of previous years), the disposable balance is £14,958. The directors recommend a final dividend of 6 per cent. for the year, £5,000 is put to a new reserve fund and £5,458 carried forward. Since the close of the year a cable has been laid across the River Tagus and the company's lines are being extended 30 kilometres to the town of Setubal and Cezimbra. The cost of this work and the capital outlay of the year have been defrayed without encroaching upon the invested funds of the company. Since the commencement of the present year there has been a further steady improvement in the company's business.

BIRMINGHAM & MIDLAND TRAMWAYS (LTD.)—The gross receipts for 1905 (including £1,701. 16s. 8d. from previous account) were £118,344. 19s. 1d.; and after providing for all expenses £42,773. 3s. 7d. remains. Deducting interest and preference dividend the available balance is £18,860. 5s. 7d., which is to be applied to the payment of a dividend on the preferred ordinary shares of 5½ per cent. for 1905 (less tax). The capital expenditure during the year was £58,128. 6s. 1d. The receipts from the tramways increased by £25,003. 17s. 2d. over 1904. Development of the power supply business in Smethwick has made favourable progress, and negotiations are in hand with several large firms in the district for supplies of power. A notice has been received from the town clerk of Birmingham of the intention of the Corporation to purchase the poles, overhead apparatus and low tension cables on the Dudley-road line within the Birmingham boundary. The lease of the line expires on June 30 next, and negotiations are proceeding with the Corporation for the maintenance of a through service between Birmingham, Smethwick, Oldbury and Dudley. Mr. H. Graham Harris, the arbitrator appointed by the Board of Trade to determine the price to be paid by Dudley Corporation for the whole of the tramways and light railways within the borough, fixed the price to be paid by the Corporation for the section in which the company is concerned at £10,631. By agreement the Corporation have to grant a 21 years lease to the company. The parcels and goods carrying service, commenced in November last, has met with considerable success. A scheme of mutual insurance has been entered into by the company jointly with other associated companies of the British Electric Traction Co.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The report for 1905 states that the plant which continues to work satisfactorily is fully loaded. To meet the increased demand for power a further unit is being installed, which it is hoped will be in operation by August. The payment made in October last cleared off arrears of interest on preferred shares to December, 1900, while the payment made in April covered arrears to Sept. 30, 1901. After paying £3,362 to preference shareholders and interest, &c., the balance is £12,086, of which £5,750 has been added to reserve for depreciation and £5,336 carried forward.

LISBON ELECTRIC TRAMWAYS (LTD.)—The directors' report for 1905 states that, after paying interest and all expenses, the net profit is £91,742. 2s. 1d., added to £16,147. 1s. 10d. from last year, making £107,889. 3s. 11d. From this £35,000 has been placed to depreciation and £5,000 added to exchange reserve account, leaving an available balance of £67,889. 3s. 11d. Preference dividend absorbs £25,533. 3s. 8d. and the directors recommend a dividend of 5 per cent. for the year on the ordinary shares, leaving £17,356. 0s. 3d. to be carried forward. 40,065,125 passengers (including season ticket holders) were carried, against 34,067,573 in 1904, and the gross revenue was 1,368,477·321 milreis, against 1,191,026·034. During the year four additional sections were opened for traffic totalling 5 miles 693 yds. To meet the demands of the increased traffic many additions to the plant of the power station and rolling stock have been carried out, and further expenditure involving considerable outlay is still necessary. The company has already expended about £107,000 beyond its capital, and it is proposed to create an additional 250,000 ordinary shares, of which 100,000 will shortly be issued.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANY.

J. LOMAX KENDAL & CO. (LTD.) (88,987.)—Reg. May 30, capital £5,000 in £1 shares, to acquire the business of J. Lomax Kendal & Co., and to carry on the business of electricians, electrical contractors, engineers, fitters, etc. Reg. office, 4, John Dalton-street, Manchester.

STATUTORY RETURNS.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—Return to April 19 gives capital as £100,000 in 25,000 preference and 75,000 ordinary shares of £1 each, of which 71,007 ordinary have been taken up. £1 per share has been called up on 1,007 and £1,007 has been received. 70,000 shares are considered as fully paid. Mortgages and charges, £50,000.

TELEPHONE CO. OF EGYPT (LTD.)—In return to April 25 capital is £200,000 in 36,000 preference and 4,000 deferred shares of £5 each, of which 24,000 preference and 4,000 deferred have been taken up. £5 per share has been called up on 12,000 preference and £60,000 has been received. £80,000 is considered as paid on 12,000 preference and 4,000 deferred. Mortgages and charges, £100,000.

MORTGAGES AND CHARGES.

NATIONAL PROVINCIAL ELECTRICITY CORPN. (LTD.)—Particulars of £5,000 debentures, created May 16, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been filed. No trustees.

CITY NOTES.

MEMORANDA (June 7).—Bank rate 4 per cent. (since May 3, 1906). Price of silver 29⅞d. per oz. Consols 89—89⅛ for money, $89\frac{3}{16}$—$98\frac{5}{16}$ for account; 2½ per cent. annuities 88—88¼. Consols Pay Day, July 4. Stocks and Shares Continuation Days, June 12 and 26; Ticket Days, June 13 and 27; Pay Days, June 14 and 28; Mining Share Carry-over Day, June 11.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended April 27, were 497,922, compared with 301,369 in the corresponding period of 1905.

GANZSCHE ELEKTRIZITATS AKTIENGESELLSCHAFT BUDAPEST.—This company has recently been formed in Budapest with a capital of 8,000,000kr., to take over the electrical department of Ganz & Co. and to enter into working arrangements with the General Electric Co. of New York, the Allgemeine Elektricitäts Gesellschaft, Berlin, and the Allgemeine Oesterreichische Elektricitäts Gesellschaft, Vienna. Particulars of this amalgamation were given in our issue of May 18.

MACKAY COMPANIES.—A regular quarterly dividend of 1 per cent. on the preferred shares and a dividend of 1 per cent. (at the rate of 4 per cent. per annum, payable quarterly) on the common shares in the Mackay Companies will be paid on July 2. Transfer books will be closed from June 18 to 30 inclusive.

MONTREAL LIGHT, HEAT & POWER CO.—The annual statement shows a surplus of $598,000, after paying fixed charges and dividend, compared with a surplus of $448,789 for the previous year.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During May 1,060,000 units of electrical energy were generated, yielding a gross revenue of £9,900, compared with 972,000 units and £9,000 for the corresponding month of last year.

REPORTED COMPANY AMALGAMATION.—We are informed that there is no truth in the rumour that negotiations are taking place regarding the purchase of the undertakings of the Northern Counties Electricity Supply Co. (Ltd.) by the Newcastle-upon-Tyne Electric Supply Co. (Ltd.), the matter not having been considered by the latter company.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 13 a special settling day in a further issue of 20,000 £5 fully paid shares of the *Calcutta Electric Supply Corpn. (Ltd.)* and have ordered same to be quoted. Quotations have also been granted to 110,000 £1 fully paid ordinary shares of the *Consolidated Electrical Co. (Ltd.)*, a further issue of £225,000 6 per cent. preferred stock and £225,000 deferred stock of the *National Telephone Co. (Ltd.)* and $4,635,000 $1,000 50 year first lien and collateral trust bonds of the *Manila Electric Railroad & Lighting Corpn.* The Committee have been asked to appoint a special settling day in and to grant a quotation to 100,000 £1 6 per cent. preferred and participating shares of the *Delhi Electric Tramways & Lighting Co. (Ltd.)*; to appoint a special settling day in 168,365 £1 fully paid vendors' ordinary shares, and £58,333 vendors' 5 per cent. first mortgage debenture stock of *Johnson & Phillips (Ltd.)*; and (renewed application) to grant a quotation to £300,000 5½ per cent. Loch Leven debentures (registered) of the *British Aluminium Co. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	May 25	219	+ 19	21	4,529	+ 449
Anglo-Argentine	June 3	14,200	+ 1,484	22	380,535	+ 55,019
Ashton-under-Lyne Corp.	May 26	3?8	+ 26	9	2,971	+ 265
Ayr Corporation	June 2	300	+ 19	3	707	− 129
Baker St. & Waterloo Ry.	,, 2	1,431	...	12	17,403	...
Barnsley	May 25	153	− 3	21	8,301	+ 89
Barrow	,, 25	228	+ 4	21	4,516	+ 250
Bath Electric Trams, Ltd.	,, 30	765	+ 50	22	15,377	+ 1,983
Birkenhead Corporation	June 3	1,089	− 8	..	...	...
Birmingham Corporation	,, 2	622	+ 275	9	5,158	+ 1,818
*Birmingham & Mid.	May 25	1,342	− 525	21	28,974	− 8,229
Blackburn Corporation	,, 30	975	− 39	¶9	9,585	+ 458
Blackpool Corporation	,, 31	665	− 116	8	6,258	− 20
Blackpool and Fleetwood	June 2	382	..	22	6,860	+ 137
Blackp'l, St. Anne's & Lytham	May 31	270	− 46	§30	5,244	+ 540
Bolton Corporation	June 3	2,095	+ 90	9	18,921	+ 773
Bournemouth Corporation	May 30	1,452	+ 419	†9	18,551	+ 3,955
Bradford Corporation	,, 26	4,173	+ 71	8	35,668	+ 1,681
Brighton Corporation	June 3	1,003	+ 22	9	8 282	− 390
Bristol Trams & Carriage	,, 1	4,923	− 190	16	75,616	+ 3,019
Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trms.	May 5	1,420	+ 206	18	25,459	+ 5,274
Burnley Corporation	June 2	1,185	+ 70	9	76	+ 627
Burton Corporation	,, 3	308	− 19	§9	2,662	− 204
Bury Corporation	May 27 June 3	943 959	... ...	9	8,771	...
Calcutta Tramways Co.	,, 2	R43,411	+ R5,019	22	R956,285	+ R99,872
Camborne-Redruth	..	..	...	..	...	...
Cardiff Corporation	May 26	1,891	+ 4	8	15,578	+ 577
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	May 25	74	+ 9	21	1,380	+ 354
Central London Railway	June 2	6,242	− 378	22	148,723	− 4,998
Chatham & Dist. Lt. Rys.	May 31	559	− 2	†21	13,109	− 116
*City of Birm'gh'm Tram Co.	,, 25	5,200	− 482	21	109,150	− 6,171
City & South London Rly.	June 8	62,404	+ 74	22	62,404	+ 342
Colchester Corporation	May 31	198	− 4	40	8,058	− 1,334
Cork Electric Trams Co.	,, 31	464	− 81	22	9,437	+ 570
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 25	447	− 5	21	8,824	− 434
Dover Corporation	June 2	289	+ 32	9	2,068	+ 227
Dublin & Lucan Railway	,, 1	114	− 18	§22	2,200	− 184
Dublin United	,, 1	4,877	− 340	‡22	102,027	+ 638
Dudley—Stourbridge	May 25	773	− 67	21	16,345	+ 125
Dundee Corporation	,, 30	1,081	+ 200	§2	2,198	+ 859
East Ham Council	June 2	897	− 1	9	8,228	+ 821
Exeter Corporation	,, 1	263	− 25	9	2,399	− 421
Gateshead & Dist. Trams.	May 25	907	+ 35	21	19,231	+ 954
Glasgow Corporation	June 2	18,065	+ 2,298	1	18,065	+ 2,298
Glossop	,, 2	125	...	22	2,765	+ 250
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	May 25	226	...	21	4,407	+ 192
Gt. Northern & City Rly.	June 2	1,789	+ 201	22	89,559	+ 2,005
Greenock & Port Glasgow	May 25	695	− 93	21	12,677	+ 639
Halifax Corporation	,, 30	1,531	− 66	9	13,597	+ 478
Hartlepool Tramways	,, 25	257	+ 36	21	5,451	+ 878
Hastings Elec. Trams Co.	,, 31	585	...	22	10,626	...
Huddersfield	...	..	...	...	...	...
Hull Corporation	June 2	2,280	+ 78	9	19,699	+ 258
Ilford Dist. Council	...	..	...	...	...	...
Ilkeston Dist. Council	May 30	120	− 16	9	1,078	...
Ipswich Corporation	June 2	419	− 42	9	3 568	− 104
Isle of Thanet Co.	,, 2	477	− 47	34	10,498	− 1,038
Keighley Corporation	May 31	143	− 11	47	6,712	...
Kidderminster & District	,, 25	94	− 18	21	2,040	− 16
Kilmarnock Corporation	June 2	162	− 2	3	399	− 57
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	May 31	881	+ 215	†22	18,490	+ 4,126
Leamington	,, 25	147	+ 101	21	2,977	+ 1,497
Leeds Corporation	...	...	...	...	...	..
Leicester Corporation	June 2	2,259	+ 42	22	45,905	+ 4,167
Leith Corporation	May 25	492	+ 277	‡2	828	+ 413
Liverpool Overhead Rly.	June 8	1,438	− 107	22	30,733	− 2 316
Liverpool Corporation	May 26	10,622	+ 94	21	217,695	+ 5,845
*London County Council	,, 25	24,482	+ 10,252	8	209,547	+ 97,672
London United	June 1	6,412	− 553	†22	118,939	+ 4,532
Lowestoft	,, 2	155	− 10	36	4,640	− 224
Maidstone Corporation	May 31	104	− 26	9	940	− 182
Manchester Corporation	June 2	13,525	+ 535	9	117,420	+ 5,599
Mersey Railway	,, 2	1,753	+ 279	22	37,877	+ 2,523
Merthyr	May 25	191	+ 4	21	8,880	− 16
Metropolitan Dist. Railway	June 3	8,523	+ 1,267	22	176,288	+ 15,203
*Metropolitan Elec. Trams.	May 25	3,220	+ 912	21	64,018	+ 20,744
Middleton	,, 25	305	− 44	21	6,487	+ 264
Nelson Corporation	June 2	159	+ 20	10	1,341	+ 129
Newcastle-on-Tyne Corp.	,, 2	4,022	+ 210	0	85,217	+ 1,782
Newport (Mon.)	,, 2	516	+ 48	9	6,435	+ 263
Northampton Corporation.	,, 1	434	− 15	9	8,687	+ [illegible]
Oldham, Ashton & Hyde	May 25	529	− 15	21	1?,173	+ 430
Oldham Corporation	June 8	1,877	+ 215	10	17,477	+ 1,131
Perth (N.B.) Corporation	May 30	154	+ 23	2	296	+ 20
Perth (W. A.) Elec Trams	June 1	1,438	+ 82	‡22	33,258	+ 1,725
Peterborough	May 25	113	− 7	21	2,242	− 157
Pontypridd District Coun.	June 2	162	+ 3	9	1,528	− 38
Portsmouth Corporation	,, 2	1,809	− 111	9	16,267	− 562
Potteries	May 25	1,746	+ 109	21	86,351	+ 2,040
Preston Corporation	,, 30	710	+ 117	...	...	...
Reading Corporation	,, 31	601	− 28	...	...	...
Rochdale Corporation	June 2	1,042	+ 225	9	9,182	+ 3,900
Rotherham Corporation	May 31	467	+ 24	9	4 127	+ 382
Rothesay	,, 25	187	+ 39	21	1,915	+ 884
Salford Corporation	June 4	4,785	+ 841	9	40,373	+ 657
Sheerness	May 23	52	− 13	21	1,047	− 189
Sheffield Corporation	June 8	5,379	+ 415	10	51,432	+ 3,819
Southampton Corporation.	May 30	945	− 43	†9	7,808	+ 19
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 25	253	− 40	21	5,896	− 24
S. Staffordshire Trams.	,, 25	750	+ 60	21	16,881	+ 2,893

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	June 1	884	+ 240	9	8,117	+ [illegible],834
Sunderland Corpn.	,, 3	1 470	+ 114	9	11,971	+ 757
Sunderland & District	May 30	367	...	22	7,772	...
Swansea Trams	,, 25	786	− 15	21	15,748	+ 4,251
Swindon Corporation	,, 23 ,, 30	164 199	− 11 − 3	¶8	1,604	− 42
Taunton	,, 25	42	− 5	21	877	− 47
Tynemouth and District	,, 25	188	− 22	21	8,865	− 102
Tyneside Trams Co.	,, 30	416	+ 5	22	8,323	+ 471
Wallasey District Council	June 2	779	+ 1	9	6,761	+ 141
Walsall Corporation	...	...	...	...	...	...
Warrington Corporation	May 25 ,, 31	347 365	+ 37 + 39	9	3,241	+ 834
West Ham Corporation	,, 31	2,187	+ 460	9	19,957	+ 6,608
Weston-super-Mare	,, 23	78	− 31	21	1,054	− 45
Wolverhampton Corpn.	...	...	...	...	...	...
* Wolverhampton District	,, 25	377	+ 15	21	8,131	+ 783
* Worcester	,, 25	252	− 28	21	5,155	− 500
Wrexham	,, 25	89	− 4	21	1,932	− 57
Yorkshire W.R. Trams	June 3	852	+ 82	22	16,476	...
Yorkshire Woollen District	May 25	807	+ 198	21	17,582	+ 5,890

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., June 6.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 5. Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	7 —7½	5 10 4	Ap, Oct	$7\frac{1}{16}$	$7\frac{1}{32}$
5	2/9	Do. 5½% Cum. Pref.	5⅞—6⅛	4 10 0	—	$6\frac{1}{32}$	$5\frac{15}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	.	..
5	..	Brisbane Electric Trams. Invest. Ord.	$1\frac{1}{8}$—$1\frac{5}{16}$	..	..	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4 —4½	5 18 0	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	94 —97	4 12 9	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115 —118	5 1 5	—	..	..
St.	5%	† Do. Pref. Ord. Stk	107 —110	4 11 0	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	107½	108
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	102%—104%	4 6 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3⅜—3⅝	4 13 6	—	3⅜	$3\frac{5}{16}$
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5⅝—5⅞	5 2 6	—	..	..
5	8/0	Do. "B"	5 —5½	5 7 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	103 —106	4 14 8	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	102 —104	4 16 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	103 —107	5 3 0	..	..	—
100	6%	Do. 5% 1st Deb. Bonds	100 —105	5 14 0	..	[illegible]½	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	9¼—9¾	4 2 0	—	[illegible]⅞	..
5	2/6	Do. Nos. 105,001 to 137,610	8½—9	4 9 0	..	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 8	—	107½	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	96 —98%	5 2 0	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	94 —98	..	..	..	..
St.	..	Do. 6% "B" Ditto	90 —95	..	..	93½	..
1	..	Lisbon Elec. Trams Ord.	1½—1¾	..	..	1½	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102 — 105	4 15 0	Ja, Jul	.	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	107 —109	4 11 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	144 —147	..	..	..	..
..	5%	† Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	100½	98
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 16 6	..	[illegible]	..
5	5/3	Calcutta Elec. (1–50,000)	8½ 0	4 4 0	—	8¾	..
10	6%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	2⅝	—
St.	5%	Do. 5% Debs.	87 —91	5 10 0	—	..	..
10	..	Havana Electricity Co. Shares	10 —11	—	—	..	..
100	5%	† Do. 5% Dbs. iss. at 95, Scrip, all pd.	98 —100	5 0 0	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113 —118	5 3 0	..	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞—1	6 0 0	—	$\frac{29}{32}$	..
1	1/6	† Rand Electric	$1\frac{3}{16}$—$1\frac{5}{16}$	—	—	..	..
1	..	River Plate Electricity Co. Ord.	$\frac{7}{16}$—$\frac{9}{16}$	..	..	..	..
1	1/2¾	Do. 6% Non. Cum. Pref.	⅞ 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4 17 0	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1–12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 — 103	4 17 0	..	..	..

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* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., June 6.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to June 6. Highest.	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	.	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 3 3	..	107¾	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛—5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¼—9¼	5 8 6	—	8¾	..
5	3/6	Do. 7 per Cent. Pref.	8¼—9¼	3 15 6	Mar, Sept	.	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	100 —103	3 17 9	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	4½	..
5	2/3	Do. 4½ per Cent. Pref.	4⅝—4⅞	4 12 6	Feb, Aug	4⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	.	—
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾—4¼	5 6 0	—	4	—
5	2/3	Do. Do. (1903)	3¾—4¼	5 6 0	..	4	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	107 —109	4 2 6	Jn, Dec ..	..	—
10	7/0	City of London Electric Lighting Ord.	10½—11¼	5 6 6	Feb, Aug	11	10⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—13½	4 9 0	Jan, July	12 9/16	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	125¼	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	102¼	..
5	4	County of Durham Elec. P.D. Ord. £3 pd.	3 —3 1/32	4 0 0	April, Oct	..	..
5	5%	Do. Do. 5% non cum. pref.	5⅛—5⅝	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord. ..	8 —9	5 11 0	—	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¼	4 18 0	Mar, Sept	11⅞	11¾
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 4	..	102½	101¾
5	3/0	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	—	..
5	5/0	Hove Electric Lighting Ord.	8¼—8¾	5 5 0	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 —11	4 11 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.) ..	98 —101	3 19 2	..	..	—
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4½	London Electric Supply Ord.	2 —2½	4 0 0	—	2¼	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb	98 —101	3 19 2	Mr, Jn, S, D	..	..
5	10%	Metropolitan Electric Sup. Ord.	8¼—9¼	5 8 0	April, Oct	—	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 0 0	Jan. July	5 9/16	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 3	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	101 —103%	4 7 4	—	101½	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12 —12¼	5 11 1	Feb, Aug	12⅛	12
100	4½%	Do. 4½% Deb.	103 —104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅞—8	5 0 8	Feb, Aug	7⅞	7½
5	5%	Do. 5 per Cent. Non. Cum. Pref. ..	6 —6¼	4 1 7	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	1 —1 1/32	3 0 0	Mar, Aug	—	..
100	4½%	Do. 4½% Deb.	101 —102	4 8 9	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	—
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	—
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½—11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86 —88	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	—	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3¾—4¼	5 6 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1 Mort. Deb.	100 —102	4 8 0	..	101½	..
5	6/6	Westminster Elec. Sup. Ord.	10 —11	5 18 0	Mar, Sept	10½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16—5 9/16	4 10 0	..	..	..
5	..	Do. Issued at 7/6 premium all paid	5 5/16—5 9/16	..	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 —96	4 3 4	—	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16—1 1/16	4 14 0	..	1	..
1	0/6	Do. 5% Cum. Pref.	31/32—1 3/32	4 11 6	..	1 1/32	1
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.) ..	101 —104	4 6 6	—	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	..	..
10	8½%	Bristol Tramways and Carriage Ord.	15½—16	5 6 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10¼	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	.	.
10	6/0	British Electric Traction Ord.	6⅞—7⅜	4 1 6	—	7 7/32	6 13/16
10	6/0	Do. 6 per Cent. Cum. Pref.	9⅞—10⅜	5 16 0	Feb, Aug	10¼	9¾
St.	5%	Do. 5 per Cent. Perpetual Debs	114 —117	4 5 6	..	.	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 —95	4 14 9	..	93¼	93
St.	4%	Central London Ordinary Stock	87 —89	4 9 9	June, Dec	88¼	87
St.	4%	Do. 4 per Cent. Pref. Stock	99 —101	3 19 0	..	100¼	100
St.	4%	Do. Deferred Stock	77 —80	5 0 0	..	78¼	—
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 —95	4 4 0	..	93⅜	93
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞—5⅛	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	41 —43	4 7 0	Feb, Aug	43	41⅞
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 3	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾—4¼	9 8 0	..	4 1/16	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	—	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	105½—106½	4 4 0	Jan, July	..	—
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 —2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	3 13/16—3 15/16	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾—9¼	5 2 6	—	9	8⅞
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 —99	4 1 0	—	97	..
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	⅞—1	5 0 0	—	15/16	..
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7 —8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	8 —9	5 11 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	—	—	—
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	..	..
..	5%	Und. El. Rys. Co. of Lond. Ex Coupon No. 6	94 —96	5 4 0	..	96¾	94
St.	3½%	Waterloo and City Ord.	100 —103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	..	..
5	..	Do. 6% Cum. Pref.	5 —5½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	95 —97	4 13 0	..	..	—

Shre.	Last Dividend	Name.	Price Wed., June 6.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 6. Highest.	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	3⅞—4⅛	4 17 0	..	4 1/16	4
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6½—7	5 14 0	July, Feb	6 19/32	6 9/16
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 —107	4 4 0	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅝—1⅞	..	..	1 11/16	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 —85	4 14 0	..	81	..
2	1/0	Brush Electrical Engineering	⅝—⅞	—	March	..	..
2	3/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½—11½	4 10 6	Jan, July	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6	4 3 4	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	..	..
1	9⅔d.	†Castner-Kellner Alkali Co.	1 1/16—1 3/16	5 1 6	..	1⅛	1 3/32
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 —102	4 8 0	—	..	..
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	—	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 3 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	2 —2¼	3 6 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%—97%	5 1 0	Jan, July	98	..
5	10/0	Dick, Kerr & Co. Ord.	1¾—1⅞	5 8 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept	—	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	..	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	—	Feb, Aug	—	..
5	2/6	Do. (£5 paid)	2½—3	—	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅝—5⅛	5 17 0	..	4 15/16	4 13/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	103	..
2	1/7½	Electric Construction Co.	½—¾	9 6 6	July	9/16	..
2	2/9⅜	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9½—10	5 0 0	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 —13	5 15 0	Feb, Aug	12⅝	12 7/16
5	9/3	Do. 4½ per Cent. Pref.	5¼—5¾	4 1 6	Feb, Aug	..	—
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	107 —109	4 2 6	..	107¼	..
St.	22/6	† Do. Do. Scrip (all paid)	107 —109	4 2 6	..	107½	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17 —18	2 17 2	Feb, Aug	17¾	..
100	..	Do. 4% Debs. Red.	99½—101½	..	..	101	99½
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅗	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	⅞—1	6 0 0	—	15/16	..
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 10 0	..	..	..
12	24/0	Telegraph Construction & Mainten'ce.	32 —34	5 6 0	Mar, July	33½	32¼
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 —104	3 17 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16—2 9/16	5 15 0	..	2 17/32	2 7/16
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1¼	4 0 0	..	1 5/32	..
St.	5%	Do. 5% Non-Cum. Preferred	112 —116	4 6 0	—	115¾	115¼
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 —105	3 16 0	..	..	..
100	4½%	† Do. 4½% 2nd Mort. Debs., Red.	104 —106	4 5 0	—	105½	104½
5	—	Willans and Robinson Ord.	1¼—1¾	—	Apr, Oct	—	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	—	Apr, Oct	..	..
	4%	† Do. 4 per Cent. 1st Mort. Debs.	78 —83	4 16 6	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	3 —3½	—	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	..	..
St.	15/0	Anglo-American	67 —69	4 14 0	F, My, Ag, N	67½	..
St.	30/0	Do. Preferred	114 —115	5 2 0	F, My, Ag, N	115	114½
St.	10/0	Do. Deferred	26¼—26¾	..	F, My Ag, N	27	26 1/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97 —99	4 1 0	Jn Ap, Jy, O	98¾	98
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	8 23/32	—
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb Aug	17⅛	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 3	Jan, July	..	..
20	4/0	Direct United States Cable.	15¾—16¼	4 6 0	Ja, Ap, Jy, O	16⅛	15⅞
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	143 —146	4 16 6	Ja, Ap, Jy, O	145	144½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 —92	3 16 0	Ja Ap, Jy, O	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 —109	3 13 4	May, Nov	..	..
10	6/6	Eastern Extension	14 —14½	4 16 6	Ja, Ap, Jy, O	14⅛	14
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	99¾	..
10	38 0	G. N. (of Copenhagen) with coupon 67	39 —41	5 17 0	Jan, July	40½	40⅛
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 —103	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57 —59	5 10 0	May, Nov	57½	..
100	4%	Mackay Companies Common	77 11/16—77 13/16	5 2 6	Jan, July	—	..
100	4%	Do. Preference	76 11/16—76 13/16	5 4 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	100 —103	3 17 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	8¾—10¼	4 17 6	..	..	..
2½	—	West Coast of America	¾—⅞	..	—	¾	..
100	4%	Do. 4 per Cent. Debs.	101 —104	3 17 0	Jan, July	..	..
10	—	West India and Panama	1 7/16—1 9/16	—	May, Nov	..	..
10	4/0	† Do. 6% 1st Pref.	6 —7	3 11 4	May, Nov	6 3/16	6
10	—	Do. 6 per Cent. 2nd Pref.	5 —6	..	May, Nov	—	..
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14 —14½	4 17 6	Mr, Jn, O, D	14 9/32	14¼
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 15 6	..	105½	..
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 —103	4 17 0	..	..	..
5	8/0	Chili Telephone (fully paid)	7⅞—8⅛	4 18 0	August	8	..
1	0/4⅘	Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	0/6	Do. 5% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 —112	5 7 0	—	111½	110
St.	5%	Do. Def. Stock	108 —110	4 11 0	—	109¼	108¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 7 0	Feb, Aug	.	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	98¾	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 0	—	104	..
1	0/9⅗	Oriental	1⅜—1½	4 0 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	..	..
St.	24/7⅜	Do. 4% Red. Deb. Stock	99 —101	3 19 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	104¾	104
5	8/0	United River Plate	7 —7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —113	4 8 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	—	..	..
10	5/0	† Globe Telegraph and Trust	10⅞—11⅛	4 10 0	Ja Ap. Jy O	11 1/16	10⅞
10	8/0	† Do. 6 per Cent. Pref	14⅝—14⅞	4 0 6	Ja Ap. Jy, O	14⅝	14⅝
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 8	April, Oct	..	—

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

We referred last week to the necessity of additional investigation with regard to the alleged shortening of life of incandescent lamps by frosting them. The article on this subject, which we reproduced last week from an American contemporary, gave an account of tests which seemed to show an enormous difference between the useful life of a frosted and unfrosted incandescent lamp. This useful life was measured on the usual basis of the number of burning hours before the candle-power fell 20 per cent. It will obviously be a few weeks before the life tests can be repeated by other observers, but in the meantime Mr. MAURICE SOLOMON raises the pertinent question, in our Correspondence columns, whether the more rapid falling off in the candle-power of the frosted lamp is not simply due to the greater amount of dust that settles on the roughened and slightly hotter bulbs. It appears that the new definition of the life of an incandescent lamp, now generally accepted, already requires a new "factor" to keep it in order. When lamps are compared on the basis of this useful life, it will be necessary to specify in future that the comparison shall be made on the assumption of a 100 per cent. "dust factor,"—or shall we follow Mr. SOLOMON'S lead and call it a "housemaid's factor"?

The rapid progress of telephony has been one of the most wonderful developments of the last quarter of a century. Even in this country, where the complaint is still made that its advance has been comparatively sluggish, it has been sufficiently fast to outstrip again and again the exchange accommodation for dealing with subscribers. More particularly has this been so in the case of trunk working, for in this the conditions of traffic and the relatively high capital cost of the lines render the problem increasingly difficult. The large rush of traffic during three or four hours of each day makes it desirable that each trunk line should never be idle, and recent improvements have been devoted much towards the approach of this ideal condition.

Some of these improvements are described in the article on the new trunk exchange at Birmingham which appears on another page. Probably the most interesting of these is the one which calls into requisition the telegraph sounder as an aid to the telephone circuits. By suitable arrangements, an earth return telegraph circuit can be superimposed on a telephone circuit without affecting the latter in any way, except, in the case of the particular connections of the trunk exchanges, by a possible slight interference with the automatic calling and clearing arrangements. The telegraph circuit, however, when it is in use, carries these signals and, by a rapid communication of code signals, suffices for all the service conversation that is necessary between the two ends of the trunk line. In this way the telegraph operators, one of whom sits close behind the telephone operator at each of the important sections of the trunk board, control the traffic absolutely, and the subscribers' conversations can follow one another over the trunk line itself with practically no intervals between them.

We have so frequently warned municipal electricity supply undertakings of the inadvisability of starting house wiring on their own account that we were surprised to receive an announcement from the Ipswich Corporation that they are about to establish an installation department, and will be glad to receive price lists of apparatus and fittings. Except in the smallest towns, in which it may be difficult to have house-wiring work of good quality done by local firms, the electricity supply department should confine itself to supply and should not undertake internal wiring. Not only is this bad policy, but in the majority of cases the Corporation have no authority to undertake such work. The ordinary Provisional Order confers no such powers: it is necessary to apply to Parliament in a special Bill, and the clause conferring wiring powers is usually refused if there be opposition by local tradesmen. The Corporation of Ipswich obtained such powers in their Tramways Act of 1900, but we think that they are unwise to put them into force.

◆

A LETTER from Mr. BURKE anent the recent expression of our opinion about the vitality of his radiobes appears in another column. We raised the question not only on account of the interest all students of electricity must feel in Mr. BURKE'S extension of their science into the realms of the science of life, but also because the already considerable amount of evidence against this extension had just been augmented by the publication of Mr. RUDGE'S Paper. Our correspondent now urges, quite correctly, that the evidence against him is virtually all negative, and, incidentally, emphasises the isolated position he holds of being probably the only person who has seen radiobes. Now it was largely on this score—namely, that no one among many competent observers had supported the discoverer of radiobes (particularly in his claim for their possession of some degree of vitality)—that we reached our conclusion that all the phenomena exhibited by radiobes are probably but the doings of dead matter. But the principal prop to our conclusion was Mr. RUDGE'S investigation. Against it Mr. BURKE offers the statement that the removal of sulphur from gelatin will prevent the growth of bacterial cultures. But till we have definite experimental evidence that bacterial cultures are made impossible by the precipitation out by barium of the sulphuric impurities unintentionally introduced into gelatin in its manufacture, we cannot fully appreciate our correspondent's argument.

◆

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Paramaribo—Cayenne	April 20, 1906
Guadeloupe—Dominica	June 11, 1906

Greenwich Observatory and the L.C.C. Power House.—The *Daily News* states that a special report is being prepared for the first meeting of the London County Council after the Whitsun recess as to the effect of the new generating station at Greenwich upon the Government Observatory.

Voltage Calibration.—In our article under this title published last week, in the seventh line on p. 295 the letter *b* has been used in error for G.

South-Eastern Union of Scientific Societies.—The *Daily Telegraph* announces that on Saturday the congress of the South-Eastern Union of Scientific Societies terminated with a visit to Pevensey Castle. At a business meeting, Prof. Silvanus P. Thompson, F.R.S., was elected president of the Union for 1907, and an invitation to hold the congress at Woolwich was accepted.

Commercial Wireless Telegraphy.—Dr. Eugen Nesper has sent us a letter with regard to the review of his book on wireless telegraphy which appeared in our issue of April 27th. The book deals chiefly with the Telefunken system, and we commented on the scant reference made to other systems. Dr. Nesper informs us that the Gesellschaft für Drahtlose Telegraphie supplied him liberally with all the information he asked for, but that he was unable to obtain any details from the Marconi Company, and could, therefore, only take his notes out of the yearly reports, &c.

The Royal Society.—Among the Papers read yesterday were the following:—"On the Electrical and Photographic Phenomena manifested by Certain Substances that are commonly supposed to be Ætiologically Associated with Carcinoma," by Dr. W. S. Lazarus-Barlow. Communicated by Prof. J. Rose Bradford, F.R.S.; "Studies of the Processes Operative in Solutions. I. The Sucroclastic Action of Acids as influenced by Salts and Non-electrolytes," by R. J. Caldwell. Communicated by Prof. H. E. Armstrong, F.R.S.; "The Origin of Osmotic Effects," by Prof. H. E. Armstrong, F.R.S.

An Illuminating Engineering Society.—Mr. L. Gaster writes to us to suggest that the formation of an Illuminating Engineering Society would contribute largely to advance and disseminate the knowledge relating to the science and art of illumination. The function of this society, he proposes, should be to discuss on a scientific basis the merits and faults of the different illuminants now used for public or other lighting purposes, and to define the sphere of useful application for each of them. The annual expenditure for lighting purposes in the United Kingdom, he says, has been estimated lately to exceed £35,000,000, so that only a small increase in the efficiency of the systems used will amount to considerable savings per annum.

"The Central."—The June number of the excellently got up organ of the Old Students Association of the Central Technical College of the City and Guilds of London Institute, contains three interesting articles on South Africa. Prof. Henrici and Dr. E. Frankland Armstrong both contribute their impressions of the visit of the British Association, and the latter article is illustrated with a number of photographs of the Zambesi river and other places of interest. The third article on the subject is by Mr. E. H. Freeman, who describes the features of the Witwatersrand district and makes brief mention of the proposed Victoria Falls power schemes. Technical matters of more internal interest are represented by a description of a new lecture table testing machine in use in the college laboratories, with attachments for automatically tracing stress strain diagrams of the materials tested. Full information as to the movements of old students of the college are contained in the "old student notes," which should be useful for keeping the members of the Association in touch with their old friends.

The Institution of Mining Engineers.—The London meeting of the Institution of Mining Engineers commenced yesterday morning at the rooms of the Geological Society at Burlington House, under the presidency of Sir Lees Knowles, Bart., when three Papers of electrical interest were read and discussed. The first was by Mr. W. C. Mountain, and contained an exposition of his somewhat unfavourable views on the commercial possibilities of electric main shaft winding which are familiar to readers of *The Electrician*. A short and sharp discussion followed, in which one or two speakers expressed their disagreement with the opinions and also with the figures of the author of the Paper, and said that they had tried electric winding in actual cases and found an undoubtedly better economy than with steam. A Paper by Mr. A. Thompson described a system in which electrically driven air compressors formed an important feature, and Mr. Sam Mavor gave an abstract of a long Paper putting forth a strong plea for the more general adoption of electric coal-cutting machinery, especially as applied to long-wall mining, and pointed out the great advantages of mechanical methods when properly applied. In the afternoon a number of the members visited the Colliery Exhibition at the Agricultural Hall, of which an account is given in another column, and to-day, after a meeting when some further Papers will be discussed, visits are to be made to the new tramway power station at Greenwich and to the Greenwich Observatory. We hope to report the proceedings more fully next week.

A New Instrument for Magnetic Testing.—Mr. A. H. Peake describes in the *Proceedings* of the Cambridge Philosophical Society a very ingenious instrument for obtaining the **B-H** curve of small samples of iron. The sample may be a strip of thin sheet iron 3 in. by ⅝ in., or a number of thin wires built up side by side to similar dimensions. It is placed in a cradle pivoted on a horizontal axis through the centre of gravity of the whole. Fixed to the lower part of the cradle is a balance weight and a vane working in a dash-pot, and to the top of the cradle is attached a long vertical pointer working over two scales. One of these scales is fixed with its zero mark indicating when the pointer and sample is vertical; the other scale is part of a frame that rotates about a horizontal axis at the level of and in line with the axis of the cradle carrying the sample. This moveable frame carries a number of permanent steel magnets that, in the zero position, produce a uniform magnetic field truly perpendicular to the sample. If the frame carrying the magnets be rotated a little from the vertical, the field acquires a component along the sample of iron, magnetises it and deflects it. The pointer indicates this deflection on the fixed scale, whose reading is thus a measure of the induced magnetisation ; and, besides, gives on the scale attached to the frame of the permanent magnets a reading that can be made a measure of the component field acting on the sample. The complete hysteresis curve of the sample can be very quickly obtained by increasing and decreasing the inclination of the fixed magnets step by step. Demagnetisation of the sample is very easily effected by removing the dash-pot below the pointer and then setting the sample swinging in the horizontal field. For specimen curves given by the instrument and for the details of the graduation of the scales the original Paper may be referred to.

The Ventilation of the New York Subway.—The adequate ventilation of the New York subway is of special importance in order to keep the tunnel cool in summer. According to the *Electrical World*, a new plan for changing the air has now been worked out. To exhaust air between stations two devices will be used, automatic valves and electric fans. The valves will be operated by the trains themselves. These valves open outward only under the increased pressure of air caused by passing trains. An outrush of the heated air between stations is thus produced, which, of course, induces an inflow of surface air at the stations. The greater the number of trains passing the greater becomes the volume of air removed. For the stretch between Brooklyn Bridge and Columbus Circle there are to be 14 of these outlet chambers. The engineers recommend that the chambers be constructed as valves and fan chambers combined, the valves to be always in operation, but the fans to be used only for the 12 night hours, or for excessive heat or emergencies. The discharge of air from these chambers will be through gratings in the sidewalk after the air has been passed through cycloidal tubes to diminish its velocity. If these sidewalk gratings prove unpopular, however, ornamental chimneys 10 ft. high can be provided to discharge the air high above the street. The valves and fans together will be able to effect a complete removal of air throughout the subway once every 30 minutes, it is said. If the fans and louvres are to work at their highest efficiency more openings for inflowing air will have to be provided at the stations. To increase these openings it is proposed to cut out 6,000 sq. ft. of vaulting at various stations and substitute gratings, with copper pans underneath for drainage.

An Improved Spherical Photometer.—An article in the *Elektrotechnische Zeitschrift* by Dr. M. Corsepius describes an improved form of spherical photometer working on Ulbricht's principle described in *The Electrician*, Vol. LVI., p. 1,057. The author's photometric sphere is considerably larger than that of Prof. Ulbricht, being 2 metres in diameter and is divided into two halves in a verticle plane. One half is mounted on a trolley so that it can be wheeled away to facilitate access to the interior. The window through which observations are taken is 20 cm. in diameter, and a diaphragm with an aperture of 16 cm. diameter is placed on the photometer bench immediately outside. A small circular adjustable screen shields the window from the direct rays of the lamp to be tested. The apparatus was calibrated by means of incandescent lamps whose mean spherical candle-power had been previously measured at the Reichsanstalt and an elaborate series of observations were taken to determine the position of lamp and screen and the size of diaphragm, which gave the most accurate results with lamps with varying distribution of light. The distribution of light on the inner surface of the globe was also investigated by exposing pieces of photographic printing paper at various places. A Lummer-Brodhun photometer head was used, incandescent lamps being employed as sub-standards. It was found that the increased size of the globe rendered the errors caused, especially in the case of large arc lamps, by the shadows of the lamp fittings of less consequence than in the case of the smaller instrument described in our previous article. A formula due to Ulbricht is discussed by which this error can be estimated. As a rough indication of the distribution of light from any lamp tested, the lamp was hung in the centre of the globe and the two halves of the globe were drawn a few millimetres apart, and a strip of photographic paper fixed round the division, screens being employed to shield the light from the sides of the inside of the globe. A series of results of tests with lamps of various kinds is given.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, June 15th.**

Institution of Mining Engineers.

10:30 a.m. Annual Meeting continued. Among the Papers down for reading are (1) "A Rateau Exhaust Steam-driven Three-phase Haulage Plant," by William Maurice. (2) "The Capacity Current and its Effect on Leakage Indicators on Three-phase Electrical Power Service," by S. F. Walker.

TUESDAY, June 19th.

Incorporated Municipal Electrical Association.

10.30 a.m. Annual Conference. First Day. Meeting at the Royal County Theatre, Kingston-on-Thames. The Presidential address will be delivered by Mr. J. E. Edgcome (Kingston-on-Thames), and the following Paper will be read:—"Steam Turbines" (illustrated by lantern slides), by Sydney Baynes (St. Pancras).

2 p.m. Trip up the River to Richmond and Hampton Court.

WEDNESDAY, June 20th.

Incorporated Municipal Electrical Association.

10 a.m. Annual Conference. Second Day. Meeting at the Wharncliffe Rooms, Hotel Great Central, London, N.W. The following Papers will be read and discussed:—"The Commercial Development of Electricity Undertakings," (1) by S. E. Fedden (Sheffield), (2) by H. Collings Bishop (Newport, Mon.). These Papers will be discussed together. (3) "Relative Economies of Electric Supply from Small Local Stations and from Power Companies," by J. F. C. Snell (Sunderland).

2 p.m. Visits will be made to the Power Stations of the Underground Electric Railway Company of London (Lot's-road, Chelsea) and the London United Tramways Co. (Chiswick).

Royal Meteorological Society.

4:30 p.m. Meeting in the rooms of the Society, 70, Victoria-street, when a series of Papers on "Thunderstorms" will be read.

THURSDAY, June 21st.

Incorporated Municipal Electrical Association.

10 a.m. Annual Conference. Third Day. Annual General Business Meeting at the Wharncliffe Rooms, Hotel Great Central, London, N.W. A Special General Meeting will be afterwards held to consider the amendment of the Articles of Association.

2 p.m. A visit will be paid to the Bow generating station of the Charing Cross, West End & City Electric Supply Co.

7:30 p.m. for *7:45 p.m.* Annual Dinner at the Great Central Hotel, London, N.W.

FRIDAY, June 22nd.

Incorporated Municipal Electrical Association.

10 a.m. Annual Conference. Fourth Day. Meeting at the Wharncliffe Rooms, Hotel Great Central, London, N.W. The following Papers will be read : (1) "Live Steam Heat Feed Water ; its Effect on the Output and Efficiency of Steam Boilers," by G. Wilkinson (Harrogate) ; "The Efficiency of Steam Plant," by W. H. Vignoles (Grimsby). These Papers will be discussed together. (2) "The Supply of Power to Tramways from Small Stations," by S. J. Watson (Bury).

2 p.m. Visit to the L.C.C. Generating Station, Greenwich.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda : (1) "The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo," by A. A. Campbell Swinton. (2) "A Comparison Between the Peltier Effect and Other Reversible Heat Effects," by A. O. Allen. (3) "The Effect of the Electric Spark on the Activity of Metals," by T. A. Vaughton. (4) "Dielectric Strength of Thin Liquid Films," by Dr. P. E. Shaw. (5) "The Effect of Electrical Oscillations on Iron in a Magnetic Field," by Dr. W. H. Eccles.

SATURDAY, June 23rd.

Incorporated Municipal Electrical Association.

11 a.m. to 1 p.m. The National Physical Laboratory will be open for the inspection of the members of the Municipal Electrical Association.

SERIES PARALLEL ARMATURE WINDINGS WITH EQUIPOTENTIAL CONNECTIONS.

BY PROF. E. ARNOLD.

1. Large multipolar machines should, when possible, have a bar winding, as the construction of a bar winding is simpler and mechanically more satisfactory than a wire winding. The individual conductors can be more carefully and better insulated and are more easily accessible for repair than wire coils. Besides, less space is required for the insulation of few thick bars than for many wires of small cross section, and, in consequence, the machine can be made smaller.

The current in one armature path is, if $2a$ denote the total number of armature paths and J_a the total current of the machine, $i_a = J_a/2a$. For a bar winding, i_a should be somewhat larger than 60 and smaller than 200 amperes; if possible, it is better to make i_a larger than 100 amperes, in order to get good dimensions for the cross-section of the bars. It may occur, however, that the current in one armature path of a machine with a given number of poles, and provided with lap winding is too small and the number of wire too great to use bars for the winding. If we attempt to use a series winding (which has only two armature paths) we get too large a current for each path and correspondingly too few commutator segments. In such a case the difficulty can be solved by using a series-parallel winding, which has a number of armature paths greater than 2 but less than $2p$.

The series-parallel winding has therefore the advantage that the number of armature paths can be made equal to any desired multiple of 2 independently of the number of poles, and in all cases a cross section for the conductors can be chosen which is favourable for the construction and dimensioning of the machine.

In the design of series parallel windings, as in all other windings, the greatest care must be taken that the armature paths are all symmetrical.

It is necessary, in order to obtain a perfect symmetry of all the armature paths, that (1) in every armature path we have the same number of coils—*i.e.*, $s/2a$ (s = number of coil sides) must be a whole number, and (2) the number of brush sets must be $2p$.

It is always possible to fulfil both of these conditions. The first condition is fulfilled, for singly re-entrant windings, when p/a is a whole number. If p/a is not a whole number the winding must be so many times re-entrant that p/a for each separate winding is a whole number. For example :—

For $p = 4$, $a = 2$, singly re-entrant.
„ $p = 4$, $a = 3$, triply „
„ $p = 6$, $a = 3$, singly „
„ $p = 6$, $a = 4$, doubly „
„ $p = 6$, $a = 6$, singly „
„ $p = 10$, $a = 3$, triply „
„ $p = 12$, $a = 8$, doubly „
„ $p = 12$, $a = 9$, triply „

The author first used the series parallel system of winding in the Oerlikon works in 1891 for four and six-pole machines, and since then the following firms in particular have constructed many large multipolar machines with series parallel windings and equipotential connections, which have given excellent results—viz., Felten & Guilleaume-Lahmeyerwerke, Frankfurt; Allgemeine Elektrizitäts-Gesellschaft, Berlin; Sachsenwerke, Dresden; Vereinigte Elektrizitäts-Aktiengesellschaft, Wien; Ateliers des Constructions Electriques, Charleroi and others.

An incorrect choice of the proportions will sometimes lead to unsatisfactory working of the machine, and it is, therefore, important to understand the rules which are necessary for the design of these windings. Experience has shown that series parallel windings must be provided with equipotential connections (English patent 11,857, 1901; U.S. patent 783,498, 1905). There have been indeed many machines built with series parallel windings which work well without these connections, they are however very sensitive as regards the position of the brushes. Experience has also shown that such machines, although they may run sparklessly, when on test, and also for some considerable time in actual work, yet later on they begin to spark unexpectedly and without apparent cause; on the other hand many machines run well for a long time if the brushes and commutator are very carefully attended to.

In many cases equipotential connections have been added later, and, in so far as the proportions of the machine are favourable, always with good and often with surprising success. Machines which sparked increasingly on account of heating of the commutator, so that they had to be shut down after half-an-hour, have run continuously without sparking when provided with equipotential connections.

Cases have, however, been known to occur when the equipotential-connections heat up to such an extent that they must be removed again. In such cases a closer examination has shown that the pitch error of the equipotential-connections was too great.

2. *The Action of Equipotential Connections in Series-Parallel Windings.*—The successful working of equipotential-connections on the commutation is accounted for in two ways.

In the first place they cause a more equal distribution of the current among the the different brush sets, and secondly they supply a non-inductive path in parallel with the brush, for the additional short circuit-currents, and thus relieve the brush of some of the load. It is true that with series-parallel windings all the brushes of the same sign are connected through the short circuited coils, but the equipotential connections supply a path of less resistance for the current, as they are almost non-inductive, and, moreover, it must be observed that if the number of armature paths ($2a$) approaches or becomes greater than the number of poles ($2p$), only two consecutive brushes of the same sign are directly connected through a short-circuited coil. A proof that a considerable part of the additional current will go through the equipotential connections is given by the oscillogram shown in Fig 1.

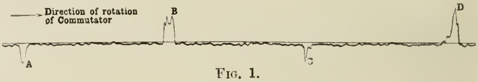

FIG. 1.

This shows the course of the current with regard to time of one armature coil of a six-pole machine with series winding ($a = 1$ and therefore without equipotential connections) running without load. All the six brushes were on the commutator and considerably (by 30 elec. deg.) displaced from the neutral zone. Since the external circuit was open we have only the additional short-circuit current in the armature.

A, B, C, D show the effect when the coil is short circuited. It is notable that the curves A, B, C, D which belong to different brushes are very different. The experiment showed, however, that the curves from the same brush which were taken after one another and apparently under the same conditions, were in many ways different in shape, so that the curves A, B, C, D could have belonged to the same brush. In the parts between A and B, B and C the coil is not without current, but a part of the short circuit current flows through it—*i.e.*, a part of the additional short circuit current of a coil flows through the winding from one brush to the neighbouring one.

If we remember now that equipotential connections have a smaller inductive and ohmic resistance than an armature path, it is evident that in consequence of the different shape of the short circuit current curves (*e.g.*, A and C or B and D), or if the brushes of the same sign do not short circuit at the same time, internal currents must flow between the connected coils.

The equipotential connections have therefore the following action: (1) In cases of unequal resistance between the brushes and the commutator, an internal current flows through the non-inductive equipotential connections. (2) The additional short-circuit currents pass partly through the equipotential connections, and therefore the brushes are relieved of some of of the load. (3) The internal currents which arise in consequence of dissymmetry of the field operate in such a way as to damp out the asymmetry and the difference of the pull of the field on the armature is diminished. (4) The P.D. between neighbouring segments becomes more equally divided around the circumference of the commutator.

The Potential Pitch.—The following symbols will be used in the investigation below :—

K = number of commutator segments.
Z = number of slots.
u_n = number of coil sides in a slot.
a = half the number of armature paths.
p = half the number of poles.
y_k = commutator pitch.
y_p = potential pitch.

As the author has shown* in the *Elektrotechnische Zeitschrift*, 1902, p. 215, the potential pitch of a series-parallel winding is

$$y_p = xy_k \pm x\frac{a}{p}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

in which

$$y_k = \frac{\mathrm{K}}{p} \pm \frac{a}{p} \quad \text{or} \quad \mathrm{K} = py_k \pm a. \quad . \quad (2)$$

There are, in general, a points to be connected in a system of equipotential connections and in order to connect the points it is necessary to make at least $(a-1)$ potential pitches and every a potential pitches form a closed figure, *i.e.*,

$$y_{p1} + y_{p2} + y_{p3} \quad . \quad . \quad . \quad + y_{pa} = \mathrm{K}.$$

If we write the equations (1) and (2) in the following form

$$y_p = x\left(y_k \pm \frac{a}{p}\right)$$

and

$$\mathrm{K} = p\left(y_k \pm \frac{a}{p}\right)$$

it is seen that

$$x_1 + x_2 + x_3 + . \quad . \quad . \quad . \quad x_a = p.$$

It is not necessary that all the a values of x be equal, if not, the a values of y_p will also be unequal. If xa/p is not a whole number, y_p will not be a whole number. It is however advisable to make y_p a whole number even if xa/p is not a whole number. In order that the difference between the calculated value of y_p and the nearest whole number shall be as small as possible, x must be as nearly as possible $= p/a$.

If we fulfil this condition, xa/p will be equal to or nearly $=1$ and we obtain immediately from formula (1) the integral value of y_p from

$$y_p = xy_k \pm 1. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

For these pitches also is the condition fulfilled that

$$y_{p1} + y_{p2} + y_{p3} \quad . \quad . \quad . \quad + y_{pa} = \mathrm{K} = py_k \pm a.$$

From the fact that with a series-parallel winding, a points are connected to the same system we get generally for every winding the main condition K/a = a whole number.

If we consider the current circuits which are formed by any two equalising systems and the coils lying between the connecting points, then in every closed circuit an equal number of coils must be arranged in opposition. This only happens for all current circuits when K/a is a whole number.

Equipotential Connections for Regularly-distributed Windings.—A regular distribution of the winding on the armature occurs when we have smooth armatures or slotted armatures with one-coil side or with two coil sides lying above one another in a slot.

We will now distinguish between the following series-parallel windings.

1. p/a is equal to a whole number. For this winding $x = p/a$ is a whole number, and, therefore, $xa/p = 1$. The pitches can be made without error. The potential pitch will then be according to equation (1)—

$$y_p = xy_k \pm x\frac{a}{p} = \frac{p}{a}y_k \pm 1 = \frac{\mathrm{K}}{a}.$$

2. p/a is not equal to a whole number. For this winding x is not a whole number. The pitches can not be made without error, and we must use formula (3)—viz., $y_p = xy_k \pm 1$ to calculate them.

The difference between the pitch y_p and the correct value, or the pitch error is

$$a_x = \pm\left(1 - x\frac{a}{p}\right). \quad . \quad . \quad . \quad . \quad . \quad (4)$$

a_x is measured in commutator segments and corresponds to an angle

$$= \frac{2\pi}{\mathrm{K}} a_x \text{ radians.}$$

In electrical degrees—*i.e.*, referred to a two-pole machine, since we have in the reduced scheme a pole pairs.

$$a_x^o = a\frac{360}{\mathrm{K}} a_x. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The formula holds good for $a \leqq p$. If a is $>p$ then for $(a-p)$ potential pitches $x = o$ and $y_p = o$. We must, therefore, if a is $>p$, put $a = p$ in the above formula in order to calculate a_x.

If p and a have g as the greatest common factor, then p/g is a whole number ; if we connect, in this case, only g points to an equalising system, we get connections without error.

The potential pitch is for these connections $y_p = \mathrm{K}/g$. To this group belong the windings with a/p equal to a whole number. In these windings p is the greatest common factor of p and a, and p points can be connected to an equalising system without error. For these connections the potential pitch y_p is equal to K/p.

Besides this $q \geqq a/p$ neighbouring conductors may be connected together at different places on the armature if the error

$$a_x^o = p\frac{360}{\mathrm{K}}(q-1). \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

is not greater than 3deg.

3. *Particular Conditions for Equipotential Connections with Slotted Armatures.*—When the coils are placed in slots there is an unequal distribution of the coil sides on the armature circumference, and only with one coil side or with two coil sides lying above one another in a slot can we obtain an equal distribution.

If we wish to secure, nevertheless, that a points of a system should have an equal potential, certain conditions must be fulfilled. If these conditions with certain proportions cannot be fulfilled, the deviation from the position of equality of potential must be calculated.

That the number of commutator segments must be divisible by half the number of armature paths is also the principal condition of symmetry for slotted armatures—*i.e.*, K/a = a whole number.

We will consider first the case of series-parallel windings, when p/a = a whole number. Potential pitch $y_p = \mathrm{K}/a$.

In order that with these windings a points shall lie in fields of equal intensity, (1) a slots must lie in fields of equal intensity, and (2) the a conductors which are connected to a system must have similar situations in the slot. These two conditions are fulfilled if Z/a is equal to a whole number. In this case we get a whole number of slots for every p/a double-pole divisions and for every ath part of the armature circumference the slots lie in similar positions relatively to the poles.

We will examine to what extent unsymmetry is produced if Z/a *is not a whole number.* In Fig. 2 a series parallel winding is shown in which $a = p = 2$ and $s = 76$; $\mathrm{K} = 38$; $\mathrm{Z} = 19$. Here $\mathrm{K}/a = 38/2 = 19$ is a whole number, but Z/a is not a whole number. The error arising from the fact that Z/a is not a whole number is two-fold :

First, the coil sides which are connected to the same system lie in slots which are in fields of different intensity, and have a different position in these slots (viz., 3, 41, the conductors 3 and 43 have a similar position in the slots) ; and secondly, when we consider the current circuit made up of two equalising connectors, and the conductors which lie between the points of connection we see that there are always conductors which, lying in different slots, are arranged in series.

If we consider the circuit

a – coil side 3 – 24 – 43 – 64 – b – (E.P.C. b – c)
c – coil side 26 – 5 – 62 – 41 – a – (E.P.C. d – a)

it is seen that the sides 62, 64, 41 and 43 lie in the same slots (viz., slots 16 and 11 respectively), whilst the sides 3, 5, 24 and 26 lie in neighbouring slots (viz., slots 1, 2, 6 and 7 respectively). In the coils 43—64 and 62—41 approximately the same E.M.F.s will be produced, while in the coils

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* See E. Arnold "Die Gleichstrommaschine," Vol. I., p. 63.

3—24 and 26—5 the induced E.M.F.s are different. This asymmetry always appears if the conductors which are connected together in the same equalising system have not the same situation in the slot. With these windings, great importance must be attached to the satisfying of the condition Z/a = a whole number.

Let us now consider the case when p/a is not a whole number. In these windings the potential pitches are different and determined from the formulæ $y_p = xy_k \pm 1$ and $x_1 + x_2 + x_3 + \ldots x_a = p$. If we take the distance between two conductors as unity instead of the distance between two segments this pitch becomes $2y_p = 2xy_k \pm 2$. Since the values of x must be as nearly as possible equal and integral, there will always be two values of x which differ by 1 from one another. We can put therefore

$$2y_{p1} = 2x_1y_k \pm 2$$

and

$$2y_{p2} = 2x_2y_k \pm 2 = 2(x_1y_k \pm 2) + 2y_k.$$

Now in order that the conductors which are connected in the same system should have the same situation in the slot, the pitches $2y_{p1}$, $2y_{p2}\ldots$ must be divisible by u_n. This is only possible for all pitches for $u_n = 2$. If we assume that $2y_{p1}$ is divisible by u_n, then in order that $2y_p$ may be likewise divisible by u_n, $2y_k$ must be divisible by u_n. If, however, $2y_k$ is divisible by u_n then $2y_{p1} = 2x_1y_k \pm 2$ cannot be divisible by u_n ($u_n > 2$).

It appears from this that the conductors connected to the same system have a different situation in the slot. Besides this, the slots in which the conductors lie and which are connected to the same system are in fields of different intensity, since Z/p can never be equal to a whole number. With these windings we have always the asymmetry explained above, and this also occurs when Z/a is a whole number and the error thus caused can become just as great as when Z/a is not a whole number. According to the experience of the author, it is nevertheless desirable where possible to make Z/a equal to a whole number. Machines with Z/a not equal to a whole number have indeed often been made (see Table) and have worked well so long as the errors do not go beyond a certain limit. If p and a have a greatest common factor g then p/g is a whole number. Further, if Z/g is a whole number and we connect g points as an equalising system we get connections without error. To this group also belong the windings with a/p equal to a whole number. If Z/p is equal to a whole number we can in these windings connect p points to the same system without error. Besides this a/p coil sides which lie together in a slot may be connected together at a few places on the armature although their potentials are not exactly same. The error thus arising can be calculated from formula (6).

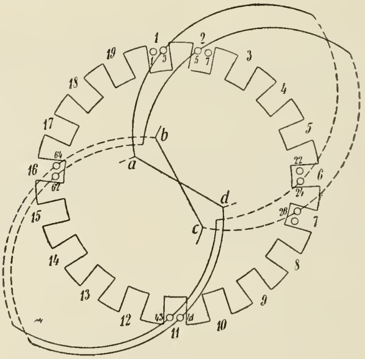

Fig. 2.

(To be concluded.)

The New York Central Railway.—It is announced in the *Engineer* that the change from steam to electrical working on the New York Central terminal section will be made on September 1st, extending at first over about 7 miles of the main line and 12½ miles on the Harlem line. Over 180 motor cars are expected to be ready by that date.

THE NEW TELEPHONE TRUNK EXCHANGE IN BIRMINGHAM.

Those of our readers who are interested in telephony will remember an article in *The Electrician* about two years ago* descriptive of the fine new exchange which the Post Office had installed in the Carter-lane telephone building for dealing with the trunk traffic which passes in and out of London. In other centres as well the number of trunk messages is increasing at an extremely rapid rate, and at Birmingham a new trunk exchange has been erected by the Post Office on the same general lines as that in the metropolis; but advantage has been taken of the experience in London, which has shown the way to improvements increasing the facility and speed of operating, and at the same time simplifying to some extent the circuits. We may add that the majority of these improvements are being adopted at once in London also. Two, especially, constitute a great advance and are already partly applied in London. The first of these is the employment of a telegraph circuit, superimposed on one of the trunk lines between the more important centres, which circuit fulfils analagous functions to the call wire in ordinary junction working and transmits all service communications, so that the trunk wires themselves, as a telephone circuit, are kept continuously employed. In some cases this has increased the earning capacity of a trunk line during the rush hours of the day to such an extent that it is carrying subscribers' messages and earning money during about 48 minutes of every hour, instead of only about 30 minutes. The second is the use of a new type of time check, which indicates to an operator by a direct lamp signal when the three minutes allotted to a subscriber has elapsed without the operator having to watch the calculagraph record.

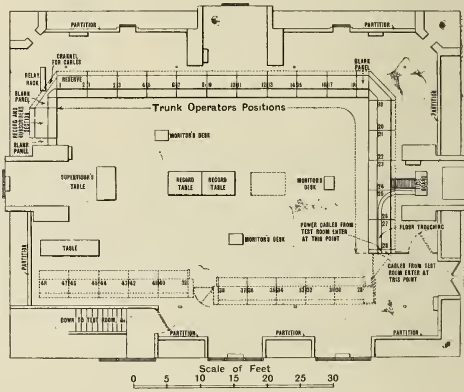

Fig. 1.—General View of Switchroom.

Birmingham as a telephone centre has about 7,000 subscribers to the National Telephone Co.'s exchange system, and, in addition to the trunk calls to and from these subscribers, a certain volume of through trunk traffic has also to be dealt with. 110 trunk wires enter the new exchange, a plan of whose switch room is shown in Fig. 1. New wires are rapidly being added, 18 additional lines being now in course of erection, while provision is made for the extension of the switchboard to the extent shown by the dotted lines. There are 102 junction lines to the National Company's Birmingham central exchange and nine lines to five branch exchanges in the Birmingham telephone area.

As is seen on the plan, there are 28 working operators' positions, of which 25 were brought into operation on May 26th last when the exchange was opened. Two reserve positions, fully equipped, have also been put in. Each operator's position deals with five trunk lines, and there is a complete multiple of 120 junction wires placed between each two operators' positions. The ringing junctions are multipled over every two positions just as the call-wire junctions, as this has been rendered possible by a simplification of the engaged test, which is now given by a click in the same way as the ordinary subscriber's board engaged test, instead of by a lamp, which necessitated the provision of a special press-button key under each ringing-junction jack. The keyboard at each position is fitted with six pairs of plugs and cords with a combined ringing and speaking key on the trunk cord, and a combined ringing and disconnecting key on the junction cord. A thirteenth key has been added for the whole position, which enables the operator to speak on the junction cord and disconnect the trunk cord without exchanging the plugs as has had to be done hitherto.

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* Vol. LII., pp. 615, 653, 682 and 727.

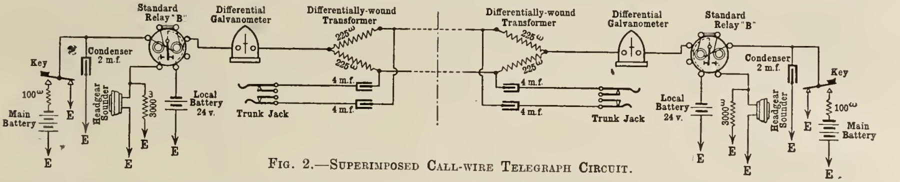

FIG. 2.—SUPERIMPOSED CALL-WIRE TELEGRAPH CIRCUIT.

The circuits and apparatus are so arranged that, when one trunk circuit is joined through to another, the connections from plug to plug are direct; but, when the more usual connection of a trunk wire to a junction wire is required, the connections are automatically completed through condensers by the actuation of a relay as soon as the plug is inserted into a junction jack. The same relay that does this joins up the relays for the local clearing signals. A third lamp has been added in association with each pair of cords in addition to the ordinary automatic clearing lamps, and this acts as a "retaining signal" for a local subscriber's magneto ring-off, and also indicates a call if given from the distant trunk exchange immediately after the conclusion of a conversation, and before the local subscriber has given the ordinary clearing signal. The trunk operator is, therefore, warned to connect up the new subscriber immediately the previous conversation is finished and without waiting for the local subscriber to clear, and this means in the aggregate a large saving of the time in which the trunk wires are not being used for conversation. The local and distant clearing or supervisory signal lamps are red and white respectively as before, and the additional lamp is white with a black bar across it.

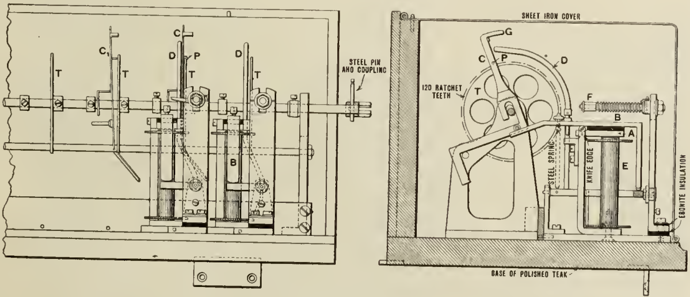

FIG. 3.—ELEVATION AND END VIEW OF TIME CHECK. (One quarter full size.)

In the provision for through connection of one trunk wire to another, the arrangements have been simplified by the omission of the intermediate transfer board. The new transfer circuits are multipled on three-point jacks fitted on the same panels as the junction line multiples between every two trunk operators' positions, the third point of the jack in each case being connected to the bush for the usual engaged test. These circuits are connected to the main springs of an eight-point "answering" jack on the trunk panel of the board, the inner springs of which are connected to the operator's telephone. In this way any operator desiring to connect one of her trunk wires with a trunk wire served by another operator can plug into the transfer jack, and, using the transfer line as a call-wire, ask for the connection. When she plugs in, a lamp above the eight-point jack glows, and this is extinguished as soon as the wanted trunk operator plugs into the jack; the same lamp afterwards acts as a clearing signal when the plug is withdrawn from the multiple. The relay associated with the eight-point jack has a high resistance, and therefore does not allow sufficient current to pass to close the relays which remove the short-circuit from the condensers when the connection is made between a junction circuit and a trunk line instead of between two trunk lines.

The arrangement of the superimposed telegraph circuit is shown in Fig. 2. A differentially wound transformer is connected in bridge across the two line wires, and the telegraph circuit is taken off from the middle point while the lines are connected to the trunk jack through 4 m.f. condensers. An ordinary telegraph key is used, arranged so that the sound is deadened, but the sounder which receives the signals is of special design. It is a diminutive sounder fitted in the case of an ordinary head-gear telephone, and covered with a diaphragm which has a hole in the centre. The telegraph operator can thus hear the sounder distinctly, but it is inaudible to the other operators near. This operator sits between two operators' positions at which the trunk lines to the centre in question terminate. She sits in front of a small board projecting from the main board, and this forms a desk and affords space for the key. In this way she is just behind the two operators and can give them instructions. All the service communications are exchanged between the two telegraph operators by means of special code letters to save time, and thus the subscribers at both ends of the line whose turn comes next to be be put into communication are called while the preceding conversation is in progress, and no time is wasted.

The time check, so far as it appears on the switchboard, is simply a lamp and key above each main trunk jack. The lamp serves a double purpose, being used alternately to indicate a trunk call and as a time check signal. As soon as the operator has put the subscribers into communication, she depresses the key, and at the end of three minutes the lamp lights and the operator offers the calling subscriber a second three minutes, and, if he does not desire to have it, disconnects him. These lamps are controlled by the "time check" itself, which is a device placed in the relay room, and one of these pieces of apparatus is supplied for each trunk line. We show it in elevation and end view in Fig. 3. A common spindle for 10 time checks drives a toothed wheel, T, in each of them so that it makes about a quarter revolution in three minutes. The spindle is driven by a strong electromagnet and a make and break ratchet arrangement at one end, not shown in the figure. A loose contact arm, C, rests on the spindle but does not revolve with it. Normally it is in the position shown at C, so that the pin P rests against the face of the toothed wheel. On the electromagnet E being energised, it attracts the armature A, and the arm B to which A is attached lifts the contact arm C which is weighted with a counterpoise so that it then assumes a vertical position and falls over sufficiently to allow the pin P to engage with the toothed wheel T. The circuit of the electromagnet and battery is closed by pressing the key, already referred to, above the trunk jack in the switchboard, and a contact in the eight-point trunk jack itself completes the circuit in such a way that it can only be closed when a plug is inserted in the jack. As soon as the pin P engages with the toothed wheel, the arm C is carried round, and at the end of three minutes its end G comes into contact with a spring controlled hinged platform F (shown only in elevation in the figure), and closes the circuit of the warning lamp on the switchboard. At the end of another 20 seconds the contact arm slides off the platform, and, owing to the weight of the counterpoise, it falls back to its original position. Every time the armature is attracted, another arm, D, travels over past C, and unless C is in its position of rest it pushes it away from the toothed wheel and allows it to assume its normal position. This occurs when the conversation is finished in less than three minutes, in which case the operator presses the key to reset the time check at zero.

Another point that may be mentioned in connection with the new arrangements at Birmingham is that, on the boards of the smaller provincial exchanges, a combined indicator and jack is now gradually replacing the 8-point jacks and P.I.R. "B" relays employed hitherto, and generator ringing is substituted for battery ringing. This indicator consists of an electromagnet fitted between the line springs of the jack, and the armature of the electromagnet is arranged normally to hold up a hinged shutter. When the armature is moved, the shutter is projected through a horizontal slot and becomes visible to the operator. On the plug being inserted in the jack, the shutter is restored to its normal position automatically by mechanical pressure. There is, of course, the usual contact on the shutter for closing a local bell circuit during night-time and slack hours.

The record circuits are now arranged differently, in such a way that the record operators can work with a far better load factor than hitherto. Instead of the subscriber being put on directly to the record table, he is connected to a record circuit transfer board, which is worked by two operators, for the most part silently. At this board, circuits from the record operators terminate in plugs, and, when a record line calling lamp glows, the operator at the transfer board simply inserts any free plug and so extends the line to the record table. The record operator has in front of her a lamp and a three-position key. This lamp glows as soon as a line is connected, and the operator takes particulars of the trunk connection desired by the subscriber and fills in a slip, which is then distributed to the trunk operators. As soon as she has finished she pushes over her three-position key, which, by means of a retaining relay, lights a clearing lamp by the plug on the transfer board corresponding to her position at the table. The third position of the key enables her to speak to the operator at the transfer board if necessary through a call wire.

THE BRIGHTON CORPORATION'S NEW ELECTRICITY WORKS.

To-morrow Mr. John Burns, President of the Local Government Board, will open the new electricity works that have just been completed at Southwick, near Brighton, to cope with the increasing demand for electric light and power and the needs of the municipal tramway service. By the courtesy of Mr. Arthur Wright, the consulting engineer, and Mr. John Christie, the engineer and manager, we have been able to inspect the new works and are able to publish a detailed description of them. We have also to thank the British Westinghouse Company and Messrs. Siemens Bros. & Co. for the loan of some of the excellent blocks which we have used as illustrations.

Before describing the works themselves, it will not be out of place to give a brief historical sketch of the Brighton electricity undertaking, for Brighton was one of the first municipalities in the country to embark on the business of electricity supply. The Corporation obtained its provisional order so long ago as 1883, and in 1890 the construction of the works was commenced, and they were opened in the following year. At this time a company were already supplying in Brighton, without statutory powers, and by means of a high-tension system with overhead wires; but after the starting of the municipal works the progress of this company was not rapid, and eventually its goodwill was bought by the Corporation. The Corporation's supply was on the three-wire system at 2 × 115 volts, and the company's network, after it had been taken over, was gradually converted to this system also. During recent years all the new consumers have been supplied at 230 volts, some across the outers of the old network, and others from a new 2 × 230 volt network. Mr. Arthur Wright was engineer and manager almost from the outset, and the popularity of the electric light in Brighton and its rapid growth are due to the energy and ability with which he conducted the undertaking. Five years ago he retired from the active management and was appointed consulting engineer, and Mr. John Christie succeeded him as engineer and manager. The tramways, opened in 1901, have helped to increase the output of the works, and Mr. Christie has done much to develop the motor load on the time-switch system, by which power consumers who are willing to forego the use of their motors during the peak of the lighting load are charged at a lower price. Brighton was also the birthplace of the maximum demand system of charging, introduced with considerable success by Mr. Wright soon after the opening of the works, and since then adopted by many other electricity supply undertakings. Until a few months ago there was no other method of charging in Brighton, but now an alternative flat rate has been introduced at the desire of some consumers.

In 1892 there were 213 consumers, with the equivalent of 11,000 8 c.p. lamps connected to the mains, and the output was 156,000 units per annum; now there are about 4,500 consumers with a lamp connection equivalent to about 300,000 and a yearly output of over 8,000,000 units. The capital expended on the undertaking has increased from £53,000 to £700,000, and the annual revenue from £4,600 to £84,000. In 1892 the plant capacity was 300 kw., and now it is 10,400 kw. with the inclusion of the new Southwick works.

The new works are situated on Shoreham harbour, a distance of 4¾ miles from the old electricity station at Brighton. Current is generated there at 8,000 volts three phase, and is conveyed to a sub-station built as an annexe to the old works. This is at present the only sub station.

To enable the arrangements to be clearly understood, we will commence our article with a description of the old works and of this sub-station. The old engine room contains a collection of 15 machines of various makes and sizes from about 50 kw. to 500 kw. output, and totalling 5,000 kw. All the engines are of the Willans pattern, and with either E.C.C., Crompton or Bruce Peebles generators. The voltages are also various: 115, 230 and 460 volts for lighting, as already explained, and 550 volts for traction. The traction generators are in a separate engine room. Mention must also be made of a B.T.-H. balancing transformer (175 amperes at 115 volts) which has been running day and night continuously for over five years with only a brief interval of a few hours on one occasion when it was moved from one end of the engine room to the other. A 400 ampere-hour Tudor battery is used for station lighting, and there is a 1,200 ampere-hour E.P.S. traction battery worked through a Ganz reversible booster. Steam is supplied by six Lancashire and 10 B. & W. boilers. The station runs condensing, and cooling towers have been erected to deal with the circulating water. The fans of these are driven by motors, and these motors as well as the motors of the other auxiliaries are switched across from one side of the three-wire network to the other to assist balancing. The switchboards are of the simplest possible design, with neither fuses nor cut-outs on the generator panels. Thirty one pairs of feeders and 11 neutral feeders are run to points in various parts of the town, and are mostly 1 sq. in. and 0·3 sq. in. in section.

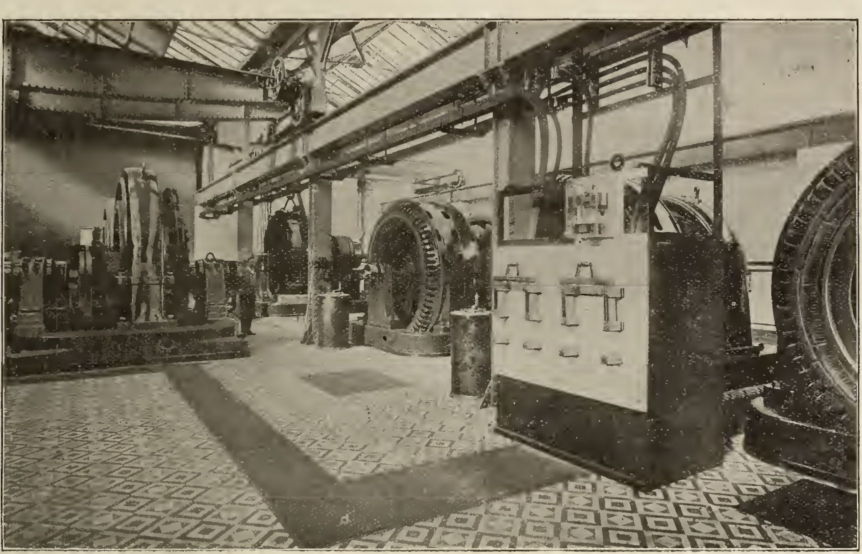

FIG. 1.—INTERIOR OF THE NORTH-ROAD SUB-STATION.

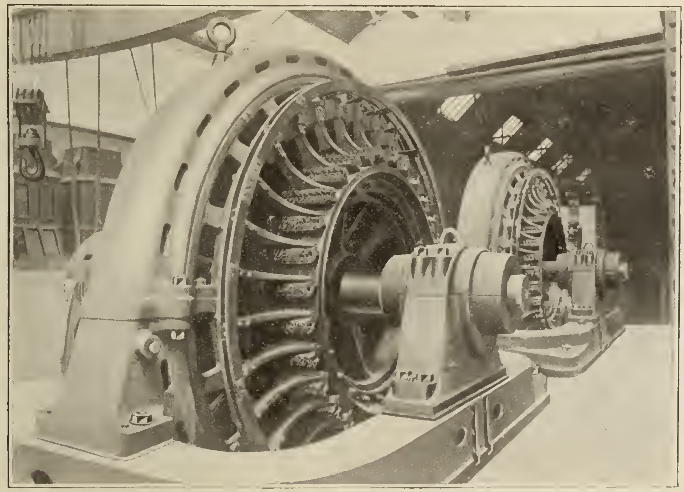

FIG. 2.—VIEW OF ROTARY CONVERTER, SHOWING CONTINUOUS-CURRENT SIDE.

The old feeder board is retained, and the new sub-station supplies continuous current at 460 volts directly to it, and also to the traction board in the traction station. Fig. 1 is a general view of the sub station, and Figs. 2 and 3 give two views of the rotary converters. These machines are rated at 1,500 kw., and receive current from step-down static transformers on a low gallery close to them. Pressure regulation is by means of an induction regulator. The sets run at 200 revs. per min., and as the frequency is 50 ~ per sec. the number of poles is 30, which means machines of large diameter. The D.C. side of the machine, illustrated in Fig. 2, also shows the large number of brushes required and the big commutator. Fig. 3 shows the slip rings, the end connections of the armatures and the induction motor for starting the machines.

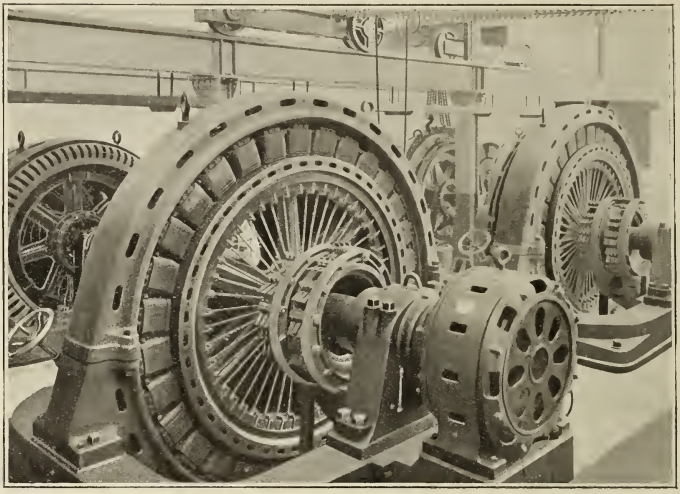

Fig. 3.—View of Rotary Converter, showing Alternating-current Side.

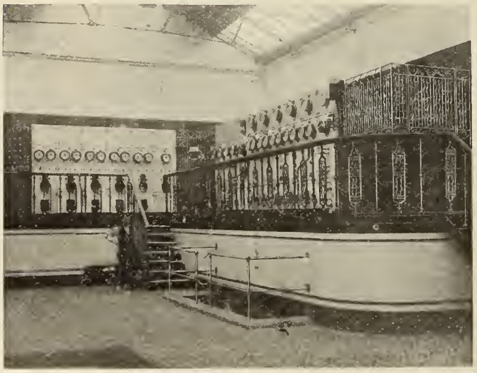

Fig. 4.—High-tension Switchboard in Sub-station.

The enormous mass of copper on the D.C. panels, which are on the floor level near the machines and independent of the remainder of the switchboard, is noteworthy. These panels connect the machines to the feeder board of the old station, and the size of the circuit-breakers and ammeter shunts, which have each to carry 6,500 amperes at 230 volts is particularly noticeable. The cables from the static transformers to the slip rings have a section of 6 sq. in. The starting motor is a 150 H.P. induction machine, receiving current at low pressure from a static transformer.

In addition to these sets, four 500 kw. induction motor generators have been supplied, two generating current at 230 volts, one at 460 volts and one at 550 volts for traction. The last-mentioned machine is compounded and the others are shunt machines, but the 460-volt set can be used on emergency for the traction load.

Fig. 4 shows the high-tension switchboard in the sub-station. The section on the right of the illustration is for the machines.

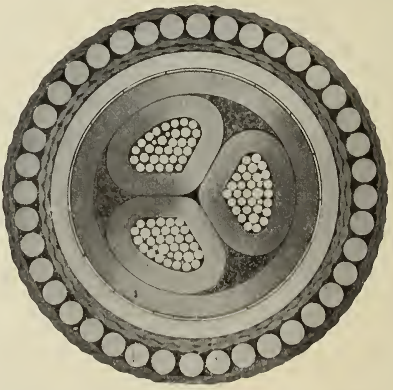

Fig. 5.—Section of Armoured High-Tension Feeder.
(Two-thirds actual size.)

Its high-tension switches are oil switches, hand-operated for the motor generators, whose bus-bars with their selector links are placed behind the board, and with electric remote control for the static transformers of the large sets. The H.T. feeder switchboard is seen at the other end of the gallery and has also electrically operated oil switches.

All these remote control switches are in the basement below the switchboards, in which also are placed the static transformers for the induction motors and the motor-driven fan for the air blast for the main static transformers. In the sub-basement where the feeders enter,—which is in reality a narrow feeder subway,—there are the isolating links for these and their spark-gaps. All the sub-station plant was supplied by the British Westinghouse Company.

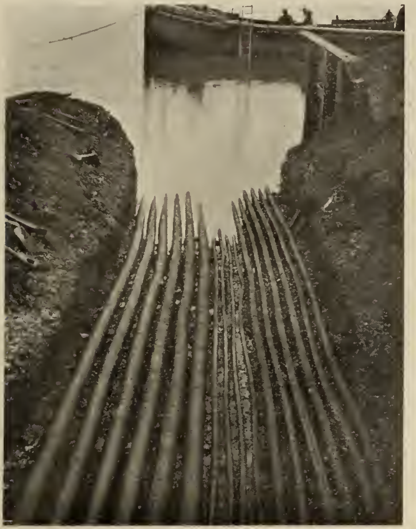

Fig. 6.—Cables entering Harbour.

The feeders from the Southwick generating station to North-road sub-station are three-core cables, 0·25 sq. in. section. They are paper-insulated and lead covered, with a copper sheath beneath the lead. The thickness of insulation between the conductors and also between the conductors and the copper sheathing is 0·5 in. As has been already stated, the working pressure is 8,000 volts; and the cables were tested at 20,000 volts at the manufacturers' works and at 16,000 volts after laying. They were supplied and laid by Messrs. Siemens Bros. & Co. Five cables were laid in separate troughs with tile covers from a point opposite the generating station at Southwick on the other side of the harbour. Cables heavily armoured with galvanised steel wires and served with strong protective coverings were taken across the water to the generating station in a trench 6 ft. deep in the bed of the harbour, and this trench had to be blasted out of the solid rock. The trench was covered in with cement in bags. Fig. 5 is a section of the armoured cable, two-thirds actual size; the cable itself is $4\frac{5}{16}$ in. diameter. The cable in the troughs underground is similar to this but without the armouring. In the trench under the water are some other cables, also supplied by Messrs. Siemens Bros, including four of 1 sq. in. section. Fig. 6 shows the cutting at which the cables enter the water. Fig. 7 is from a photograph taken during the laying operations, and Fig. 8 illustrates the five underground cables in the trench before filling in.

Fig. 7.—During the Laying Operations.

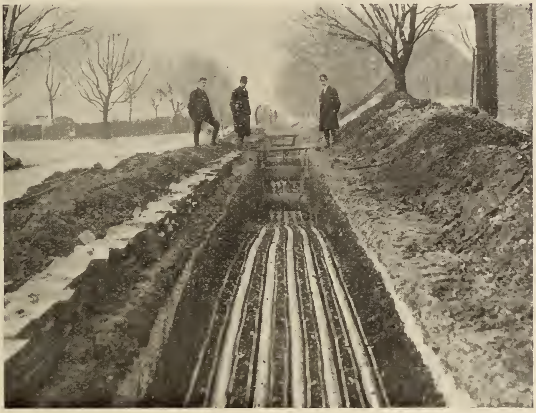

Fig. 8.—Underground Cables in Trench before Filling in.

(*To be continued.*)

THE CLASSIFICATION OF ALTERNATE-CURRENT MOTORS.

BY V. A. FYNN.

(*Concluded from page 287.*)

Motors with a Shunt Characteristic.

Single-phase Shunt Conduction Motor (Fig. 31).—We have seen that in a series machine there was no difficulty in obtaining close phase coincidence between motor field and armature current; in fact, from the very nature of the connections it is the reverse which it would be difficult to secure, so that the torque per ampere was always high although the power factor may not in all cases have been satisfactory. The conditions for a shunt machine are very different, and placing ourselves on the standpoint that no machine which is not commercially applicable is worth classifying, we must at once exclude all those so called alternate current shunt motors in which the E.M.F. applied to the field winding is of the same phase as that applied to the armature. The uselessness of such machines was recognised in the 80-ties and numerous but unsuccessful attempts were made to improve their operation. If we admit, as we must do, that an alternate-current motor in order to be a commercial machine must have a high power factor and a large output for weight, then we must make use of a motor with as little self-induction in the armature circuit as possible, and one in which the phase of the motor field agrees very closely with the phase of the armature current. Now it is quite impossible to achieve those results if armature and field are connected to E.M.F.'s of equal phase, for if there is no self-induction in the armature (the condition for a good power-factor) then the armature current will be practically in phase with the E M.F. applied to the armature. An E.M.F. of same phase being applied to the field winding can but produce a motor field lagging by practically 90 deg. behind that E.M.F., and consequently all but in quadrature with the armature current.

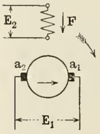

FIG. 31.

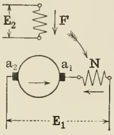

FIG. 32.

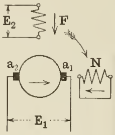

FIG. 33.

The first condition for success is therefore that the E M.F. (E_2) impressed on the field winding shall be *nearly* (not necessarily quite) in quadrature with the E.M.F. (E_1) impressed on the armature.

Such a motor is shown in Fig. 31, it is separately excited, the back E M.F. is due to rotation in the motor field F, and because of same phase as that field is nearly in phase, but opposite in direction, to the working E.M.F. (E_1) impressed on the armature. The power factor of this motor will be bad because the self-induction of the armature will be great, the armature ampere-turns not being neutralised. As a consequence, the torque per ampere will be small, for in a shunt machine power factor and torque efficiency are closely associated; in this respect these motors differ widely from the series machines. The motor is reversible.

Neutralised Single-phase Shunt Conduction Motor (Fig. 32).—Differs from the one just described in that the armature ampere-turns are neutralised by means of the stator winding N connected in series with the armature. The machine is in all other respects identical with the previous one, the power factor is, however, much higher, and the speed much more constant.

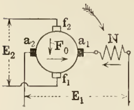

FIG. 34.

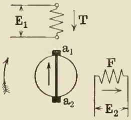

FIG. 35.

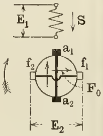

FIG. 36.

Neutralised Single-phase Shunt Conduction Motor (Fig. 33).—Only differs from the last in that the neutralising current is induced in N, and not conducted through it. It suffers from the same disability, as compared with Fig. 32, as has been fully set out when dealing with Fig. 14, as compared to Fig. 13.

Neutralised Single-phase Shunt Conduction Motor (Fig. 34).—Differs from Fig. 32 only in that there is no special field winding on the stator, the rotor winding in the direction of the field axis being made use of as a field winding in a manner now familiar.

Single-phase Shunt Induction Motor (Fig. 35).—The working E.M.F. and the working current are conveyed into the rotor along the armature axis by transformer action from T. The armature ampere-turns are therefore neutralised. The back E.M.F. is generated by rotation in the motor field produced by the field winding F connected to an E M.F. (E_2) nearly in quadrature with the E.M.F. (E_1) applied to the transformer winding T. By properly selecting or adjusting the phase relation between E_1 and E_2 the motor can be fully compensated. This can be achieved in the case where these two E.M.F.'s are derived from a two-phase supply; for instance, by applying to the winding F a resultant E.M.F. made up of two components, the larger one of the same phase as E_2 and a smaller one of the same phase as E_1. Other means for achieving the same result have been described by the author in some of his patents. As the motor is illustrated in Fig. 35, it only has a fair power factor and fair output for weight, whilst its speed is not quite constant. As was the case with the motor shown in Fig. 16, an E.M.F. is generated in the rotor winding along the motor field axis and by rotation in the transformer field, this E.M.F. of rotation which may be opposite in phase to the phase of the transformer field is not made use of in this motor, but is fully utilised in the next.

Self-excited Partly compensated Single-phase Shunt Induction Motor (Fig. 36).—The stator winding S conveys into the rotor by induction both working E.M.F. and working current along the armature axis a_1 a_2 and with the help of a transformer field which remains practically constant as long as E_1 is constant. The E.M.F. of rotation $E_{,}$, referred to in the previous example, and which is opposite in phase to the transformer field, is produced along the axis f_1 f_2. Since it is opposite in phase to the transformer field it is nearly in quadrature with E_1 and nearly cophasal with E_2, and therefore of the phase required in order to produce a motor field which will nearly coincide in phase with the armature current. The armature ampere-turns are neutralised, the back E.M.F. is nearly of opposite phase to the working E.M.F., the power factor is fairly high, the speed is nearly constant. Fuller particulars of this motor will be found in the author's recent article entitled: "A Contribution to the Theory of the Single-phase Induction Motor." This motor is equivalent to the squirrel-cage machine, now simply known as the single-phase induction motor.

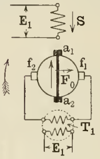

FIG. 37.

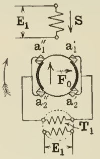

FIG. 38.

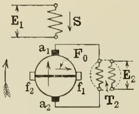

FIG. 39.

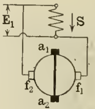

FIG. 40.

Self-excited Compensated Single-phase Shunt Induction Motor (Fig. 37).—Differs from the former only in that the phase of the motor field is adjusted by means of an auxiliary E.M.F. introduced into the exciting circuit for the purpose of improving the power factor of the motor. The theory of this motor has been more fully set out in the author's Paper entitled "A New Single-phase Motor," and read before the Institution of Electrical Engineers on March 8, 1906. This auxiliary E.M.F. is preferably chosen co-phasal with E_1, and either derived directly from the mains with the help of a transformer T_1 independent of the motor, or by making use of the motor itself as a transformer and disposing on the stator an auxiliary winding co-axial with S, or even by tapping S itself.

Self-excited Compensated Single-phase Shunt Induction Motor (Fig. 38).—Differs from the former only in that the arrangement of the brushes is similar to that in Fig. 26, bringing with it all the marked advantages already set forth on that occasion.

Self-excited Compensated Single phase Shunt Induction Motor (Fig. 39).—This is a machine identical with that shown in Fig. 36, but total phase compensation is achieved in a different manner from that shown in Fig. 37 or 38. Here an E.M.F. (E_2) practically in quadrature with the working E.M.F. in the rotor or with E_1, therefore nearly of the same phase as the E.M.F. of self-induction in the armature axis, is introduced into the armature circuit in a direction opposed to that of the E.M.F. of self-induction in that circuit, in order to cancel the latter or substitute for it an E.M.F. which will act as a capacity. The Institution Paper already referred to gives further particulars of this method. Phase compensation under these circumstances can only be entirely successful if the source from which E_2 is derived, and through which the armature current of the motor must flow, is at least devoid of self-induction. E_2 may be derived from the motor itself.

The Fig. 40 has often been described in the technical press as a shunt motor or a compensated shunt motor, and it has been said that the compensation was brought about by the short-circuited brushes a_1a_2. This view is entirely erroneous, and this figure has only been included here in order to point out these fallacies. As usually depicted, the machine is neither one thing nor another. It has been pointed out in connection with Fig. 31 that no alternate-current shunt machine is worthy of any attention if the E.M.F.'s impressed on field and armature winding are co-phasal. Fig. 40 is supposed to, and does, convey the impression that it is a shunt machine with co-phasal E.M.F.'s applied to the armature and to the field winding, whereas in reality it represents, for ordinary conditions, a machine over-compensated (by the means indicated in Figs. 37 and 38) to such an extent as to make it entirely useless. Indeed, in Figs. 37 or 38 the compensating E.M.F. included in the field circuit is perhaps one-fifth or one-quarter of the E.M.F. (E_r) generated by rotation at the brushes $f_1 f_2$. As the ratio of transformation between stator and rotor is about 4 : 1 for, say, 200 volts line pressure, this means that the compensating E.M.F. co-phasal with E_1 should be about one-twentieth to one-sixteenth of the line pressure instead of the full-line pressure as suggested in Fig. 40. Unless it is to be understood that Fig. 40 refers to a machine in which the ratio between stator and rotor is of the impossible order of 1 : 5 or 1 : 4, that figure must be described as misleading.

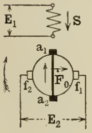

Fig. 41.

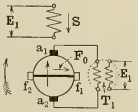

Fig. 42.

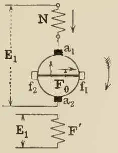

Fig. 43.

Single-phase Shunt Induction Motor with Mixed Excitation (Fig. 41).—Is a machine similar to that shown in Fig. 36, and such as recently more fully described by the author, it can be made to operate at speeds differing from the synchronous by either assisting or counteracting the E.M.F. (E_r) (generated at the brushes $f_1 f_2$ in the motor itself, and by rotation of the rotor conductors in the transformer field) by means of a co-phasal E.M.F. derived from an outside source or from the motor itself.

Self-excited Partly-compensated Single-phase Shunt Induction-conduction Motor (Fig. 42).—Similar to the machine shown in Fig. 36, but in which the working E.M.F. is conveyed to the armature axis partly by induction and partly by conduction. A similar arrangement has been described with reference to the series motor shown in Fig. 28. The E.M.F. conveyed by conduction should be co-phasal with that induced by transformer action and either of the same as or of the opposite direction to the latter.

Self-excited Partly-compensated and Neutralised Single-phase Conduction Motor (Fig. 43).—The energy is conveyed to the armature axis by conduction, and N neutralises the armature ampere-turns. An E.M.F. co-phasal with that impressed on the armature is applied to the stator winding F^1, and produces a transformer field co-axial with the armature axis. By rotation in this transformer field an E.M.F. (E_r) is set up in the rotor along the field axis, and if short-circuited brushes $f_1 f_2$ are applied along that axis a motor field of the proper phase is set up in the same manner as in Fig. 36. The power factor is, if anything, a little better than in the last figure, and the speed of the motor is easily regulated. This machine, like all of the others shown, can be easily fully compensated.

Partly-compensated Two-phase Shunt Induction Motor (Fig. 44).—Is the equivalent of the ordinary squirrel-cage motor; differs principally from that shown in Fig. 36, in that it is *separately* excited. The transformer field due to phase 1 acts as such relatively to the armature axis of phase 1 (a_1 a_2), but that same field also acts as motor field relatively to the armature axis (a_3 a_4) of phase 2, and vice versa. The power factor is good, but not unity.

Compensated Two-phase Shunt Induction Motor (Fig. 45).—Differs from the previous, in that an auxiliary E.M.F. is included in each axis of a phase opposite, or nearly opposite, to the E.M.F. of self-induction in that axis. The compensation is, therefore, on the same lines as have already been indicated in connection with Fig. 39, and suffers from the same disabilities, not, however, to such a great extent, because for the same size of motor the current to be dealt with in each armature axis is only about half of that current which is to be dealt with in one axis only in the case of a corresponding single-phase machine. The E.M.F. to be introduced into the armature axis of phase 1 is preferably chosen co-phasal with the E.M.F. of phase 2, and vice versa. The source of the compensating E.M.F. should again be preferably non-inductive.

Neutralised Two-phase Shunt Conduction Motor (Fig. 46).—Energy is conveyed to the armature from one phase, E.M.F. (E_1), along an axis (a_1 a_2) also passing the neutralising winding N_1 in series with the armature. Energy from the other phase, E.M.F. (E_2), is conveyed in a similar manner to the armature, but along an axis (a_3 a_4) perpendicular to the first. The motor field winding F_1 for the first axis is connected in parallel to the second phase and vice versa. The speed of the motor can be regulated with ease and the power factor may be improved, for instance, as described in connection with Fig. 35.

Exactly similar arrangements to those illustrated in the last three figures can be carried out for three-phase motors.

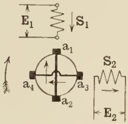

Fig. 44.

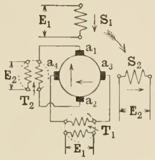

Fig. 45.

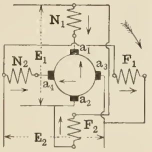

Fig. 46.

Although no less than 36 examples have been dealt with, the author is well aware that he has not included all the known or possible alternate current motors of practical value, but it is thought that these examples will amply suffice to define the system of classification here proposed, beyond all possible doubt or misunderstanding. It may not be amiss to point out for the benefit of those who might still hanker after the meaningless but time-honoured term "repulsion motor" that if used at all it can be applied with equal justification to at least 24 out of the 36 examples given, and to shunt and series motors alike. Surely the multiplicity of these alternate current motors and their fast-increasing commercial importance, calls for some more scientific nomenclature. To the thoughtful student the arbitrary term which it is proposed to discard, has no doubt caused much difficulty and waste of time; nowadays where even specialists have an immense ground to cover, all such ambiguities should be most carefully avoided.

No inventor's name, with the exception of Elihu Thomson's, has been coupled with the various motors considered, so as to avoid any possible discussion on a subject which can be of personal interest only.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Report of the Electric Railway Test Commission to the President of the Louisiana Purchase Exposition." (New York: McGraw Publishing Co.)

"Dictionary of Engineering Terms," in English and Spanish. By A. Garcia. (London and Glasgow: Hirschfeld Bros., Ltd.) 3s. 6d. net.

THE INTERNATIONAL COLLIERY EXHIBITION.

First Notice.

The Colliery Exhibition, which was opened on Tuesday last by Right Hon. D. Lloyd-George, M.P., at the Agricultural Hall, contains a large proportion of exhibits of electrical interest, and shows clearly the great progress which has been made in the application of electrical working to collieries and mining generally during the last few years. It is worthy of note that, of all the coal cutters and drills and such appliances shown on the various stands, by far the largest majority were driven electrically. Electrically-driven pumps of a variety of makes are shown, and the special enclosed switchgear for use in fiery mines is quite a feature of the exhibition. On glancing round the stands one cannot help being struck with the increasing study of details of colliery requirements which has been made by designers and the way in which the electrical equipment, in coal cutters, for example, forms part and parcel of the whole machine instead of consisting, as is often the case in other branches of work, of standard motors, switches or other electrical gear, simply tacked on, so to speak, to apparatus not primarily designed for electrical working. A number of well-known firms exhibit, and not a few novelties are shown for the first time.

Of the stands devoted entirely to electrical plant the largest and most imposing is that of the British Westinghouse Company, who have a very complete series of exhibits of up-to-date electrical equipment for mining purposes. A number of motors both for continuous and alternating currents are shown, specially enclosed for mining work, and a 45 H.P. motor generator set is running to supply current to the three-phase exhibits. Several electrically-driven pumps and fans are on view. The collection of switch gear is particularly interesting. A couple of complete high-tension panels have been built up, showing the special arrangements adopted for mining work. The oil switches behind the panels are operated by handwheels on the front of the board, and the whole of the working parts are contained in a cell closed by an expanded metal cover. This door is interlocked with the switch mechanism so that it cannot be opened unless the switch is off, nor can the switch be closed unless the door is shut. The 'bus bars are placed above the chamber, entirely out of reach and separated by a slate partition, so that a man entering the switch cell cannot touch any live parts. A number of patterns of special switch pillars and switch boxes for mining work are shown which we hope to describe more fully in our next issue. Some of the novelties on the stand include a new form of liquid motor-starting rheostat, and a new design of automatic circuit-breaker with a magnetic blow-out but without carbon contacts. The Westinghouse Company have given a good deal of attention lately to the question of electrically-driven winding engines for collieries, and have developed a system for dealing with the sudden and violent variations of load entailed by this class of work, which differs somewhat from some of the methods used by other firms. The Westinghouse system involves the use of an auxiliary set with a flywheel, which the company term a "converter equaliser;" this acts as a buffer to deal with the heavy overloads and keeps the load on the generating station constant. The flywheel sets, however, do not carry the whole of the load, as in some other systems, but are simply connected in parallel with mains after the manner of a buffer battery. By this means, as the flywheel set only has to deal with the excess of load above the normal and not the whole load, and is, therefore, of comparatively small size. Another advantage is that in event of a mishap to the flywheel set, the winding engine can still be run at a reduced speed. Two systems have been worked out. One, which the company recommend for adoption whenever possible, involves the use of alternating-current winding motors, while the other employs continuous-current winding motors.

The system using an alternating current motor is as follows: A rotary converter si connected through transformers to the high-tension transmission lines. On its continuous current side, the rotary converter is connected to a continuous-current machine acting sometimes as a generator and sometimes as a motor, and fitted with a heavy flywheel. The rotary converter is compounded in a special way so as to supply automatically the magnetising currents required for the induction motors on the system. The voltage of the continuous-current flywheel machine is controlled automatically by a quick-acting regulating apparatus, which is actuated from the high-tension transmission line through series transformers. This whole arrangement constitutes the converter equaliser, the action of which is to discharge energy into the high-tension line system whenever the load on the latter is greater than the constant output; and to store up energy in the flywheel whenever the power demand in the high-tension supply system is less than the constant output of the station. When there is no load on the high-tension system, the rotary converter runs with approximately 100 per cent. power factor, and gives up to the flywheel, through the medium of the D.C. machine acting as a motor, energy corresponding to the constant output of the station, until the maximum speed is reached. The flywheel is of sufficient capacity to take care of the overload and underload periods. The flywheel machine is preferably built for high speeds in order to obtain high electrical efficiency with light weight; and may have a maximum slip of 40 per cent. of its maximum speed, though in ordinary service 30 per cent. slip is sufficient.

With this arrangement, one converter equaliser can be used to equalise the variable load of an entire system, there being no necessity to provide an equaliser for each winding engine, as with other equalising plants, and the flywheel set may be connected at the most convenient point in the high-tension line, without regard to the location of the winding motor.

On light loads, especially during night-time, when the output, as a rule, is small, the equaliser may be shut down if necessary without affecting the winding engine &c. This is obviously not possible with a flywheel motor-generator, even though under such conditions its equalising capacity is not required, and its load factor is very low. The speed of the equaliser is automatically regulated by a resistance in the shunt circuit of the continuous-current machine. The loss of power through field regulation is so small as compared with the total capacity of the machine as to be negligible, thus allowing a slip of from zero to 60 per cent. or more without appreciably lessening its efficiency. As previously mentioned, however, a slip of 30 per cent. will be sufficient, as it will enable the flywheel to part with about 50 per cent. of its total kinetic energy. The necessary weight of the flywheel is thus reduced to approximately one-third of that requisite in the case of a motor-generator system of the same output.

In the continuous-current converter-equaliser system, which is also adapted for use with a high-tension three-phase supply, the rotary converter is connected to the alternating-current mains in the same way as before, the continuous-current side being joined up to a continuous current machine fixed on the same shaft as the continuous-current regulating machine. The latter is electrically connected in series with the machine, and acts as a voltage regulator by means of which a variation of voltage on the winding motor terminals between minus maximum and plus maximum is obtained. The continuous-current voltage of the auxiliary machines is one-half of the maximum voltage of the winding motor, so that if the latter is built for 500 volts, the voltage of the former will be 250 volts. When the winding motor has to be started, the voltage of the regulating machine will be equal and opposite to that of the machine. By decreasing gradually the voltage of the machine to zero and increasing it in the reverse direction, any desired pressure between zero and maximum may be applied to the winding motor. In order to regenerate, it is only necessary to decrease the voltage impressed on the winding motor. The energy will always be taken from the alternating-current supply circuit with approximately 100 per cent. power factor; or leading current may be delivered to it by properly regulating the shunt field of the rotary converter.

The electrical and mechanical control gear for use with the alternating-current winding motor has been very fully worked out. The drum or friction-wheel brakes are normally actuated by the compressed-air cylinder; or, in case of emergency, by means of a weighted lever, and the whole control-gear is operated by means of three levers which are fixed on the driver's platform. The lever on the right-hand side of the driver actuates (1) the main reversing switch, and (2) a liquid starting rheostat.

The reversing lever can be moved either forwards or backwards from its central or off position, the direction of rotation of the winding motor depending on this. When the other lever is moved, the main switch is actuated first, the movement of the liquid starter being secondary, beginning only after the lever has reached a definite position. If the lever is moved into an intermediate position, the reversing switch is operated as before—viz.: to its full final position, whereas the liquid starter is only moved to a position corresponding with that of the operating-lever handle. In this manner the speed of the winding engine can be varied within wide limits. The action of the liquid starter is such that the acceleration is automatic and quite independent of the speed with which the lever is operated. The design of the control gear is such that the electrical braking of the motor when lowering may be arranged for if necessary. The lever on the left-hand side of the driver operates the pneumatic brake, and the foot lever, which is between the two others, is only operated by the driver in cases of emergency, when it is required to stop the winding drum at a moment's notice. A tripping mechanism is also provided and interlocked with the depth indicator which automatically applies the brakes to prevent overwinding in either direction.

Another large stand devoted to electrical power plant for mines, including portions of electric winding engine equipments, is that of the Lahmeyer Electrical Co. An interesting exhibit on this stand is the depth indicator and retardation indicator for electric winding engines, for showing to the attendant the relative position of the cages to the landings and for automatically preventing overwinding. A lever frame and other parts of the control apparatus for a large electric winding plant are also shown in connection with the depth indicator. The control is effected by placing a lever in one of several forward or backward positions. Should the driver not bring the lever back to the "off" position in time, this is done automatically by the rising and dipping nuts on the depth indicator, through the medium of a cam and a series of rods and levers which push back the control lever. The shape of the cam is so chosen as to reduce the speed of the winding drum gradually. The gear is fitted with means of adjustment so that the retardation may be arrranged to occur sooner or later, and at the same time another cam is provided preventing the driver from restarting too quickly.

The whole gear is interlocked with the emergency brake, and this is distinct from the foot brake which the driver is supposed to use under ordinary circumstances. The depth indicator is arranged with two spindles, one being worked by the loose drum and one by the fast drum, and an attachment is provided by which a gong is sounded to warn the driver shortly before the control-lever is automatically brought to the off position. The whole gear is very substantially made and is well thought out in matters of detail. Another part of the equipment is the Karlik speed indicator for measuring the rope speed.

This instrument is arranged to trace a continuous record of the rope speed on a drum, and should prove of value in cases of accident or irregularity of working in showing exactly what took place at any moment. We understand that some of the Continental authorities have made the use of an apparatus of this nature compulsory.

A further appliance in connection with winding-engine control is a signalling set to show the driver by means of coloured lamps whether the load is to be men or material or whether the wind is to be made for inspection purposes. This apparatus serves as a communication between the pit head and the driver in the engine room, and at the same time a signal is made, for whatever purpose, the main control lever is interlocked, so that no wrong action can be performed by the driver. The gear consists of two main parts, one being a cast-iron case mounted on a pillar and containing one voltmeter, three glow lamps, two switches and two lamps for illuminating purposes only, the second part being a panel with a series of signal lamps and labels carrying the corresponding inscriptions. These are placed in front of the attendant. If material is to be wound, a switch is closed whereby the attendant receives the signal "look out," then the signalling switch is moved until the pointer attached to it indicates winding of material. In this position a circuit is automatically established in which two white glow lamps are in series, one at the pit head and the other on the driver's indicator panel. At the same time a release magnet is brought into operation, and by means of appropriate levers the control lever is permitted to be moved freely. Suppose, now, that men are to be wound; the driver first receives the signal "look out" as before, and the signalling switch is then brought into the position marked "men winding." This opens the circuit containing the white lamps and closes another containing two red lamps. The release magnet now receives no current and the core drops, causing the control lever to be locked so that it cannot be moved beyond the position corresponding to the speed prescribed for winding men. The same holds good when the signalling switch is brought into the position marked "inspection winding," the indicator lamps being green in this case. There is also a voltmeter at the pit head which allows the man who gives the signals to see when the motor generator gets up speed, so that winding can begin. The remaining switch merely serves the purpose of switching on the two incandescent lamps at the commencement of working, in order to light up the inscriptions on the signal panel.

An important part of a winding plant on the Ilgner system is the automatic regulator, which keeps constant the input to the motor of the flywheel set while permitting the speed variation necessitated by the alternate storage and giving out of energy by the flywheel. In the regulator exhibited, this is accomplished by switching resistances in and out of the rotor circuit of the induction motor driving the set by an automatic arrangement actuated by a pulley driven by a belt from the set, and working in conjunction with a pendulum which automatically shifts the multiple contact switch one way or the other, according as the speed is above or below the normal. Other items on the same stand are a standard oil-immersed controller with oil-immersed resistances for a 160 B.H.P. haulage motor of a type which has been supplied to a large number of collieries in this country, and a 50 B.H.P. three-phase induction motor of special fire-damp-proof design on order for an underground haulage plant in a very fiery part of a mine in South Wales. The motor is of the slip-ring type for a 440-volt 25 cycle circuit and is fully enclosed except for a specially arranged air inlet and outlet through which a forced circulation of air is obtained for cooling by means of fan blades attached to the rotor. These air inlets and oulets are rendered flame-proof after the manner of the safety lamp by deep grids composed of fine laminations. A new pattern of liquid starter is shown, and some samples of specially protected mining cables.

The Brush Electrical Engineering Co. also show some of their mining specialities amongst which is the Birtley Falcon electric coal cutter which presents some interesting points of detail. This cutter is of the disc type, and various sized discs are supplied with a single machine so that any depth of undercut can be obtained to meet varying conditions of coal and the nature of the roof or floor. The design of the machine with the cutting disc situated midway between the two motors greatly diminishes the side thrust and has the further advantage of cutting with equal facility in a forward and backward direction along the coal face. The standard machines are supplied with two 15 B.H.P. continuous-current motors arranged for series-parallel control. The motors drive the cutter pinion through a spiral gear running in an oil bath, and the feed mechanism is of the variable type, so that the cutting rate can be regulated from either end of the machine, and from slowest to full speed, by varying the effective throw of an eccentric without the necessity of stopping the machine. The controller is of the drum type, with magnetic blow-out. It is interlocked with the reversing handle, and can be worked from either end of the machine. Resistances of the grid pattern are employed and are arranged without soldered connections. The motors are of a flat two-pole type, and the standard machine is so constructed that either motor can be removed complete. The continuous-current and alternating-current motors for these coal cutters are interchangeable, so that a machine can readily be connected for use on one or the other kind of circuit. The side frames are solidly constructed of rolled steel plate in a similar way to the company's electric locomotives. The machine can be arranged with either skids or rollers, and is fitted with an improved face wheel, adjustable at will to suit the varying contours of the coal face. By this means damage to timber caused by wedging the machine is prevented, as the wheel can be set to suit the width of the cutting. The connecting cables about the machine are all enclosed in steel tubes. A special form of double concentric impregnated canvas hose is used to enclose the flexible trailing cables. This is connected to a special double-pole fuse box of substantial design. A magnetic blow-out is fitted to each pole, and small pockets are provided inside for the reception of a store of spare fuses, which goes far to remove the temptation to insert any odd piece of wire after a fuse has blown. Higher up the gallery of the mine is placed a special enclosed gate switch box, which has an automatic circuit-breaker fitted on one pole. Another interesting item on the stand is a working model of a Holland-Johnston electrically-driven coal hoist of the travelling bucket type, which is a particularly compact piece of apparatus suitable for use in any position on board ship, in a mine or elsewhere. The apparatus is quite self-contained, and can be worked either on a permanent stand or slung from a derrick. Other exhibits include a 300 kw. 3,000:300 volt three-phase oil transformer of the three-core type on order for the County of Durham Electric Power Distribution Co., and one or two motors driving pumps of various descriptions.

Messrs. Johnson & Phillips' stand is mainly occupied by switchboard instruments of the moving-coil and hot-wire types, of which a large number are shown. Some samples are also exhibited of vulcanised bitumen cables specially suitable for mining work.

The Diamond Coal Cutter Co., who did much pioneering work with regard to the application of electricity to mining work, have a large stand devoted to their well-known electrical coal-cutting machines and other electrical mining equipment, which we hope to describe and illustrate in our next issue.

Another stand, devoted almost entirely to coal-cutting machines, is that of Austin Hopkinson, who exhibits several long-wall cutters and some special motors for underground work. The coal cutter is of the chain type, and is fitted either with continuous-current or three-phase motors. The jib upon which the chain is mounted, which can be instantly detached from the machine if required, can be slewed through an angle of 180 deg., and is thus capable of cutting its way through the coal at the start, avoiding the necessity of first cutting a "stable," such as is required for disc cutters. The frames are of tough cast steel all in one, including the bottom half of the motor, magnet frame, bearings, brackets and oil baths, and have no loose attachments of any description. The machine can be carried on cast-steel double-flanged runners, or on skids so arranged to be easily replaced by single flanged wheels for flitting. The motor which in the case of continuous-current machines have four poles are all manufactured by the firm itself. They are entirely enclosed in cast steel flame-tight cases split axially to allow of easy removal of the armatures. The three-phase motors are all of the squirrel cage type arranged for a fairly large slip and are started up by means of auto transformers. All these coal cutters are provided with a single motor set longitudinally in the frame, which results in a compact and narrow machine. The three-phase machine shown is provided with a 30 B.H.P. motor, and a 20 B.H.P continuous-current machine is also exhibited. The main driving gear consists of a pair of planed steel mitre wheels, and a four threaded polished steel worm working on a cut phosphor-bronze wheel, the thrust being taken on ball bearings, thus making a very efficient and silent gear. Worm gearing is also employed for the feed mechanism. The controller is of the tramway type, completely immersed in oil to avoid sparking at the contacts. The machine is so constructed that on removal of the covers forming the top half, every portion of the gearing and shafting can be lifted out for examination, all the electrical connections being made outside the casing, and being effectively protected. The same firm also manufacture a number of patterns of electrical haulage gears, both of a portable nature and for fixed purposes.

Messrs. Mavor & Coulson also show some coal cutters presenting particular points of interest, which we hope to describe and illustrate next week.

Messrs. John Davis & Son of Derby exhibit a number of mining appliances of different kinds, including an example of the Jeffrey electrically-driven heading machine. This machine is of low type, and is used for pillar and stall work, driving narrow places, and where it is necessary to drive strait work quickly. The motor is totally enclosed, as also is its starting switch, and drives through cut bevel wheels on to a vertical shaft; it is fixed with its gearing on a movable frame, and is moved forward by two pinions in racks fixed on to the stationary frame. The latter frame is provided with two jacks; the one in the front is fixed against the coal, and set at an angle to prevent the tools from running across the coal face and so slewing the machine out of line. The back jack is set against the roof, and thus jambs the frame firmly into its proper position to guide the cut. The chain is composed of tool-holders and links, and runs round the front end of the movable frame on two idler sprockets. The driving sprocket under the motor is the apex of the triangle made by the chain. On the back shaft are two clutches with one handle for operating them; one clutch feeds the chain forward and the other withdraws it, and the driver can let the chain run idle at any point of the cut. The feed is at the rate of about 6 ft. in $3\frac{1}{2}$ minutes, and the return is done in half a minute, but the feed speed depends upon the material being cut, and it may be made as slow as 6 ft. in 7 minutes. There are knock-off brackets attached to the stationary frame so that the machine may not overrun itself and so become jambed.

A particularly compact magneto exploder for shot firing is shown by the Cotton Powder Co. This apparatus is only 5 lb. in weight, but is capable of firing about 10 shots in series, with a sharp turn of the wrist.

There are a large number of other exhibits of an electrical nature, which we purpose to describe and illustrate in our next issue.

Messrs. Babcock & Wilcox have on their stand a working model of one of their electrically driven silent gravity bucket conveyors of a similar design to that supplied to the Powell Duffryn Colliery Co., and models of their well-known water tube boilers.

A good show of boiler fitting is to be found on Messrs. J. Hopkinson & Co.'s stand including their parallel steam valves. They also show a model of a new automatic feed-water regulator and a new design of flue for Lancashire type boilers which is constructed with the plain part of the flue ring slightly undulated or waved about the thickness of the plate itself. This diminishes liability to cracking of the plate at the root of the flanges, and at the same time the tube is stronger to resist collapse but will yield longitudinally, to compensate for the difference of expansion between the shell and the flue.

The Stirling Boiler Co. show a small working model of their water-tube boiler illustrating the circulation through the tubes, and have on view drawings of a new pattern of independently fired superheater in which is incorporated a small auxiliary boiler through which the furnace gases pass before reaching the superheater tubes, as this is found to make their temperature more easily regulable. The steam generated in the auxiliary boiler passes into the main drum of the superheater.

The only large engine shown actually under steam is a 330 B.H.P. two-cylinder compound high-speed engine on the stand of Messrs. Browett, Lindley & Co.

The Worthington Pump Co. show a number of electrically driven pumps of various kinds, and electrically driven three-throw pumps are also exhibited by Messrs. Frank Pearn & Co.

Messrs. Gwynnes, Ltd., have a display of high lift centrifugal pumps, mostly for electrical driving.

On the stand of Messrs. Heenan & Froude, in addition to an electrically worked tippler and some haulage gears, is shown a 5 ft. 6 in. ventilating fan of the pattern of which a large number have been supplied to the London Underground Railways Co. These fans are capable of exhausting 20,000 cubic ft. of air per minute at 1 in. water gauge when running at 240 revs. per min. They are designed to run with as little vibration as possible, and are constructed entirely of steel plate. A fan of this description was illustrated in *The Electrician*, Vol. LVI., p. 704, in connection with the Baker Street & Waterloo Railway.

Messrs. Reavell & Co. exhibit two of their patent direct-coupled air compressors, in which the motor armature is mounted on the compressor crank shaft and the frame of the motor forms the connection between the two halves of the machine. The largest of these is a double-ended machine of 270 cubic ft. capacity, driven by a three-phase 50 B.H.P. motor by the Electric Construction Co. It is of the two-stage type, provided with an intercooler, and runs at 325 revs. per min. A small gear-driven compressor is also shown. Electrically driven haulage gears are exhibited by Messrs. Ernest Scott & Mountain, Messrs. R. H. Longbotham & Co., the Sheepbridge Coal & Iron Co., and others.

THE CORRUGATION OF RAILS.

The June official circular of the Tramways and Light Railways Association is devoted to the question of Rail Corrugations, and contains some particulars of communications which have been received from various sources as a consequence of the circulation of a paper on the subject.

The secretary and treasurer of the American Street and Interurban Railway Association writes that this problem does not appear to be nearly as serious in that country as in Europe, but that he will be pleased to take up the matter in a larger way with the electric railway companies in the United States.

Sir Frederick R. Upcott, K.C.S.I., President of the Indian Railway Board, writes that the "roaring rails," as they are called in India, continue to give a great deal of annoyance. He mentions the extraordinary fact that brick ballast has a tendency to develop the corrugation, and that on the Eastern Bengal State Railway in a great many instances brick ballast has had to be taken out and sand and earth or stone substituted. A technical Paper by Mr. G. Moyle, Engineer-in-Chief, Eastern Bengal State Railway, issued by the Government of India, is reproduced in the circular, of which we give extracts below:—

The term "roaring" originated on the Eastern Bengal State Railway some 10 years ago, and may be defined as the noise caused by the development of furrows across the running head of a rail, usually oblique to its length, the tops of the furrows being very hard and the bottoms soft. The common objection to these rails is that they occasion a deafening noise when trains are passing over them, which causes great discomfort to passengers. However, there is a still more important and serious objection, which will be referred to below. The engineers of Indian railways have had roaring rails under observation for the past eight years, but up to the present no definite conclusion has been formed on the real cause of the phenomenon, and no manufacture-specification has been drawn up with a view to produce a metal likely to be exempt from its development.

Plates accompany the report showing reproductions of photographs prepared to give clear ideas of the superficial appearance and microscopic structure of such rails. The mean pitch of the corrugations has been found to be 0·74in., and the mean depth 0 0035in.

The following are the principal ascertained facts concerning the phenomenon:—

(*a*) Both double-headed and flat-footed rails develop it: it is not confined to any particular weight or section, or to double or single line, (*b*) It develops in rails rolled by various manufacturers. (*c*) It develops with equal facility on banks or cuttings, grades or levels, straights or curves. (*d*) It appears to be found more generally in extremely damp climates, especially when the atmosphere contains salt brought from the sea; but it is found in a variety of climates, and even in exceptionally dry inland tracts. (*e*) It develops most rapidly where brakes are freely used; for instance, just outside and inside station signals; but it is not necessarily produced by brake action, since it exists abundantly in parts of tracts where brakes are never put down. (*f*) Cases are common in which a roarer occurs, while the rails fished to it or immediately opposite it in the track, though delivered by the same manufacturer in the same year, do not roar. (*g*) Roarers taken out of the track, planed smooth, and replaced, have again developed roaring. (*h*) Roarers almost invariably develop where the track is packed and boxed with brick or burnt clay ballast, and on open girder bridges. (*i*) Roarers are scarcely ever found where the ballast is stone, and never where the track is packed and boxed with earth. (*j*) Roarers on brick-ballasted roads can be got smooth if the brick boxing is removed and replaced by earth. The trains then wear the rails smooth. It is not necessary to remove the brick-ballast packing under the sleepers. (*k*) Roaring has only been found in steel rails and never in an iron rail. One lot of steel double-headed 73-lb. rails, delivered about 1880-82, have never developed roaring, though packed and boxed with brick ballast, and subjected to the same conditions which have attended roaring in adjacent rails. (*l*) Roarers have been cut into thin slices, both parallel and at right angles to the vertical axis. (*m*) The ridges of a roaring rail resist a file, but the metal in the hollows is removed quite easily. (*n*) It has been found dangerous to reverse double-headed roarers in the track, *i.e.*, to place them upside down, as they have been found to fracture. It is also undesirable to change the positions of sleepers under flat-footed roarers. This also leads to fracture. (*o*) So far as roaring rails have been examined by experts, their opinion is that there is nothing in the chemical composition, physical condition, or microscopic structure to explain the phenomenon.

The following are amongst the causes of roaring suggested by various engineers:—

(*a*) To vibrations set up in some unknown manner on an imperfectly packed road in a yielding formation, and that once this cause is removed and the vibration arrested the effect will also be eliminated and the wear become even. (*b*) To portions of the rail rusting away under the action of dew, and leaving ridges, the cause of this being want of homogeneity in the metal. (*c*) To rails after rolling being stacked whilst hot in layers crossing each other at right angles, so that unequal cooling is produced, the surface being annealed locally and at uneven intervals. (*d*) To accidental irregular cooling after rolling. (*e*) To the ingots from which the rails were rolled being cooler than they should have been. (*f*) To the effect of brakes which lift the wheels from the rails. When this happens, the brake ceases to act and the wheel falls down on the rails; the brake begins to act again, and so on, the flexibility of the springs accentuating this undulatory motion. (*g*) To wheels being braked with maximum retarding force, which is just short of skidding; that is to say, by a force on tyres rather less than the weight of the vehicles on the rails. This is brought about by a vibratory action set up in bearing springs by the jolts occasioned in passing over the joints. (*h*) To excess of manganese in the metal. (*i*) To the existence of alternating lenticular masses of pearlite and ferrite. (*j*) To the rails being finished from the rolls at an improper temperature.

To give an idea of the extent to which roaring can develop under favourable conditions, it may be stated that in a section of metre-gauge single track on the Eastern Bengal State Railway between Dacca and Mymensingh, 12½ continuous miles of which were very carefully inspected, all roarers and non-roarers being counted, it was found that 89 per cent. of the rails were roarers. The traffic in this section is light, the speed low, and the track maintenance excellent. No continuous brake is, or ever has been, used. On the other hand, the section examined is brick-ballasted, the climate is extremely moist, the rain excessive, and the atmosphere is said to be charged with salts.

The following is a note on a piece cut from a typical rail taken out of the above nest of roarers : "Measurement of depth and pitch of all the corrugations in a piece of roaring rail from the Dacca section, Eastern Bengal State Railway (41¼ lb. steel flat-footed), 34·54 in. long.

Depth of corrugations.		Pitch of corrugations.	
Maximum	0·0068 in.	Maximum	1·14 in.
Minimum	0·0011 in.	Minimum	0·50 in.
Mean	0·0035 in.	Mean	0·74 in.

There appears to be no relation between pitch and depth, but generally greater depth goes with greater pitch."

An extract from an official report made in January, 1902, is given below : A roaring rail was found fractured on the line, between Chogdah and Ranaghat Eastern Bengal State Railway, on December 26, 1901. The original head of the rail, which shows the alternations of hard and soft metal which are characteristic of roaring rails, displays unmistakable skin cracks across the head at the places where the soft metal exists, and apparently fracture has occurred through one of these skin cracks. As far as is known, these skin cracks are not generally noticeable in roaring rails ; but it is quite possible they exist, and that microscopic examination would discover them.

If skin cracks are general in roaring rails there can be no doubt that they constitute a serious defect. The two pieces of this rail were forwarded to England for examination, and one piece together with two other pieces of rail sent to England on former occasions were examined in the laboratory of the Royal Indian Engineering College, Cooper's Hill.

The following is extracted from the report submitted from that laboratory :—

"I have very carefully examined the three rails submitted to me, and neither from the chemical composition, physical condition, nor microscopic structure, can find anything to explain the phenomena, and I feel convinced that the unevenness of the surface which is responsible for the roaring is not due to the chemical composition or physical state of the rail, but to some local cause. Rail 2,020 is quite abnormal, containing over 2·00 per cent. of manganese. It was extremely hard; and could only be sawn up with the greatest difficulty, and cracks in numerous places extended into the running head to a depth of ⅓ in. under high powers of the microscope (1,500 diameters), the structure is almost entirely pearlite, there being little or practically no ferrite, which is what one might expect from the percentage of carbon. The other rails were fairly normal as regards composition, except the high silicon in No. 2,082, and both these give normal micro-structures of ferrite and pearlite. A suggestion was made in the correspondence that the uneven wear of the rails might be due to alternating patches of ferrite and pearlite, the soft ferrite being more readily worn away than the pearlite ; but when it is remembered that the ferrite areas are microscopic and never exceed $\frac{1}{100}$* of a square inch in any of the rails, the impossibility of having alternating patches an inch or more in length will be fully realised. From the abnormally high carbon and manganese and hardness of rail 2,020, it might be assumed that the roaring was due to this, but this assumption is at once negatived by the composition of rail 2,081, which is a fairly soft normal rail, and behaves in the same way. Consequently the only conclusion to be drawn appears to be that the roaring is not due to any peculiarity in the rail itself."

The Board of Trade, England, some 14 years ago, appointed a committee to inquire into the loss of strength in steel rails through use on railways. Their report, from which the following extract is taken, may possibly throw some light on the subject.

"Another important point illustrated by these results is the influence exerted on the character of atmospheric corrosion by the unequal distribution of iron and carbide of iron in the rail, which is particularly marked in the presence of much manganese. When, owing to the method of annealing and other processes to which the steel is subjected during manufacture, the iron is deposited in large veins and laminæ, the micro-photographs appear to show that these are eaten out by atmospheric corrosion forming superficial furrows, the extent and significance of which remain to be determined by further experiments. So far as the evidence goes at present, it appears that while they probably lead to increased loss by wear and tear, there is no proof that they are starting points for fractures in the rails."

From the concluding words of the extract given in the preceding paragraph it would appear that it was suspected in 1890 that skin cracks might exist in furrowed or corrugated rails, and the report on rail No. 2,020 now confirms this suspicion, though in the case of that rail the excess of carbon might account for them.

The only important fact evolved from the examination of the rails at Cooper's Hill is that the roaring rails contained an excess of manganese. This has been put forward as a cause by the locomotive superintendent, Burma Railway, who wrote as follows in 1899 :—

"I hazard an opinion that the mischief will be found to be confined to the steel made in the early eighties of the expiring century, all of which has an excess of manganese." This opinion rather conflicts with what is stated above, but this may be accidental.

Extracts from various letters and reports calling attention to cases of rail corrugation are given in an appendix to the report. We reprint a few below:

The district engineer of the southern division says : "I have noticed the phenomenon in a few scattered rails of the Indian Midland Railway, 80 lb. steel type, and an examination has invariably shown that the roaring was due to inequalities caused by worn rails." The Indian Midland Railway is generally laid with 80 lb. flat-bottomed steel rails. At present the matter does not appear to have assumed a serious aspect on this railway, at any rate so far as the 80 lb. steel rails are concerned. Wherever unevenness of wear is discovered, I should be glad for pieces of the rails to be cut out and sent to me with particulars of the traffic passing over them, and of the position in the road from which they were taken, whether where the brakes are generally put on or otherwise. I regret that, in the absence of complete data, I am unable to give "an explanation of the cause of roaring in rails," as desired by the agent. On receipt of further information I will go further into the matter.

Extract from inspection report of the East Indian Railway for the half-year ending December 31, 1899 : At Pirpointi there are "noisy" steel rails which were laid on the line only two years ago ; the inference is, I think, that inferior material is responsible for the noise.

Extract from inspection report by Major O. Thackwell, R.E., Government Inspector of Railways, for the half-year ended December 31, 1898, of the Bengal Central Railway : The rails are 62 lb. steel, flat-footed, and have been about 15 years in the road ; no considerable renewals are yet found to be required, seven rails only having been renewed during the last half-year. The noisiness of the rails—not throughout, but in many different places—was very marked, and is a source of so much discomfort to passengers that it would appear advisable to consider whether it is not possible to find a remedy. From inquiries on this line and on the Eastern Bengal State Railway and from personal examination, I find it generally agreed that the noisiness is caused by corrugations on the rails, due to portions of the rail rusting away under the action of dew and leaving ridges, the cause of this being want of homogeneity in the steel of the rail. This would point to the necessity for a more strict inspection of the process of manufacture on the part of the buying agency in England, so as to prevent this irregular wear in the case of future consignments of rails.

Extract from a letter from the manager, Eastern Bengal State Railway, to Sir A. Rendel : At the request of Mr. Haughton, who had some conversation with you on the subject in England, the storekeeper of this railway despatched to your address two pieces of rail cut from rails taken out of the main line which have earned for themselves the name of roaring rails. As you will see at a glance, if the bright spots have not become tarnished, the top of the rail has worn into ridges and hollows which produce a deafening noise when run over at speed. The rails will probably have to be taken out of the line long before they would have worn out in the natural course of events, and any investigation which you can make by analysis or inquiry into the process of manufacture should prove instructive.

The engineer-in-chief, Eastern Bengal State Railway, writes that the development of the peculiar wear resulting in roaring is general throughout both the standard and metre gauge systems in all steel rails, whether double-headed or flat-footed, except in some 72 lb. double-headed rails 20 ft. long, laid in the Goalundo extension, when the standard gauge section belonged to the Eastern Bengal Railway previous to 1879. It has not developed in the 25 lb. steel flat-footed rails of the 2 ft. 6 in. lines ; but the traffic there is extremely light and the brake power comparatively small. The wear is most pronounced and occurs more rapidly where brakes are generally applied, that is, near distant signals of stations. It is decidedly more general and continuous in the Dacca section, which is laid throughout on 41¼ lb. steel flat-footed rails, laid about 1884. The upper surface of a rail which has developed roaring usually consists of a series of hard lumps or bars projecting above the general level of the rail top, the lumps being at fairly equal distances. These lumps resist a file, but the metal between the lumps is removed quite readily by a file. A pair of double-headed steel rails which had developed roaring near Kanchrapara were removed, and the top table planed smooth. Within 12 months one of the rails had commenced to develop the same wear. The fact that roaring is general and that no steel rails, except those mentioned above seem to exempt, would seem to point to the conclusion that the defect is due to some peculiarity in the specification to which the rails are manufactured.

After investigating a case of rail corrugation, Sir A. M. Rendel & Co. write that they do not think it probable that the specification of the rails has anything to do with this peculiarity, as it is quite an ordinary one, and rails elsewhere have not, so far as we know, developed this peculiarity.

A further appendix gives some fuller information from the engineers of the various Indian railways on the subject.

The executive engineer of the North-Western Railway, Bhatinda, states that the roughness of the rails varies from mere pitting to a continuous series of hollows and indentations, and suggests it is probably due to the rails after rolling being stacked whilst hot in layers crossing each other at right angles, and that unequal cooling is produced, the surface being annealed locally and at regular intervals. He adds that the matter was thoroughly investigated on tho Burma State Railway, and the conclusion arrived at was that roaring rails chiefly existed where trains were braked, the hollows being produced by the jumping motion of the vehicles.

The executive engineer, Karachi, states that in the case of new 75 lb. f.f. rails roaring is due to a series of shallow ridges running across the rails at an angle of about 60 deg. to the axis of the rail and from 1 in. to 1½ in. apart, and that these ridges existed in the rails before they were laid and are not due to wear. The rails roared the first time a train went over them, but the roaring is less now than it was when the rails were first laid. There are no signs of flaw, but merely the corrugations referred to, and he is therefore of opinion that the defect in the rails is due to faulty manufacture. In the case of 68 lb. rails the roaring, he says, was due to small circular nobs of very hard metal, and in this instance he has no doubt that the state of the rail surface was due to brakes.

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* $\frac{1}{100}$ in. is the actual figure stated in the copy of the Cooper's Hill Laboratory report which reached India, but is believed to be erroneous.

Only a few cases of noisy rails have been noticed on the Rajputana-Malwa Railway, and these have been mostly near distant signals and stated to be probably due to the excessive application of brakes.

The consulting engineer for railways, Lucknow, remarks: "That the rails are always silent at level crossings where they are completely boxed in. The noisy rails are found as much at places between stations where brakes are never or seldom applied as elsewhere."

The engineer-in-chief of the East Coast Railway forwards correspondence from which the following extracts are taken, and remarks "that in my experience rails which have been damaged by sea water and become pitted, do produce noisiness or roaring." There have been several cases of roaring rails on No. 2 Division, and in those cases, where the noise was very great, I have had the rails removed from the main line. The worst case was noticed when about 200 rails, which had been laid for some months at the wharf and had occasionallly been submerged under the sea, were included in a consignment sent out to be laid near Delang on the Puri branch plate-laying. These rails were pitted all over their tables to a depth of about $\frac{1}{32}$ in., and the noise while running over them was deafening. Rust is, in my opinion, the cause of the rails wearing so as to cause roaring.

The engineer to another division at the same railway says: "A great many rails in this division have the same defect. The cause of the corrugation is well known. Corrosion of rails is due to sea air and salt water. The rails are corrugated before a wheel had touched them. I have formed a theory on this subject that the rails which suffer in this way were rolled from ingots cast when the steel was colder than it should have been. As you know, the steel is poured from the converter into a pot and allowed to run from the latter direct into the ingot mould. The stream would, when the steel is not perfectly liquid, fall, like all viscous liquids do (treacle, for instance), in folds, and the outside skin would be hardened slightly by contact with the air and would form when rolled out alternate hard and soft places.

The superintendent way and works of the Burma Railways, remarks: "Roaring rails are generally found at approaches to stations where brakes are first applied. They are more frequent amongst the $41\frac{1}{4}$ lb. rails than amongst those of the heavier sections, which is probably due to the lighter rails having undergone more work. There are no roarers amongst the iron rails. This noisiness is caused by the wheels rolling over slight corrugations on the head of the rails." These corrugations may be due to the repetition of the following process: "The application of the brake lifts the wheels from the rails; when this happens the brake ceases to act and the wheel falls down on the rails, the brake then begins to act again, and so on, the flexibility of the spring accentuating this undulatory motion." The locomotive superintendent remarks: "roaring rails may be found approaching every station between Prome and Toungoo, where the rails are about 10 years old or older with a heavier traffic over them. The worst places are just above where the brakes are first applied with trains at high speed, when skidding rarely or never occurs. As the station yard is approached, where more or less skidding constantly occurs (with decreasing speed), there is not a sign of the roaring corrugations, but the rails are smooth and brightly polished. The rails approaching Krunnendine from the north on the up line are now commencing to roar, being just about 10 years old. I have detected no roarers north of Toungoo yet, though the line to Mandalay is now 11 years old, but the traffic has not been heavy. The old rails laid into the Meiktila branch a few years ago are roaring badly. "I feel convinced that the corrugation action on the rails is produced by wheels being braked with maximum retarding force, which is just short of skidding—that is to say, a force on the tyres rather less than the weight of vehicles on rails. I also feel pretty sure that this is brought about by a vibratory action, set up in the bearing springs by the jolts occasioned in passing over the rail joints; but why steel should thus suffer, and not iron, I cannot do more than guess. I, however, hazard an opinion that the mischief will be found to be confined to the steel made in the early eighties of the expiring century, all of which has an excess of manganese. This same steel rusts fearfully, as we know only too well to our cost in maintaining rolling stock, and the rusting occurs in a pitted form very much allied in appearance to the corrugutions formed on the rails."

The following is extracted from a report by Mr. Lovell, assistant engineer of the East Bengal State Railway:—

The rails inspected are on the Dacca section, between miles $10\frac{1}{2}$ and 23, and between miles $76\frac{1}{2}$ and 86. The total number of rails looked at was 9,674; out of this 5,494 are "roarers," or about 57 per cent. The road is ballast-packed and boxed (except at level crossings) along certain sections. On this portion out of a total of 6,180 rails, 5,487 are roarers, equalling a percentage of about 89. The remainder is packed and boxed with mud. Here, out of 3,467 rails, seven roarers were found, 0·2 per cent.

The total number of rails in cutting is 448, and out of these 396 are roarers, or, roughly, 90 per cent. From the above facts the following would seem to be the most noteworthy points: (1) That the roarers are not all of one particular contract, nor confined to one particular make; (2) the difference in the percentage of roarers found in the ballast-packed and boxed part and the mud portion; (3) they are found not only in "banks," but also on the "level" and in "cuttings."

Another report notices the following points with regard to "roaring" rails: (1) They are not found in cuttings or on solid ground, being met with only on banks and open bridges; (2) they develop only on a road carried on coarse broken ballast, especially on brick ballast, and are never found on a road boxed up with earth, or where a ballasted road is chocked with earth, as at a level crossing; (3) they do not appear to develop on a road carried on cast-iron sleepers, certainly not to the same extent as on a wooden-sleeper road, but when rails which have already developed roaring are laid on cast-iron sleepers they continue to roar; (4) they are not confined to the proximity of stations or localities where the speed is liable to systematic checks; (5) on an experimental length near Dacca, where the rails are very badly corrugated, and where the ballast had some months previously been removed from one side of the centre line and replaced by earth packing, it was observed that the rails on that side are unmistakably wearing evenly, and the corrugations gradually disappearing, whereas those on the side over the ballast show no such signs; (6) they are not confined to rails of any special make or section, but are found on many different types on the Eastern Bengal State Railway; (7) such rails appear to be unknown on well-maintained roads, such as the East Indian Railway, the North-Western Railway and the English railways. From these facts it does not appear to be unreasonable to assume that this irregular wear on certain rails is due, in the first place, not to any inherent defect of the rail, but to vibrations set up in some unknown manner on an imperfectly-packed road on a yielding formation, and that once this cause is removed and the vibrations arrested the effect will also be eliminated and the wear become even.

Another report states that "roaring" rails are of frequent occurrence. On the Eastern Bengal State Railway it was noted that they occurred only where brick ballast was used, and when this was renewed and good stone ballast substituted the rails were gradually worn smooth again. In all the cases I noted on this railway the ballast was of broken brick. With few exceptions, they occurred just outside station yards, in such positions as to make it reasonable to suppose that the application of the brakes, and consequent "dragging" or "skidding" of wheels, is a principal agent in producing the corrugations of the surface to which the "roaring" is due. It is also noticeable that over the same length of rails the "roaring" is more pronounced when the train is leaving the station than on entering it. But though the "dragging" of the wheel under the application of the brakes may be the active agent, it may still be that broken brick ballast in moist localities produces an effect on the surface of the rail predisposing it to be furrowed by this action, and if this predisposing cause is removed the nuisance may be abated.

A SIMPLE FORM OF ROTATING ELECTRODE FOR ELECTROCHEMICAL ANALYSIS.*

BY F. MOLLWO PERKIN.

At the first meeting of the Faraday Society I published a note upon a rotating electrode for electrochemical analysis (*Electrochemist*, III., 26). It consisted of a sand-blasted gauze cylinder fastened on to the end of a stout iridio-platinum wire, and which was rotated within a circular anode. The anode was made of two rings of thick platinum wire which were connected together by four small baffles. The object of the baffles was to prevent the liquid being swirled round in the electrolysing vessel by the rapid rotation of the cathode. The results obtained with this electrode were quite satisfactory, and in their Paper on the "Electrolytic Deposition of Zinc," Dr. Price and Mr. Judge have also obtained very satisfactory results with this form of cathode.

As it is always an advantage to use the simplest possible apparatus for analytical purposes, more especially apparatus which can readily be obtained, or at any rate constructed, in any laboratory, it occurred to me to endeavour to simplify the cathode for rotation work. The cathode as originally described could not be made in the laboratory, but the one which I have recently adopted can be made without any difficulty.

The cathode simply consists of a spiral of platinum wire. It is, however, best to use iridio-platinum wire because this is much more rigid and the electrode is less likely to "throw, out" when rotated at high speeds. The electrode originally employed was made of ordinary platinum wire 1 mm. in diameter. The ones at present in use are made from an alloy of platinum with 20 per cent. of iridium. It must be admitted that as this alloy is very hard it is not easy to coil into a spiral, and it is therefore better to get the makers (Messrs. Johnson, Matthey & Co.) to make the spiral when ordering the wire. It is a further advantage to have the spiral sand-blasted; for a great many metals, however, this is unnecessary. The total active surface of the electrodes now in use is about 23 sq. cm. The anode consists of a 1 mm. platinum wire wound into two or three spirals so as to fit tightly against the electrolysing vessel. I use the same apparatus —viz., a tap funnel for holding the solution to be analysed as that described by Dr. Price and Mr. Judge, and I am indebted to them for the suggestion. This form of electrolysing cell is extremely useful and very simple, and is of great advantage for washing the deposited metal without stopping the current or removing it from position.

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* Paper read before the Faraday Society on Tuesday.

Below is appended the results obtained with this form of cathode in the analysis of copper:—

$CuSo_4$ taken.	Current in amps.	E.M.F.	Time in min.	Deposited copper
0·0506	0·45—4·8	2·7—6·0	35	0·0498
0·1013	0·6 —2·0	2·8—4·8	38	0·1005
0·1266	1 0 —5·5	3·0—9·0	32	0·1253
0·1013*	0·5 —2·0	5·0—7·6	40	0·1009
0·1266	0·45—3·0	..	40	0·1266
0·1266	0·5 —4·5	..	35	0·1263

* From cyanide solution.

The bulk of solution was in all cases about 50 cubic cm., and the quantity of concentrated nitric acid added from 0·5 to 1 cubic cm.

Owing to the extremely high cost of platinum, one would often like to employ less expensive metals for cathodes. I might say that a spiral of nickel wire can quite satisfactorily be employed for a good many metals; for example, for copper, zinc, or iron. The metals are readily removed by means of, in the case of copper, moderately strong nitric acid, and it is surprising how little the nickel itself is acted upon by this acid. In the case of zinc or iron dilute hydrochloric or sulphuric acid may be used, and also against these acids the nickel is very fairly resistant. Of course, when nickel electrodes are used it is necessary to weigh them after each determination before they are used again. With platinum this is not absolutely essential, but it is always a wise precaution to take. I have an electrode of nickel wire which has been used 15 times for copper and nickel determinations, and it looks as if it might be used for quite another 40 such determinations.

Platinum is usually regarded as a metal which is practically unacted upon by reagents, with the exception of aqua regia. When employed in electro-chemical work as an anode, however, it is by no means so stable as it is generally considered; this is especially the case when high current densities are employed. For example, in potassium cyanide solution the platinum is distinctly soluble, as the following numbers will show: A weighed anode of platinum wire having a surface of about 10 cm. was placed in a 4 per cent. solution of potassium cyanide, and a current of 4 amperes passed for 35 minutes. At the end of the time the platinum had lost 0·0016 gramme. It was again placed in the solution and a current of 3 amperes passed for 50 minutes; the loss in weight was now 0·0015 gramme. In this connection it should be of interest to electro-chemists to hear that Messrs. Johnson, Matthey & Co. are now supplying iridium of over 99 per cent. purity. I am informed that this is the first occasion that the metal of such a high state of purity has been obtainable. The metal is as hard as steel, and may be boiled in aqua regia without being attacked; it is also unacted upon by molten lead. I understand that the fact of its not alloying with lead is made use of in its preparation. It has not been found possible to draw it into wire, and it can only be rolled into sheets when hot.

THE KING EDWARD VII. SANATORIUM.

This sanatorium, situated at Midhurst, Sussex, was opened by the King and Queen on Wednesday. It will be remembered that the inception of the idea of building and endowing an open-air sanatorium for tuberculosis was due to the King himself, who decided to devote a large sum of money which had been placed at his disposal to this object, and appointed an Advisory committee to deal with the matter, laying the foundation stone of the buildings himself in November, 1903. The sanatorium stands on the southern slope at Easebourne Hill about 7 miles from Haslemere at an altitude at 495 ft., and the buildings were designed by the architect, Mr. Percy Adams, after a careful study of similar institutions in other parts of the world. As it is situated in the open country, the building has its own electric generating plant, and Mr. E. R. Dolby, who has acted as consulting engineer for the engineering work in connection with the sanatorium, has sent us the following particulars with regard to it.

The steam generating plant, engines, calorifiers and laundry machinery are all houses in a building placed at some distance from the sanatorium and connected with it by a subway. There are two 30 ft. by 7 ft. 6 in. Lancashire boilers, built by Messrs. Galloway Bros. The working pressure is 160 lb. per square inch. A Green economiser is fixed in the back flue and the scrapers are actuated by a small steam engine. The stokehole is about 10 ft. below outside ground level, so that the coal can easily be delivered from carts. The steam piping in the boiler house is of mild steel throughout and in duplicate. Adjoining the boiler house on one side is a workshop containing the usual machine tools driven by an electric motor, and on the other side is a room occupied by the feed pumps, hot well, &c. The feed pumps are by Messrs. G. & J. Weir. From this room access is obtained to the engine room, a fine room 53 ft. 6 in. long by 35 ft. wide and 11 ft. 6 in. high, in which are installed the electric lighting sets and the calorifiers, pumps, &c. The walls are of white glazed brick throughout and the floor is paved with dark red tiles.

Messrs. Foote & Milne (Ltd.) were the contractors for the electric lighting, telephones, &c. The generating plant consists of three combined sets, each comprising one of Messrs. Willans & Robinson's compound high speed engines, capable of developing 48 B.H.P. at 150 lb. pressure at a speed of 470 revs. per min. Each engine is coupled to a compound-wound dynamo by Messrs. Newton's (Ltd.), giving 250 volts and 100 amperes. Two of these sets are sufficient to supply the maximum demand for light and also the current for the various motors hereafter described.

There is at present no secondary battery, as it was considered desirable to limit the initial cost of the plant, and, moreover, the heating plant is so designed as to use the exhaust steam so that the running of one set on a comparatively light load at night is not so uneconomical as it might appear.

The cables from the three sets are carried to a white marble switchboard let in flush with the wall and surrounded by a teak frame. Access is obtained from the pump room at the back. Upon the board are mounted Kelvin voltmeters, ammeters and automatic cut-out switches.

Two feeders from the switchboard supply a ring main which passes round the subways below the main buildings, and the network is so arranged that in case of accident to one feeder the other would still be able to furnish the supply of current. From the ring main are taken branches to various distribution boards.

The wiring is chiefly run in wood casing of segmental section on the face of the walls, so as to afford easy access to the wires, while providing no lodgment for dust. The principal rooms are, however, wired in steel tube sunk in the plaster or behind the tiles. The fittings in the chapel, dining hall, &c., are of an ornamental character, but elsewhere they are of strong simple design.

There is a complete system of telephones, with an exchange in the porter's lodge, and also a very complete system of electric bells. The bell pushes are so designed that a telephone can be hung upon each push to enable a patient to communicate directly with the nurse on duty in the service room.

Messrs. Dargue, Griffiths & Co. were the contractors for the heating and hot-water service, and also for the work in the boiler house. The heating and hot-water service are both carried out on what is known as the forced circulation system and the calorifiers are fixed in the engine room so as to be easily controlled. The exhaust steam from the electric light engines is carried to three large calorifiers, one of which supplies the hot water for heating, the second the hot-water service and the third is a reserve and can be used for either service. Each calorifier consists of a cylindrical vessel inside which is a group of copper tubes through which the exhaust steam is passed. In case no exhaust steam is available, live steam is reduced to a suitable pressure. Each calorifier is provided with a circulating pump which forces the water through the mains which pass along the subways and so round the buildings. The mains for heating and hot water service are both in duplicate.

An electric motor is fixed on top of the airing room of the laundry, and drives the whole of the shafting and machinery in this department. A electrically-heated iron is also used there The passenger lift, by Messrs. Waygood & Co., is electrically driven; its motor and gearing are placed in the basement. It has press-button control and suitable safety devices. The car is built to carry a load of 12 cwt. at a speed of 100 ft. per minute. A vacuum-cleaning apparatus, presented by the Vacuum Cleaner Co., is installed in the feed pump room near the boiler, and is driven by an electric motor.

Susceptibility of Iron in Colloidal Solution.—Messrs. E. F. Burton and P. Phillips have carried out in the laboratory of the University of Birmingham a number of experiments on the susceptibility of iron in colloidal solution which are described in the Lent number of the *Proceedings* of the Cambridge Philosophical Society. They used Kelvin's method for weakly magnetic substances. This method consists in hanging the counterpoised specimen from one arm of a balance so that the lower end of the specimen just reaches into the strongest part of the horizontal field between the poles of an electromagnet, and weighing the attraction. In the case in point, of course, the colloidal solution was contained in a glass vessel; but corrections were made for the susceptibility of the glass, and of the solvent used, by preliminary experiments. The colloidal solution was prepared by sparking between two soft iron electrodes beneath the surface of pure methyl alcohol kept cold by ice. The final results of the measurements show that after the susceptibility of the solvent is allowed for, the susceptibility of the colloidal solution is directly proportional to the mass of iron per cubic centimetre, and about 13 times greater than that of the iron in ordinary ferric salts in water solution and 16 times that of the iron in ferrous salts.

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The accumulation of evidence and the discussion of opinions on the important subject of rail corrugation is throwing light upon this mysterious trouble. The most important and far-reaching body of observations and investigation yet published is that contained in the Paper prepared by Mr. G. MOYLE, Engineer-in-Chief of the Eastern Bengal State Railway, issued by the Indian Railway Board in July 1904. It is reproduced in the June *Circular* of the Tramways and Light Railways Association, and we give an abstract of it elsewhere in this issue. This Paper should dispose finally of the statements put forward by various writers that corrugation is unknown on steam railways, since all the observations therein collected refer to Indian railways.

Other recent publications bearing on the causes of corrugation have been brought to our readers' notice from time to time, such as Mr. ARNALL'S and Mr. PANTON'S Papers suggesting that vibrations set up by the rolling stock in certain ways are the causes of the trouble. We may also refer to the article in the *Light Railway and Tramway Journal* of June 1st, which is a collection of opinions and experiences of Continental and English tramway engineers called forth by Mr. PANTON'S Paper.

It would be impossible to summarise within any reasonable length all the theories which have been put forward to account for rail corrugation. We believe that it is now superfluous to discuss the majority of them because the evidence shows that a great many must be rejected by the process of "cancelling out." It will be more useful to show what positive facts emerge from the collation of the evidence and how the line of profitable investigation appears to be now clearly indicated. The periodic character of the corrugations suggests at once that they originate from vibrations set up by the passage of

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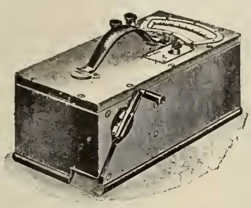

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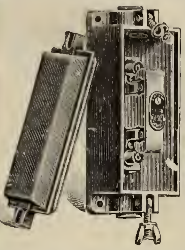

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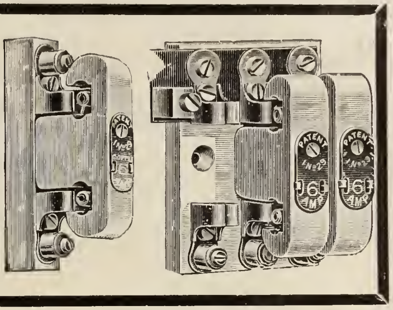

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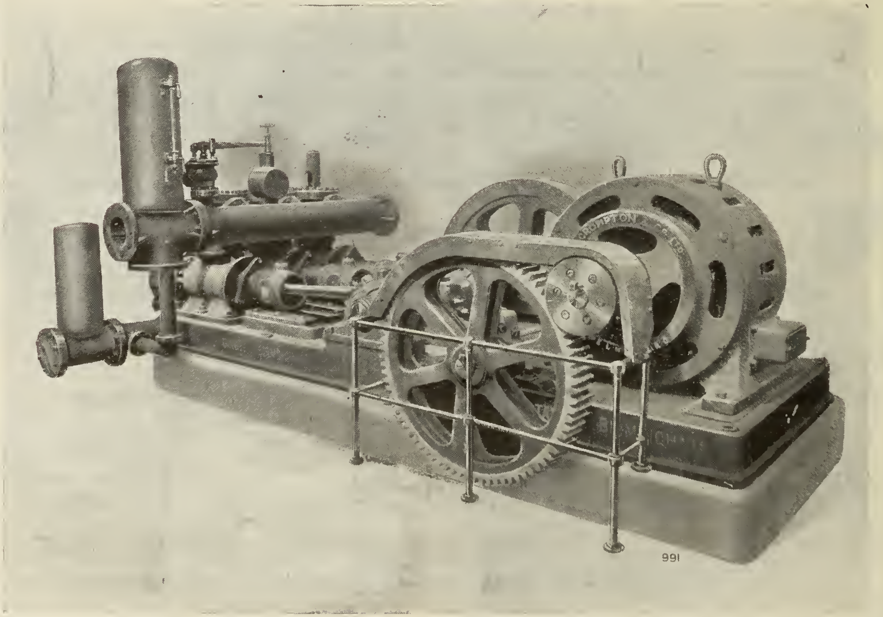

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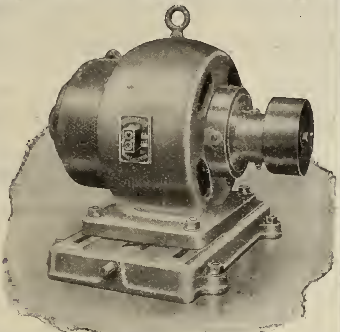

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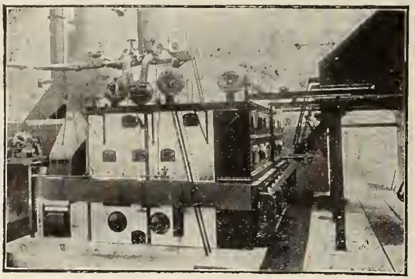

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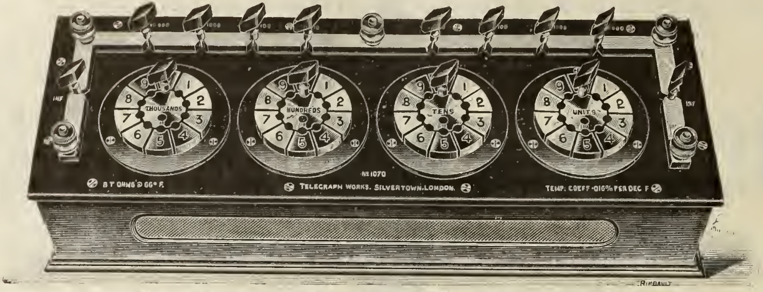

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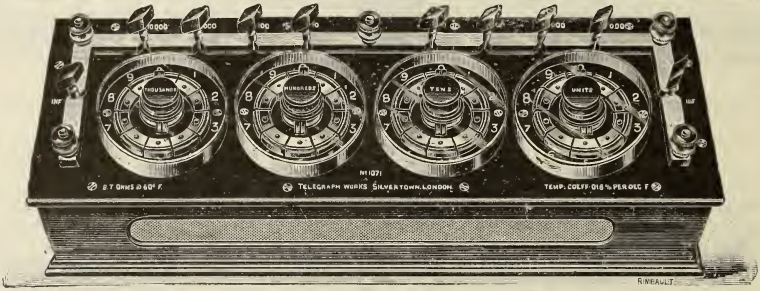

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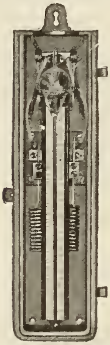

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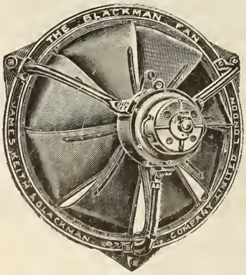

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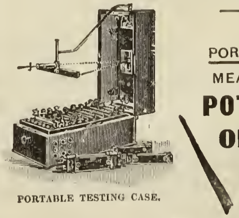

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the wheels over the rails. Such vibrations may be produced in many ways. The fact that tramways worked by cables and electric power, and railways worked by steam power are all affected show that the cause is not peculiar to any one method of traction, and suggests that there may be not one cause but several. This line of reasoning is supported by a considerable number of facts. Since, however, rail corrugation is rarely evenly distributed over the whole length of track worked over by a given class of vehicles, and varies greatly in degree of severity and extension in lines which are apparently working under similar conditions, it seems probable that the character of the rails or the substructure on which they rest has a material influence upon the effect produced.

It has been suggested that the chemical composition of the rail has something to do with it. In one sense this appears to be true, in another sense it is not yet proven, and in yet another it seems to be quite disproved. The Indian experience is most valuable and relevant on this point, because it has been gained under more uniform traffic conditions and more variable permanent way conditions than are afforded by tramway experience. One positive statement is that no case of corrugation has ever been observed in iron rails. So far as we know, the same thing can be said of English tramways. Though iron rails are hardly to be found now, some of early girder sections were laid on steam tramways in the Midlands in the early eighties, and, when worn out by 20 years' traffic, have shown no corrugations but a good deal of deformation as well as loss of metal by attrition and rusting. This fact that corrugation is confined to steel rails is the full extent to which chemical composition is at present proved to contribute to the trouble. There is some evidence that the presence of manganese in rather large proportions is a contributory cause. It cannot be held as proved, and the fact that practically all steel rails contain considerable amounts of manganese may be the only foundation for this somewhat widespread opinion. That corrugation is due to periodic irregularity in the composition of the rail has been frequently suggested, but may be definitively dismissed. Analysis fails to detect the slightest difference between the composition of the ridges and valleys on the rails.

The materials and methods used to support the rails are shown by Indian experience to have the greatest influence upon corrugation. Burnt clay or "brick" ballast and corrugation appear to go together. Mr. MOYLE gives us some of "the principal ascertained facts." "Roarers almost invariably develop where the track is packed and boxed with brick or burnt clay ballast, and on open girder bridges." "Roarers are scarcely ever found where the ballast is stone, and never where the track is packed and boxed with earth." "Roarers on brick-ballasted road can be got smooth if the brick boxing is removed and replaced by earth. The trains then wear the rails smooth. It is not necessary to remove the brick-ballast packing under the sleepers." We may add to these facts the following: Corrugation is more pronounced and troublesome on English tramways than on American. The New York elevated lines, since electrification, have developed corrugations to a serious extent. Now English tramway track is of a much more rigid character than railway track, and more rigid than most American tramways, which are mostly sleeper tracks without concrete, and without sett paving alongside the rails. The elevated railway, however, has the rails continuously supported in a more rigid way than an ordinary sleeper track. It will be noticed how this coincides with the Indian experiences on open girder bridges.

The total effect of all the evidence now available may be summed up thus: Rail corrugation is primarily due to vibration or chattering set up by the wheels and axles of the vehicles in various ways. The physical qualities of the rail contribute to the effect if they are such that, firstly, the rail by its resilience and hardness maintains or reinforces the vibrations of the wheels; and secondly, by its ductility or malleability permits the drag of the wheels to produce a surface flow. The character of the rail support contributes to the effect if it is so rigid or has such a large frictional hold upon the rail that the latter is unable to deaden and absorb the wheel vibrations by yielding over a considerable length.

Dealing with these points shortly, it is evidently desirable to analyse the vibratory effects set up in the rolling stock with a view to seeing which of them are the most potent and how they may be reduced or eliminated. Mr. ARNALL and Mr. PANTON have dealt with some of these effects. We would add that incipient skidding by brakes is probably the most general, and this is perhaps the one point in which tramway experience and Indian railway records and opinions emphatically confirm each other. Again, quoting Mr. MOYLE:—"It develops most rapidly where brakes are freely used; for instance, just inside and outside station signals; but it is not necessarily produced by brake action. . . ." Of our own knowledge observation on certain London tramways shows almost perfect coincidence between corrugations and stopping places, a coincidence strengthened by consideration of the probable severity of brake application in each case. There are other probable causes of wheel vibration, which will occur to anyone who studies the literature of the subject. It is desirable that their character and relative importance should be determined. It seems idle to hope that all such effects can be suppressed in any sort of rolling stock, but it is well known that short period vibrations, rattling and chattering are highly destructive and should be eliminated wherever practicable.

As regards the rails, it must be admitted that the hard steel rail is a necessity for street tramways. It seems desirable to find out what chemical composition, or what heat and mechanical treatment in manufacture will give the best combination of hardness to resist attrition, toughness to prevent breakage, and lack of malleability to resist surface extensions by wheel drag. There is a general impression that the manganese which is usually introduced to toughen high carbon steel rails produces susceptibility to "cold rolling." We do not think this definitely proved, but we have some reason to believe that tramway rails from certain Continental works, containing high carbon with relatively low manganese, but high silicon contents, remain free from corrugations under conditions which generally produce them with rails of more usual composition. It may be, however, that heat treatment, or the conditions of rolling rather than chemical composition, account for the different results. We have above alluded to the absence of any chemical difference between the ridges and valleys of corrugated rails. There are, however, great differences in hardness. The ridges can hardly be touched by a file, the valleys file easily. There are also differences in the micro-structure. Subject to further investigation, these differences are more likely to be effects of the corrugating process than causes.

The character of the track sub-structure has an influence in the matter of the most important kind. Whether the Indian brick ballast packs into a hard mass offering great resistance to the flexure of the rail does not appear from Mr. MOYLE's article. It seems probable from the known qualities of burnt clay ballast as made in this country. However that may be, it is clear that street tramways here must have a rigid road-bed, and that with concrete below and tightly-packed paving setts on either side the rail is practically held in a vice upon an anvil, and has no chance, nor can it be permitted to damp out the wheel vibrations by flexure. The rigid track has to be accepted for street tramways at any rate, and it is noteworthy that the tendency of railway engineers is towards more rigid permanent way. There is, however, one point about the Indian facts that seems worthy of consideration in this connection. The general opinion of the engineers is that the bad effect of brick ballast is due to its absorption and retention of moisture, producing a damp atmosphere about the rails, with consequent corrosion. Mr. MOYLE puts down as another of "the principal ascertained facts" that corrugation "appears to be found more generally in extremely damp climates, especially when the atmosphere contains salt brought from the sea; but it is found in a variety of climates, and even in exceptionally dry inland tracts." There are some tramway opinions on record suggesting that dampness of soil accentuates or predisposes to corrugation. It is possible that this is true, but we cannot see how corrosion from damp surroundings can initiate corrugation or assist its development, excepting possibly by the high hard ridges being less easily rusted than the softer metal of the valleys. The investigations now necessary appear to be connected with wheel vibrations and physical qualities of the rails.

The importance of the matter is very great, and affects all tramway undertakers in this country and wherever else rigid track is imposed upon them. The most economical and satisfactory mode of investigation would be by co-operation between those directly interested, and we trust that the forthcoming meeting of the International Union of Tramways and Light Railways at Milan, where Papers on the subject will be read, will be utilised to bring about such a co-operative investigation.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

(*Continued from page 290.*)

CONNECTING WIRES FOR SHOT-FIRING CIRCUITS.

Conductors for shot-firing circuits are composed of single wires, or of a number of wires twisted together to form a small cable. The latter type have the advantage of greater flexibility and consequent lessened liability to rupture in the necessarily frequent coiling and uncoiling of the firing line. A stranded cable will also withstand blows from pieces of coal or rock and other rough treatment much better than a solid wire, and is in every respect decidedly to be preferred for all blasting circuits.

Guttapercha or vulcanised rubber insulation is most suitable in wet places, or wherever a highly-insulated cable may be necessary. No. 5 (Table, p. 341) is a high-class cable, suitable for high tension blasting, but not so well adapted to rough treatment as No. 4. No. 7 will be recognised as a class generally used for electric lighting. A cable of this kind, though heavier than those more commonly used, possesses greater wearing capabilities, and it is not so liable to short-circuit as a twin wire enclosed in a single outer covering.

No. 8 is a pattern extensively used for shot firing in mines. No. 9 is a concentric cable the conductors in which are composed of very fine wires. This renders the cable exceptionally flexible and well adapted for working off a small reel or drum.

No. 10 is a class of wire sometimes used for shot-firing cables but it is not economical, although it is cheap.

TESTING.

The facility with which the condition of the several parts of an electric blasting circuit can be ascertained at any time up to the moment of firing constitutes one of the special advantages of this method of blasting, as against ignition by slow fuse or friction igniters. The several parts which go to make up a blasting circuit have, however, now reached such a high state of practical efficiency that it is only during the development of important and large-scale blasting operations that preliminary testing becomes either necessary or desirable. In the routine practice of shot firing in a coal mine more time would be wasted in testing fuses and circuits than is required to fire several shots. In mines where exceptional precautions for the prevention of explosions are considered to be necessary—as, for example, in South Wales—special arrangements are made to secure that fuses and shot-firing apparatus shall be tested before going down the mine. Some people have a fancy for testing, and seem to think that a test is equivalent to the removal of a risk.

Testing fuses at the mine is, in fact, a "fad." They are tested before delivery; some, indeed, are guaranteed to be double tested, and since it is not a matter of very serious import that one fuse out of several thousand should fail to "go off," there is no earthly, or even subterranean, reason why they should be tested over again.

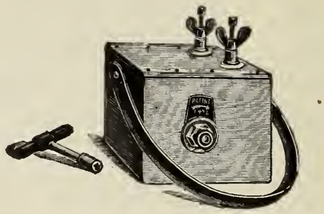

FIG. 15.—DYNAMO EXPLODER WITH AUTOMATIC FIRING CONTACTS.

The notes here given on testing are rather designed to indicate some of the causes of failure, and are for the most part applicable to quarrying operations or wherever a series of shots have to be fired simultaneously.

1. *Exploders.*—Mechanically-operated exploders are on the whole well made and reliable. The newest patterns, such as that recently introduced by the Explosives & Chemical Products (Ltd.), and shown in Fig. 15 are models of good design and good workmanship. The troubles that may from time to time occur are usually trivial and such as can be seen on casual examination. Displaced or worn-out brushes (in the case of dynamo exploders), loosened terminals, oxidised contacts, and similar ruptures, complete or partial, in the electrical circuit are the principal causes of failure. Magneto-exploders may fail through loss of magnetism or breakdown of insulation in the armature coils. The latter may arise through imperfect design, or it may result from storage of the exploder in a damp place.

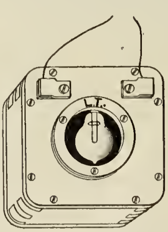

FIG. 16.—EXPLODER TESTER.

Messrs. John Davis & Son have introduced a simple form of exploder tester, which fulfils all the requirements of an instrument intended to be used by workmen. Fig. 16 almost conveys in itself sufficient information to indicate the manner of its application. It consists of a special incandescent lamp, carried in a suitable lampholder, and enclosed in a small case which has on one side a stout glass disc about 2 in. diameter, mounted in a bezil. Wires from the lamp are connected respectively with

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Shot Firing Wires.

No.	I.	II.	III.						IV.	V.	VI.	VII.
	S.W.G.	Specification.	Diameters.						Resist'nce per double yd.	Weight per double yd.	Length per lb.	Length per kg.
			Wires.		Strand.		Finished.					
			Inch.	Mm.	Inch.	Mm.	Inch.	Mm.	Ohms.	lbs.	Yards.	Metres
1	3/22	Three-strand conductor, covered with guttapercha to No. 8 S.W.G., longitudinal warps, strong braid, then drawn through preservative composition	0·028	0·711	0·059	1·500	0·240	6·1	0·2650	0·156	6·41	12·9
2	4/25	Flat twin conductor, each covered with guttapercha to No. 12. S.W.G., laid together, taped and braided over all, and served with preservative composition	0·020	0·508	0 045	1·143	0·310 by 0·200	7·8 by 5·0	0·0390	0·065	15·38	31·0
3	3/22	Three-strand tinned conductor, covered with pure and vulcanising rubber and proof-tape, all thoroughly vulcanised together, braided and served with preservative compound, and then armoured with galvanised wire braiding	0·028	0·711	0·056	1·422	0·192	4·8	0·0265	0·354	2·82	5·7
4	4/25	Four-strand twin circular conductor, each insulated as in specification (3), the two laid together, wormed, braided and covered with preservative compound	0·020	0·508	0·045	1·143	0·260	6·6	0·0390	0·110	9·09	18·3
5	4/25	As in specification (4), but outer covering consisting of plain cotton braid, without preservative compound	0·020	0·508	0 045	1·143	0·265	6·7	0 0390	0·092	10·87	21·9
6	4/25	Four-strand flat twin conductor, insulated as in specification (4), then laid together, braided and compounded black	0·020	0·508	0·045	1·143	0·265 by 0·175	6·7 by 4·4	0 0390	0·090	11·11	22·4
7	3/22	Two three-strand tinned copper conductors, each double-cotton covered and served, then covered with one layer of pure indiarubber, one of proofed tape, braiding and preservative compound, and afterwards twisted together	0·028	0·711	0·056	1·422	0·330	8·3	0·0265	0·092	10·87	21·9
8	3/22	Three-strand plain copper twin conductor, double cotton-covered, one layer of pure indiarubber, braided, the two laid together, braided over all, and served with preservative compound	0·028	0·711	0·056	1·422	0·283 by 0·146	7·1 by 3·7	0·0265	0·082	12·19	24·5
9	7/29	Seven-strand plain copper concentric conductor, insulated with pure indiarubber and proofed tapes, braided over all, and served with ozokerite	0·013	0·033	0·013 to each conductor	0·033	0·290	7·3	0·0480	0·085	11·76	23·7
10	1/22	Single-strand plain copper twin conductor, each wire double-cotton covered and paraffined, the two then laid together, braided over all, and paraffined	0·028	0·711	0·028	0·711	0·185 by 0·110	4·7 by 2·8	0·0794	0 030	33·33	67·2

two brass-plate terminals arranged to make wedge-contact with a pair of wires from the exploder that is to be tested. To make a test, the exploder wires are wedged on the indicator terminals, the firing key is pressed and the handle rotated at normal speed. Satisfactory working condition is shown by incandescence of the lamp, as seen through the disc in front of the instrument. These testers may be used to ascertain the strength of either continuous or alternating current, high-tension or low-tension generators; but, it need be scarcely observed, the same instrument is not applicable to every machine. To ensure reliability, the makers should be advised as to the kind of exploder with which it is intended to be used.

A little device identical in principle with that already detailed has been devised by Mr. H. Bonser for the purpose of testing accumulator cells. It consists of a minute incandescent lamp enclosed in a glass tube having a metal cap over each end. A conducting wire from the lamp is attached to each brass tube, so that by merely placing these on the respective positive and negative terminals of a shot firing cell the current capacity is indicated by more or less brilliant illumination of the bulb. A better method of testing accumulators or dry-cell exploders would obviously be to use an accurately calibrated low-reading voltmeter.

2. *Fuse Testing.*—It is generally considered that the principal, if not indeed the only, advantage possessed by low-tension over high-tension fuses is that the former may be tested for continuity before firing. It is doubtful, however, whether the supposed advantage is of so much importance as is frequently assumed. On the average there is probably not more than one defective fuse per thousand issued, and it may well be that the defect in that cannot be ascertained by testing. That a continuity test is not necessarily evidence that a fuse answering to it will fire may be seen by reference to Fig. 17, which has been drawn from an actual fuse.

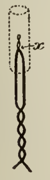

Fig. 17. Diagram showing Low-tension Fuse with Short-circuited Bridge at Point *x*.

Certain high-tension fuses may be as readily tested as any low-tension make, but even if it were impossible to apply any test it is not clear that any pronounced advantage remains with the metallic bridge variety. The practice of electric blasting is indeed in need of simplification. There does not appear to be sufficient reason why two kinds of exploding apparatus and two kinds of fuses should be necessary. It would lessen the cost of appliances, eliminate a good deal of futile controversy, and doubtless benefit everyone interested, both in the manufacture and uses of electric fuses, if one system were adopted and the other dropped.

Low-tension fuses are tested by passing a feeble current through them and observing the deflection of a galvanometer needle which is connected in the circuit. It should be remembered that any primary cell in good order will explode a fuse. Consequently, the battery used for testing must either be run down, or a resistance must be inserted in the testing circuit. A simple method of testing fuses without a galvanometer is to join each one (or a group if preferred) in series with a single Leclanché cell and a long-distance electric bell, or a telephone receiver. A magneto telephone (bell circuit) is often used as a substitute for a high-tension exploder, and it is, therefore, scarcely necessary to observe that such an instrument should not be used for testing.

If the fuses to be tested are capped, that is to say, if they are detonator fuses, every possible precaution is necessary. A detonator fuse should never under any circumstances be tested for continuity unless it is enclosed within a metallic pipe or vessel or otherwise so arranged that in the event of an explosion it cannot possibly cause any injury.

3. *Complete Circuit-testing.*—Some exploders carry a self-contained tester, adapted for testing the continuity of a blasting-circuit in situ. The action of the testing device depends in this, as in all fuse-testers, on the fact that an electric current of definite intensity is required to fire a fuse, and therefore a current of less strength but yet sufficiently powerful to act on a suitable indicator may be passed through it without destroying the bridge. To test a fuse, or a complete firing-circuit, the current generated by the exploder is, therefore, reduced below the heating-point of the fuse bridge by passage through along fine wire, wound upon a bobbin and termed a resistance coil. The disposition of [illegible]e

coil and the indicator is shown diagrammatically in Figs. 18 and 19, the former being a side elevation and the latter a plan-diagram of the Smith machine. It has not been thought necessary to indicate in these figures details of the exploder proper, since these have been fully described in the text referring to Fig. 8 (*The Electrician* of June 1, p. 255); only such points as are essential to an explanation of the tester are therefore shown. The electro-magnet, J, consists of cores wound with insulated wire in such a manner as to show opposite polarity on the passage of a current. The polar extremities of the magnet are concaved to receive a rotary armature, which is rotated by the depression of the handle, G, attached to a rack-bar, I; the handle being allowed to rise without turning the armature by a suitable arrangement of clutch-gear.

A fuse or firing circuit is tested by placing the lever switch in the position shown in Fig. 19 and joining the terminal wires to the binding posts T^1, T^2. On actuating the rack bar an electric current passes from one pole of the field magnet through wire *a* to T^1; thence through the fuse or firing circuit to T^2. From T^2 the current goes by the wire *e* through the resistance coil D, and wire *d*, *c*, to the other pole of the magnet, thereby completing the circuit. The interposition of a properly proportioned resistance coil in this manner permits the passage of a current through the fuse, but not sufficient to bring about its ignition.

The indicating movement consists of an armature, S, which is pivoted to the end of the bracket R in front of the coil D. A bent-wire pointer, U, is attached to the armature near the pivot. The weight of the pointer tends to keep the armature swung away from the coil D, but on the passage of a current it is attracted and moves the wire *a*, so that the pointer U comes opposite the glass disc V in the casing A. Circuit through the fuse is thus shown to be complete. Should the outside circuit be broken there will be no movement of the indicator.

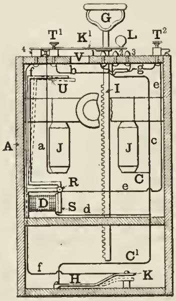

Fig. 18.—Combination Exploder and Circuit Tester.
Side Elevation.

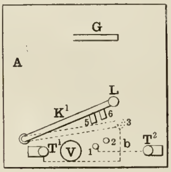

Fig. 19.—Combination Exploder and Circuit Tester.
Plan-diagram.

When it is desired to fire the fuse, the switch K^1 is turned into the position shown by the dotted lines in Fig. 19. The pins 1 and 2 are then in metallic connection through the switch bar, and the resistance coil is cut out. This exploder, with the improved circuit tester, is one of the most efficient machines of its class now in use.

(*To be continued.*)

CORRESPONDENCE.

ON THE ACTION OF RADIUM ON GELATIN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In view of the interesting remarks which have appeared recently on this subject in *The Electrician*, the following notes in reply to the criticisms which have been urged by various workers of the results of my observations on the effect of radium salts on gelatin and *bouillon* may be of some importance to record. Some of these criticisms do not appear so far to have a direct bearing, if I may say so, upon the actual points at issue. But those offered by Sir William Ramsay have certainly been most suggestive and fruitful in enabling a theory to be formed of the physical causes of the sub-division of such artificial cells, and possibly of natural cells in general. There is no doubt in my mind as to their actual sub-division owing to the nature of the cleavage.

It would take too long to describe here the details of the physical theory of segregation of cells, which I have worked out on the basis of this conception, but it may perhaps be possible to indicate in outline at least the principle upon which that theory rests—namely, that the radium salt produces minute, ultra-microscopic cellular bubbles, due to the gaseous emanation which it emits. These act as the nuclei of the larger aggregates, due no doubt, to direct chemical action on the surrounding medium, or to indirect ones brought about by the intense electromagnetic disturbances from the radium atoms, as in the case of photographic actions; and as I have tried to show in the case of fluorescent and phosphorescent bodies, too. The cellular bubble of emanation will multiply, as the emanation increases, since it will force its way through the cell-walls, at the lines of least resistance. Their mode of sub-division, however, would be different from that of the aggregates, which divide up into clean-cut segments or sections; while "emanation" cells would retain their smooth surface due to surface-tension. The cellular bubbles, however, if acting as nuclei, will force the sub-division of the larger aggregate and tear it asunder.

It seems not improbable, as I have shown elsewhere, that the sub-division of natural cells is accomplished in some similar way, although the nuclear substance is not necessarily radium. It seems probable that there is in the nucleus a substance with somewhat similar properties, but in a more or less marked degree, which enables the cell to perform this cyclic process; each portion possessing some of the original nuclear substance.

M. Dubois' observations in many ways agree with mine. He has had no difficulty in observing the effects of sub-division. Some observers, however, have failed to see any such effects, and have gone so far as to suggest that these effects, if they do occur, are due to fortuitous aggregation, not to segregation. A glance at the photographs and drawings which I have published in my book will show that the sub-division cannot be due to mere aggregation of particles.

M. Dubois' eobes and my radiobes, although differing in some respects have, at any rate, enough in common to show that such negative experiments and observations, through some cause not easily to be ascertained, are somehow not altogether to the point. Various reasons have occurred to me as to why these negative results should have been obtained.

1. It seems extremely probable that the salts used may have been in excess, so that only large colonies or aggregates would be visible. The use of $\frac{1}{2}$ in. powers by Mr. Rudge when the particles themselves are only visible with an oil-immersion confirm this view. I understand, further, that Mr. Rudge uses *solutions*, which, as will appear, render the repetition of the experiment impossible.

2. I have used throughout a Leitz's twelfth-inch oil-immersion lens. The use of smaller powers would not merely diminish the opportunities of seeing the effects owing to lack of magnification and resolving power but prevent them from being seen altogether.

3. In the next place, it may be said that whatever chemical effects are produced by radium, it may be expected that similar effects will be produced in an imitative way by barium. Though they may differ in some respects, they are sure also to resemble each other in others.

4. But further again it has been apparently inferred that since barium does produce aggregations by itself, and as it is the predominant factor in radium and barium salts, the effects produced in the latter case are merely due to barium. This is an inference for which there is no foundation whatsoever. Nay, rather, since barium and radium have similar chemical properties, should it not be expected that what barium does radium will do, too? And that the more remarkable effects are those which are due to radium, owing to its still more varied and more remarkable qualities?

5. It has been found that if all the sulphur in gelatin be removed no marked cultures are formed, and it has been inferred that the effects are due to sulphates. This inference is of the same nature as that which might be made if it were inferred that since certain, if not most, types of bacteria fail to grow in

media from which sulphur—a marked constituent of protoplasm—is not present, that therefore such cultures are merely due to sulphates! This is the argument reduced to its strictly logical form. Are bacterial cultures due to sulphates? If the premises are the same, why not the conclusion? If these bodies are crystalloids, it merely shows that sulphur enters into their composition.

6. Lastly, may I venture to point out that these bodies are soluble in warm water. Mr. Rudge, as he tells us, warms his gelatin to get a precipitate, and, further, uses *solutions* of radium salts, which would certainly dissolve the cells and act *catalytically* producing a huge precipitate. Could one in the circumstances do anything which would more obviously prevent the successful repetition of the experiment?

With M. Dubois I am in agreement; and although I do not think that he has noticed the more minute and more remarkable effects produced by radium which I have described elsewhere, he has, at any rate, seen some of the more marked effects of sub-division. There is nothing fortuitous in this sub-division any more than in the sub-divisions of natural cells, and I only rejoice to think that his testimony should have been given and his observations recorded quite independently from those which I have made. These bodies are unquestionably a unique and highly-developed form of cells, as cytologists admit. If they are organic crystalloids, as they resolve themselves into these, they are, at any rate, more remarkable than any others of that type hitherto observed. If Mr. Rudge has obtained them, which I very much doubt, owing to their solubility, he has, I think—and Mr. Zingler has emphasised this in your columns—only shown that sulphur enters into their composition. But perhaps more than that, that like many other cells and organic crystalloids they do assimilate some of the constituents of their surroundings.—Yours, &c.,

Cambridge, June 11. JOHN BUTLER BURKE.

THE FROSTING OF LAMP GLOBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am much interested in the article on the above subject which appeared in your last issue and in your editorial note thereon. May I point out two things in connection with the experiments? In the first place I would like to emphasise the result found by Messrs. Cravath and Lansingh that acid frosting produced an absorption of only 9 per cent. of the mean spherical candle-power. The tests seem fairly conclusive as they are the result of determinations of 10 lamps the *same* lamps being used before and after frosting. It is noteworthy also that the tests on the holophane globes show an absorption of only 16·5 per cent. when calculated on the mean spherical candle-power, whereas if calculated on the mean horizontal candle-power the absorption is approximately 30 per cent. I drew attention a short time ago in your columns* to some experiments I had made, which tended to show that the figures generally given for globe absorption were too high, and I am glad to see experiments confirming this view. How generally the opposite opinion is held is shown by the recent Paper by Mr. Andrews, in which he states that 'opalescent globes absorb about 40 per cent. of the light.

Secondly, I should like to refer to the effect of the frosted globe on the useful life. You say in your note that no hint is given of the cause of this. Is not such a hint to be found in the fact that the lamps were not cleaned in any way during the experiments, combined with the statement made on the authority of Messrs. Legge & Townsend that merely wiping a clear lamp and shade can result in an increase of light of nearly 30 per cent.? It seems to me probable that the smaller surface of the frosted bulb, the fact that it was probably much hotter than the holophane globes, and the fact that its rough surface soon gets dirty and discoloured account for the difference in life. I should like to see a repetition of the experiments with careful cleaning of the lamps and globes before each photometry, for, after all, the lamp manufacturer is expected to supply the public with good lamps, but not with good housemaids.—Yours, &c.,

Carbon Works, Witton, Birmingham. MAURICE SOLOMON.

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* See *The Electrician*, Vol. LVI., p. 91.

WIRELESS TELEGRAPHY.

We understand that the following circular is being issued by Col. Sir H. M. Hozier, K.C.B., the secretary to Lloyds:—

When wireless telegraphy became practical, its possibilities as a source of intelligence and a means of communicating between ship and shore and ship and ship were recognised. The Corporation of Lloyds took steps to follow its development and utilise its capabilities. With a view of dimishing the disadvantages that might ensue from the inteference of various systems of wireless telegrapby with one another, Lloyds suspended experiments which were being conducted with its own system, and concluded an agreement in 1901 with the Marconi International Marine Communication Co. By its terms all maritime intelligence received at stations equipped with the Marconi system was to be the property of Lloyds, and Lloyds was to be at liberty to instal the system at stations which Lloyds might wish to equip for the purpose of communicating with outlying signal stations or with vessels equipped with wireless telegraphy.

The Admiralty and the Post Office were kept advised of all arrangements made by Lloyds with regard to wireless telegraphy.

The Post Office agreed to grant Lloyds licences for wireless telegraphic stations, and the Admiralty agreed to take over the working by the Coastguard of wireless telegraphy, in the same way as flag signalling, for the sake of the stragetic defence of the country, at certain stations, and at such other Lloyd's stations as the Admiralty might select.

Lloyds became aware that agreements between these Government departments and the Marconi Companies were under discussion, but it was not anticipated that anything affecting Lloyds would be dealt with in these agreements without reference to Lloyds.

On the faith of the licences promised to Lloyds by the Postmaster-General, Lloyds took no measures to promote opposition to the passing of the Wireless Telegraphy Act in 1904. Lloyds was then in complete ignorance of the arrangements between the Postmaster-General and the Marconi Companies concluded a few days before the passing of that Act. The Post Office led Lloyds to believe that Lloyds was to be treated exactly on the same footing as the Marconi Companies. Lloyds has as yet obtained no licences, and has, till within the last few weeks, been kept in ignorance that the Post Office had entered into a secret agreement with the Marconi Companies in August, 1904, which rendered licences for those companies practically unnecessary. This agreement was not disclosed until it was moved for in the House of Commons by the Hon. Claude Hay, M.P., and was only published by order of the House on April 11, 1906.

The Postmaster-General proposed on May 17, 1906, to grant to Lloyd's licences for wireless telegraphy under the Wireless Telegraph Act of 1904, but the Postmaster-General, under the agreement with the Marconi Companies, which only accidentally became known to Lloyds through the publication of the Parliamentary paper, has promised licences to those companies for eight years from 1904, or for six years more than the Post Office has power to grant licences under the Act of 1904, or for three years beyond the period of the present Bill, as amended in the House of Lords, to extend the Wireless Telegraph Act of 1904, while the licences proposed to Lloyds are only suggested to endure till the latter part of July 1906. Yet Lloyds was promised by the Department of the Postmaster-General the same identical treatment as might be accorded to the Marconi Companies.

Under the Telegraph Acts existing before 1904, the Post Office could have made it a condition, when the Marconi Companies established wireless stations in the United Kingdom, that those companies should have no claim for compensation in the event of these stations passing under the control of the Government, but the Post Office apparently neglected to take this precaution. When the Wireless Telegraph Act of 1904 was passed, the Department apparently made the arrangement alluded to above with the Marconi Companies in order to be absolved from paying compensation to those companies at some future time. It appears that, in order to avoid the possibility of having to pay compensation to the Marconi Companies, a necessity which need never have arisen if the Department of the Postmaster-General had taken precautionary measures on the establishment of wireless stations, the interests of Lloyds and of the whole shipping and mercantile community of the world are to be sacrificed, and Lloyds and the mercantile and shipping community placed at the mercy of the Marconi Companies.

It is now discovered from the secret agreement and the draft licences suggested to Lloyds by the Postmaster-General that only one station can be established at any one point, and thus as the Marconi Company is to be licensed for eight years from 1904, and Lloyds only for a few weeks, till July 1906, it will be impossible for Lloyds to maintain stations at any points of importance on the coast, for the draft licence suggested to Lloyds contains the following:—

"Only one installation, whether established by the licensees (Lloyds) or by the Marconi Company, shall be established at any one of the stations specified in the second and third schedules hereto."

The Marconi Companies have already declined to equip one Lloyds' signal station, as they where bound by their agreement to do, alleging as a reason that Lloyds has no licence, and have installed a new station of their own close to Lloyds' station, thereby preventing Lloyds' station being equipped. The Postmaster-General has placed it in the power of the Marconi companies to adopt the same course with every other station Lloyds may wish to instal round the coasts of the United Kingdom.

The action of the Post Office will render Lloyds incapable of competing with the Marconi Company, and under the conditions proposed by the Government may thus preclude Lloyds from establishing wireless telegraphy at any of Lloyds' signal stations in the United Kingdom.

In the licences promised to the Marconi Companies and in the Wireless Telegraph Act, which the Government now seeks to extend, no provision apparently has been made as to the cost of wireless messages transmitted by the Marconi Companies. Thus Lloyds and the whole shipping and mercantile community, who depend upon Lloyds for their intelligence, are at the complete mercy of the Marconi Companies as to any toll they may be pleased to levy for sea telegraphic messages.

By a clause in the draft licence offered to Lloyd's the operators at stations within the Empire must, very rightly, in the opinion of my committee, be British subjects. Presumably a similar clause has been or will be inserted in the licence of the Marconi Companies. There seems very little advantage, however, in insisting that operators must be British subjects when the majority of the directors of the company controlling the operators are aliens, since these directors must have full control over all the intelligence transmitted by their operators whether British or otherwise.

The practical result of the action of the Post Office, as far as can be foreseen by the committee at Lloyds, will be to give an absolute and uncontrolled monopoly of wireless telegraphy in the United Kingdom to the Marconi companies, and to sacrifice the whole of the interests of Lloyds and of the shipping and mercantile community to secure dividends for those companies.

The committee of Lloyds, therefore, most earnestly and urgently trust that the bill which is now before the House of Lords for the extension of the Wireless Telegraphy Act may be rejected.

Mr. H. Cuthbert Hall, managing director of Marconi's Wireless Telegraph Co., has sent us the following communication :—

In 1901 Lloyd's entered into a contract with our company, which contains the following recital :—

"And whereas Lloyd's is of opinion that it is desirable that one system of wireless telegraphy should be in general use. And whereas the Marconi system is in such general use, and has been proved to the satisfaction of Lloyd's to be a good working system."

At that time there was no Government restriction on the erection of wireless telegraph stations. Consistently with the view expressed in the recital, Lloyds contracted not to use at or in connection with any of its stations for 14 years any system of wireless telegraphy except the Marconi, and protected its interests by securing the exclusive right in the United Kingdom to use the Marconi system both at Lloyd's own stations and at the company's stations for reports of ships and maritime intelligence.

The contract provided for a payment of £20 per annum by Lloyds to the company in respect of each Lloyds station equipped, and no charge at all was made by the company to Lloyds for maritime intelligence obtained through the Marconi Company's stations. At that time the Marconi Company had a considerable organisation of coast stations for ship-to-shore communication, which presumably Lloyds regarded as substantially adequate for their purposes, for during the three years between 1901, when Lloyds made the contract, and 1904 when the Wireless Telegraphy Act was passed, Lloyds equipped only three of their own stations, two of the installations being on islands a short distance from the coast and used primarily for purposes other than reports of ships."

Lloyds whole case against the bill, therefore, falls to the ground. They urge that it confers a monopoly on the Marconi Company, and they have expressly stated their view that there ought to be one system in general use. They say that the Marconi Company is, by the monopoly conferred upon it, placed in a position to exact onerous terms for reports of ships, and the Lloyds contract, which is for 14 years, provides that Lloyds get maritime intelligence through their own stations for £20 per station per annum, and through the Marconi Company's stations for nothing. They infer that the Marconi Company may compete with Lloyds in respect of reports of ships, and Lloyds have exclusive rights in maritime intelligence.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL

(Continued from page 263.)

Tuesday, June 12.

The Hybrid Committee of the House of Commons, of which Mr. Luke White is chairman, resumed its consideration of the London County Council (Electric Power) Bill on Tuesday. The case for the North Metropolitan Electric Power Supply Co., which was opened at the last sitting on May 29 (*The Electrician*, June 1), was continued.

Mr. BALFOUR BROWNE, K.C., without calling further evidence, addressed the Committee. He said his company was a purely bulk supply one, and it objected to competition at the hands of the L.C.C. From the very commencement of these proceedings, he said, no case had been made out by the Council for taking a portion of the area of the North Metropolitan Power Co., and neither in Mr. Freeman's opening speech nor in the cross-examination of the various witnesses had any reason been assigned except that some area must be defined. It was a very serious thing to ask a Committee to sanction a bill which empowered a county council to trade outside its area against the wishes of a very considerable number of the local authorities concerned. As to the bill as a whole he had nothing to say so far as it did not affect his area, but at the same time it was evident that the scheme was not calculated to supply the portion of the area of his company scheduled in the bill, because all this was beyond the limit of economical supply as laid down by Mr. Rider viz., 6 miles from either Battersea or Greenwich. No evidence from any of the districts of the North Metropolitan Co.'s area had been called to complain of the company, except from Wood Green, but the witness in that case spoke as an individual, and not on behalf of his Council. He therefore asked that the portion of his company's area included by the L.C.C. should be struck out.

The case for the Electric Lighting Companies of London was then taken. There are 14 companies joined in one opposition.

Mr. JOHN CONACHER, general manager of the Metropolitan Electric Supply Co., was called and explained the general conditions applying to the 14 electric lighting companies of London represented in the petition. He said the total capital authorised was £18,550,013; the total capital paid up was £12,622,663, and the balance unissued £5,927,350. He pointed out that the Charing Cross Co. had power to supply in bulk in West Ham, Poplar, part of Stepney and in Bethnal Green; the County of London Co. had power to supply in bulk to canals, railways, tramways, &c., the Metropolitan Electric Supply Co. was authorised to supply in bulk to Hampstead, Fulham, Marylebone, and in parts of West Middlesex, and the South Metropolitan Electric Light & Power Co. had power to supply in bulk to adjoining undertakers, tramways and certain railways. Mr. Conacher then explained the statutory obligations put upon the electric lighting companies of London which work, for the most part, under provisional orders, such as the revision of prices and many other matters which were placed under the control of the L.C.C. Reference was also made to the compulsory purchase clause of the Electric Lighting Act of 1888, the prohibition against the association of one company with another, &c. All these matters were fully gone into last year. In only one case had an application been made to the B.O.T. for a revision of prices, and in that case the B.O.T. decided that no case had been made out. Mr. Conacher handed in a table showing that whereas the average price charged by the electric lighting companies in London in 1893 was 6·22d. per unit, it was now 3·24d. per unit. Similarly, the units sold in 1893 were 10,232,958 and in 1906 119,546,734, whilst the revenue had increased from £265,259 to £1,615,259. On the question of dividends, the average return on the capital last year was, he said, £5. 8s. 7d. per cent., and in addition something had been set aside for depreciation. Every possible effort had been made to popularise the use of electricity by the distribution of literature, the holding of exhibitions and the appointment of canvassing staffs, and he failed to see what more could be done. The greatest difficulty had been experienced in inducing power users to take out their steam plant and substitute electric driving. He compared the London electric supply authorities to all the provincial towns where the supply for all purposes is given under provisional orders. In none of these, he said, did a power company or authority operate. The solution of the problem in London was to remove the legal disabilities under which the supply authorities now laboured so as to allow each of them to give mutual assistance and to link up the existing stations.

Mr. RUTHERFORD: Do you mean to say that by linking up the existing stations you will be able to meet all the requirements of London?

Mr. BALFOUR BROWNE: That is what I am going to try and prove, and my next witness, Sir Alexander Kennedy, will go into that matter more fully.

Mr. RUTHERFORD: I don't think you will get anyone to believe you.

Mr. BALFOUR BROWNE: Very likely not. That is a secondary matter, and rests with you. But that is what we will try to prove.

Mr. CONACHER was cross-examined by Mr. FREEMAN on behalf of the L.C.C. He said that no actual scheme had been prepared for linking up the existing works, but the details had been worked out, and if the clause in the Electricity Supply Bill which sanctioned linking up were to be passed, then it would be gone on with at once. The companies had petitioned the B.O.T. to this effect, and the answer had been that the B.O.T. was considering the desirability of introducing the Electricity Supply Bill into Parliament this session. Asked as to the West End Electric Undertakers Bill, Mr. Conacher said that this did not commend itself to him, and the Metropolitan Electric Supply Co.'s name had been included without its consent.

In answer to the Committee, Mr. CONACHER said the first effect of linking up both companies and local authorities would be to set free a further 25,000 kw. of plant, whilst, in addition, the existing buildings and land were capable of accommodating plant many times the capacity of the existing machines.

Mr. RUTHERFORD said that this considerably altered the view he had expressed a short while previously. He had been under the impression that it was not intended to enlarge the existing plant capacity.

Sir ALEXANDER KENNEDY, F.R.S., engineer to the Westminster Electric Supply Corpn. and the Central Electric Supply Co., said that the capacity of the present stations of the 14 companies was 56,000 kw., in addition to 45,000 kw. spares. By a system of linking up, 25,000 kw. of these spares would be set free, whilst the existing buildings were capable of holding a further 60,000 kw., which would have an overload capacity of 20,000 kw. The existing lands also were capable of holding buildings for 520,000 kw. Details were being entered into, but

The CHAIRMAN said that this was really an imaginary scheme, for which no Parliamentary sanction has been received, and it was hardly necessary to go into detail.

Sir ALEXANDER KENNEDY said the point of his scheme was that the same amount of plant as that proposed by the L.C.C. scheme—viz., 60,000 kw.—could be provided in the present stations at a much less capital expenditure than was estimated in the London County Council bill, inasmuch as the land had already been bought and some buildings erected and paid for.

The CHAIRMAN asked if any agreement had been come to by the companies to make a combination such as that now proposed.

Mr. BALFOUR BROWNE said that if the Committee were to report under the terms of its reference that the best means of supplying London with electricity was by means of linking up, that report would be acted upon in the next session of Parliament, so far as the companies were concerned

The CHAIRMAN asked Sir Alexander Kennedy whether he thought that the existing companies, as they were at present constituted, could meet the requirements of London adequately.

Sir ALEXANDER KENNEDY said he was of the opinion that they could so far as their own areas were concerned, but that with the removal of the legal disabilities under which they now laboured the whole of London could be provided for on terms equal to those proposed in the County Council Bill, with much less capital expenditure.

Mr. RUTHERFORD said it was quite clear that the existing supply companies could not supply railways.

Mr. TALBOT, who is appearing with Mr. Balfour Browne for the electric lighting companies, said his clients did not take that view. In fact, one of the London companies had contracted to supply one of the London suburban railways and were willing to take the risk of acting illegally.

Wednesday, June 13.

Sir ALEXANDER KENNEDY, continuing his evidence, said that in the present state of engineering knowledge it would be extremely inopportune to start upon an entirely new scheme of such a nature as proposed either by the L.C.C. or the Administrative County of London Co. Many questions remained to be settled before any definite scheme should be embarked upon. A most important problem still unsettled was that of railway working; it was quite certain that railway companies would not adopt three-phase working, and whoever undertook this work would probably be compelled to put down special plant. The possibilities of the use of gas rendered riverside sites comparatively unimportant, whilst the extra high-tension direct-current series system, which involved very much reduced cost in mains, was attracting considerable attention. All these things, and there were probably others, tended to prevent standardisation so far as a large undertaking now put down was concerned. That there were rapid developments now going on was well shown by the difference between the Administrative scheme of last year and that of this year, both as regards the size of the units and the probability of using gas. He considered that standardisation would be more assisted by helping the existing companies to expand their businesses in the ordinary course.

Cross-examined by Mr. FREEMAN: With regard to the linking-up scheme, he said that, although it was naturally thought probable that many of the existing uneconomical stations would be closed down so far as generation was concerned, the actual stations so to be abandoned had not been decided upon. The chief stations which would be used in this linking-up scheme were Willesden, Grove-road, Wood-lane, Bow, Bankside, Blackwall Point, Greenwich and Wandsworth. A long cross-examination ensued, having for its object the proving of the fact that the same difficulties as to transformation of the supply to the other companies, under this linking-up scheme, would exist as under the L.C.C. scheme, the periodicities and voltages being so different. He thought, however, that the balance of the advantage lay with the linking-up scheme, because the frequencies of the eight main stations were 50 and 60, which were also adopted by two-thirds of the companies, whereas the County Council frequency was 25.

Mr. J. S. HIGHFIELD, chief engineer to the Metropolitan Electric Supply Co., dealing with the question of frequency, said he regarded 25 cycles as totally unsuitable for the general supply in London. It could certainly be used for motors in works, but this was a class of business which he understood the L.C.C. was not to take. The subcommittee of the Engineering Standards committee which dealt with the matter had recommended 50 periodicity, and the only reason for the L.C.C. adopting 25 cycles was the fact that the tramway station at Greenwich was on this system. He put the disadvantages of using 25 cycles throughout London as (1) the greater part of the supply in London was at 50 periodicity. (2) 50 cycles alternating current could be much more cheaply converted to direct current, through static transformers, than the 25 cycles current which would have to be converted by motor converters. (3) The difficulties of parallel running the motor generators with the steam plant. On this latter point he stated that it had been tried by his company and had had to be abandoned. Machines that could be relied upon in this respect at certain frequencies did not exist. The great future promised by gas engines he thought should preclude any attempt to standardise the method of generation, as would be the case if either of the power bills for London were passed. In fact, he regarded the gas engine as the motive power of the future, but a great deal of experimental work remained to be done which, he contended, could not be carried out by a municipality. Such work must be left to the companies. Another point against the L.C.C. scheme was that, in his opinion, the bulk supplier should also be the distributor. Another system which was attracting great attention was the high-tension direct-current system, which had been adopted in Switzerland for a 110 miles transmission, under which the voltage could be increased to 120,000 volts, and he showed a specimen of a cable for such a pressure. This pressure, however, had not been reached in practice, but it showed the possibility of being able to go at least 110 miles from London in the future if necessary. He did not suggest that he would put down such a system, but he mentioned it to indicate the progress that was being made in electrical generation.

Cross-examined: The 50 cycles was recommended by the Standards Committee as being the best for general supply, with 25 cycles for special cases, such as tramways. But he disagreed with the view that there were great economical advantages in generation at 25 cycles.

Mr. C. P. SPARKS, chief engineer to the County of London Electric Supply Co., was the next witness. His objections to the London County Council Bill were that the scheme was tied up to the tramway scheme, and that this being so the power supply scheme could not in the nature of things be to the best advantage of London. Had the tramway scheme not existed a much higher voltage would have been adopted and the stations erected outside the metropolis. By the system as now arranged, and with the cables estimated for, only 6,000 kw. could be delivered at each of the sub-stations without reopening the streets to lay further cables. With higher pressure this state of affairs would not have existed. The most important point, to his mind, was that the bulk supply authority should also have control over the distribution, and he emphasised this. In London there were, practically speaking, no large power users, for the average horse-power of the power consumers on the mains of the City Co., the Charing Cross Co., and the County of London Co., was only 7½, and on the County of London mains alone, which company had one-third of the power in its district, it was only 5½ H.P. The difficulty of securing custom for power purposes against the competition of gas, &c., was shown by an instance in which he had quoted 0·4d. for a 700 H.P. consumer with a load factor of 66 per cent., and yet failed for this reason. He considered now that the proposal to connect up the companies, as proposed, would be more beneficial to them than the agreements entered into with the Administrative County of London Co. last year.

The CHAIRMAN here intimated that on Tuesday next week independent experts would be heard.

Mr. BALFOUR BROWNE then addressed the Committee on behalf of the combined companies. He considered the argument that this scheme merely provided for a permissive supply was hardly correct, because if it merely meant that the London County Council was to wait for the supply authorities in London to ask for a bulk supply, he was convinced that not one of them would avail themselves of it and the scheme would inevitably be a dead failure. Parliament would never allow two millions of money to lie fallow, and consequently the L.C.C. would then practically force fresh terms from Parliament which would operate to the serious disadvantage of the existing authorities. He contended that the basis of the whole scheme was wrong. Last year the L.C.C. felt the disadvantage, when opposing the Administrative Co., of being told that they had no scheme. As a result they had pitchforked Mr. Hammond and other gentlemen into this scheme, and the result had been disastrous. At the commencement they had argued that 6,600 volts was the most economical, but in the course of cross examination the counsel for the L.C.C. had intimated that they could at Battersea go to a higher frequency or pressure. They appeared to have "swallowed the 25 cycles" as a consequence of the Council's inordinate idea of its own competence to deal with everything. Although water was a more important commodity than electricity, he failed to see why electric lighting companies should be treated in a different manner to the water companies. Parliament did not set up a competing authority with the water companies, but authorised the establishment of an independent board which, before it could commence operations, had to purchase the existing companies at a valuation, and this same treatment he claimed for the electric lighting companies if the County Council Bill were passed. If, on the other hand, competition of such a nature as was proposed in this bill were to be sanctioned he prophesied that private enterprise not only in London, but in England, would be killed, and that investors would go elsewhere with their capital. It might possibly be time that private enterprise was killed; that was a matter of high politics which he had nothing to do with, but even the Committee could not deny that existing interests must be considered, and that compensation should be made for interfering with a Parliamentary bargain, such as he contended had been granted to the electric lighting companies under the Act of 1888.

LONDON OUTER CIRCLE RAILWAY.

The Committee of the House of Commons which is considering this bill continued its sittings on Tuesday, after an adjournment of a fortnight over Whitsun. The case for the promoters was completed at the last sitting and one of the opposition heard. There was no objection to any of the electrical engineering details, no cross-examination having taken place of Mr. Dawson's evidence with regard to the single-phase equipment. On Wednesday and yesterday further opponents were heard, each dealing specifically with the general question of the possibility of the railway earning sufficient revenue to make it a dividend-earning undertaking. The question of competition with the existing lines has also been discussed at length.

The Committee adjourned.

GREENWICH OBSERVATORY AND THE L.C.C. POWER STATION.

In answer to a question by Mr. ASHLEY in the House of Commons on Wednesday, who asked the Secretary to the Admiralty whether he would advise the London County Council to substitute turbines for reciprocating engines at the Greenwich power station in order to abolish the vibration at present experienced at the Royal Observatory,

Mr. E. ROBERTSON stated that the Admiralty did not consider that it was in the interests of the public service to make any statement at the present stage of this extremely serious question.

[Evidence will be given next Thursday by the Admiralty before the Committee considering the London County Council Electric Power Bill.]

MISCELLANEOUS.

The London County Council Tramways, the South Lancashire Tramways and the Watford and Edgware Railway Bills were read a third time in the House of Commons on Friday.

The Preston, Chorley & Horwich Tramways, the North-West London Railway, and the London County Council (General Powers) Bills were read a third time and passed in the House of Commons on Monday.

The Southport–Lytham Tramroad (Extension of Time) Bill was read a second time in the House of Commons on Wednesday.

LEGAL INTELLIGENCE.

Chitty v. British Westinghouse Electric & Mfg. Co. (Ltd.)

Mr. Justice Bigham and a special jury commenced on Tuesday the hearing of this action for damages for alleged breach of a covenant and for the return of a dynamo which plaintiff claimed as his property, or for damages in lieu thereof. Defendants denied the alleged breach, and claimed the machine as theirs.

Sir EDWARD CARSON, K.C., said plaintiff sued for breach of a covenant by which defendants undertook, in consideration of plaintiff disclosing certain inventions which he had made, not to use those inventions nor to disclose them to others, and plaintiff said that certain disclosures had been made, and that defendants had adapted certain of plaintiff's inventions to certain machines of theirs. The other cause of action arose out of a separate agreement by which a machine, designed by plaintiff, was built in defendants' works, and plaintiff claimed that under the arrangements made the machine was to be his when finished. When it was finished defendants declined to give it up, and plaintiff accordingly claimed to have it returned or damages. As far back as 1892 plaintiff obtained a patent for a system of ventilating dynamos. The aim of all inventors was to make a light machine at small cost giving a great output with the least possible waste by sparking. Mr. Chitty had spent some £10,000 upon his efforts. In 1902 he had completed at Sir Hiram Maxim's works two dynamos, which, according to his idea, ought to give a very much larger output than any other dynamo constructed up to that date. He brought into that machine not only the improvements he had patented in 1902, but many other matters he had discovered in the meantime. On April 23, 1902, he had lodged a provisional specification in regard to certain matters which were included in the machine. He came in contact with a Mr. Spencer, who held a subordinate position in defendant company's works, and on April 14, 1902, he received a letter from Mr. R. Belfield, manager of defendants' patent bureau, suggesting that he should appoint an interview with one of their representatives with a view to supplying him with such information as would enable the defendant company to form an opinion as to whether his invention was one they could identify themselves with. An appointment was made with the manager (Mr. Wells), and plaintiff said that before he told or showed them anything he must have a strict covenant that they would not use any technical knowledge or information which he gave in the event of matters between them going off. A deed of covenant was entered into on Oct. 15, 1902. Plaintiff did not complain that anything which defendants had used was in breach of any patent of his. If that had been so, he would have had his remedy in an action for infringement. By that deed plaintiff covenanted to allow defendants to test the machines constructed by him, and the company covenanted not to directly or indirectly disclose or give information to anyone as to the improvements, the method of construction of machines, or any special technical information communicated or ascertained in the course of the investigations and testing. The whole meaning of the contract was that, if the parties did not come to terms after the tests, defendants were not to have the benefit of any knowledge or information or invention which they might acquire from plaintiff in the course of the tests. Shortly after the agreement was entered into plaintiff was put into communication with Mr. Belfield for the purpose of his disclosing, as he did, many of his secrets in connection with his inventions, and, when he had disclosed them, Mr. Belfield suggested to him that he should enter into an agreement to allow defendants to use, free of charge, any patents which might be taken out in the course of the investigations for two years. Plaintiff absolutely refused, preferring to rest on the agreement of Oct 15. After the agreement had been entered into he removed his machines from Sir Hiram Maxim's works to defendants' works at Trafford Park. He explained them to defendants and disclosed to them and their experts all his improvements, not merely the improvements under the patents, but certain special features which had been introduced and which had not been in use by defendants. The machines were tested, and he believed that there was a question whether they were good or bad. Mr. Chitty would prove that the tests were highly satisfactory, but, except as a collateral matter, the question of whether they were good or bad, or whether they turned out to the satisfaction of the defendants, had nothing to do with the case, because defendants had no right whatever to use any portion of the information or technical knowledge which had been given them in the course of the negotiations and tests. The only question was whether defendants applied to their own use certain information they acquired in the course of the negotiations. On Nov. 13 the whole matter was explained to Mr. Wells, and on Dec. 14 a second agreement was entered into. Defendants were to construct under the instructions of plaintiff, and from designs prepared by him, a motor combining the essential features of his inventions, and to pay plaintiff's expenses in preparing the designs and in superintending the construction. At the time that agreement was entered into Mr. Wells said that the motor would be plaintiff's when made. Defendants would be unable to make any use of it under the previous agreement. When they had appropriated certain of plaintiff's inventions they said the machine was theirs because they built it. Plaintiff, who had spent 15 months upon it, was to get nothing. The two dynamos were completed in March, 1903. According to plaintiff, the tests upon them were absolutely satisfactory, but on March 27 Mr. Malcolm MacLaren, one of defendants' engineers, made a report in which he found considerable fault with them, and on the whole reported unfavourably upon the machines. That report was not accepted by plaintiff, who sent in an analysis pointing out serious errors. Notwithstanding that report, defendants went on for another year or 15 months trying to get information, and as late as three months after that report they put into plaintiff's hands an order for the erection under his guidance of a turbo-generator. It was to be constructed at their expense under his supervision and from his drawings. Plaintiff had what he called secondary ventilating devices, and he disclosed to defendants certain ventilating plates of thin sheet steel standards. It had always been necessary to put in certain plates with a view to creating a draught of air through the machine so as to keep it cool. Up to the time plaintiff came into the business defendants had always used heavy and costly solid cast ventilating plates in which the vanes were solidly cast, and they did not supply nearly as much draught as plaintiff's improvement which they said defendants had now adopted. Instead of the vanes being solid, plaintiff invented the device of punching through a torque with which he constructed the vanes. This invention was disclosed to defendants ; and he thought he would be able to show that they had deliberately taken and applied it to a large number of their machines in breach of their agreement. On February 2, 1903, plaintiff took his drawings for these ventilating plates into defendants' patent bureau, and he had no reason to doubt that defendants were acting bona-fide in the matter till he heard some time in May that they were beginning to use the ventilating plates or plates formed on the same principle in some of their machines. Upon April 20, 1903, Mr. Maclean, who was in defendants' employ, actually suggested that he should take out a patent for a new and almost identical style of ventilating plate, although, under their agreement, defendants were bound to take out patents in plaintiff's name. Mr. Cachemaille asked what about Mr. Chitty's ventilating plate, and, when the matter was submitted to Mr. Wills, he suspended all further action on Mr. Maclean's invention until further instructions in order that there should be no question as to the company interfering with plaintiff's invention. Notwithstanding that admitted state of facts, defendants, on their own admission, had been using these ventilating plates for which they could not get a patent having regard to the previous drawings and designs made by Mr. Chitty. Defendants' answers to interrogatories amounted (counsel contended) to an admission that prior to the date of their agreement with plaintiff they had never manufactured anything but heavy, cast metal plates. They had even to admit that they had not one particle of information in their office.

Mr. Justice BIGHAM: No, that is just what they do not admit. They say they never used these improved ventilating plates, but they do not say they had not information in their offices.

Sir ED. CARSON said it was certainly curious, if they had them in their offices, that they never used them, and that as soon as they received the information from plaintiff they began to use them. The machines in which these plates had been put brought in something like £228,000. There were two other branches of invention which Mr. Chitty brought before the company. He had an arrangement of auxiliary poles and windings to regulate the current so as to prevent sparking. He did not profess that it was a new matter or that he had invented it, but it had not been used by dynamo manufacturers, and certainly defendants had never used it. He brought it to their notice, and they admitted that it had never been used by them before. Plaintiff had, however, invented a certain arrangement of slots in the pole pieces made parallel to the axis of rotation, the object of which was to prevent cross-magnetization ; and this in combination with the spark commutation was a most important invention. In May, 1903, when they had had considerable experience of his ability, defendants asked plaintiff to design and superintend the construction of a turbo-generator which they were going to erect at the Savoy Hotel. He made all the necessary drawings, and the machine was constructed under his supervision. He introduced the spark commutation and the arrangement of slots. They had got provisional protection here and in certain other countries, but when they went to Germany, where they made a closer investigation, they found that there was either an existing patent or an application for a patent which was held in some way or other to prevent plaintiff from obtaining his patent in Germany. Defendants advised him for the present to withdraw the application, because if it had been unsuccessful the whole thing would have become public. But having found that out they brought over to this country a Mr. Beyer to construct a turbo-generator—there were four altogether ordered for the Savoy Hotel—and it was clear that having got the knowledge that plaintiff could not get his patent in Germany they thought that under their agreement they had a right to adopt the spark commutation and the arrangement of slots to their own work. Speaking generally, Sir Edward concluded that the machines that the defendants could not retain were now an absolute success, and were by far the best and cheapest machines, giving the greatest possible output of electrical energy upon the market. The defendants, of course, had got all they wanted. They had had the advantage of plaintiff's skill and information for a year, and he had not got a penny. He asked the jury to say what was the value of the information he had given and which defendants had appropriated in breach of their agreement.

Mr. HY. CHITTY was then examined by Sir E. CARSON, and said that in his patent of 1892 ventilating passages were carried right through the pole-pieces. He patented a device in 1892, and in April of that year he got provisional protection for an improvement and development in the ventilating scheme. In the course of his researches, he also devised other improvements. In 1902 he constructed two dynamos (at least they were built under his supervision at the works of Sir Hiram Maxim). These machines comprised his ventilating improvements and certain of his other improvements. In addition to the ventilation, there was difficulty with relation to the distorting effect of the armature current. He had devised a system of slots which was, in his judgment, likely to reduce that difficulty. There was also a third matter—viz., the means of getting good commutation, that is to say, sparkless commutation. That was done by the use of a system of auxiliary poles and pole windings. The auxiliary poles were used in the two machines in question, but the system of slots was not used, but there was a partial equivalent in a central division right through the pole-pieces. In his interview with Mr. Wells he explained not only the results, but how those results were obtained. He gave Mr. Wells the results of the outputs obtained by experiments with other machines he had constructed years previously. Those experiments showed that a machine of his which weighed 8 or 9 cwt. could put out as much electricity as any other weighing 40 or 50 cwt. He had at the date of the interview one invention protected and published an improvement on that which was not published. He told Mr. Wells that he had discovered other ideas not embodied in the two machines. Ultimately a deed of covenant was prepared on Oct. 15, 1902. After that had been executed he sent his two machines to the defendants' works at Manchester. Besides that he had made disclosures of his patents and ideas to the Westinghouse Patent Bureau.

Mr. CRIPPS, K.C., for defendants, said the Westinghouse Patent Bureau was not part of the Westinghouse Co.

Mr. CHITTY: Mr. Wells proposed that the Patent Bureau should acquire the patents, defendants finding the money. He disclosed to the Patent Bureau all his discoveries and ideas in general terms. The Bureau made a number of applications in his name for patents. Defendants had declined to give up to him the machine made under his agreement with them of Nov. 14. He valued this at what it would cost him to replace it. He put an estimate of £1,500 upon it, but in reality he could not get it built for that. Owing to the use of his inventions and his designs, he caused a letter of complaint to be written by his solicitors to defendants on April 15, 1904, and an interim injunction was obtained in June.

Cross-examined by Mr. CRIPPS, Mr. CHITTY said he did not suggest that the original machines would give any information to the defendants which was not common knowledge with regard to ventilating plates. A patent of Mr. Westinghouse's brought out in 1895 showed punched-up lugs. That specification did not show punched-up lugs but vanes. Lugs answered the purpose of vanes, but it was a different thing altogether. Witness then identified models of the ventilating plate which he disclosed to defendants, of the form of plate according to Mr. Westinghouse's patent of 1895, and of the plate which he said defendants had used in 219 machines of which he complained as being a breach of the covenant. In the first model curved vanes were held in position by means of lugs, and a specification for a United States patent of 1900 of Mr. Faure showed vanes attached to armature plates by substantially the same system of punched up lugs.

Mr. Justice BIGHAM: Supposing you had known of the Faure patent would you have suggested that there was any secret or novelty about your system?—Not in regard to the method of holding vanes.

Mr. CRIPPS: There was nothing in any sense new in attaching vanes to armature plates at that date by means of lugs?—I should not like to say that.

Mr. Justice BIGHAM: Does the advantage of your system consist merely of punched-up pieces out of the plate?—Yes, for the purpose of holding the vanes.

Then it boils down to this, that what you claim as the novelty you disclosed to defendants was the holding of the vanes in position by punched-up pieces?—Yes, whether turned down or not.

Mr. Justice BIGHAM: Have you ascertained that the system was known at that time, although not to you?—I think there is no doubt that it was known to some manufacturers, but I do not know that it had been used.

Then though you knew they did not know it, it was a thing which was known?—Yes, it may have been known to some.

Mr. CRIPPS: You signed a memorandum saying that it had been decided to omit the part of the invention relating to these ventilating plates because you had ascertained they were old?—I did.

Therefore, what you were giving to us as information in May, 1903, by the diagram was the same as the diagram it was proposed to attach to the specification?—Yes.

And at the date of the specification you were willing to abandon any claim as regarded these ventilating plates on the ground that they were known and old since 1900?—Yes.

By Mr. Justice BIGHAM: He was willing to abandon the patent of his plates because he was satisfied that they were not novel.

Mr. Justice BIGHAM: If defendants have not used a form of slotting that you disclosed to them, I do not know what they have done wrong.—My specification describes a means of regulating the strength of a magnetic flux in such a way that it is stronger at the sides and weaker in the middle, and defendants had used that method.

Do you now complain that you divulged to defendants any specially-shaped slots?—I do not attach any importance to the shape of the slot. He was claiming all forms of slots, whether they had brought about the symmetrical or unsymmetrical distribution of flux. If defendants used any slots for any purpose his assertion was that they broke their bargain.

Mr. CRIPPS: At this date the use of slots to prevent distortion was well known in the use of dynamos?—It was not known to me.

He was aware in 1903 of the use of auxiliary poles in connection with dynamos. He did not claim any novelty in regard to auxiliary poles, but he claimed novelty in connection with auxiliary poles and slots. At the time he gave the information to defendants he was aware of Prof. S P. Thompson's book, which contained a drawing of a portion of a dynamo showing the combination of slotted and auxiliary pole pieces.

His LORDSHIP: You had read it?—Not that edition; it was an earlier edition.

The machine built under the agreement of November, 1902, was without auxiliary poles, which it required to make it satisfactory, as defendants wanted to handicap him by compelling him to exclude auxiliary poles. Maclean, who was head of the drawing department, took the drawings from the draughtsman, who was preparing them from witness's instructions, and sent them to the works manager in London. Defendants said that his auxiliary poles were additions to his original design, but he said that they were not. His original drawing had no auxiliary poles in it. It was not true that Mr. M. Walker suggested to him that the machine would not work without auxiliary poles. His machines were completed without auxiliary poles, but they could be added afterwards. In the machine as originally constructed there was room for auxiliary poles.

His LORDSHIP: When was it that you first gave instructions to the draughtsman to make any drawings with the auxiliary poles?—Either early in December or towards the end of November.

Mr. CRIPPS: That was long after you said your machine was ready for testing?—It was only the next month. The first drawing prepared under his instructions showing auxiliary poles was on December 10, 1903. It was not till after failure of his machine that he gave instructions to his draughtsman to prepare auxiliary poles. In the turbo-generator made under his direction for the Savoy Hotel the combination of auxiliary poles and windings with his arrangements of slots was used. It had been shown that defendants had only used slots after they had been introduced by him.

Mr. ARTHUR MEIKLE, assistant electrician in plaintiff's employ, said he was present at the preliminary tests of the two machines constructed at the Maxim works and which embodied Mr. Chitty's system of ventilation and auxiliary poles, and they were electrically satisfactory. He was at defendants' works from November, 1902, till 1904, and until within a few weeks before leaving the works he was allowed free access to every department of the works, but then he was ordered by the works manager to restrict his movements to a radius of 10 ft. from Mr. Chitty's machine. He knew that they were using certain of plaintiff's inventions in the machines for the Savoy Hotel, and an employé named Sowerby admitted that they were. About the same time he saw Mr. Chitty led out of the premises. There were no machines being built with slotted pole pieces when he first went to defendants' works, but he saw machines being so made some three or four months before he left.

Mr. WYNNE, chief electrical engineer at the Earls Court Exhibition and formerly in defendants' drawing office at Manchester, said that in January, 1903, plaintiff instructed him to prepare drawings for a ventilating plate. Defendants were then using plates of cast metal in one section, but in the following May he saw on the table in defendants' drawing office a ventilating plate of stamped metal with punctured projections. He communicated that to Mr. Chitty.

In cross-examination he admitted that he had no reason to suppose that any unauthorised person was prying into his drawings during his absence.

Mr. FREDK. NICHOLSON, M.I.E.E., said he had notes of three tests of plaintiff's dynamos, and, comparing it with the ordinary commercial machine of the day, it was about $4\frac{1}{2}$ times as good as the other. That was due to the ventilation, combined with the auxiliary poles, and also to the divided pole pieces. He could not see that there was any fundamental difference between plaintiff's ventilating plate and that alleged to have been used by defendants.

In cross-examination, witness maintained that a six hours' test justified him in saying that the Chitty machine was $4\frac{1}{2}$ times as good as others, although he admitted that defects in machines developed sometimes after running four or five days. There was nothing new in punching up pieces for the purpose of attachment. It was used in a variety of trades.

Mr. Z. H. KINGDON, A.M.I.C.E., said he entered the service of Siemens Bros. & Co. in 1881, and he was now in the service of the Admiralty as an electrical engineer. He witnessed tests of the Chitty machines. They gave an abnormal output for a machine of the size and weight. The commutation was absolutly sparkless and satisfactory. The machines underwent severe tests. He had never seen such results obtained from that kind of machine and weight. They were well within the usual limits of rise of temperature allowed. He witnessed further tests on March 2 this year, and they were equally satisfactory. He judged that it was correct to say that the weight of the machines was 1,750 lb. each, and comparing them, in respect of weight, speed and output, with machines by various well-known makers, he should say that the Chitty machines gave from $2\frac{1}{2}$ to $3\frac{1}{2}$ times the output of an ordinary standard machine by good makers. Assuming that the Chitty machine reached 75 kw. at 1,050 revs. per min., he should judge from the tests that the machine could maintain that. Plaintiff's ventilating plate had the advantage over defendants' old style, because it was made of a magnetic material, whereas defendants' plate was made of cast iron, which was unsuitable to dynamo construction; and then it was also an advantage to have the ventilating plate as thin as possible.

In cross-examination witness admitted that, so far as the armature itself was concerned, they could have exactly as good ventilation in every respect with cast-iron as with steel plates. The Hiram-Maxim machines were about $2\frac{1}{2}$ times less in weight than the ordinary dynamo.

Mr. STANLEY BRIGHT, M.I.E.E., said that on February 17th he tested Chitty's two dynamos. The commutation was very good at all loads. The selling value of a dynamo was based mainly upon its output, and about $3\frac{1}{2}$ to 1 was the comparison between the output of the machine and an ordinary machine. There was nothing in the Chitty machines which made them commercially valueless.

In cross-examination witness admitted that his test lasted only 20 minutes.

Mr, WM. ARMISTEAD said he was present at the tests of plaintiff's machines on May 31. They were tested for six hours with a load of 65 kw., and the commutator was excellent. On the following day they were run for half an hour with a load of 100 kw., and they went through it perfectly. He made and broke the circuit at full load several times without any trace of sparking. Since then he had put the load up to 120 kw., and had made and broken the circuit without the least sign of sparking and without any movement of the brushes. Speaking from experience, he should say that it would require a machine 2½ to 3 times the weight of the Chitty machine to give the same output. Two years ago no notice was drawn to machines with auxiliary poles, but now there were many advertisements drawing attention to them.

Mr. Henry M. Sayers, M.I.E.E., consulting electrical engineer, also gave evidence on behalf of plaintiff, and the hearing was adjourned.

Hutton v. Burnand Transformer Co. (Ltd.) and Another.

In the Chancery Court of Lancashire (Liverpool) on Tuesday, before Vice-Chancellor Leigh-Clare, Mr. Grant applied, on behalf of plaintiff (holder of the first debentures) for the appointment of a receiver and manager of the company's assets and business. The company, which was incorporated in March, 1902, and carried on the business of electrical and mechanical engineers in Salford, had an execution issued against it for £29, which it could not pay, and that, and interest being in arrear, had (said counsel) made the debentures immediately payable. His Honour directed a reference to the Registrar to appoint a receiver and manager, who was not to act for more than three months without further application to the Court.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Sanitary Commissioners of Gibraltar require the services of an assistant electrical engineer. Commencing salary £200 per annum, rising by annual increments of £10 to £250 per annum. Applicants must have had experience in high-tension alternating distribution with transformer stations, in laying h. and l.-t. concentric cables, installing a.-c. and c.-c. motors, street and private lighting, &c. Applications to the secretary and engineer to the Sanitary Commissioners (Mr. Wm. Wallace Copland), Gibraltar, by June 30. See also an advertisement.

The Electric Construction Co. requires on its engineering staff at Wolverhampton a thoroughly qualified designer of direct and alternating-current plant. Applications to the Managing Director, Dashwood House, New Broad-street, London, E.C. See an advertisement

The governing body of Northampton Institute, St. John-street, London, E.C., invite applications for the following appointments:—Drawing office and lecture assistant in mechanical engineering department (salary £120 per annum), two demonstrators for electrical engineering laboratories (£100 and £80 per annum respectively), demonstrator and lecture assistant in technical chemistry department, and instructor in moulding in mechanical engineering department. Further particulars and forms of application (which should be returned by 10 a.m. June 25) from the principal, Dr. R. Mullineux Walmsley. See also an advertisement.

A junior electrician, with some practical experience in electrical work and preferably with technical college training, is wanted by Messrs. Harland & Wolff, Belfast. See advertisement.

An additional assistant is required in the electrical engineering department of the Central Technical College, Exhibition-road, London, S.W. Salary £150 per annum. Applications to Prof. W. E. Ayrton. See advertisement.

An assistant is required in the department of electrical engineering of Glasgow and West of Scotland Technical College to teach dynamo design. Salary £100 per annum. Applications before 28th inst. to Prof. Magnus Maclean.

Ipswich Corporation Electric Supply & Tramways committee invite applications for the positions of mains superintendent and general engineering assistant (commencing salary £150 per annum) and installation department assistant and canvasser (commencing wages £2 per week). Applications to the chief engineer and manager (Mr. Frank Ayton) by June 18.

Battersea Polytechnic, London, S.W., will require from September next the services of an instructor in the drawing office. Salary £150 to £200 per annum. Particulars from Secretary.

Southend Corporation require a traffic superintendent for their electric tramways. Salary £150, rising to £210. Applications to town clerk by noon 26th inst.

Monmouth Corporation require a resident electrical engineer. Applications by 25th inst.

Woolwich Borough Council want a station engineer, with experience in 3 wire c.c. generating station and of h.t. polyphase working. Applications by noon 18th inst.

York Electricity committee have advanced the chief assistant-engineer (Mr. J. W. Hame) to the position of chief electrical engineer at £300 per annum, rising by yearly increments of £25 to £400 per annum.

Mr. Donald E. Greenwood, now of Hammersmith (London) Council electricity works, has been appointed junior assistant engineer to the Central Electric Supply Co. at Grove road, St. John's Wood.

Clacton Council have appointed Mr. H. W. Everitt as chief engineer at the electricity works, Mr. Whybrow as fitter-engineer, and Mr. F. Fitch as switchboard attendant.

Mr. W. E. Milns, of Gateshead, has been selected for the position of commercial assistant on the staff of the Birmingham Corporation electric supply department at a salary of £300 per annum. There were 431 applicants for the position.

Aldershot.—In the report for the year ended March 31 the electrical engineer (Mr. F. Garside), states that, although the revenue showed an increase of £315, there was a deficit on the year's working of £145, mainly due to expenses incurred in renewing the battery, which entailed a special expenditure of £345, and which had been paid out of revenue. Otherwise there would have been a net profit of about £200.

The capital expenditure is £26,264, an increase of £644. Revenue was £3,841 and working expenses £2,371, leaving £1,470. 7s. 1d. Interest and repayment of loans absorbed £1,615. 239,830 units were generated and 203,396 sold, increases of 15,354 and 17,200 respectively. The maximum load was 207 kw.; 15 new consumers were connected during the year, and the increase in lamps connected was equivalent to 1,126 8 c.p., the total being 11,854 8 c.p.

Arbroath.—The Council on Monday approved the agreement with Mr. Geo. Balfour in regard to his application for a provisional electric lighting order.

Argentina.—The "Review of the River Plate" says Mr. A. G. Pruden has asked the municipalities of Parana, Concordia and Gualeguaychu for 99-year concessions for electric tramways, and offers to pay over 4 per cent. of the gross receipts.

Athens.—It is announced that an Anglo-Belgian syndicate is to be formed to float a Greek company to lay down a complete system of electric tramways in Athens and Piræus. The negotiations between Messrs. Henderson & Co., Athens, acting for Messrs. Bruce Peebles & Co. (London and Edinburgh) and the Greek Government have been concluded, and the contract will, it is stated, be signed in a few days.

Association of Tramways and Light Railway Officials.—At Edinburgh on Monday, the 11th general meeting of this association was held, the president (Mr. H. England, of Wakefield) being in the chair. The membership is now 74, an increase of four over last year.

The Chairman, in his address, referred to tramway progress in Edinburgh. Some of them were strong advocates of the overhead trolley system, but he submitted there was no conduit, surface contact or cable system known that could compare with the overhead trolley for economy in first cost or for subsequent maintenance and repairs. Æsthetic considerations did not weigh with him, but he knew no town in the kingdom that was disfigured by a properly erected overhead system. He even ventured to say that the ancient and proud city of Edinburgh would have been no less beautiful with such a system. He was of opinion that the unreliability, noise, discomfort and cost of operation of motor 'buses effectually barred them from competition with tramways, but in course of time those drawbacks might be minimised, if not obliterated, and they should be ready to avail themselves of motor 'buses either as feeders to their present routes or for testing the traffic possibilities of new districts. It was folly to assert that tramways were doomed, and that motor 'buses were about to displace all other methods of road traction. They would all agree that cross-town traffic or, indeed, any traffic which brought grist to the mill, must be cultivated, but, at the same time, it was inadvisable to attempt to work a system of transfers, and in so doing provide passengers with an easy means of defrauding the Corporation and company working the tramways.

Seven new members were elected, and then Mr. J. E. Pitcairn, general manager of the Edinburgh and District Tramway Co., was elected president. Mr. A. R. Fearnley, Sheffield, was elected vice-president.

In the discussion on the president's address, Mr. C. W. Shepherd (traffic manager, Edinburgh) said in Edinburgh the transfer ticket was adopted on April 1 last, and at present the company's weekly output in those tickets exceeded 60,000, and that at least recommended the transfer ticket to a fair trial. In no case had he found fraud by the conductors, and in only ten cases was there abuse by the passengers. Neither had it been found that the transfer ticket was bothersome to the conductors. In his opinion there was more abuse with the ordinary ticket than with the transfer. Mr. H. L. White (Grimsby) supported Mr. Shepherd's views. After lunch the members visited the Tollcross power station and the traffic office at Shrubhill.

On Tuesday, the discussion on the address of Mr. H. England was continued by Mr. R. Aitken (Edinburgh), who drew attention to the manner of taxing tramway companies, by Mr. W. Wyld (Birkenhead) and Mr. F. Coutts (Paisley).

Mr. Pitcairn thought more power should be given to Edinburgh Corporation to prohibit the 'buses competing with the tramways, more especially as the tramways company paid more than £90,000 in rent. In replying to the discussion, Mr. England said he had yet to find a person who would say that there was a perfect system of transfers. No fare less than a penny, he held, was profitable to companies.

On the motion of Mr. F. Coutts (Paisley) it was agreed to communicate with other interested associations as to the compulsory rear-lighting of all vehicles.

The next conference will be held in Norwich.

Australasia.—The St. Kilda-Brighton (Melbourne) electric tramway was opened by the Victorian Premier (Mr. Thomas Bent) on May 5.

The "Australian Mining Standard" states that this is the first electric line in the Melbourne area, but the opening of the Essenden-Flemington electric line is within measurable distance and others will soon follow. The new line, which is 4½ miles in length and extends from St. Kilda railway station to Middle Brighton, cost about £8,000 a mile to build. The rails weigh 92 lb. per yard. Australian General Electric core-type bonds are used at every joint, with cross bonding at every 80 ft. The gauge is 5 ft. 3 in., this being the gauge of the suburban steam lines, which will probably be eventually converted to electric lines. The overhead work is partly on span wires and partly on centre poles. The generating plant consists of two direct-coupled 100 kw. Bellis & Morcom–Australian General Electric sets, and there is a storage battery of 182 ampere-hours capacity (supplied by the Accumulatoren-fabrik A.-G., of Berlin, through Messrs. Noyes Bros.). The boiler house plant comprises two Babcock & Wilcox boilers, with a B. & W. feed water heater and duplicate Weir vertical pumps. The cars are single-decked and were designed by Mr. F. E. Bradford. The cars are 30 ft. in length and have an open compartment at either end, the seating capacity being 36 passengers per car. Mr. Bradford has been appointed by the Railway Commissioners to manage the line, with Mr. Massey as assistant.

Launceston (Tasmania) Council have referred to a committee of the whole house the question of constructing a system of tramways.

Melbourne Corporation have purchased 150 new flame arc lamps for street lighting and are about to place all their lighting mains underground.

The formal inauguration of the Kerang (Victoria) Electric Light Co.'s works took place last month. Paul Ball & Co., of Bendigo, supplied the generating plant.

Richmond (Victoria) Council have put up 10 450-watt flame arc lamps as an experiment in street lighting. Current is supplied by the Electric Lighting & Traction Co. of Australia

Fitzroy and Collingwood (Victoria) Councils have decided to light Smith-street with 21 2,000 c.p. flame arc lamps. The contract for supplying current has been given to the local company for five years at £320. 10s. per annum.

Shepparton (Victoria) Council have instructed their engineer to report on the cost of establishing and maintaining electricity works for street lighting.

Mr. Hy. Noyes, of Noyes Bros., has been engaged to report to Prahran and Malvern (Victoria) Councils as to the best means of carrying out a projected electric tramway scheme.

Barnsley.—For the year ended March the gross profit on the electricity department was £6,024, and the net profit £3,152, of which £550 has been allocated to the rates, £1,500 to reserve, and £500 on loan to the public lighting account, leaving £602. The accumulated profits now amount to £3,831.

Birmingham—The accounts of the electricity department for the year ended March 31 were adopted at the last meeting of the Corporation.

The total revenue was £74,089. 18s. 10d., including £71,568. 19s. 5d. net from sale of current. The expenditure was £32,632. 8s. 6d., including £20,649. 12s. 7d. generation expenses, £1,254. 0s. 1d. distribution, £3,734. 3s. 1d. rent, rates and taxes and £6,252. 16s. 1d. management expenses, leaving £41,457. 10s. 4d., which, with £1,189. 12s. 2d. interest allowed by bank, made £42,647. 2s. 6d. After providing interest on loans and redemption of debt (£13,469. 16s. 10d.), the surplus (£6,097. 11s. 9d.) has been carried to reserve. The total amount borrowed is £863,928. 17s. 1d., and the amount authorised is £987,496. 17s. 1d.

Blackburn.—The income of the Electricity department for the past year was £29,947 and the expenditure £14,376, leaving a gross profit of £15,571, compared with £14,548 the previous year. After paying interest and sinking fund the net profit was £277, against £251.

The engineer (Mr. P. P. Wheelwright) considers an increase of £1,700 in the income satisfactory, as 1905-6 was the first full year's working after the considerable reductions made in the rates for lighting and power and the abolition of meter rents, as well as the decrease in theatre charges, which has now been in effect for some nine months. The amount required for interest and sinking fund increased by about £1,000. The numbers of consumers increased from 1,110 to 1,332, equal to 25,115 8 c.p. lamps. The total number of 8 c.p. lamps connected is 131,473, exclusive of tramway demand. The units sold were 3,331,460, compared with 3,129,215.

At the meeting of the Council last week the chairman of the Tramways committee stated that there never had been any loss on the tramways, and if they had been in the hands of a private company they would have paid dividends.

The gross profit for the past year was over £20,000, but that amount was more than absorbed in interest, sinking fund, &c. From the time the trams had been taken over up to date the loss had been taken at £30,429, but they had paid interest, and £68,207 was wiped off capital.

Bootle.—The annual report of the borough electrical engineer (Mr. T. Dawson Clothier) for the year ended March 31 states that there has been surplus revenue sufficient to meet interest on capital, amount required for repayment of loans, sum allowed for depreciation and obsolescence, and £1,000 provided for relief of rates.

The council have also allowed in their estimates that £1,000 shall also be provided out of current year's operations. The year's total income was £16,621. 2s. 9d., generation expenses came to £5,223. 15s. 11d., cost of distribution, £269. 2s. 3d.; rent, rates and taxes, £674. 5s. 7d; management expenses, £1,032. 10s. 10d., and with special charges the total was £7,288. 15s. 1d., leaving a gross profit of £9,332. 7s. 8d to meet interest and sinking fund instalments (£6,888. 19s. 1d.) and other charges. The total capital expenditure is £108,541. 15s., an increase of £4,401. 11s. 7d. Negotiations have been commenced with Litherland Council for supplying electricity to that district. At the end of the year there were 122 consumers using prepayment meters and during the year over £100 was received from this source. The equivalent of 74,123 8 c.p. lamps is connected to the mains, an increase of 11,149. There are 588 consumers, compared with 381. 2,576,573 units were generated, increase of 227,000, and 2,292,974 units were sold (881,397 to private consumers, 354,278 to public lamps, and 1,057,299 to tramways), an increase of 178,717, of which 177,662 were to private consumers. The total costs were 0·76d. per unit sold, compared with 0.82d. in 1905.

Bordeaux.—Writing on the subject of the trade of Bordeaux for 1905, Mr. Consul R. Macdonald refers to a demand for large semi-portable engines of from 80 H.P. to 300 H.P. for generating electric current, which Mr. Macdonald states are being imported into the Bordeaux district from Germany, and he suggests that British manufacturers of these engines could secure this trade if an adequate effort in this direction were made. The Consul also refers to a small engine introduced upon the Bordeaux market at the beginning of 1906 from America in the shape of a small low-speed oil engine for use in farm work. These engines run at 300 revs. per min. instead of the usual French style of engine running at from 1,500 to 2,000 revs. The smaller sizes of these engines are provided with an automatic ignition device.

Brighton.—The net profit on the municipal electric tramways for the past year, after providing for interest and sinking fund, was £1,615.

The accounts of the Electricity Department abstracted in our last issue were submitted to the Council at the last meeting and were adopted.

The Chairman of the Lighting committee (Councillor BUTT-THOMSON) gave a lengthy explanation of the accounts, and said that the deficiency of £980 was due in a great measure to the large sums which had to be provided for repayment of loans and interest, to insufficient amount of increased trade to meet increased payments, and to the fact that the economics promised and hoped for at Southwick had not come into operation to any material extent. They were, and had been, in a transition state, and until they could get all their machinery at Southwick there must necessarily be a duplication of expenses, and consequently they could not effect the saving which they ultimately hoped for.

Ald. BLAKER said it was unfortunate that the adverse balance had been largely brought about by the indiscretions of a former Lighting committee in going to Southwick and building a station costing a sum approaching £400,000. They must be prepared for a much worse balance-sheet next year, unless there was an immense improvement in trade.

Other members continued the discussion, and Councillor SONE asked as to depreciation on meters, which should, he thought, be allowed for.

Councillor HUEN advocated the adoption of prepayment meters, free wiring for workingclass houses, &c.

Councillor BUTT-THOMSON, in reply, said he could not state the exact date of the transfer to Southwick, but September was mentioned tentatively. At the completion of those works he hoped the capital cost would not be more than £313,000, as against the £400,000 authorised.

Bury (Lancs.)—The income of the electricity department for the year ended March 31 was £13,514. 9s. 10d., including £6,975. 19s. 1d. for private lighting, £5,300. 17s. 3d. for traction, and £553. 5s. for public lighting. The expenses were £5,656. 15s. 3d., including £2,873. 6s. 10d. for generation, £1,003. 8s. 5d. management expenses, £555. 8s. 6d. for repairs and maintenance, and £491. 1s. for distribution.

The gross profit was £7,857. 14s. 7d., and, after providing for interest and sinking fund (£5,340. 5s. 10d.), the net profit was £2,517. 8s. 9d., against £2,931. 1,931,675 units were generated, 703,224 units were sold to private consumers, 1,106,267 were supplied to the tramways, and 60,069 to the public lamps (34 arcs and 18 incandescents). The total maximum supply demanded was 1,144 kw. The load factor was 18·6 per cent., compared with 12·6 per cent., the improvement being principally due to increase in units sold for power. At the end of the year the equivalent of 50,622 8 c.p. lamps was connected to the mains, an increase of 6,423. Good progress has been made in the application of electric motors to driving of machinery. During the year 13 motors (equal to 68 H.P.) were hired out to consumers and 13 (equal to 111 H.P.) were put in by consumers at their own cost. Three of the hired motors (equal to 21 H.P.) have been disconnected owing to users giving up business or leaving premises. There are now 71 hired motors in use (equal to 428 H.P.) and 51 motors owned by consumers (of 311 H.P.), giving a total of 122 motors (equal to 739 H.P.). The report of the electrical engineer and manager (Mr. S. J. Watson) contains an interesting table of the number and horse-power of the motors connected and the type of machinery driven. It appears that there are 25 distinct trades represented in the table. During the past year a 500 kw. Belliss-Siemens generating set was added to the plant. A jet condenser consisting of two Edwards' single-acting air pumps and one double-acting circulating pump, driven by an inverted compound engine, has also been added, as well as three superheaters, a mechanical stoker,

&c. The capital expended is £84,661, an increase of £7,203, mainly on mains and additional generating plant. The generating cost per unit was 0·69d., and the total cost 1·37d.

C.S. "Silvertown."—We learn that the India Rubber, Gutta Percha and Telegraph Works Co.'s c.s. "Silvertown," which was reported a few days ago to be ashore in Suez Bay, is not damaged, and is now on her way home.

Carriage of Mails on Tramways.—The Sunderland & District Tramways (Ltd.) have entered into an arrangement to carry the mail bags from the post offices on the route of their 13 lines of tramways to Fencehouses station.

Chesterfield.—The borough electrical engineer and tramways manager (Mr. R. L. Acland) has presented his annual reports of the lighting and tramways departments.

For the fourth year of working the revenue of the lighting department was £8,336, and total costs were £3,632. Interest and sinking fund absorbed £3,214, leaving a net balance of £1,490, which has been appropriated as follows: Written off capital account on meters, motors and consumers' services £720, leaving £771 for reserve, which stands, after 4½ years' working, at £2,801. During the same period £1,517 has been written off capital account. 836,608 units have been sold. The total cost was 1·04d. per unit, 0·696d. for generation, and 0·345d. for general charges. The total capital expenditure is £53,031.

The tramways report shows a total capital expenditure of £70,842. The total revenue was £10,865, working expenses £5,526, interest and sinking fund £3,873, leaving £1,466, which has been appropiated as follows: £338 has been written off preliminary expenses, £400 off cost of promotion, and £726 placed to reserve. 269,981 car-miles were run and 2,195,956 passengers carried. The average journeys per head of population of area served were 58, and the total revenue 9·6d. and total operating costs 4·9d. per car-mile.

The new sub-station for supplying current for lighting at 240 volts off the traction feeders is now regularly at work, and under the control of the Tirrill regulator the pressure is kept absolutely steady. This is said to be the first installation of this particular kind in this country.

Clacton.—An unopposed inquiry was held on Monday into the application of the Council for sanction to borrow £1,000 for the purchase of a private electric lighting undertaking.

The clerk (Mr. G. T. Lewis) explained that an arrangement had been come to between the Council, who had just recently erected municipal works under their 1900 order, and Mr. Ainslie (the owner of a private electric lighting installation) who supplied 32 properties in the Electric Parade, whereby the Council should take over Mr. Ainslie's plant and goodwill at £1,000.

Customs Decisions.—By a resolution of the Dutch Ministry of Finance it has been decided that the following are admitted into Holland duty free, as factory engines:—"The various sorts of motors, with the exception of those susceptible of use for motor-cars and motor cycles; dynamos: engines, the arrangement of which shows they will be worked by mechanical power; and measuring, registering safety and other similar appliances belonging thereto and imported therewith."

Dublin.—At the meeting of the Corporation on Tuesday a report of the Lighting committee recommending reductions in the charges for electric current was adopted.

Edinburgh.—In accordance with the recommendation of the consulting engineer (Sir Alexander Kennedy) and the borough electrical engineer (Mr. Frank A. Newington) in their recent report on depreciation and obsolescence of plant, &c., the Electric Lighting committee have now decided to bring the reserve fund of the electricity department up to its maximum at the earliest possible date, and thereafter to provide a depreciation or suspense fund to the extent of 5 per cent. of the capital outlay.

The question came before the Council on Tuesday when the convener of the committee (Mr. Stevenson) moved the adoption of the committee's recommendations. While admitting that there was no real ground for alarm and while they were within measurable distance of the reserve fund on the 10 per cent. basis, he quoted from the report to show the unreliability of the life of much of their plant and the necessity of the additional depreciation fund.

Mr. Stewart moved the previous question. He had come to the conclusion that the undertaking was on a sound financial basis, and they should leave things as they were, and while building up the reserve to the maximum, which it would soon reach, they ought to retain the power of disposing of the surplus as they wished each year.

Treasurer Brown said the L.G. Board were adverse to the position taken up by their engineers. The report contained no facts or figures which justified them in adopting such a policy. The undertaking cost £900,000, and it had been written down to £650,000. Of all the undertakings in the country, Edinburgh stood financially in the best position.

Mr. Leishman pointed out that in Glasgow on one head alone (dynamos) they had sold plant for £6,445 less than what was standing in their books. Glasgow last year paid off 11 per cent. of capital, compared with 5 per cent. in Edinburgh, and the undertaking which was writing off from machinery and plant was in an immeasurably better condition than a company or a corporation that was not doing so.

The recommendation was lost by 20 votes to 14.

The Council on Tuesday appointed a deputation of seven members to inspect surface-contact and other systems of electric traction in certain towns. It is proposed to include Bournemouth, Wolverhampton, Lincoln and Mexborough.

Electricity on Board Ship.—The new "Royal Mail" steamer, the "Amazon" (there are many Royal mail steamers, but only one Royal Mail Steamship Line), owned and worked by the Royal Mail Steam Packet Co., makes its maiden voyage to the River Plate to-day (Friday), and leaves Southampton fully recognised by experts as one of the most complete and up-to-date liners ever built and equipped by British enterprise. The beautiful vessel, which we inspected just prior to her departure, is replete with every luxury and convenience that the wit of man could devise for the comfort and safe keeping of passengers of a class which demands more than ordinary consideration in these respects. For the South American on travel looks for and will have, when able to afford it, many things which, to the ordinary person, savour of indolence and indulgence. The "Amazon" meets these requirements to a marked degree, and in no department more completely than that which provides for the electrical needs of its passengers. Besides electric lighting, electric fans, electric ventilation, and other more everyday features, passengers, both male and female, are provided with electrical "comforts" in the shape of cigar lighters, curling irons, water heaters, radiators, hair-dryers and other items which go to make a journey across the seas thoroughly enjoyable. There is also an electrically-operated laundry on board, and in fact the electric current is employed for every possible purpose where it can administer to the convenience and pleasure of the voyager. The lighting arrangements on board the "Amazon" are of a most complete and elaborate character, nearly 2,000 16 c.p. lamps being installed. There is an electric fan in every cabin, electric pedestal reading lights, electric bell pushes everywhere at hand, and generally the arrangements are admirable, making the new boat (one of a number recently added to the "Royal Mail" fleet) a veritable hotel afloat.

Epsom.—A scheme for the extension of the electricity works, prepared by the electrical engineer (Mr. H. F. Foster), and estimated to cost £3,145, has been approved by the Council. The extensions comprise a 300 kw. steam dynamo, a water-tube boiler and induced-draught apparatus.

Exhibition.—At a recent meeting of Edinburgh citizens it was decided to hold a Scottish National Exhibition in Edinburgh in 1908. The committee and executive of the exhibition proposed to be held in 1907 was dissolved, and the Lord Provost (Sir Robt. Cranston, K.C.V.O.) was appointed chairman of the new committee and Mr. Jas. Marchbank interim secretary.

Fareham.—The Council have applied for sanction to a further loan of £800 to pay for a new 60 kw. alternator and to meet an overdraft of £300, leaving £200 in hand for extensions of mains, &c.

Farnworth.—An inquiry was held last week into the Council's application for sanction to a loan of £5,000 for extensions of the electricity works.

Fire Brigade Tournament.—The eighth annual competition of the London Private Fire Brigade Association took place on Saturday last at the Crystal Palace, and out of a total of 38 brigades 31 entered the tournament competition. The result of the contest was that the Robertson Electric Lamps brigade for the second time took the "Marshall" championship cup, and out of six events the Robertson Brigade secured three firsts, one second, one fourth, and one fifth prize. In addition to the championship cup, they also won the Hitchcock shield for the two-men hydrant drill. The aggregate time taken by the Robertson Brigade in the whole six drills was $220\frac{4}{5}$ths seconds, which easily established a record for any previous tournament.

Gravesend.—The net profit of the municipal electricity department for the past year was £786. The charge for current has been reduced from 5d. to 4½d. per unit.

Hackney (London).—The Council seek a loan of £900 for extension of arc lighting.

Hull.—The salary of the city electrical engineer (Mr. H. Bell) has been increased by £100 a year, with two further annual increments of £50. The assistant engineer's salary has been increased by £50 per annum, with two further increments of £25.

Income-Tax Appeal.—Three years ago the Commissioners of Income Tax decided to allow 2 per cent. depreciation from the profits of St. Pancras electricity undertaking in respect of mains and plant, but the Surveyor of Taxes only allowed depreciation on the written-down value of mains, &c., plus any additions or extensions. The borough treasurer contended that a fiftieth part of the original capital and subsequent extensions should be allowed each year for tax purposes, and upon appeal the Commissioners recently upheld this view, and in future the Council will get the full allowance of 2 per cent. upon the whole original cost of mains and plant and the cost of any subsequent extensions.

As indicating the seriousness of the position, it is calculated that, if the surveyor's contention had not been overruled, actual loss to the

Council, assuming income tax at 1s., would have amounted to £2,500 per annum during the next 50 years, without taking into consideration extensions of mains, &c.

The Commissioners have also allowed sums each year for all moneys spent upon repairs and renewals paid either out of revenue or reserve. The 2 per cent. referred to above is simply in respect of any possible explosion, breakdown or obsolescence of plant.

The Commissioners further held with the borough treasurer in respect to law costs in the action for an injunction against a nuisance by vibration ("Colonell and others *v.* St. Pancras Council"), and which the Surveyor of Taxes had refused to allow as expenditure on current account. The Commissioners, however, held that the law costs in respect of the purchase of the plaintiffs properties could not be treated as expenditure on current account.

Inquest.—At Blaina, on Wednesday, an inquest was held by Mr. J. B. Walford as to the death of Edward J. Rees, engine driver at the Pyle and Blaina Company's works.

The father of the deceased said his son started work as a "coke pusher" a fortnight ago. Apart from being able to work those engines neither he nor his son had any knowledge of electricity.

John Adney, foreman mechanic, said practically the whole of the mains to the motor under the "pusher" were protected, but several inches were unprotected, and witness thought deceased received the shock from the naked terminals in reaching over the unprotected part. The voltage of the current was 440.

Mr. A. H. Palmer, of the British Westinghouse Co., at present engaged at the works upon another contract, stated that the voltage was low but it depended under what conditions anyone received the shock whether it would prove fatal. The voltage was not considered to be dangerous to life, which was one of the reasons why it had been adopted by the company at their works. In English plant of that kind they never had naked terminals in such a position.

Herr August Linkert, engineer for the German firm supplying the electrical plant at the works, said he had fully instructed deceased and others in the work.

The jury returned a verdict "That deceased was killed directly or indirectly by receiving an electric shock from naked terminals or wires, improperly left bare."

Inter-urban Tramways and Motor 'Buses.—Manchester Tramways committee have approved an agreement with Oldham Corporation providing for mutual running powers over the lines of each authority. Oldham cars may run through to Piccadilly (Manchester) and Manchester cars may run through to Waterhead (Oldham), and the distance between the extended points is about 8 miles. Fares earned in Manchester area go to Manchester Corporation, and those earned in Oldham to Oldham. Arrangements have also been made for revising fares to the outlying districts.

Manchester Tramways committee, who have been experimenting with motor 'buses, have decided to purchase six further motor 'buses, in addition to the existing three 'buses.

Italy.—The Società Italiana di Industrie Elettriche of Spezia have received authority to construct and work an electric tramway between Via del Prione and Porta Rocca.

Light Railway Rating.—About 50 local authorities have decided to combine in order to appeal from the judgment of the Divisional Court in the case Wakefield Corporation *v.* Wakefield and District Light Railway Co. (reported in *The Electrician* for April 13), which decided that light railways are entitled to be rated at one-fourth the full value.

Limerick.—It has been decided to apply for sanction to a further loan of £5,000 for the purchase of additional plant for the electricity works.

The Mayor (Ald. Joyce, M.P.) announced at the last meeting of the Corporation that the electric lighting department was making good progress, and in the first quarter of last year, for power alone, £695 was earned, while in the corresponding quarter of this year the amount was £1,122. With another generating set the income, it was estimated, could be increased £6,000 a year.

London County Council Tramways.—The new electric tramway between Lewisham and Rushey Green, Catford, and the extension of the Greenwich line to Blackwall Tunnel were opened for traffic on Sunday. When the Vauxhall Bridge route is completed through cars will run from Victoria Station, Westminster, to Catford.

Longton.—An unopposed inquiry was held on Tuesday into the Council's application for sanction to borrow £3,500 for extending the electricity mains. The town clerk (Mr. G. C. Kent) gave particulars of the progress of the electricity undertaking.

Long Eaton.—The charges for electric current for public and private lighting have been reduced.

Mansfield Woodhouse.—Mansfield Council have given notice of intention to apply for a provisional order for this district.

Monmouth.—The borough electrical engineer (Mr. A. W. Blake) has resigned in order to take up an engagement with Messrs. Mills, English & Co., electrical engineers, of Swansea. The Council have, however, retained Mr. Blake as consulting engineer.

Newport (Mon.).—The chairman of the Electricity committee announced on Tuesday that satisfactory progress had been made since Jan. 1, when a lower scale of charges was brought into operation. The committee had gone in for insuring in their own funds, which they had found a great success.

Nottingham.—The accounts of the electricity department, abstracted in our last issue, were adopted by the City Council on Monday.

Obituary.—The death took place at Bournemouth on 6th inst. of Mr. Francis William Webb, for many years chief mechanical engineer of the London & North-Western Railway. Apart from locomotive engineering, Mr. Webb devoted considerable time and attention to other subjects, such as steel sleepers, continuous brakes, signalling apparatus, &c., and his inventions in connection with railway plant generally were numerous. He was the joint inventor of the Webb-Thompson system of electric train signalling and was one of the first locomotive engineers to fully appreciate and take full advantage of electricity not only for lighting but for driving machine tools, welding, &c. An interesting description of the electric power and lighting installation at the Crewe works of the L. & N W. Railway appeared in Vol. XXXV. (pp. 7-9) of *The Electrician* Mr. Webb, who served as a vice-president of the Institution of Civil Engineers, retired from the service of the L. & N.W. Railway Co. in 1902, and a breakdown of his health occurred almost immediately after his retirement.

The death is announced of Mr. Malcolm Guthrie, director of the Blackpool, St. Anne's & Lytham Tramways Co. and other companies.

Patent Amendment.—Mr. Stanley Matthews, engineer, 32, Cowcross-street, London, E.C., seeks leave to amend specification of letters patent No. 28,044 of 1904 granted to him for "Improvements in electricity meters." Particulars of proposed amendment are given in the "Illustrated Official Journal" (Patents) of June 13, and notices of opposition must be given within one calendar month from that date.

Personal.—At Umtali (Rhodesia) Mr. Harold Wragg, chief engineer of the Panhalonga Proprietary Mines and Rezende Mines, Mashonaland, was married on the 2nd inst. to Miss Bertha Frances Walker, of Sheffield. Mr. Wragg was formerly on the staff of the Sheffield electric light department.

Plymouth.—At their meeting on Wednesday the Corporation adopted the accounts of the electricity supply department, abstracted in our issue of June 1.

Portsmouth.—The Electric Lighting committee propose to devote £3,500 out of the profit on the past year's working of the electricity undertaking to relief of rates, and £1,000 has been placed to a special fire insurance fund.

Post Office London Telephone System.—The Sutton exchange of the Post Office London telephone system was opened on 13th inst. Trunk communication will be afforded through the London trunk exchange.

Provisional Order Transfer.—Cannock District Council give notice of intention to transfer their electric lighting order to the Shropshire, Worcestershire & Staffordshire Electric Power Co. for £550. Objections to Board of Trade within one month.

Roumania.—The public lighting of Bralia is now wholly electrical, and there is a considerable demand upon the generating station for current for private lighting. Public buildings, banks and shop premises are rapidly adopting electricity as a means of lighting.

Russia.—H.M. Consul at Rostov-on-Don, Mr. A. F. Medhurst, states that the imports of electrical appliances, in which a good trade is done, come from Germany and the United States.

St. Pancras.—The units sold during the three months ended March 31 were 2,184,772, value £21,919, against £1,856,134 units, and £20,384 in the corresponding period of 1905. Power supply increased from 219,910 to 418,251, and private lighting from 1,124,678 to 1,210,552. Application is to be made for a loan of £1,011 for arc lamps.

Salford.—An unopposed inquiry was held here on Wednesday into the application of the Corporation to borrow £7,720 for extensions of the Frederick-road electricity works.

The deputy town clerk (Mr. Jackson) stated that the station was opened in 1901, and there had been such an increase in the demand for the supply of current for private lighting and power that the projected extensions were absolutely necessary. The capital expenditure on the electricity undertaking was £555,409, and the outstanding debt £484,289.

The chairman of the Electricity committee (Councillor Hodgson) said that the effect of the reduced charges had resulted in a big demand for current for power.

Severe Test of a Turbo-generator.—The 5,500 kw. turbo-generator of the Willans & Robinson type, supplied to the Kent Avenue station by the Allis-Chalmers Co. of Milwaukee, was recently subjected to a severe test of its mechanical strength.

By an accident a large jack-knife was left inside the turbine before it was closed up, and the machine ran with this obstruction inside it, a knife leaf being wedged between the stator and rotor. This condition of affairs lasted for nearly a month, the maximum load taken being 9,800 kw., whilst on occasion the load averaged 8,000 kw. for 1½ hours. On then opening up the turbine the obstruction was discovered. It was found that a piece of steel from the knife had been wedged into such a position that it had acted like a lathe tool, and had turned a groove on the drum $\frac{3}{16}$ in. deep by $\frac{3}{8}$ in. wide. This had loosened the caulking strip which held the ring of blades in place, loosening the latter, so that the channel-shaped shroud ring, which is riveted over the ends of the blades, came in contact with the fixed cylinder, with the consequence that its flanges had been almost worn away. Notwithstanding this, not a single blade came out, and the turbine continued to work under at times an enormous overload. The incident is a striking testimony to the mechanical efficiency of the system of holding the blades introduced by Capt Sankey, which is that adopted by the builders. As it was not feasible at the time of the discovery to lay the turbine off long enough for permanent repairs, the damaged ring was merely removed, and the cover being replaced the turbine was immediately set at work again.

Sheffield.—For the 12 months ended March the total output of the electric light department was 5,188,949 units at a cost of £16,306, or 0·75d. per unit, a saving of £928 with an increased output of 1,208,896 units. On the coal bill there was a saving of £1,356.

In the report of the engineer and manager (Mr. S. E. Fedden) it is stated that there has been a continuous increase in the number of consumers of energy for light and power and in the output. Many old consumers have increased their demand by adopting electric heating, lifts and power. The success of the motors now so largely used in every trade of the city and the improvement in business has led to an increased interest on the part of the local manufacturers in electric driving and lighting, which has resulted in many orders to the department and to contractors for electrical plant. Many works are gradually replacing their existing engines by electric motors, and Mr. Fedden feels confident that the great and steady increase in the sale of energy for power which has characterised recent years will be well maintained. During the past year the additions to capital account have been small, and the amount borrowed on behalf of the department has not exceeded £5,440, the additional charges on which will be easily met by the increasing turnover. Mr. Fedden again suggests that his department should be entrusted with the light and power supply to every municipally-controlled building, and also with the illumination of the principal thoroughfares of the city. Capital expenditure for the year was £34,508. 11s., making a total of £839,035. 16s. 11d. The total income from all sources was £61,972. 10s. 4d., and the total cost (generation, distribution, rates, taxes and management) was £16,887. 14s. 4d., leaving a net revenue of £45,084. 16s. Interest absorbed £27,671. 15s. 6d., and the seventh instalment for extinction of loan came to £18,787. 16s. 10d., so that the deficit was £1,374. 16s. 4d.

Southport.—The 12th annual report of the electricity department states that the undertaking continues to grow in a satisfactory manner.

During the year 149 additional consumers were connected, representing 7,526 8 c.p. lamps. There has been a substantial increase in the number of units sold to the Tramways committee and the Southport Tramways Co. The units sold to private consumers increased from 1,023,892 to 1,101,801. The electrical exhibition held in November created considerable interest and had been of great value to the department inasmuch as it brought to the notice of present and prospective consumers the modern developments of electricity for lighting, heating, power and other purposes. The price to new domestic consumers has been fixed at 4½d. per unit, and old consumers have been given the option of this flat rate, or remaining on the maximum demand system.

Southwark.—The Council have resolved to take no action with regard to an offer from the County of London Electric Supply Co. to discuss the matter of supplying the Council with electricity in bulk cheaper than it can be generated at the Council's works, and to supply current for public lighting at 1¼d. per unit for a minimum of 200 lamps, with power to the Council in case the number of lamps should be increased to require a reconsideration of this contract sum.

Spain.—Mr. A. Keyser, British Consul at Cadiz, says the long talked of coast railway from San Fernando to Tarifa has made no progress and suggests that a light electric railway to open up the country would be remunerative to the promoters.

Standard Templates for Pipe Flanges.—The Engineering Standards committee have not only drawn up various lists of standards, but have, with a view of ensuring greater accuracy and interchangeability, introduced series of standard templates for tramway, bull-headed and flat-bottomed rails and for pipe flanges. It was felt that templates for pipe flanges could be manufactured more cheaply and accurately in quantities by proper machinery than by the old-fashioned way of making a single template at a time, and the committee, therefore, entered into an arrangement with Joseph Sankey & Sons, Bilston, to manufacture commercial sets of standard pipe-flange templates in large quantities. In order to ensure a high degree of accuracy in the commercial sets of templates, the committee, in the first instance, arranged for the manufacture of a set of male templates for all the sizes and drillings recommended by them in their standard tables for pipe flanges. These male templates, which were made with extreme care, were forwarded to the National Physical Laboratory, where they were carefully measured up and a certificate of their accuracy obtained. All the commercial sets are carefully checked against the verified standard set before being issued. Accuracy of drilling is thus ensured, and it is hoped that the difficulty of flanges made by one maker refusing to fit the flanges of another, though they both may purport to be drilled in accordance with the committee's recommendations, will thus be overcome. The templates are made of thin steel plate painted over with aluminium paint, a small piece being cut out at the extremity of each centre line so as to enable the fitter to see that the centre line of the template coincides with the centre line of his flange.

Stockport.—The Council have decided to extend the electric lighting mains to Davenport.

Stockton-on-Tees.—In the annual report of the borough electrical engineer (Mr. J. J. Smith) it is stated that the net profit for the past (the fifth) year's working of the electricity department was £279, against losses of £227 and £928 for 1905 and 1904 respectively, and but for the allowance of discounts (£150) to large consumers, the profit would have been £430. The cost of generation per unit had been reduced from 1·57d. to 1·35d. per unit. The increase in units sold was 31 per cent., and the gross profit was 6½ per cent. on capital expenditure. The income was £7,445, against £6,278.

Sunderland.—The Corporation adopted on Wednesday the accounts of the Electricity & Lighting committee abstracted in our last issue.

The chairman (Ald. Bruce) said that the output during the year showed a great increase compared with the preceding year, and resulted in a gross profit of £21,404. The policy of the committee was to give the first benefits of the increased profits to consumers in the shape of a reduction in charges. The ratepayers had not been asked to provide a penny for the undertaking since it was commenced 11 years ago.

Swansea.—The total receipts of the electricity department for the past year were £16,097. 1s. 9d., against £12,918. 1s. 2d. in 1904-5, and the expenditure was £8,199. 7s. 3d., against £6,188. 2s. 10d., leaving £7,897. 14s. 6d. to meet interest and sinking fund (£7,558. 8s. 8d.), so that the net profit was £339. 5s. 10d. The deficiency brought forward was £1,477. 12s. 3d. Of the receipts £9,163. 13s. 9d. was from private consumers (against £8,848. 4s. 5d.); public lamps, £1,630 (£1,528); power, £4,994. 7s. 3d. (£2,541. 6s. 6d.), and £301. 0s. 8d. for rents of motors, &c. The cost of generation was £4,952. 12s. 4d.; rent, rates and taxes, £903. 7s. 7d.; management expenses, £980. 15s. 9d. The Electricity committee has under consideration tenders for supply and erection of a 600 kw. steam dynamo, with condensing plant, &c.

Taunton.—For the year ended March 31 there was a net profit of £421. 10s. 9d. on the electricity works, making, with £20. 12s. 5d. from previous year, a total of £443. 3s. 2d. The whole of the increased revenue has been derived from private consumers.

Worcester.—The electricity department has decided to supply current at 1½d. per unit from May 31 to Aug. 31 to new consumers.

Yarmouth.—The income of the electricity department for the past year was £17,327, against £15,196 in 1905. The total works costs were £8,362, against £8,401, leaving a gross profit of £8,900, compared with £6,770.

After paying interest, sinking fund, &c. (£5,546), the net profit was £3,353, against £1,350. With amount from previous year, the disposable surplus was £4,804, and the Electricity committee recommended that £1,200 be devoted to relief of rates, £1,500 be placed to reserve, the balance being carried forward. 5 per cent. is to be allowed to consumers for cash payments. The accounts were approved by the Council on Tuesday, when it was decided to increase the salary of the borough electrical engineer (Mr. Gordon Bryant) from £300, by three annual increments, to £400 per annum.

The income of the municipal tramways for the past year was £18,328. 19s. 9d., against £8,726. 8s. 3d. The expenditure was £12,400, against £6,348, leaving a gross profit of £5,928, against £2,388. Interest, sinking fund, &c., absorbed £4,460, leaving a gross profit of £1,468. The committee recommended a grant of £400 in relief of rates, and also that £800 be placed to renewals fund, the balance being carried forward. The Electricity committee has reduced the charge for current to 1¾d. per unit. 2,850,827 passengers were carried, an increase of 264,627 for the Yarmouth cars, and the Gorleston system carried 1,464,012 passengers in nine months. There are now 12½ miles of single track, with 23 cars, and three more on order. The accounts were approved.

York.—The Council have appointed a special tramway committee to consider questions arising out of the contemplated purchase of the tramways, and to prepare a workable scheme for the Council.

Sports.—On Whit Tuesday the employés of Robertson Lamps (Ltd.) held their first sports on their new grounds at Shepherd's Bush, when between 300 and 400 (mostly ladies) were present, and the three chief events (a 100 yds. handicap and ½ mile handicap race for men, 50 yds. handicap race for ladies) secured a large number of entries. The prizes for these and a number of other items in the programme were presented by the works manager, Mr. C. Wilson. This new ground has been provided as a continuation of the social club so that sports and other outdoor amusements can be enjoyed by the club members. Not only has the company paid for the ground, but a large pavilion and dressing rooms have been provided and many improvements made.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Portsmouth Town Council invite tenders for the supply, delivery and erection of water softening plant, water storage tank, steam, feed and exhaust piping, and sundry ironwork. Specifications, &c., may be obtained at the Town Hall, Portsmouth, and a copy of the specification may be also be inspected at (but not obtained from) the offices of the consulting engineers (Messrs. Kincaid, Waller, Manville & Dawson), 29, Great George street, Westminster, S.W. Tenders to the town clerk (Mr. Alexander Hellard) by noon of Wednesday, June 27th. See advertisement.

Edinburgh Corporation invite tenders for supply of lead-covered paper-insulated copper cables for the year ended May 15, 1907. Specification, &c., from the chief engineer (Mr. Frank A. Newington), electricity supply station, Dewar-place. Tenders to the Town Clerk, City Chambers, Edinburgh, by June 25. See an advertisement.

The Electricity committee of *Stepney* (London) Council invite tenders for supply of meters, demand indicators and arc lamp carbons. Tenders to the engineer and manager (Mr. Wm. C. P. Tapper), 27, Osborn-street, Whitechapel, E., by noon June 18.

The Electricity committee of *Stepney* (London) Council also invite tenders for supply and erection of flame arc lamps and cast-iron columns, switches, &c., for lighting certain streets in the borough. Tenders to the Chairman of Committee by noon June 18.

Colchester Corporation want tenders by 18th inst. for extension of Magdalen-street tramcar shed, and by 4 p.m. 20th inst. for 12 months' supply of coal to the electricity department.

Finchley Council invite tenders for feeders, distributing mains and other cables, network and joint boxes, &c. Tenders by 5 p.m June 18.

Chorley Corporation want tenders by noon 18th inst. for electric light installation at refuse destructor works. Specification from Mr. O. Hansom, Albert-square, Fleetwood.

Cleckheaton Council require tenders by 4 p.m. June 22 for 12 months' supply of coal for the electricity works.

Erdington Council want tenders by noon June 27 for the electrical equipment (on the overhead system) of about 2¼ miles of tramways.

Brynamman & District Electric Supply Co. (Ltd.) want tenders by 20th inst. for electric street lighting extensions.

Bermondsey (London) Council want tenders by noon 22nd inst. for coal.

Maidstone Electricity committee want tenders by 19th inst. for coal.

Rotherham Corporation want tenders by 30th inst. for 12 months' stores, including incandescent lamps, tools, paints, oils, &c.

TENDERS RECEIVED AND ACCEPTED.

Hackney (London) Council has received the following tenders for positive accumulator plates with which to renew some cells of the Tudor battery:—

Tudor Accumulator Co. (*accepted*), 12s. per plate; Chloride Accumulator Co., 9s. 5d.; Electrical Power Storage Co., 10s. 10d.; D.P. Battery Co., 14s. 5d. The plates are to be delivered in lots of 25, and the quotations were given on an estimated consumption of about 250 plates per annum.

St. Pancras (London) Council have received the following tenders for the annual supply of carbons:—

	£	s.	d.		£	s.	d.
Geipel & Lange (*accp.*)	£580	11	1	H. G. Mayer & Co. ..	£723	1	10
Siemens Bros. & Co...	903	7	9	Sloan Electrical Co. ..	714	19	2
E. H. Cadiot & Co. ..	877	11	3	Crompton & Co.......	645	16	2
Electrical Co.........	872	1	6	G. Braulik	640	4	9
Sun Electrical Co.....	749	16	0	Compagnie Française..	616	12	9
General Electric Co. ..	749	15	0	International Elec. Co.	609	3	0
Johnson & Phillips				Pestalozzi & Co.......	607	10	0
£731 19 3 and	658	5	0	H. Tuchman	574	15	0

Among recent contracts secured by Johnson & Phillips, Victoria Works, Charlton, Kent, are the following:—

Battery, booster and switch gear for Belfast Tramways and Electricity committee; also an order (through Messrs. Combe, Barbour, Ltd.) for a 400 kw. dynamo for Belfast. For Oldham Electricity committee, motors, &c., for sale or hire for 12 months. For the Japanese Navy, 100 open type arc lamps.

The British Thomson-Houston Co. have received the following orders for electric tramway equipments, cars, &c.:—

Lanarkshire Tramways Co., 6 double deck cars; Stockport Corporation, 5 double deck cars; Colne & Trawden Light Railways Co., 2 double deck cars; Pontypridd Council, 8 double deck bogie cars, with G.E. 58 four-turn equipments and B.T.-H. magnetic track brakes; Dublin & Lucan Electric Railway Co., 1 electric locomotive.

Gravesend Council have accepted the following tenders:—

Siemens Bros. & Co., switchboard, £360, plus £25 for Groves test panel; Mirrlees-Watson Co., condensing plant £746, feeder heater £98, and welded pipes £42; Chloride Electrical Storage Co., Highfield automatic reversible booster £321. 4s.

Accrington Corporation have accepted the following tenders: Yates & Thom, one Lancashire boiler with valves and fittings, one mechanical stoker and one superheater. Browett, Lindley & Co, one 600 I.H.P. triple-expansion engine of the vertical type; and Dick, Kerr & Co., one 400 kw. compound-wound multipolar dynamo.

Warrington Electricity committee has accepted the tender of the British Thomson-Houston Co. for the supply of a.c. motors for the next twelve months.

Wallasey Council has accepted the tender of the British Thomson-Houston Co. for a twelve months' supply of a.c. meters for 100 and 200 volts.

Bradford Tramways committee have accepted the tender of Bolckow, Vaughan & Co. for 500 tons of steel girder rails at £3,393. 15s.

Lynton Council have accepted the tender of the Lynton & Lynmouth Electric Light Co. for public lighting for seven years at 50s. per 32 c.p. lamp per annum.

Brighton Corporation have accepted the tender of Babcock & Wilcox for stand-by induced-draught apparatus for the Southwick generating station at £2,080.

Bedford Corporation are recommended to accept the tender of Siemens Bros & Co. for high and low-tension cables. 11 firms submitted tenders.

Rotherham Council have accepted the following tenders: Ibbotson Bros. & Co, tie bars, bolts and nuts, £107. 8s. 9d; British Insulated & Helsby Cables, trolley wire; Naylor Bros, bracket arms.

Darlington Electricity committee have accepted the tender of the Haste Pump Co. for the supply of low-level condensing plant.

Halifax Council have accepted the tender of R. Turner for 12 roof covers for tramcars at £68. 10s.

Dublin Corporation have accepted the tender of P. Shortall for erecting a sub-station at Clontarf at £360.

Alternator Contracts.—The alternator selected by Leeds to be coupled to the Willans turbine is of Dick, Kerr's manufacture. (This contract is referred to elsewhere in this issue.) The success which Messrs. Dick, Kerr & Co. have achieved in the design of high-speed alternators suitable for coupling to turbines is shown by the list of these machines supplied or under construction for the following authorities:—

Glasgow Corporation, four 3,000 kw. sets; S. Metropolitan Electric Light & Power Co., two 1,500 kw. sets; Leeds Corporation, one 3,000 kw. set; Lancashire & Yorkshire Railway, one 3,000 kw. set; Islington Borough Council, one 1,500 kw. set; Metropolitan Electric Supply Co., one 3,000 kw. set; Bristol Corporation, two 1,000 kw. sets; Midland Electric Power Co., two 1,500 kw. sets; Drake & Gorham, one 750 kw. set; West Ham Corporation, one 1,500 kw. set.

BUSINESS NOTICES.

The Yorkshire Enamelled Slate Co., Hull, inform us that they have taken up as a speciality, and are now supplying, switch and fuse boards, bases, discs, &c., for electrical work. The company keeps on hand a large stock of selected slates for this purpose.

Kramos Limited announce that they have opened an office and showrooms at 169 and 170, Shoreditch High-street, London, E.C.

Messrs. Macartney, McElroy & Co. (Ltd.) are removing to Caxton House, Westminster, to which address all inquiries should be sent after the 23rd inst.

The title of the firm of Moores, Farrell & Co., Manchester, has been altered to J. Moores & Co., and the offices have been removed to 37, Blackfriars street, Manchester.

Leonard Stallybrass and Lionel S. Aldridge (trading as the District Electric Co., 39, Berry-street, Wolverhampton) have dissolved partnership. Debts by Mr. Aldridge, who continues under the old style.

BANKRUPTCIES, LIQUIDATIONS, &c.

An application was made to Judge Russell at Wandsworth (London) County Court on Monday, in the bankruptcy of George Webber, William Leslie and Alice Frances Cheesman.

It will be remembered that in November last the two first-named bankrupts were sentenced to terms of penal servitude, and Cheesman to a period of imprisonment, for extensive frauds upon electrical firms. The creditors had been divided into two classes, viz., one comprising Webber's ordinary trade creditors (including his father, who proved for £1,400 money advanced), and trade debts amounting to nearly £1,000; and the other consisted of defrauded creditors, about 30 of whom had proved for £25,367. The defrauded creditors contended that they were entitled to prove in the bankruptcy of Webber, whose assets amounted to £1,247, because he was engaged in the fraud. In Leslie's case the assets consisted of £4,780 9s. 3d. handed to the trustee by the Aberystwyth police, £480 4s. 6d. value of goods found at a Putney garage, and £529 13s. amount realised by sale of convict's jewelry. The present application was that the estates should be consolidated, and that the defrauded creditors should be allowed to prove for dividend against all three bankrupts. Judge Russell granted the application.

The first meeting of creditors of Theodore Ferdinard Rene, electrical engineer, 6, Snow-hill, and 9, Plum Tree-court, London, E.C., was recently held. Debtor resided at 58, Kensington Hall-gardens, the house being rented by his wife, who claimed the furniture. Debtor was engaged on the Continent on the business of Rene Limited, and the meeting was adjourned for his attendance

A meeting will be held on July 9 at 24, North John-street, Liverpool, to receive an account of the winding up of the South Lancashire Electric Traction & Power Co. (Ltd.)

Plant for Sale.—Messrs. Chas. Kirkby and Sons, Arundel Case Works, Sheffield, advertise for sale a 1¼ B.H.P. Royce C.C. motor with pulley and starting switch.

Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale two Browett-Lindley compound vertical engines coupled direct to Siemens dynamos, two Willans & Robinson compound vertical engines coupled to dynamos, and two Lancashire boilers. See advertisement.

Messrs. Watson, Laidlaw & Co., 98, Dundas-street, Glasgow, advertise for sale a shunt-wound Mavor and Boulson dynamo, giving 75 amperes at 110 volts.

Old Machinery for Sale.—The Secretary of State for War is prepared to receive tenders for the purchase of old machinery, engines, lathes, shaping, drilling and other machines at the Royal Arsenal, Woolwich. Forms of tender may be obtained at the War Office, Pall Mall, S.W. Tenders by noon of Wednesday, June 27th. See advertisement.

Factory Premises, &c., for Sale and to Let.—Messrs. George W. Dawes & Co., 12, Basinghall-street, London, E.C., advertise that they have available many factories, workshops, &c., suitable for the engineering trades, &c.

Messrs. Fuller, Horsey, Sons & Cassell have a large number of eligible factories, warehouses, &c., for sale and to let detailed in their register.

Mr. Sills, architect, 30, Norfolk-street, Strand, London, W.C., has for sale foundry works at Bury St. Edmunds, suitable for engineers or other works.

"Sunshine" Flame Lamp.—The following particulars of the "Sunshine" flame arc lamp supplied by the Electrical Co. are issued, and will be read with interest:—

The principle of the flame lamp is that the carbons converge together at an angle of 20 deg., each carbon being fed down at the same rate. The arc is maintained by a special composition of the core of the carbons. The mechanism of the lamp can be of the ordinary type, such as used in open-type lamps, but in actual practice the clockwork mechanism with an escapement has been found the most satisfactory on account of its great sensitiveness. The flame lamp requires a mechanism which will prevent the voltage across the arc varying more than 5 per cent. The Electrical Co. claim for their "Sunshine" flame arc lamp that this steadiness is obtained by reducing the pull of the shunt coils by one-third when the mechanism begins to feed, thereby ensuring that the pawl engages with each of the teeth when the lamp is feeding, so ensuring that it cannot over-feed. In the alternating-current lamp the principle is that of an induction motor, except that the copper disc is run very saturated in order to produce a sensitive feed. The carbons themselves must be of the highest quality, and in those supplied for this flame lamp the core consists of a composition of metals of the sodium group, the exact composition being a secret of the carbon makers. An economiser is used in order to prevent any draught from getting to the arc and making it unsteady, and the company have found it necessary to use carborundum as being the hardest material obtainable, burning the arc well inside the cup, thereby producing a semi-enclosed effect and increasing the hours of burning. Special precautions have to be taken to ensure that the fumes given off the arc, which are deleterious to any metal, do not come in contact with the mechanism of the lamp. The testing of the lamp requires great care to ensure that the lamps feed at precisely their correct voltage, and when the lamps are fixed it must be assured that the current and voltage are correct. In the case of alternating current lamps it is often necessary to adjust for the particular current curve of the generator from which they are to run, on account of the very large difference of station machines in the variation from the pure sine.

Jandus Flame and Photographic Arc Lamps.—We illustrate below the Jandus patent flame arc lamp (of British manufacture), which Messrs. Drake & Gorham (as sole agents) are placing upon the market, and we extract the following from the particulars sent us relating to the lamp:—

Sir: It has been apparent from articles which have been published on the subject and the recent discussions at the Institution of Electrical Engineers that the flame lamp has come to the rescue of electric lighting when it was needed in order to compete with high-pressure gas systems. Any advance, therefore, in flame lamps will be received with satisfaction by the trade. The Jandus Co., finding the flame lamp, under certain conditions, a competitor to their enclosed type lamps, have been endeavouring to go one better as regards simplicity and reliability of mechanism, the want of which they consider has hitherto interfered with the progress of the flame arc lamp. It appeared to them that lamps which fed by gravity and were supported by a stop offered the best solution of the problem if a suitable stop could be found which was reliable and inexpensive. Previous attempts with platinum, iridium and other costly materials had met with only partial success, and the Jandus Co., with the lamps now being put on the market, claim to have overcome this difficult problem by an entirely satisfactory method and at small cost. Patents for this method have been applied for, and the lamps run three in series on 200 volts, and one special feature is that they regulate without shunt coils of any kind. They have no make or break contacts, screws or other impedimenta.

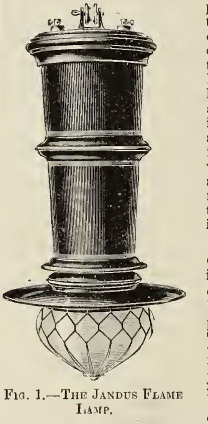


Fig. 1.—The Jandus Flame Lamp.

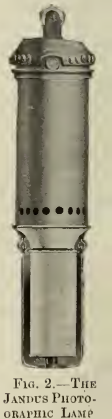
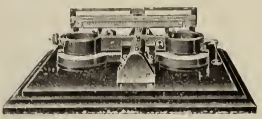


Fig. 2.—The Jandus Photographic Lamp.

Another form of Jandus arc lamp described in a new pamphlet received from Messrs. Drake & Gorham is the photographic lamp. This, an enclosed arc lamp, is illustrated in Fig. 2. It is stated that many methods have been adopted to overcome the trouble of judging the varying degrees of daylight over which the operator in photography has no control, and a solution of this difficulty has now been found which enables portraits to be taken at any time of the day or night with a definite exposure, practically instantaneous, as well as giving a constant ratio between the value of the luminous and actinic radiations. It is claimed that the Jandus photographic arc lamp secures this equally as well as with daylight, and there is no flash of light to cause uneven and harsh lighting. Interesting particulars are given of the advantages which this lamp offers in different branches of photographic work.

Kelvin Balances.—Messrs. Kelvin and James White have just issued the 14th edition of a pamphlet (No 7) giving full illustrated particulars relating to, and the method of using, the well-known Kelvin ampere balances and watt balances. The pamphlet was originally published when this type of instrument was first placed on the market, and although no very material change has been made in the construction of these balances certain improvements have been introduced to facilitate ease of manipulation and to bring the instruments into line with modern requirements, and therefore the issue of the new pamphlet is of interest to all who have or are likely to have Kelvin balances in use. Owing to the extended employment of alternating current fuller particulars are given in the new pamphlet of the Kelvin watt balances and the method of connecting these in circuit with the resistance usually supplied. In connection with the instruments, several patterns of which are illustrated (including the Board of Trade pattern), it is pointed out that in order to facilitate their reading when used on a circuit with a slightly varying load dashpots have been fitted on some types of balances with satisfaction to users. In regard to the watt balances, the moving coils of these instruments are now so designed that self-induction is reduced to a minimum. The instruments are absolutely unaffected by wave form or by frequencies at power factors usually met with in practice. The external non-inductive resistance is now sub-divided into a large number of coils in order to annul any error due to capacity. Fuller particulars are also given in the new pamphlet of composite balances as ampere meter, voltmeter and wattmeter, and various improvements have been introduced to facilitate these measurements. The many uses to which these instruments are being applied is shown in the pamphlet, and much other information is given which will be of interest. We show a special form of kilo-ampere balance in the accompanying figure. It is important to state that the list of prices which is now issued cancels all previous lists relating to these instruments. A copy of the pamphlet can be obtained by any of the company's existing customers or by others interested on application to the London offices, 66, Victoria-street, S.W.



Kilo-Ampere Kelvin Balance.

Catalogues, &c.—Electric drilling machines, electric pulley blocks and motor combinations are listed in a new catalogue of Kramos Limited, Bath and London.

Archibald J. Wright (Ltd), Leyton-green-road, London, N.E., have ready a price list (sections M and I) of automobile accessories and electrical instruments.

A new circular (No. YM 111) from Siemens Bros. Dynamo Works (Ltd.) describes and illustrates some forms of drum type crane controllers which have been recently introduced. Some of these are arranged with braking positions in addition to the "off" and reverse notches. A number of forms of these controllers are made for fixing in vertical or horizontal positions, and with hand wheel, lever or rope control. The three-phase controllers are of the same general design, and are intended for regulation of slipping motors by cutting resistances in and out of the rotor circuits. These are supplied with three different arrangements of connections: (1) For full reversal without braking positions, (2) for lifting and lowering with current impulse and (3) for lifting and for lowering with opposing current and with current impulse. An ingenious "universal" mechanism for working two controllers with the same lever for combined lifting and slewing is described. The same company issue a pamphlet (YM 14) devoted to direct-coupled alternators for lighting, power and traction. A fully-illustrated description of the standard UR type of revolving field alternator made at Stafford is given, together with outline dimensions of the various sizes.

Messrs. Crompton & Co. have ready two new catalogues (D27 and S8) dealing respectively with alternating-current generators and motors and switch gear. There are some excellent illustrations in both lists, and particularly does this apply to the machines illustrated in the first-mentioned list, which also contains some useful formulæ and notes relating to alternate-current working. The machines described and illustrated are Crompton standard machines. It is pointed out that in the case of the alternate-current motors there is a constant demand for machines to work on circuits of 25 to 50 cycles, and Messrs. Crompton have therefore arranged their standard windings to suit these conditions, and it is the outputs given by these standard machines which are listed in this pamphlet. In the second list some fine examples of switch gear are shown, several complete boards supplied by Messrs. Crompton being illustrated. The lists are compact and well printed, and the illustrations are of more than usual excellence.

The British Thomson-Houston Co. have ready three new pamphlets (Nos. 195, 196 and 197), in which rheostatic controllers and resistances, B.T.-H. Meridian lamps and continuous-current motors and generators (type D.A.) are respectively treated. Some good illustrations accompany each list, and a number of tables of ratings and speeds are given in the motor and generator pamphlet.

A well-printed pamphlet describing a "Universal" system of machine moulding is being circulated (in English) by Ph. Bonvillain and E. Rongeray, of Paris-Aubervilliers. Automatic sand mixing and crushing machinery, machines for making pattern plates, moulding plant and machinery for a variety of uses and of several types, and other useful machines are listed, and the illustrations accompanying the text are numerous and clear.

In the General Electric Co.'s Progress Sheet for June a useful form of incandescent lamp guard (the "Security") is listed and illustrated. This guard has no cap or gallery to obstruct the light, is unbreakable and is so constructed as to render it impossible for any unauthorised person to remove the lamp enclosed within the folds of the guard. A useful electric light table standard (the "Flexo") is also shown. An improved pattern of the "Link" branch switch for circuits up to 250 volts, cut-out boards and automatic circuit-breakers (both of which are listed at reduced prices), and some particulars and excellent illustrations of the "P.O." telephone wall set are included.

"Bull" electric motors are described and illustrated in a new price list issued by the East Anglian Engineering Co., Stowmarket.

"Tung" varnish, for which merits as an insulating material and for general uses are claimed, is dealt with in a circular issued by Harold Heydon & Co., Old Paradise-street, London, S.E.

Imports.—The following are official values of imports of electrical machinery, material and apparatus imported into this country during May, 1906:—

Electrical machinery, £30,871 (an increase of £1,394); telegraph and telephone cables, £16,116; telegraph and telephone apparatus, £39,374; other electric wires and cables (rubber insulated), £4,839; (with other insulations), £4,009; other electrical goods and apparatus, £36,767. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £101,105 (increase, £3,572), and for the five months ended May 31, £500,343 (increase £61,938).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from June 7 to June 12, with the ports of destination:—

Africa—Alexandria, £516 (including £373 telegraph material); Cape Town, £6 (telegraph material); Delagoa Bay, £132; Durban, £1,292 (including £459 telegraph material); East London, £90; Port Elizabeth, £39. *Argentina*—Buenos Ayres, £465; Rosario, £1,443. *Australasia*—Adelaide, £50; Auckland, £315; Brisbane, £42; Melbourne, £1,676 (including £1,275 telegraph cable); Otago, £7; Perth, £362; Rockhampton, £39; Sydney, £702; Wellington, £260. *Belgium*—Ostend, £32. *Brazil*—Bahia, £5,067; Rio Janeiro, £5,033 (submarine telegraph cable). *British Guiana*—Demerara, £10. *Canada*—Montreal, £89. *Ceylon*—Colombo, £385. *China*—Shanghai, £105; Tientsin, £64 (telegraph material). *Denmark*—Copenhagen, £190 (telegraph cable). *France*—Boulogne, £10. *Holland*—Amsterdam, £145. *Hong Kong*, £65 (including £45 telegraph cable). *India*—Bombay, £611; Calcutta, £2,402 (including £14 telegraph material). *Italy*—Genoa, £120. *Japan*—Nagasaki, £715; Yokohama, £85. *Malta*, £60. *Mauritius*, £11 (telegraph material). *Norway*—Christiania, £22. *Russia*—St. Petersburg, £74. *Spain*—Bilbao, £25; Huelva, £160. *Straits Settlements*—Penang, £84 (including £16 telegraph material); Singapore, £36. *Sweden*—Gothenburg, £47. *U.S.A.*—New Plymouth, £15; New York, £22. *Uruguay*—Monte Video, £209. *West Indies*—Trinidad, £10. *Zanzibar*, £16. Total (for six days) £23,355 against £21,813 for eight days last year (June 7 to 14).

PATENT RECORD.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

5,059 Mascord. Application and distribution of electric motive power, particularly for starting machinery and similar purposes.
7,133 Fellows & Pickup & Tice. Regenerative battery. (Post-dated May 31, 1905.)
7,733 Jones & Auto-Electric Rifle & Target Co. Target practice apparatus and targets where no projectile is employed.
9,837 Bruce Peebles & Co. & La Cour. Compounding synchronous alternating-current machines.
9,864 Hirsch *née* Schönrock. Bodies for incandescent lighting.
9,965 Lake. (Fabrik Elektrischer Zünder Ges.) Electric group time fuzes.
10,214 B.T.-H. Co. (G.E. Co., U.S.) Electric-current rectifiers.
10,288 Sunderland & Pillinger. Holders for incandescent lamps.
10,299 Boucherot. Dynamo-electric machines. (Date applied for, 17/5/'04).
10,341 Trinder & Cramb. Iron standard for fixing guard boards on electric railways.
10,495 Ellis & Taylor. Charging and discharging accumulators.
10,601 Zehnder. Wireless telegraphy with earth currents. (Rights not granted.)
11,391 Koch. Brushes for dynamo-electric machines.
11,840 Whyte. Electric block railway signalling and train control system.
12,003 Saxby. Socket connectors for electric light cables.
12,100 Jackson. Electric tail-lamps for motor cars.
12,221 Hepburn & Mather & Platt. Electrolytic apparatus.
12,645 Leitner. Regulating dynamos.
13,816 Jensen. Electromagnetically actuated friction reversing gear.
13,974 B.T.-H. Co. (G.E. Co., U.S.) Fuse boxes.
14,145 Parsons & Stoney. Turbines.
14,788 Marconi & Marconi's Wireless Telegraph Co. Wireless telegraphy.
15,365 Major, Stevens & Stevens. Electric lifts with electromagnetic control.

15,546 Turner, Dixon & Stewart. Controlling and operating points of electric railways and tramways.
16,179 Simms. Electrical ignition gear for internal combustion engines.
17,286 De Veulle. Electrical contact makers and breakers for internal combustion engines.
17,288 Reonart. Electric candle lamps.
20,579 Siemens & Halske A.-G. Photographic recording apparatus for electrical measuring instruments. (Date applied for, Oct. 11, 1904.)
20,690 McIlwain & Bennett. Electrical block signalling apparatus.
20,772 A.-G. Brown, Boveri & Co. Alternating-current motors. (Date applied for, Oct. 17, 1904.)
21,673 Peckham. Trucks for tramway, railway, or like vehicles.
21,870 Lines. Securing a wire supplying electricity to a terminal.
21,130 Hadfield. Magnetic materials. (Date applied for, June 8, 1905.)
22,353 Thompson. (Deutsche Gasglühlicht A.G., Auergesellschaft.) Incandescence lamps with metallic filaments.
22,946 Boudreaux. Self-lubricating brushes for dynamos. (Date applied for, Nov. 11, 1904.)
23,624 Elektricitäts A.-G. vorm. W. Lahmeyer & Co. Circuit breakers for alternating currents. (Date applied for, Dec. 22, 1904.)
24,452a Harbison. Switches for incandescent lamps. (Date applied for, Nov. 27, 1905.)
24,502 Blondel. Smoke escape devices for arc lamps.
25,391 Soc. l'Eclairage Electrique. Multicellular centrifugal turbine pump. (Date applied for, Dec. 8, 1904.)
26,032 Sturmey. (Duryea.) Electric ignition for internal combustion engines.
26,072 Siemens & Halske A.-G. Telegraphs for transmitting orders. (Date applied for, Dec. 14, 1904.)
26,506 Lake. (Stone & Webster.) Rail bonds.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—At the meeting on Friday, Mr. H. Allen said that in 1905 there was no interruption in the steady improvement which had marked the company's progress for some years. In the last half-dozen years the gross revenue had increased from £19,223 to £29,808, whilst their net profits had grown from £3,519 to £9,702. They were now establishing exchanges on the south side of the River Tagus, and from that hitherto untouched portion of their territory they ought to derive remunerative business. In certain respects the board of a telephone company was always in somewhat of a predicament. They had, in a sense, two conflicting interests to reconcile, and in the endeavour to hold the scales as evenly as possible between the public and their shareholders, they ran the risk of not wholly pleasing either. The telephone-using public was apt to forget that mere surplus of income over current expenses was not net profit; that the property all the while was depreciating; and, in the case of a company working under a limited concession, provision had to be made against its expiration in case of non-renewal. Although the past year had given satisfactory results, the real benefit arising from the recent reconstruction of the Lisbon system should be yet more marked in the next year or so, as the present offices and plant are sufficient, with relatively little addition to working expenses, to serve a greatly-increased number of subscribers. He believed there was no class of commercial undertaking in which the precise measure of depreciation was more difficult to gauge than in that of a telephone company. As their present concession expired in 1937, the possibility of not getting a renewal, and the doubt as to the precise amount of compensation which they might receive if their system were taken over by the Portuguese Government, in was in contemplation by the board to take out a redemption policy of sufficient amount to relieve the shareholders of any anxiety they might otherwise feel, and to defray the cost of that policy out of such sums as they might from time to time appropriate from revenue to reserve. Their relations with the Portuguese Government and the municipal authorities were of the most cordial character.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The balance at credit of profit and loss for the year ended March 31 was £14,354. 9s. 9d., and after deducting £5,025. 1s. 1d. for management expenses, depreciation, &c., the balancs was £9,329. 8s. 8d., from which £6,000 has been paid in preference dividends and an interim dividend of 8 per cent. on the ordinary stock, leaving, with balance forward, £10,916. 12s. 4d. The directors propose a dividend on the ordinary shares of 14 per cent. (less tax) for the half-year ended March, making 11 per cent. for the year.

CORK ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—At an extraordinary meeting on Friday it was resolved to increase the capital by £20,000 in 1,000 5 per cent. cumulative preference and 1,000 ordinary shares of £10 each.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)—The report for 1905 states that the rent of 1,100,000 pesetas receivable under the lease of the company's undertaking in Madrid to the Cia General Madrileña de Electricidad has been regularly paid, producing £32,907. 10s. 6d. compared with £31,668. 15s. 2d. in 1904, an increase of £1,238. 15s. 4d. Of the revenue 545,000 pesetas (£16,473. 5s. 11d.) was remitted to London. Including interest, &c., the gross revenue was £33,381. 19s. 11d. After deducting debenture interest, &c., amounting to £17,801. 18s. 2d., £15,580. 1s. 9d. remains. Of this £14,142 has been applied to redemption of debentures and £500 to reserve for contingencies, leaving £938. 1s. 9d., which, with £6,540. 10s. 7d. from last year, makes £7,478. 12s. 4d., which the directors propose to carry forward.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—At the meeting on Wednesday the chairman (Mr. R. Wallace, K.C.) said that, after some negotiation, the directors had succeeded in making an agreement with the Tramway Co. for postponing the contract for leasing the tramways for five years, and that, in the meantime, the Tramway Co. should pay the Power Co. a fixed rate for current. Until he visited Kalgoorlie he had no idea that the engineers of the various mines were so competent and that they had such efficient electrical plants of their own. The mining engineers had a considerable advantage over them, inasmuch as they could put down their plant in their own works at a lower cost, because they had no extra establishment charges to pay and they did not charge themselves any interest on cost. Since his visit they had given the company large orders for current, and companies who were about to instal their own plants decided to take supply from their company. The whole of their supply is now contracted for, and they were going to put down a fresh unit of plant.

LISBON ELECTRIC TRAMWAYS (LTD.)—At the meeting on Wednesday the chairman (Sir C. Euan-Smith) said that the results of their operations for the past year had more than justified their expectations. They had added about 5½ miles of track, which was yielding fair returns, and they had further extensions in view. They proposed to create an additional 250,000 ordinary shares. For the first four months of 1906 their gross profits showed an increase of about £7,000, and the figures for May were £26,500. After reviewing the accounts the report was adopted and a dividend of 5 per cent. was declared.

SOUTH STAFFORDSHIRE TRAMWAYS (LESSEE) CO. (LTD.)—The report for 1905 states that the total revenue was £40,513 and expenditure £41,433, leaving a net loss of £920. The directors anticipate that the satisfactory results of the electrification of the Wednesbury–Darlaston line and of the new agreements with the local authorities will secure a marked improvement in both gross receipts and net result for the present year.

STATUTORY RETURNS, MORTGAGES AND CHARGES.

STATUTORY RETURNS.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—In return to March 29 capital is £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on 50,000 preference and 10,000 ordinary, and £3 per share on 40,000 ordinary, and £381,220 has been received, leaving £38,780 unpaid (call of £1 per share made only a fortnight before date of return and not payable till April 19). Mortgages and charges, nil.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The capital in return to May 29 is £132,520 in 53,008 shares of £2. 10s. each, of which 45,008 have been taken up. £2. 10s. per share has been called up on 8 and £20 has been received. £112,500 is considered as paid on 45,000 shares. Mortgages and charges, £170,000.

WILLANS & ROBINSON (LTD.)—According to return to April 25 capital is £750,000 in 75,000 preference and 75,000 ordinary shares of £5 each, of which 66,666 preference and 66,666 ordinary have been taken up. £5 per share has been called up on 52,203 preference and 52,204 ordinary and £522,035 has been received. £144,625 is considered as paid on 14,463 preference and 14,462 ordinary. Mortgages and charges, £246,549.

MORTGAGES AND CHARGES.

MANN, EGERTON & CO. (LTD.)—Issue on May 29 of £300 5 per cent. debentures, part of series created April 1, 1905, to secure £10,000 charged on company's assets and undertaking, including freehold and leasehold property in Norwich and Ipswich. Trustees, C. F. Buxton and J. J. D. Payne. Previously issued of same series, £9,400.

SIR HIRAM MAXIM ELECTRICAL CO. (LTD.)—Issue on May 25 of £4,500 5 per cent. debentures, part of series created May 16, 1906, to secure £10,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA (June 14).—Bank rate 4 per cent. (since May 3, 1906). Price of silver $29\frac{11}{16}$d. per oz. Consols $88\frac{3}{4}$—$88\frac{7}{8}$ for money, $88\frac{7}{8}$—89 for account; 2½ per cent. annuities $87\frac{7}{8}$—$88\frac{1}{8}$. Consols Pay Day, July 4. Stocks and Shares Continuation Day, June 26; Ticket Day, June 27; Pay Day, June 28; Mining Share Carry-over Day, June 25.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The transfer books and register of holders of the debenture stock will be closed from the 18th to the 30th inst. inclusive, preparatory to payment of interest due July 1.

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 2½ per cent. has been declared.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of 5 per cent. first and 4½ per cent. second debenture stock will be closed from 16th to 30th inst. inclusive.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of the debenture stock will be closed from the 18th to the 30th inst. inclusive, preparatory to payment of interest due July 1.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 27 a special settling day in 18,851 £1 fully-paid vendors' shares of the *National Electric Construction Co. (Ltd.)*, and have granted a quotation to £300,000 5½ per cent. Loch Leven debentures of the *British Aluminium Co. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc, or Dec. (a)	Aggregate, No. of weeks	Aggregate, Amount.	Aggregate, Inc. or Dec, (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	June 1	230	+ 30	22	4,759	+ 479
Anglo-Argentine	,, 10	15,048	+ 2,051	23	345,583	+ 87,070
Ashton-under-Lyne Corp.	,, 2	328	+ 23	10	3,299	+ 288
Ayr Corporation	,, 9	325	- 13	4	1,033	- 143
Baker St. & Waterloo Ry.	,, 9	1,444	...	13	18,847	...
Barnsley	,, 1	167	...	22	3,463	+ 89
Barrow	,, 1	241	+ 5	22	4,757	+ 254
Bath Electric Trams, Ltd.	,, 6	1,288	+ 616	23	16,666	+ 2,599
Birkenhead Corporation	,, 10	1,255	+ 249	..	...	...
Birmingham Corporation	,, 9	705	+ 343	10	5,863	+ 2,156
***Birmingham & Mid.**	,, 1	1,373	- 736	22	80,347	- 8,965
Blackburn Corporation	,, 6	1,463	+ 417	¶10	11,048	+ 854
Blackpool Corporation	,, 7	2,258	+ 1,588	9	8,546	+ 1,563
Blackpool and Fleetwood	,, 9	1,9'3	+ 1,473	23	8,273	+ 1,609
Blackp'l, St. Anne's & Lytham	,, 7	971	+ 669	§31	7,215	+ 1,209
Bolton Corporation	,, 10	2,819	+ 865	10	21,741	+ 1,639
Bournemouth Corporation	,, 6	2,261	+ 1,311	†10	15,812	+ 5,266
Bradford Corporation	,, 2	4,307	- 200	10	46,829	+ 3,784
	,, 9	5,854	+ 2,302			
Brighton Corporation	,, 10	1,398	+ 439	10	9,681	+ 48
Bristol Trams & Carriage	,, 8	7,451	+ 2,329	17	83,067	+ 5,848
Buenos Ayres & Belgrano	,, 3	3,900	- 92	¶24	82,498	+ 5,604
	,, 10	3,745	+ 430			
Buenos Ayres Elec. Trms.	May 12	1,406	+ 237	19	26,865	+ 5,511
Burnley Corporation	June 9	1,580	+ 448	10	12,356	+ 448
Burton Corporation	,, 10	393	+ 61	§10	3,055	- 142
Bury Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 9	R43,895	+ R2,399	23	R1,000,180	+ R102,271
Camborne-Redruth	,, 9	199	+ 14	..	...	...
Cardiff Corporation	...	...	...	...	...	...
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 1	91	+ 28	22	1,471	+ 383
Central London Railway	,, 9	6,096	- 741	23	154,819	- 5,734
Chatham & Dist. Lt. Rys.	,, 7	953	+ 294	†22	14,062	- 177
***City of Birm'gh'm Tram Co.**	,, 1	5,899	- 722	22	114,549	- 6,892
City & South London Rly.	,, 10	2,422	- 475	23	64,826	- 133
Colchester Corporation	,, 7	328	+ 127	41	8,886	- 1,206
Cork Electric Trams Co.	,, 7	573	+ 83	23	10,010	- 213
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 1	418	- 48	22	9,242	- 483
Croydon Corporation	,, 8	2,120	+ 776	1	2,120	+ 776
Dover Corporation	,, 9	344	+ 138	10	2,403	+ 365
Dublin & Lucan Railway	,, 8	197	+ 52	‡23	2,397	- 82
Dublin United	,, 8	6,378	- 1,165	‡23	108,501	+ 1,827
Dudley—Stourbridge	,, 1	811	- 76	22	17,156	+ 50
Dundee Corporation	,, 6	1,120	+ 242	§8	3,318	+ 601
East Ham Council	,, 9	1,2?5	+ 481	10	9,513	+ 1,302
Exeter Corporation	,, 8	422	+ 160	10	2,822	- 261
Gateshead & Dist. Trams.	,, 1	984	+ 38	22	20,214	+ 992
Glasgow Corporation	,, 9	18,701	+ 3,105	2	25,305	+ 1,878
Glossop	,, 9	176	+ 52	23	2,911	+ 802
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 1	238	- 3	22	4,646	+ 189
Gt. Northern & City Rly.	,, 9	1,746	+ 143	23	41,285	+ 2,148
Greenock & Port Glasgow	,, 1	680	+ 55	22	13,356	+ 692
Halifax Corporation	,, 6	2,938	+ 1,302	10	16,546	+ 1,762
Hartlepool Tramways	,, 1	311	+ 43	22	5,761	+ 421
Hastings Elec. Trams Co.	,, 7	1,057	...	23	11,683	...
Huddersfield	,, 9	2,178	+ 820	10	15,496	+ 2,214
Hull Corporation	,, 9	2,574	+ 882	10	22,274	+ 641
Ilford Dist. Coun.	,, 9	738	+ 277	10	5,150	+ 403
Ilkeston Dist. Council	,, 6	205	+ 82	10	1,284	+ 67
Ipswich Corporation	,, 9	697	- 263	10	4,262	- 164
Isle of Thanet Co.	,, 9	961	+ 472	35	11,459	- 561
Keighley Corporation	,, 7	218	+ 75	48	6,930	...
Kidderminster & District	,, 1	102	- 23	22	2,142	39
Kilmarnock Corporation	,, 9	162	- 3	4	561	- 40
Kirkcaldy Corporation	,, 6	236	+ 6	...	...	...
Lanarkshire Trams Co.	,, 7	1,012	+ 322	†23	19,501	+ 4,447
Leamington	,, 1	182	+ 130	22	3,153	+ 1,626
Leeds Corporation	,, 2	6,181	+ 91	10	63,430	+ 5,521
	,, 9	8,640	+ 2,660			
Leicester Corporation	,, 9	3,066	+ 822	23	48,973	+ 5,001
Leith Corporation	,, 2	529	+ 303	‡3	1,358	+ 716
Liverpool Overhead Rly.	,, 10	1,779	+ 229	23	32,512	- 2,087
Liverpool Corporation	,, 2	10,864	+ 16	23	228,561	+ 5,862
***London County Council**	,, 2	25,961	+ 10,010	9	235,508	+ 107,681
London United	,, 8	11,053	+ 4,998	†23	130,052	+ 9,530
Lowestoft	,, 10	205	+ 37	37	4,846	- 187
Maidstone Corporation	,, 7	147	+ 30	10	1,0?8	- 101
Manchester Corporation	,, 9	17,943	+ 4,968	10	135,373	+ 10,574
Mersey Railway	,, 8	2,025	+ 434	23	39,9?2	+ 2,957
Merthyr	,, 1	199	+ 8	22	4,079	- 8
Metropolitan Dist. Railway	,, 10	8,274	+ 409	23	184,512	+ 12,612
***Metropolitan Elec. Trams.**	,, 1	3,388	+ 725	22	67,406	+ 21,469
Middleton	,, 1	335	- 59	22	6,772	+ 205
Nelson Corporation	,, 9	191	+ 55	11	1,532	+ 135
Newcastle-on-Tyne Corp.	,, 9	4,831	+ 602	10	39,547	+ 2,331
Newport (Mon.)	,, 9	882	+ 298	10	6,318	+ 561
Northampton Corporation	,, 8	718	+ 274	10	4,400	+ 335
Oldham, Ashton & Hyde	,, 1	551	- 25	22	1?,724	+ 406
Oldham Corporation	,, 10	2,182	+ 518	11	19,659	+ 1,649
Perth (N.B.) Corporation	,, 6	187	...	8	485	...
Perth (W. A.) Elec. Trams	,, 8	1,431	+ 20	‡28	34,703	+ 1,745
Peterborough	,, 1	118	- 29	22	2,359	- 186
Pontypridd District Coun.	,, 9	271	+ 12	10	1,800	- 80
Portsmouth Corporation	,, 9	2,979	- 1,101	10	19,246	- 549
Potteries	,, 1	1,842	+ 133	22	88,1?8	+ 2,173
Preston Corporation	...	...	...	...	...	..
Reading Corporation	,, 7	843	+ 202	...	...	...
Rochdale Corporation	,, 9	1,537	+ 719	10	10,719	+ 4,519
Rotherham Corporation	,, 7	793	+ 363	10	4,92?	+ 695
Rothesay	,, 1	132	+ 13	22	2,047	+ 397
Salford Corporation	,, 11	6,439	+ 1,775	10	46,811	+ 2,431
Sheerness	May 30	58	- 14	22	1,105	- 204
Sheffield Corporation	June 10	6,617	+ 1,651	11	58,049	+ 4,970
Southampton Corporation	,, 6	1,252	- 620	†10	9,055	+ 279
Southend Corporation	,, 6	570	+ 232	10	3,428	+ 301

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 8 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended	Amount.	Inc. or Dec. (a)	Aggregate, No. of weeks.	Aggregate, Amount.	Aggregate, Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	June 1	312	- 15	22	5,707	- 89
S. Staffordshire Trams.	,, 1	767	+ 38	22	17,148	+ 2,481
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	...	...
Sunderland Corpn.	,, 10	1,980	+ 659	10	13,951	+ 1,427
Sunderland & District	,, 6	662	...	23	8,434	...
Swansea Trams	,, 1	786	- 26	22	16,534	+ 4,225
Swindon Corporation	...	..	...	...	...	...
Taunton	,, 1	43	- 4	22	9?0	- 52
Tynemouth and District	,, 1	238	- 42	22	4,103	- 144
Tyneside Trams Co.	,, 6	664	+ 228	?8	9,057	+ 698
Wallasey District Council	,, 9	1,126	+ 356	10	7,896	+ 497
Walsall Corporation	,, 9	794	- 305	20	11,583	+ 1,096
Warrington Corporation	,, 7	429	+ 103	11	3,670	+ 437
West Ham Corporation	,, 7	2,872	+ 1,273	10	22,839	+ 7,971
Weston-super-Mare	May 30	?5	- 39	22	1,139	- 85
Wolverhampton Corpn.	June 6	1,425	...	...	...	...
***Wolverhampton District**	,, 1	392	+ 3	22	8,523	+ 735
***Worcester**	,, 1	270	- 38	22	5,425	- 537
Wrexham	,, 1	94	+ 4	22	2,075	- 53
Yorkshire W.R. Trams	,, 10	1,489	+ 686	23	17,965	...
Yorkshire Woollen District	,, 1	921	+ 236	22	18,503	+ 5,626

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., June 13.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 13. Highest.	Business, Week to June 13. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	$6\frac{13}{16}$—$7\frac{1}{16}$	5 14 0	Ap, Oct	7⅛	6⅞
5	2/9	Do. 5½% Cum. Pref.	$5\frac{13}{16}$—$6\frac{1}{16}$	4 11 8	—	$6\frac{1}{16}$	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	140—143	4 3 9	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104—106	4 14 3	—	105	104½
5	..	Brisbane Electric Trams. Invest. Ord.	1¼—1½	..	..	$1\frac{11}{32}$	$\frac{9}{32}$
5	2/6	† Do. 5 per Cent. Cum. Pref.	4¼—4½	5 1 0	—	4⅜	$4\frac{5}{16}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	94—97	4 12 9	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115—118	5 1 6	—	..	..
St.	5%	† Do. Pref. Ord. Stk	107—110	4 11 0	—	..	..
100	5%	Do. 5% Cum. Perp. Pref. Stock.	107—110	4 11 0	—	108½	108
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	102%—104%	4 6 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103—106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	8⅜—8⅝	4 15 6	—	8½	$8\frac{7}{16}$
5	3/0	Do. 6 per Cent. "A" Cm. Pref.	5⅝—5⅞	5 2 6	—	5⅝	$5\frac{1}{16}$
5	3/0	Do. "B"	5—5½	5 7 0	—	$5\frac{3}{16}$	..
St.	5%	Do. 5 per Cent. Debs.	106—108	4 12 6	—	106¾	106¼
St.	5%	Do. 5% 2nd Deb. (red.)	103—106	4 14 8	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	102—104	4 16 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	103—107	5 3 0	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	100—105	5 14 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8¾—9¼	4 6 6	—	9	..
5	2/6	Do. Nos. 105,001 to 137,610	8⅜—8⅞	4 10 0	..	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106—108	4 3 8	—	107¾	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100—102	4 18 0	—	101¼	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	97—99%	5 1 0	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91—93	..	..	92½	92¾
St.	..	Do. 6% "B" Ditto	90—95	..	..	..	..
1	..	Lisbon Elec. Trams Ord.	$1\frac{7}{16}$—$1\frac{11}{16}$	..	..	$1\frac{9}{16}$	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100—103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102—105	4 15 0	Ja, Jul	—	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102—104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	107—109	4 11 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	144—147	..	..	145½	..
..	5%	† Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	98½	97¾
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	..	..
5	5/3	Calcutta Elec. (1-50,000)	8½—9	4 14 0	—	8⅞	..
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50—52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94—96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	87—91	5 10 0	—	..	..
10	..	Havana Electricity Co. Shares	10—11	—	—	..	..
100	5%	† Do. 5% Dbs. iss. at 95, Scrip, all pd.	98—100	5 0 0	..	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113—116	5 3 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞—1	6 0 0	—	$\frac{31}{32}$	$\frac{15}{16}$
1	1/6	Rand Electric	$1\frac{3}{16}$—$1\frac{5}{16}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{7}{16}$—$\frac{9}{16}$	..	..	..	..
1	1/2⅜	Do. 6% Non. Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101—103	4 17 0	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99—102	4 8 0	Ap, Oct	..	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101—103	4 17 0	..	101¾	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., June 13.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to June 13. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 —12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 —12	5 0 0	..	11½	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106 —108	4 8 3	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛—8⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 6	—	102¾	102
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8¾—9¼	5 8 6	—	8¾	..
5	8/6	Do. 7 per Cent. Pref.	7¾—8¼	4 5 0	Mar, Sept	7¾	..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	100 —103	3 17 9	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 —5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅞	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —103	3 17 6	—	—	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾—4¼	5 6 0	—	.	..
5	2/3	Do. Do. (1903)	3¾—4¼	5 6 0	—	4⅛	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 —110	4 2 0	Jn, Dec ..	..	..
10	7/0	City of London Electric Lighting Ord.	10½—11¼	5 6 6	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12½—13½	4 9 0	Jan, July	12½	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 —126	3 19 4	Jn, Dec ..	—	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —103	4 8 0	..	..	..
5	4	County of Durham Elec. P.D. Ord. £3 pd.	3 —3 1/32	4 0 0	April, Oct	2 3/32	..
5	5%	Do. Do. 5% non cum. pref.	5⅛—5⅜	4 15 3	April, Oct	5 5/16	5¼
10	6/0	County of London Elec. Supply Ord.	8 —9	5 11 0	—	8¼	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¼	4 18 0	Mar, Sept	11¼	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 —112	4 0 4	..	109½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —103	4 7 4	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	5 7/16	5⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 —104	4 6 6	—	..	..
5	5/0	Hove Electric Lighting Ord.	8 —8½	5 6 0	—	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 —11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 2	..	100¼	99½
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4⅘	London Electric Supply Ord.	2 —2½	4 0 0	—	2 3/32	..
5	3/0	Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	5 1/32	5
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	98 —101	3 19 2	Mr, Jn, S, D	..	..
5	10%	Metropolitan Electric Sup. Ord.	8 —9	5 11 0	April, Oct	8 11/16	8
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜—5⅝	4 0 0	Jan. July	5 15/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 —114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 3	—	96	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	100 —103%	4 7 4	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12 —12½	5 11 1	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 —104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅞—8	5 0 8	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞—6	4 1 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	—
1	8%	Northern Counties Elec. Sup.	1 —1 1/32	3 0 0	Mar, Aug	1 1/32	..
100	4½%	Do. 4½% Deb.	101 —102	4 8 9	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 —14	6 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6½—7	4 16 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 —101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½—11½	5 8 0	Feb, Aug	..	..
5	8/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 —98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼—2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾—3¼	6 8 0	..	3 1/32	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1¼—1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3¼ 3¾	6 0 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100 —102	4 8 0	..	100½	..
5	6/6	Westminster Elec. Sup. Ord.	10¾—11¼	5 15 6	Mar, Sept	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16—5 9/16	4 10 0	..	..	..
5	..	Do. Issued at 7/6 premium all paid	5 5/16—5 9/16	..	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 —96	4 3 4	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16—1 1/32	4 14 0	..	15/16	..
1	0/6	Do. 5% Cum. Pref.	31/32—1 3/32	4 11 6	..	31/32	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 —104	4 6 6	..	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	101 —103	4 7 9	..	..	..
10	3½%	Bristol Tramways and Carriage Ord.	15½—16	5 6 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 —10¼	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	103 —105	3 16 0	Feb, Aug	..	.
10	6/0	British Electric Traction Ord.	6¾—7¼	4 8 0	—	7¼	6 11/16
10	6/0	Do. 6 per Cent. Cum. Pref.	9¾—10¼	5 17 0	Feb, Aug	10 3/16	10
St.	5%	Do. 5 per Cent. Perpetual Debs	115 —118	4 4 4	..	117¾	116
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 —95	4 14 9	..	93	..
St.	4%	Central London Ordinary Stock	86 —88	4 11 0	June, Dec	87¼	86
St.	4%	Do. 4 per Cent. Pref. Stock	99 —101	3 19 0	..	..	..
St.	4%	Do. Deferred Stock	77 —80	5 0 0	..	77½	-
100	4%	Do. 4 per Cent. Debs.	110 —112	3 11 3	..	112	111½
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	93 —95	4 4 0	..	96½	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞—5⅜	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	40 —42	4 9 0	Feb, Aug	42	41⅛
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 —123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½—15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾—4¼	9 8 0	..	3 31/32	3⅞
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 —103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 —16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 —12½	4 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	105½—106½	4 4 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 —2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 —85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8⅛—8⅜	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾—9¼	5 2 6	—	9	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 —99	4 1 0	—	97½	97
St.	..	Mersey Con. Ord. Stock	4 —6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 —11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	⅛	..
1	0/6	Do. 5% Cum. Pref.	¾—1	5 0 0	—	15/16	..
St.	4½%	Do. 4½% Deb. Stock	102 —104	4 6 6	—	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7 —8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾—8¼	6 1 4	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	—	—	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93 —96	5 4 0	—	..	..
..	5%	Und. El. Rys. Co. of Lond. Ex Coupon No. 0	94 —95	5 4 0	..	94⅝	94½
St.	3½%	Waterloo and City Ord.	100 —103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 —3½	..	—	..	..
St.	4½%	Do. 4½% 1st Debs.	95 —97	4 13 0	—	96	—

Shre.	Last Dividend	Name.	Price Wed., June 13.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 13. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	..
1	2/4⅘	Babcock & Wilcox Ord	3⅞—4⅛	4 17 0	..	4⅛	4
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6½—7	5 14 0	July, Feb	6¾	6⅝
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 —107	4 4 0	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 —98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1 —1½	..	..	1⅜	1½
St	4%	Do. 4 per Cent. Mort. Deb. Stock	79 —84	4 5 0	..	80	..
2	/6	Brush Electrical Engineering	⅝—⅞	..	March ..	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 —99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 —86	5 4 6	Jan, July	..	—
5	10/0	Callender's Cable Con. Ord.	10½—11½	4 10 6	Jan, July	11	10 13/16
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾—6	4 3 4	Jan, July	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108½—110½	..	Nov, May	..	..
1	5⅞d.	†Castner-Kellner Alkali Co.	1 1/16—1 3/16	5 1 6	..	1 3/32	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 —102	4 8 0	—	99¾	99½
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	1 5/16	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅞—2⅛	3 7 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%—97%	5 1 0	Jan, July	98	..
5	10/0	Dick, Kerr & Co. Ord.	1¾—1⅞	5 8 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept	1 3/16	..
St.	4½%	Do. 4½% Deb. Stock	104 —107	4 5 0	..	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	—	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½—3	—	Feb, Aug	1 3/32	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 —88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4½—5	6 0 0	..	4½	4⅝
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	—	103½	..
2	1/7½	Electric Construction Co.	⅜—⅝	11 4 0	July	½	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 —2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	89 —92	4 7 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼—9¾	5 2 6	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 —13	5 15 0	Feb, Aug	12½	—
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	..	—
St.	4½%	† Do. 4½ per Cent. 1st Mt. Db. St.	107 —109	4 2 6	..	..	..
St.	22/6	† Do. Do. Scrip (all paid)	107 —109	4 2 6	..	108¼	—
10	10/0	India Rubber, Gutta Percha, &c., Wks.	17 —18	2 17 2	Feb, Aug	..	—
100	..	Do. 4% Debs. Red.	99½—101½	..	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	⅞—1	6 0 0	..	31/32	..
St.	4½%	Do. 4½% Perp. Deb. Stock	97 —100	4 10 0	..	..	..
12	14/0	Telegraph Construction & Mainten'ce.	32 —34	5 6 0	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 —104	3 17 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16—2 9/16	5 15 0	..	2 17/32	2 15/32
1	6d.	Do. 5% Non-Cum. Preference	1⅛—1¼	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	114 —117	4 5 4	—	115	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 —105	3 16 0	..	103	..
100	4½%	† Do. 4½% 2nd Mort. Debs., Red.	104 —106	4 5 0	—	104½	..
5	—	Willans and Robinson Ord.	1¼—1¾	—	Apr, Oct	1	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	—	Apr. Oct	3 1/16	3
	4%	† Do. 4 per Cent. 1st Mort. Debs.	78 —83	4 16 6	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 —102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	8 —8½	—	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	83 —88	..	..	..	..
St.	15/0	Anglo-American	67 —69	4 14 0	F, My, Ag, N	67⅛	67
St.	30/0	Do. Preferred	114 —115	5 2 0	F, My, Ag, N	115¼	114
St.	10/0	Do. Deferred	26½—26¾	..	F, My Ag, N	26½	25 15/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97 —99	4 1 0	Jn Ap, Jy, O	99	..
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	..	—
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	8⅝	—
50	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable	15½—16	4 13 9	Ja, Ap, Jy, O	15 11/16	15¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 —103	4 7 6	Jn, Dec ..	..	..
St.	26/0	Eastern Ordinary	143 —146	4 16 6	Ja, Ap, Jy, O	145½	144
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 —92	3 16 0	Ja, Ap, Jy, O	91	90½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 —109	3 13 4	May, Nov	108¾	107½
10	6/6	Eastern Extension	14 —14½	4 16 6	Ja, Ap, Jy, O	14 7/16	14
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	107	..
100	4%	Eastern & S. African 4% Mrt. Deb. 1909	99 —101	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) with coupon 67	39 —41	5 17 0	Jan, July	40	39¾
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 —103	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57 —59	5 10 0	May, Nov	58	..
100	4%	Mackay Companies Common	77 13/16—78 3/16	5 2 0	Jan, July	—	..
100	4%	Do. Preference	76 7/16—76 13/16	5 4 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	101 —104	3 17 0	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾—10¼	4 17 6	..	..	—
5	—	West Coast of America	¾—⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	101 —104	3 17 0	Jan, July	..	..
10	—	West India and Panama	7/16—9/16	..	May, Nov	..	..
10	4/0	† Do. 6% 1st Pref.	6 —7	3 11 4	May, Nov	6⅝	6⅛
10	—	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	5 1/16	4 15/16
100	5%	* Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼—14¾	4 15 0	Mr, Jn, O, D	14½	14 5/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 —103	4 17 0	June, Dec	..	.
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 15 6	..	105½	104½
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 —98	..	..	—	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 —103	4 17 0	..	..	..
5	8/0	Chili Telephone (fully paid)	7⅞—8⅛	4 18 0	August	..	..
1	0/4⅘	Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	0/6	Do. 6% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 —112	5 7 0	—	111½	111⅜
St.	6%	Do. Def. Stock	108 —110	4 11 0	—	109¼	108¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 —14	4 5 6	Feb, Aug	13¼	13
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	—
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½—5¾	4 7 0	Feb, Aug	5½	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	98½	98¼
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 0	—	104½	103½
1	0/9⅗	Oriental	1⅜—1½	4 0 0	April, Oct	1⅜	—
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	..	—
St.	24/7⅗	Do. 4% Red. Deb. Stock	99 —101	3 19 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103 —106	4 4 9	..	..	.
5	8/0	United River Plate	7 —7½	5 6 8	July	7⅛	7
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜—5⅝	4 9 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 —113	4 8 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾—5¼	5 14 0	..	..	..
10	5/0	† Globe Telegraph and Trust	10⅞—11⅛	4 19 0	Ja, Ap, Jy, O	11	10⅞
10	3/0	† Do. 6 per Cent. Pref	14⅝—14⅞	4 0 0	Ja, Ap, Jy, O	14⅝	14⅝
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 3	April, Oct	..	—

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption.

ividend, ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

A LARGE proportion of our space this week is devoted to a report of the proceedings of the Incorporated Municipal Electrical Association. The meeting at Kingston on the first day was chiefly devoted to a lecture on Steam Turbines by Mr. S. W. BAYNES, illustrated by over 100 lantern slides. Mr. BAYNES described in succession practically all the makes of steam turbine on the market, and as he also made a digression to show some fine illustrations that he had collected of turbine steamers, the time left over for the discussion was shorter than it might have been. The discussion chiefly turned on the question of stripping. Some turbines, it appears, have an ostrich-like digestion, and a few dozen stripped blades does not affect them in the least, while in other cases a "strip" necessitates an immediate shut-down. A representative of Messrs. WILLANS & ROBINSON begged electrical engineers to be satisfied with less steam consumption, for this meant greater clearance and greater immunity from stripping, and in this he was supported more or less by Bailie WILLOCK, of Glasgow, who emphasised the point that the great saving in using turbines in place of reciprocating engines was the saving in capital expenditure, which was far more important than a few pounds of steam per unit,—although he expressed it somewhat differently.

THE greater portion of the morning of the second day was occupied with the discussion upon the two Papers by Messrs. FEDDEN and COLLINGS BISHOP upon the commercial development of electricity undertakings. Contrary to anticipation, the Chairmen of Committees hardly took so prominent a part in the discussion as is usual on the "Councillors' Day," and despite the assertion made by one Chairman that on commercial matters he declined to allow his engineer to know anything, the debate pretty clearly demonstrated that the commercial destinies of many of our municipal electricity undertakings are shaped more by the engineers than by the Committees. The efforts made to "push" the sale of electricity all over the country, judging from the discussion, have been far more persistent than is commonly understood, and probably the high-water mark, so far, has been reached at Sunderland, where there is an intelligence department whose business it is to ascertain what is being done by its competitor, the gas company. This discussion should do much to remove the reproach that little has been done in England on the commercial side of electricity undertakings. The fact seems to be that, although it is only now that special departments for dealing with this branch are being organised, yet a very large amount of work has been carried out by the engineers and their staffs, in addition to their ordinary duties. There is, indeed, some indication that the new commercial departments are being developed with almost too much energy in some cases. When the Borough Electrical Engineer becomes the head of a wiring business, the manager of a hire-purchase department, a lamp referee, a public lecturer, an organiser of exhibitions and even an editor, it is evident that he will have to leave to an assistant the important detail of supplying electrical energy.

AT the general meeting yesterday, Mr. S. E. FEDDEN was elected President for next year, and it was decided that the meeting should be held at Sheffield. We are able to publish a full report of yesterday's proceedings on a later page, and may call attention particularly to the important discussion on the periods for loans granted by the Local Government Board. It is to be hoped that the action to be taken by the Association in this matter will have its proper effect.

MR. JOHN BURNS, at Brighton on Saturday, did an unkind and tactless thing in insisting on condemning the maximum demand system; in fact, he could hardly have been more emphatic if he had employed the more forcible terminology preferred by Bailie Willock on Wednesday. Brighton has decided to adopt an alternative flat tariff, and Mr. Burns might have left the matter there instead of taking sides in a controversy that must necessarily have been distasteful to the consulting engineer to the Brighton Corporation. Nor was Mr. Burns fortunate in his advice to a municipal undertaking in the sixteenth year of its life "not to worry about making a loss of a few thousands." Mr. Burns must have forgotten that he was President of the Local Government Board, a body whose function it is to control municipal expenditure.

We commence this week a preliminary description of some of the features of another link in the chain of the conversion of the London local and suburban railways from steam to electric traction. The setting to work of the generating station of the Great Western Railway Co. at Park Royal, which is to supply the Hammersmith and City and other associated lines, will have an important effect on the railways already worked electrically, and when the last of the steam trains has disappeared from the north side of the inner circle, a great improvement in the service should result. The track work is, of course, similar to that of the other lines, but there are considerable points of difference in the generating and distributing arrangements. The power house, instead of containing large turbine-driven sets generating at 11,000 volts, as in the case of both the Metropolitan and Metropolitan District Railways, contains a number of comparatively small 6,600 volt alternators driven by reciprocating engines. The sub-station equipments also present important points of difference, notably the use of La Cour motor convertors instead of "rotaries," and the adoption of sub-station batteries controlled by Highfield boosters. In view of the difference of opinion which prevails regarding the use of batteries for heavy traction, the results of working should be of interest.

It is surprising how few electrical firms have established any regular superannuation fund for their staff; the practice is confined to the largest firms and companies, and in point of fact, several of these have made no such provision, so that the grant of a superannuation allowance occurs only as an act of grace on the part of the directors. In smaller firms, the provision of such a fund is more difficult, and these firms especially may find it of considerable advantage to profit by the invitation issued by the British Electrical Superannuation Fund to come into the scheme. The Fund has been in existence nearly six years, and reports from well-known actuaries show that it is on a thoroughly sound basis. It was founded for the salaried staff of the British Electric Traction Co., but with a view to its extension to the electrical industry generally a conference of companies interested in the question is to take place early in July.

The interesting action of Chitty v. the British Westinghouse Electric & Manufacturing Co. (Ltd.) was concluded yesterday afternoon, and a verdict was given for the plaintiff with £1,600 damages. The evidence went to show that Mr. Chitty had devised certain improvements in the design and construction of dynamos and had offered his suggestions to the British Westinghouse Company who undertook to construct some experimental machines and to acquire the inventions from Mr. Chitty if the machines proved successful. The Company contended that there was practically nothing new in Mr. Chitty's inventions, but the plaintiff urged that his diagrams and suggestions had been of considerable utility to the Company. He claimed damages for breach of agreement, and, after a lengthy hearing before Mr. Justice Bigham and a special jury, he succeeded as mentioned above.

After a hearing extending over many weeks the London Outer Circle Railway Bill was rejected by Sir George Doughty's Committee of the House of Commons yesterday. As an engineering problem the proposal was of extreme interest, for it may be remembered that it was intended to adopt the single-phase system of traction. On the other hand, it must be confessed that there was but a remote probability of a profitable revenue being earned by a line running in a semi-circle from the far west to the far east of Middlesex, not through London, but via the northern suburbs.

Personal.—Prof. W. F. Kohlrausch, of Hanover, has been elected president of the Verband deutscher Elektrotechniker for 1906-8.

The Origin of Life.—Owing to great pressure on our space this week we are compelled to hold over an interesting letter from Dr. H. Charlton Bastian, M.D., F.R.S., on Mr. Burke's theory of the origin of life.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904 ..	—
Paramaribo—Cayenne	April 20, 1906 ..	June 18, 1906
Guadeloupe—Dominica	June 11, 1906 ..	June 16, 1906

The Electrical Contractors' Association.—It is announced in the *Daily Telegraph* that the Electrical Contractors' Association has entered into an agreement with the Cable Makers' Association with the main idea of inducing the members of the Electrical Contractors' Association to use entirely English-made cables.

Opening of the Duke-street Italian Garden.—On Saturday last the Italian garden in Duke-street, Grosvenor-square, was opened by the Mayor of Westminster. The feature of the garden is that it is laid out on the top of the Duke-street sub-station of the Westminster Electric Supply Corpn. A complete illustrated description of the sub-station, together with a view of the garden, was published in our issue of September 22, 1905.

The Royal Society.—Among the Papers down for reading at yesterday's meeting of the Royal Society were the following: "Ionic Velocities in Gases at Different Temperatures," by P. Phillips; "The Action of Radium and certain other Salts on Gelatin," by W. A. Douglas Rudge, both communicated by Prof. J. J. Thomson, F.R.S.; and "On the Electric Inductive Capacities of Dry Paper and of Solid Cellulose," by A. Campbell, communicated by Dr. R. T. Glazebrook, F.R.S.

The Society of Arts.—Amongst recipients of silver medals awarded by the Council of the Society of Arts to the readers of Papers during the session just completed are the following: Mr. Leon Gaster, "Progress in Electric Lighting"; Capt. G. S. C. Swinton, "London Traffic"; Mr. Bernard B. Redwood, "Motor Boats"; and Mr. J. B. Millett, "Submarine Signalling." The Society's conversazione will be held, by arrangement with the Council of the Royal Botanic Society, in the Gardens of that Society, Inner Circle, Regent's Park, on Tuesday evening, July 3rd, from 9 to 12 p.m.

Metallic Filament Lamps.—The *Elektrotechnischer Anzeiger* announces that the Deutsche Gasglühlicht Gesellschaft will put the new "Osram" lamp on the market in the course of a few months. The lamps are to be made for 100 to 200 volt circuits in various sizes from 32 to 200 c.p., and up to 240 volts in sizes from 40 to 200 c.p. The energy consumption up to 200 volts is given as 1 watt per c.p. and 1·2 watts per c.p. for lamps over 200 volts and up to 50 c.p., and at 1 watt per c.p. over 50 c.p. Some examples of the lamp were exhibited at the recent congress of the Verband Deutscher Elektrotechniker at Stuttgart, and they showed a much whiter light than the usual carbon lamp. A life of more than 1,000 hours is expected.

Commutation Poles in Continuous-current Motors.—A Paper on the above subject, read by Mr. C. H. Bedell at the Milwaukee Convention of the American Institute of Electrical Engineers, gave the following summary of the advantages to be obtained by the use of auxiliary poles: A powerful commutating field is provided to assist the carbon brushes in resisting the sparking tendency, and this field is independent of the main field. The intensity of the commutating field is proportional to the load on the armature. The brushes are placed on the neutral line, and in consequence the machine is perfectly reversible, and may operate either as a motor or dynamo without shifting the brushes or changing any of the connections. A large number of ampere-turns per inch of periphery is permissible, also small air-gaps, resulting in a large output for the material used. The form of the efficiency curve is better suited to the average load.

Obituary.—We regret to announce the death of Mr. Thomas Percy Gunyon, which took place on June 13. Mr. Gunyon was born on March 4, 1854, and entered the service of the late Metropolitan Board of Works in December, 1872, remaining in the service of that Board, and afterwards with the London County Council (as principal assistant in charge of the highways, electric lighting, subways and Embankments lighting branch of the engineer's department) until his decease. The interment took place on Saturday, June 16, in St. Nicholas Churchyard, Chislehurst, in the presence of many of his former colleagues, both of the Council and of the late Board of Works.

The death is also announced of Mr. George James Snelus, F.R.S. Mr. Snelus, who was a well-known metallurgist, was a member of the Institute of Mining Engineers, and a vice-president of the Iron and Steel Institute.

The Association of Teachers in Technical Institutes.—Some resolutions have been adopted by the Council of the above Association regarding electrical engineering examinations of the City and Guilds of London Institute. It is proposed to change the title of the subject from "Electric Light and Power Transmission" to "Electrical Engineering," and to hold a written examination for wiremen independently of the general examination. The following sub-division of the subject into grades and sections is suggested :—

Grade 1. General principles of applied electricity. Grade 2*a*. Continuous current work. Grade 2*b*. Alternate current work. Honours (*a*) Electrical instruments, &c.; (*b*) Design of continuous current machinery; (*c*) Design of alternate current machinery; (*d*) Traction; (*e*) Central stations: Power transmission.

No student is to be allowed to enter for grade 1 unless he has attended a preliminary course corresponding to the Board of Education stage 1 syllabus.

Thunderstorms.—At a meeting of the Royal Meteorological Society on Wednesday last Mr. F. J. Brodie read a Paper on "The Mean Prevalence of Thunderstorms in Various Parts of the British Islands during the 25 years 1881-1905." Figures were given of the thunderstorms which occurred in each month during the period at various parts of the United Kingdom. July is the month with the largest number of thunderstorms over Great Britain as a whole, and August at some places in the north of Scotland and north-west of England, while June is the stormiest month at nearly all the Irish stations. For the whole year, the largest number of thunderstorms is over the northern and eastern parts of England, where more than 75 occur, while there are less than five in the west and south of Ireland, and at most places in the north of Scotland. The summer distribution of thunderstorms is very similar to the annual distribution, while the winter distribution is quite different, when the largest numbers occur along the west-coast of Ireland and Scotland and extreme south-west of England.

Royal Society Conversazione.—Comparatively few of the exhibits at the conversazione of the Royal Society, held on Wednesday night, had direct bearing on electrical science. Mr. Campbell Swinton, however, gave an interesting demonstration of vacuum tubes, in which the cathodes were formed of platinum strips coated with an oxide of one of the alkaline earths heated to incandescence by an electric current. With these tubes, as has been shown by Owers and Wehnelt, the passage of a discharge is immensely facilitated, and with the examples shown, a bright visible discharge was obtained by connecting cathode and anode across the ordinary 200 volt continuous current supply. Some of the tubes showed well-marked striations which were strongly affected by a neighbouring magnet. Another tube which had only a small spot of lime on the cathode produced a narrow visible stream of cathode rays which exhibited some curious effects when deflected electrostatically and electro-magnetically. Perhaps the most significant point in the display was a tube in which radium took the place of heated lime, which showed precisely similar effects. Sir James Dewar, F.R.S., showed a number of experiments involving low temperatures obtainable by means of liquified gases, amongst which was the formation of "electric ice crystals" on an electrified glass rod which had been cooled by immersion in liquid air. A series of photographs of electrical discharges was shown by Mr. Kenneth J. Tarrant, showing the characteristic discharge from an interrupted continuous current on a high-frequency oscillating current, also between parallel conductors of varying capacities and with various condenser conditions.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, June 22nd.**

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

10 a.m. Annual Conference. Fourth Day. Meeting at the Wharncliffe Rooms, Hotel Great Central, London, N.W. The following Papers will be read: (1) "Live Steam Heat Feed Water; its Effect on the Output and Efficiency of Steam Boilers," by G. Wilkinson (Harrogate); "The Efficiency of Steam Plant," by W. H. Vignoles (Grimsby). These Papers will be discussed together. (2) "The Supply of Power to Tramways from Small Stations," by S. J. Watson (Bury).

2 p.m. Visit to the L.C.C. Generating Station, Greenwich.

PHYSICAL SOCIETY.

5 p.m. Meeting at the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo," by A. A. Campbell Swinton. (2) "A Comparison Between the Peltier Effect and Other Reversible Heat Effects," by A. O. Allen. (3) "The Effect of the Electric Spark on the Activity of Metals," by T. A. Vaughton. (4) "Dielectric Strength of Thin Liquid Films," by Dr. P. E. Shaw. (5) "The Effect of Electrical Oscillations on Iron in a Magnetic Field," by Dr. W. H. Eccles.

SATURDAY, June 23rd.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

11 a.m. to 1 p.m. The National Physical Laboratory will be open for the inspection of the members of the Municipal Electrical Association.

MONDAY, JUNE 25th.

NATIONAL PHYSICAL LABORATORY.

2:45 p.m. Opening of the Electrical Laboratory by the Right Hon. R. B. Haldane, K.C., M.P.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. Banquet to the Foreign Visitors at the Hotel Cecil.

TUESDAY, June 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.

9:30 a.m. Visit of Foreign Engineers to works in London.

9 p.m. Reception of the Foreign Visitors, and Annual Conversazione at the Natural History Museum.

WEDNESDAY, June 27th.

INSTITUTION OF ELECTRICAL ENGINEERS.

9:30 a.m. Foreign Visitors' trip to Windsor.

THURSDAY, June 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8:15 a.m. Foreign Visitors leave Euston (London) for Birmingham and Rugby.

FRIDAY, June 29th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Foreign Visitors at Manchester.

SATURDAY, June 30th.

INSTITUTION OF ELECTRICAL ENGINEERS.

Foreign Visitors at Liverpool.

THE ELECTRICAL EQUIPMENT OF THE GREAT WESTERN RAILWAY.

The new generating station of the Great Western Railway Co. is placed at Park Royal, beside the new line to High Wycombe. A siding from this line is carried to the station for the delivery of the plant and coal and removal of ashes. The electrical power is generated as three-phase current at from 6,300 to 6,600 volts and 50 periods. It is transmitted from Park Royal by six H.T. three-core, paper insulated, lead covered and armoured cables laid underground on the solid system. These cables run from Park Royal beside the railway line to Old Oak Common, where the first sub-station is built at the junction between the High Wycombe line and the Great Western main line. From the Old Oak Common sub-station five H.T. main feeders are carried beside the main line to Westbourne Park, where they branch in a special inspection chamber, four feeders going to a sub-station on the south side of the main line at Royal Oak, and three going to a sub-station on the west side of the Hammersmith and City line near Shepherd's Bush. The positions of these sub-stations are shown in Fig. 1. The distance from Park Royal to Old Oak Common is about 1 mile, to Royal Oak about 4$\frac{1}{3}$ miles, and to Shepherd's Bush about 5 miles.

In the sub-stations the greater part of the three-phase current is transformed down by motor generators from 6,600 volts to 630 volts continuous current. At this pressure it is distributed from the Royal Oak and Shepherd's Bush sub-stations by concentric lead-covered cables to the conductor rails of the Hammersmith and City Railway. At Old Oak Common and at Royal Oak continuous current at 630 volts is also distributed for lighting the locomotive sheds, carriage sheds, goods yards and offices, and part of Paddington station.

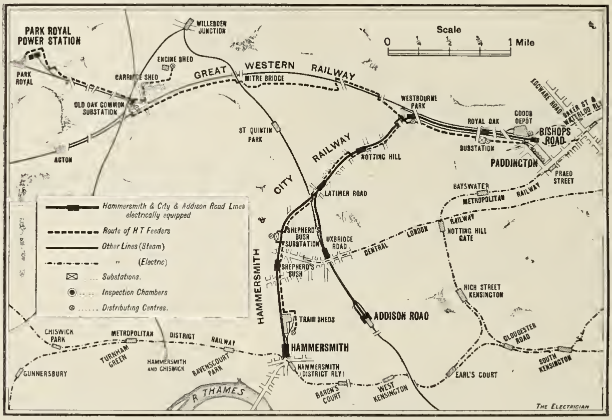

Fig. 1.—Map showing Hammersmith and City Railway.

A certain part of the three-phase supply to each sub-station is again distributed at the full pressure of 6,600 volts to distributing centres, of which there are 11 in all, where it is transformed down by static transformers to either 220 or 110 volts. At this pressure alternating current is used for arc and incandescent lighting and small motor work throughout the Great Western Railway Co.'s stations, goods yards, offices, and the hotel at Paddington and on the Hammersmith & City Railway.

The main engine room at Park Royal is built in three bays, as shown in Fig. 2. Four 750 kw. three-phase generators driven by reciprocating engines are placed in line in each outer bay, making altogether a total capacity of 6,000 kw. These generators were built by the Electric Construction Co., and are of the ordinary rotating field type, star-connected, but the centre point is not permanently earthed. They have an overload capacity of 25 per cent. for one hour. The armatures can be slid sideways for inspection or repair. Each generator is coupled directly to a Bellis & Morcom triple-expansion side-by-side engine, and runs at 250 revs. per min. The governor of each engine is controlled by an electric motor from the switchboard gallery for adjusting the load between sets running in parallel. Electrically-controlled emergency switches are also fitted, so that under emergency steam can be entirely cut off at the switchboard. Excitation for the main three-phase generators is obtained from two auxiliary sets and two batteries. One of these exciters is steam-driven and the other is motor-driven. The exciter generators are exactly similar machines, each of 150 kw. output at 220 volts. The auxiliary engine is of Belliss & Morcom's make, compound with two cranks and runs at 428 revs. per min. The motor driving the second exciter set is a three-phase induction motor designed for the full pressure of 6,600 volts.

The batteries which form a stand-by for the excitation are worked in parallel with the exciters, with motor-driven boosters for charging them from the 'bus bars. Each exciter generator with its battery can be worked by itself and used for exciting any or all of the main generators when required. There is therefore a complete stand-by generator and battery for excitation.

In addition to these two exciter sets there are two auxiliary three-phase 150 kw. generators, one steam-driven and the other motor-driven. The two generators are alike and generate three-phase current at 630 to 660 volts. The steam engine is a duplicate of that driving the exciter set described above, but a continuous-current motor is used for driving the second three-phase auxiliary generator supplied from one of the exciter switchboards. The auxiliary three-phase supply at 630 volts is used principally for driving the various motors throughout the generating station, such as the circulating pumps, automatic stokers and coal conveyors. An auxiliary three-phase switchboard is placed on the switch-board gallery between the two main high-tension switchboards mentioned below. Two sets of step-down transformers are provided by which all the auxiliary three-phase plant can be driven, when necessary from the main high-tension supply without running any of the auxiliary sets. The motor-driven three-phase generator can be used when required for charging feeders, or it can be run inverted taking current through the transformers from the H.T. supply or direct from the auxiliary supply and delivering continuous-current to the exciter switchboard.

There are two main H.T. three-phase switchboards, one at the west end of each main engine room bay. These two boards can be worked independently of each other, or can be worked in parallel. Each board has a duplicate set of main 'bus bars and also H.T. synchronising 'bus bars which are used for testing and charging the feeders as well as for synchronising the generators. Any generator or feeder can be connected to either set of main 'bus bars. A somewhat novel arrangement of making these connections has been adopted. The circuit from each main generator and each feeder is branched and connected to two oil-break automatic switches. Each automatic switch is directly connected to one set of the main 'bus bars. By this arrangement the two automatic switches are used also as selector switches, and are also a stand-by to each other. The machines can be changed from one set of 'bus bars to the other through the machine's own switches or through a separate bar coupling switch. In order to avoid any mistake in synchronising with the wrong set of 'bus bars when switching in a generator, a system of mechanical interlocks is fitted at the back of the control panels. This arrangement was proposed by the British Thomson-Houston Co., who have supplied all the switchboards at the generating station.

The H.T. part of the board extends from the basement to a total height of 33 ft., and consists of a steel framework filled in with stone slabs. Each circuit runs from the bottom to the top of the board and is separated from the rest by vertical stone partitions. The switches, transformers, &c., of each circuit are further separated from each other by four horizontal partitions which divide the whole structure into a set of fireproof cells. Iron doors are fitted to the back of the cells, giving access for inspection and cleaning. The control board is placed on a gallery about 14 ft. above the engine-room floor and slightly in front of the H.T. switchboard proper. The main switches are worked from the control panels mechanically by rods and cranks. All the instruments are placed on the control panels and are worked off transformers, so that all connections on these panels are low tension. Immediately in front of the control panels are placed the main generator field regulating resistance columns and also a set of signal columns and indicators by which the switchboard attendant can communicate with the driver of any engine.

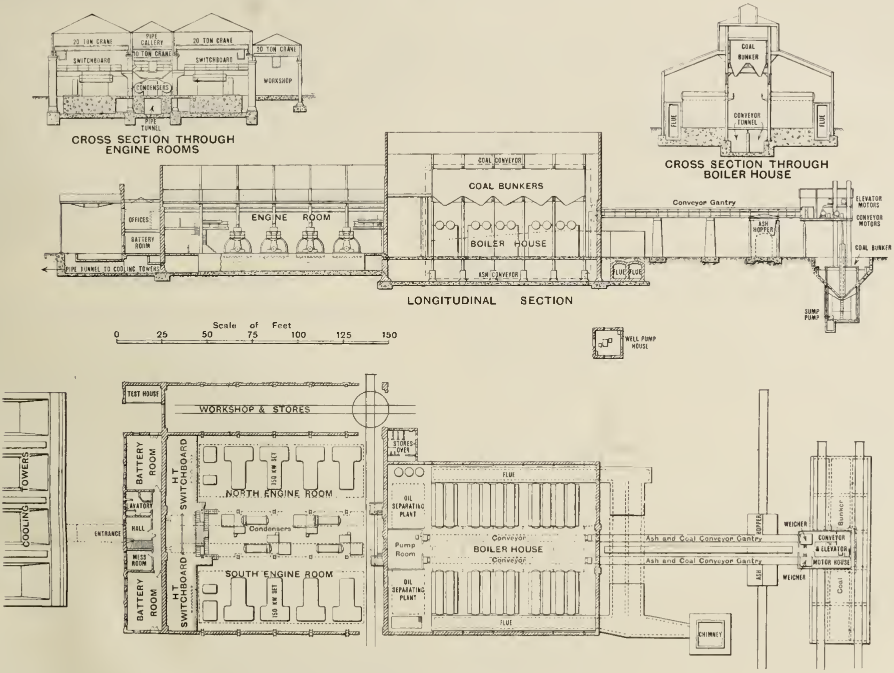

Fig. 2.—Section and Plan of Generating Station.

At the end of the centre bay of the engine room the auxiliary three-phase board, working at 650 volts, is placed on the same gallery as the main switchboard control panels. This auxiliary board is also fitted with two sets of 'bus bars, and is connected through step-up transformers with each of the main H.T. boards. The supply is, however, normally obtained from the two three-phase auxiliary generators described above. Feeders are taken from this board to the various three-phase motors throughout the power house. Two continuous-current exciter boards working at 220 volts are provided, one at the end of each of the main engine room bays. These are placed at the floor level immediately under the front of the main switchboard gallery. These two boards can be worked separately or in parallel. The supply for working the crane motors and the arc and incandescent lighting of the power house is also taken from these boards.

The main steam pipes are arranged on the duplicate system in the boiler house and on the ring system in the engine room. The ring in the engine room is teed off the double line in the boiler house through the necessary valves, and is itself divided into sections by valves between the branch pipes to the several engines. The whole of the steam pipes are made from solid-drawn steel tubes, and were supplied by Messrs. Aiton & Co.

The condensing plant is placed in the centre bay of the engine room and consists of four surface condensers with their air pumps and circulating pumps. They are provided with condensers with steam-driven air pumps and a small force pump is also driven by each air-pump engine for raising the condensed water to the filtering plant. The circulating pumps are of the centrifugal type, driven by three-phase motors. The circulating water, after passing through the condensers, rises vertically to a set of four Klein cooling towers. A large oil separator is placed in the exhaust pipe between each engine and its condenser, and from the bottom of this separator the oil falls by gravity to a small steam-driven force pump, by which it is pumped to settling tanks in the basement. After the condensed water has passed through the air pumps it is taken through the filtering plant, which is of Messrs. Davis-Perrett's electrolytic type. The continuous current required is taken from the lighting supply. The make-up feed water is treated in a softening plant of the Paterson Engineering Co.'s make, which is in duplicate to facilitate overhauling and cleaning.

The boiler house contains 10 Babcock & Wilcox water-tube boilers arranged in two rows of five, and each fitted with a superheater. The working pressure of the boilers is 200 lb. per square inch, and each boiler is guaranteed to evaporate 19,200 lb. of steam per hour. The steam, as it leaves the boilers, will be superheated 150° F. Mechanical stokers of the chain grate type are fitted, worked from an overhead shaft driven by a three-phase induction motor. Worm reduction gear is used, and an arrangement of claw clutches enables a spare motor to be brought into use when required, driving the shaft from the opposite end. A duplicate set of feed pipes is provided. The feed pump suctions are carried into the two large hot-well tanks in the basement of the boiler house under the pump room floor, but the feed pumps can also draw direct from the water supply pipe or from the circulating water pipes from the cooling tower tanks.

The coal handling plant forms an important feature of the station. Coal is brought to the station in special steel waggons holding 20 tons each, which are shunted on to the siding over the large coal silo at the east end of the boiler house. This consists of a row of funnel-shaped bunkers of reinforced concrete, below which is a tunnel running from end to end. The whole of the silo is below the rail level, so that the coal can be discharged by gravity from the waggons which are made with bottom doors.

Two tray conveyors are placed in the tunnel under the hoppers by which the coal is brought from any one of the hoppers to the bottom of two vertical bucket elevators. The coal is raised in this way to a height of 50 ft. above the boiler-house floor level, where it is discharged into two bucket conveyors running parallel to the centre line of the boiler house. Each tray conveyor and bucket elevator is driven by one three-phase induction motor. The bucket conveyors pass over automatic weighing machines of Messrs. Denison's make, which automatically register the weight of coal passed into the boiler house. The bucket conveyors run over a gantry from above the coal siding into the boiler house, and discharge into a row of large steel hoppers built over the boilers from which the coal falls by gravity through measuring boxes into the hoppers of the chain-grate stokers. The bucket conveyors after passing over the coal-storage bunkers pass down vertically to the basement, and return under the boiler-house floor. The ashes from the boilers are filled into the conveyors as they pass below the boilers, and are so taken back to the railway siding where they are discharged into a large steel hopper, from which they can be discharged by gravity into waggons. The whole of the conveying and elevating plant for handling the coal has been made and erected by Messrs. J. Spencer & Co., of Melksham.

The H.T. three-phase supply is transmitted at 6,600 volts from Park Royal to the sub-stations by the main feeders mentioned above. Each feeder has three cores of 0·15 sq. in. sectional area insulated with paper, lead-sheathed, and protected by an armouring of galvanised wire. The whole of the cables have been supplied and laid complete by Messrs. Siemens Brothers & Co. (Ltd.). The cables are all laid in Howard asphalte troughing, a separate trough being used for each cable. These troughs are filled in with bitumen, and covered with a layer of asphalte concrete carried over all the troughs, which are placed side by side so as to form a waterproof covering. The trenches in which the troughing is placed are excavated about 2 ft. deep, and have a 4 in. layer of concrete laid in the bottom to form a bed for the troughing. Where the cables have to cross any railway lines a trench is excavated which is floored with concrete, and brick walls are built up at the side, on the top of which are laid old rails or steel troughing to form a floor for the sleepers and rails. In this way all weight and pounding from the passing trains is kept off the cables. At Old Oak Common and at Westbourne Park the cables enter a small brick building, referred to above as the inspection chambers, and in which any incoming feeder can be joined to any outgoing feeder by a simple arrangement of plugs and switches. In this way it is possible to keep one or more cables as spare in any section, and connect them to the spare cable in the next section, or to any other cable or sub-station as may be necessary. The route chosen for the feeders has, as far as possible, been at the side of the line, so that any repairs, examination or jointing can be done with greater ease. In certain places, however, more particularly between Westbourne Park, Royal Oak and Shepherd's Bush, it has been necessary to lay the feeders in the 6 ft. way. All the laying and jointing had to be done without interfering with the traffic, and great care had to be taken to avoid accidents. We are glad to say that not a single life was lost in carrying out this part of the work.

There is one point of special interest in connection with the way in which these cables were jointed. The usual method of jointing the cables after they had been laid was departed from, as it was considered a much better joint would be made if more space was given to the jointer than is possible after the cables are laid and where there are a number placed side by side. The method adopted in the present instance was to leave the last 20 ft. or 30 ft. of each length of cable unlaid until the end had been jointed to the next length of cable to be laid in the same trough. The trench was covered over with a platform of boards for about 10 ft. on either side of where the joint was to be made. The ends of the two cables to be jointed were laid on this platform, and all jointing done where there was ample room and things could be kept clean. The completed joint was covered with a lead sleeved filled in with compound and wiped to the lead sheath of the cable. The outside diameter of the joint was a little less than the width of the trough, so that it could be lowered into position wherever it came in the trough and the laying of the next length of cable be proceeded with.

The high and low-tension cables from the sub-stations to the distributing centres and to the conductor rails of the Hammersmith & City Railway, &c., were laid in exactly the same way as described above, but concentric lead-covered cables are used for the L.T. continuous current, and for the L.T. alternating current. No armouring is provided on these cables, as was done on the H.T. feeders in order to meet the requirements of the Board of Trade. The same trenches are used wherever possible for the cables entering and leaving the sub-stations.

(To be concluded.)

THE LONDON MEETING OF THE INSTITUTION OF MINING ENGINEERS.

The meeting on Thursday morning, June 14th, at the rooms of the Geological Society, commenced with the reading of the Presidential address of Sir Lees Knowles, Bart. The address was devoted to a detailed study of the subject of employers' liability and workmen's compensation, especially with relation to the working of the "contracting out" clauses, and gave an interesting account of the president's own experiences in the working of a workmen's compensation scheme which he had himself introduced.

Several Papers were read and discussed, amongst which were those abstracted below :—

COMMERCIAL POSSIBILITIES OF ELECTRIC WINDING FOR MAIN SHAFTS AND AUXILIARY WORK.

BY W. C. MOUNTAIN.

The applications of electric winding so far have been principally in German pits, and the writer visited Germany and inspected the two principal electric winding installations at the Preussen II. colliery and the Zollern II. colliery, both of which have been fully described in a previous Paper. The conclusion arrived at after inspecting these installations was, that although the work performed was excellent, the first cost of the equipment of engines, dynamos, motors and winding-gear was so excessive, that he questioned whether there was any commercial advantage in adopting electric winding in preference to high-class steam winding-engines. The great mistake which writers on this subject have made in the past is that they only compare the results of electric winding with old-fashioned uneconomical steam-engines, but in order to get a true comparison it is necessary to make the comparison on equal lines. The advocates of electric winding content themselves as a rule by making a statement that the consumption of steam per "useful horse-power" is anything varying from about 27 lb. to 31 lb., and they quote the consumption of steam for steam winding-engines as from 50 lb. to 150 lb. (the figure generally approaches the latter), and having done this, they consider that they have satisfied the mining engineer that electric winding is necessarily much more economical.

On the Continent, the success of electric winding is largely due to the use of the Koepe system. Of course, by this system, it is necessary to have a balance rope, and, further, it is not usual to use keps at the pit head; this makes the banking-out or changing very slow, as the load is brought quietly to rest, otherwise there would be a risk of the rope slipping in the groove.

The advocates of electric winding have also made many claims, such as (*a*) quicker acceleration, (*b*) greater simplicity and (*c*) greater safety appliances. The writer feels sure that whilst no doubt electric winding is extremely steady, unquestionably quicker acceleration can be obtained with a steam engine than with an electric motor. The safety appliances which are fitted to an electric winder are fitted on all high-class modern winding engines, and as regards simplicity it is impossible to imagine anything better than a steam engine directly coupled to its winding drums; whereas with the balancer system of electric winding there is, between the steam engine and the winding drums, the generator, switchboard, cables, motor, flywheel running in two bearings, generator, switchboard, connecting cables and two motors on the winding gear. This apparatus, if well constructed, should give little or no trouble, but it is foolish to bring forward simplicity as one of the advantages when there are all these links in the chain, when the failure of any one of them would throw the whole gear out of work.

The Paper was accompanied by a series of tables setting forth in some detail particulars and costs of working for a number of cases of steam and electric winding plants both estimated and based on results.

The conclusions to be drawn from the results recorded in the table relating to steam winding is that for large outputs coal can be wound, including interest and depreciation, at from 5s. to 6s. per 100 tons.

Having obtained and worked out the cost of steam-winding, the writer then proceeded to make calculations of the cost of electric winding on the same data, that is, the same quantity, depth of shaft and time.

The same general system of calculation was adopted, and the cost of winding per 100 tons is summarised in Table I. The figures making up this estimate have been very carefully prepared, they are really based upon actual estimates given of the cost of winding-plants, they provide for slow-speed motor-generators and for ample capacity in the proportion of generating-plant and in the boilers to deal with the work, and they are based upon the consumption of steam equal to 25 lb. per kilowatt-hour.

Table I.—*Cost of Electric Winding per 100 Tons.*

Coal wound per day of eight hours.	Depth of shaft.	Cost of coal per ton.		Cost of winding without interest and depreciation.		Cost of winding with interest and depreciation,	
Tons.	Yards.	s.	d.	s.	d.	s.	d.
1,000	500	3	6	3	8½	13	9½
1,500	500	3	6	2	11½	11	7
2,000	700	3	6	3	0½	12	5
2,000	700	6	0	4	4	13	8¼
2,000	700	8	0	5	4¼	14	8¾
2,000	700	10	0	6	4½	15	9

When the writer read his Paper on "Electrical Winding" before the Institution of Electrical Engineers,* Messrs. Siemens Brothers challenged his figures as regards the cost of winding plants; he has, therefore, added to the table the actual figures given by Messrs. Siemens; but Messrs. Siemens' costs are very much lower than the actual costs of existing winding plants and how near the costs of the actual plants compare with the writer's own estimates. The reason for this difference is probably as follows: (*a*) In the winding plant, presumably the Koepe system is adopted, but the motor-generator is increased in speed from 300 to 465 revs. per min., and the weight of the flywheel reduced from 67 to 28 tons. (*b*) The amount provided for the generating plant—namely, £3,000—is too small a sum to cover the cost of the 1,000 kw. generating plant, together with the cost of fixing, &c. (*c*) The sum of £2,000 provided for two boilers, 30 ft. long by 9 ft. in diameter, together with the proportion of condenser, steam pipes, exhaust pipes, feed pumps, &c., is considerably too small. Adopting these figures, however, the cost of winding works out as shown in Table II. It will be noted, however, that these figures, although they are unquestionably based upon a capital cost much too low, compare very unfavourably with the cost of high-class steam winding.

Table II.—*Cost of Electric Winding per 100 Tons.*

Coal wound per day of eight hours.	Depth of shaft.	Price of coal per ton.		Cost of winding without interest and depreciation.		Cost of winding with interest and depreciation.	
Tons.	Yards.	s.	d.	s.	d.	s.	d.
2,000	700	3	6	2	7¾	8	2¾
2,000	700	6	0	3	8	9	3
2,000	700	8	0	4	5½	10	0½
2,000	700	10	0	5	3½	10	10½

A further reference is made in the Paper to the cost of winding at the Grand Hornu colliery, where unquestionably electric winding is the right system to adopt, because there are three small shafts running practically continuously, and the current is supplied from one central station, and the winding gears are driven by three-phase motors directly coupled, with rheostat control.

The remarks so far have dealt exclusively with what might be called heavy work, that is to say, where the output is not less than 1,000 tons from a depth of 500 yds., but there are an immense number of collieries in Great Britain and elsewhere where the outputs are smaller and the depths less, and there is an undoubted field for the commercial application of electric winding in these cases.

Staple winding, that is, from small underground pits, also offers another extremely valuable field, and the writer has installed a number of electric winders for this purpose, which have shown extraordinarily economical results when compared with the costs of using steam or compressed air.

It is quite possible that the electric energy can be produced at such a low price that it may pay to spend more money on the winding gear and to adopt electricity for every conceivable purpose throughout the pit. Under these circumstances electric winding will have a fair chance, but where heavy winding is to be done at a single colliery and the winding absorbs probably two or three times as much power as the rest of the machinery, and is also only running, say, eight to ten hours per day, there can be no doubt that it is almost impossible to compete with high-class steam engines.

The discussion which followed the reading of Mr. Mountain's Paper was opened by

Mr. F. C. SWALLOW (West Cannock) who thought the author of the Paper had taken up a very bold position. The first cost of an electric winder was perhaps more than some colliery owners would be prepared to meet, but he certainly thought that in the majority of collieries the employment of electric winding would result in a marked improvement in economy. There were several ways in which the methods adopted on the Continent could be improved upon in this country. The published costs of working at the Grand Hornu colliery for example he thought could be reduced if English conditions obtained. In his own collieries he had suggested the putting in of an electric winding plant in conjunction with other application of electric power, he had thoroughly considered the matter and looked with confidence to smaller costs than if he installed a steam plant.

Prof. REDMAYNE said that he had recently had occasion to work out the relative costs of steam and electric winding for a mine of considerable depth in South Wales, and was satisfied that there would be a material saving. There were two main shafts 500 yds. deep, and 1,200 tons were to be wound per day. Electric power was also to be adopted for coal cutting, haulage, pumping, and the generating station would also supply current to some neighbouring collieries. The only purpose for which they were not going to employ electrical working was for the ventilating fans, as he considered the speed variation required could be obtained better by other methods. He hoped at a later date to publish full figures as to relative costs of working.

The next speaker was Mr. McLAREN, who referred to his satisfactory experiences with the electric winding plant recently installed at the Tarbrax pit of the shale mines at Cobbinshaw in Scotland. He was surprised at Mr. Mountain's remarks regarding the complication of electric winding apparatus, and thought them most unfortunate. In all the complication of valve gear, &c., of a steam winding engine there were quite as many links in the chain, the failure of which would stop the working. With his own plant they raised 320 tons per day of eight hours from a depth of 140 yds., and he had found in practice that there was a considerable saving over steam working. He thought there were great possibilities in concentration of power plant as against an isolated plant, and in his own case the current was supplied from a central station. He also used electric power for pumping and other purposes, and went further than Prof. Redmayne in employing it also for the fans.

Mr. HOLLIDAY held rather an opposite view from the preceding speaker, but did not apparently speak from experience. He thought that the complication alone should make one halt before installing electric winding, and suggested that the satisfactory results at Tarbrax were due to the concentration of power, and not to the economy of the winder, which was not the chief part of the work.

Mr. S. F. WALKER, who spoke at some length, reminded the meeting that electric winding was not yet in its final stage, and if it followed a similar course to other applications of electricity, a great reduction in working expenses might be expected in the future. Electrical men, he thought, were indebted to Mr. Mountain for showing them what they had to compete against.

Mr. HUMPHREY added a few words in praise of electric power, based on his experience in the North Wales slate quarries.

Mr. MOUNTAIN, in his reply, created some amusement by remarking that the Tarbrax plant was too small to be actually called a winding plant, and came under the heading of the small hoists, in connection with which he had admitted an economy in the Paper.

The next Paper to be read at the meeting was on the subject of

ELECTRICALLY-DRIVEN AIR COMPRESSORS AT OUSTON COLLIERY.

BY A. THOMPSON.

The writer is confident that, as the use of electricity, and more especially the distribution of that power, from central generating stations, becomes more general, so also will the use of underground electrically-driven air compressors of a suitable portable design, to be moved forward as the face advances, be adopted.

The adoption of electrically-driven air compressors, it must at once be admitted, involved the introduction of a second stage in the production of the motive power required, that is, steam to electricity and then to compressed air, with a consequent further loss of efficiency. But in our case, having once decided that electricity at the coal face was out of the question, owing to the amount of gas given off by the Busty seam; and seeing that a large amount of capital had already been expended in putting down a well-equipped modern central generating station at the pit, to provide current not only for this pit (where underground pumping and haulage was already extensively done by electricity) but also for distribution to surrounding pits for coal cutting, haulage, &c., it appeared reasonable to conclude that (granting compressed air was a necessary motive power) it would be cheaper to utilise the existing plant for generating the current than to put down at bank, in addition, a steam-driven air-compressing plant and to conduct the air to the face in the usual way

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* *The Electrician*, Vol. LVI., pp. 999 and 1045.

The greater ease with which cables can be taken down the shaft and along the roadways, as compared with bulky air pipes will be readily admitted. In this particular case, the first cost was simply that of the conducting cables, together with the motor and the air compressor as compared with a steam-driven air compressor at bank and tubes to conduct the air down the shaft to the face. At present two air compressors are at work, the first supplied by Messrs. Alley & Maclellan, (Ltd.), and the second by the Ingersoll-Sergeant Drill Co., and a third and fourth by the latter firm are at present being installed. The Alley-Maclellan air compressor is of the single cylinder type with the receiver placed underneath, and an overhung flywheel, which also acts as a driving wheel. The drive, at first adopted, was by means of six cotton ropes, 1 in. in diameter; but they have been replaced by a belt drive, at a speed of 140 revs. per min., the output is 350 cubic ft. of free air per minute. The Ingersoll-Sergeant air compressor is of the duplex cylinder type, mounted on one bedplate with a central flywheel, which acts as a driving-belt pulley.

Both machines are provided with automatic unloading devices, the effect being the same in each case, namely, to keep the pressure in the air receiver uniform within a range of 2 lb. to 3 lb. per square inch, although the construction is different. Various devices are being introduced, which automatically stop the motor instead of simply stopping the compression of the air, a specially-arranged valve being supplied, which re-starts the motor and allows it to get up full speed before the bye-pass valve closes and compression re-starts. Taking into consideration the extra cost of this gear, and the electrical difficulties which would appear inseparable from its use, owing to the frequent stopping and starting, the most economical plan would appear to be to work the compressor to its utmost capacity, the governor being looked upon more as a safety-valve than as a current-saving apparatus.

The air-compressors are each driven by compound-wound motors of 90 h.p., made by the British Thomson-Houston Co. (Ltd.), running at 550 revs. per min., and wound for a pressure of 500 volts.

The switch gear for both motors consists of two panels mounted on a wrought-iron frame, which is firmly fastened to the wall.

Current is conducted from the generator to the shaft-bottom by 37/12 vulcanised indiarubber insulated cables of the 2,500 megohms grade. The cables are protected from a very destructive water by being placed in haskinized-wood troughing, run solid with clarified bitumen, and covered by a lid firmly screwed down. The efficiency of this method of protecting cables is shown by the fact that an insulation-test, made a few days ago, read 10 megohms, and this is all the more satisfactory as it was taken with a 1,000 volts Evershed testing-set. The cables after leaving the shaft are carried in 1½ in. insulated conduiting to a distribution-house situated near by. From here, 37/13 mains are carried to the junction-box, where 37/14 cables are taken to each air-compressor. The cables are suspended by yarn from the rolleyway-timber. The underground mains are all of vulcanised indiarubber of the 600 megohms grade, the high degree of insulation being maintained by periodical covering with bitumastic paint.

Some efficiency tests were taken, of which particulars are given in Table I.

Table I.—*Test of Electrically-driven Air-Compressors.*

Type of air-compressor	Alley-Maclellan.	Ingersoll-Sergeant.
Revolutions per minute	140	180
I.H.P. of air leaving the compressor	52·1	90
Volts	480	500
Amperes	100	160
Electric horse-power	64·5	107
Efficiency per cent.	80	84

The efficiency of the compressed air-plant from the actual output on the switchboard for the Ingersoll-Sergeant compressor was worked out, giving a result of 60 per cent. in one set of observations and 62 per cent. for another case. The efficiencies of 62 and 60 per cent. would, the writer thinks, compare favourably with that of any steam-driven air-compressor plant.

The latter part of the Paper contained a description of the pneumatic heading machine to which air was supplied by the compressors, and a summary of the working costs of the system per ton of coal worked.

At the conclusion of this Paper Mr. KIRKUP further explained the methods of working and the reasons which led to its adoption.

Mr. ABEL, of Duffield, endorsed the author's views as to the advantages of using electrically-driven compressors, and

Mr. S. F. WALKER briefly referred to a similar system which had been adopted in Germany some years ago.

A short abstract was then read of a Paper entitled

PRACTICAL PROBLEMS OF MACHINE MINING.

BY SAM. MAVOR.

The earlier part of the Paper dwelt on the benefits accruing from the adoption of mechanical coal cutters in general, and treated fully of the details of the system of working and arrangement of cuts and gate roads. In speaking of electrically-driven coal cutters the author remarks:—

It is claimed that the bar type has special advantages in respect of electric driving, in that (1) the rate of rotation of the tool-holder more nearly corresponds to the speed of the electric motor than in other types in which the lineal velocity of the cutting tools is similar, but the larger diameter and slower rate of rotation of the tool-holder requires a higher ratio of gear reduction; (2) owing to the comparative absence of friction of the tool-holder in the cut, the consumption of power is lower and more uniform than in other types; and (3) the freedom of the bar from liability to jam relieves the motor of the excessive strains and periods of overload, to which other types are subject. This last characteristic, which endows the bar-machine with its well-known immunity from breakdown of its electrical parts, places it in a pre-eminent position when the system of supply is two-phase or three-phase alternating current. A large number of Pickquick bar-machines of the alternating-current type, fitted with simple squirrel-cage rotors, without any moving contacts, are now at work, yielding most gratifying results and providing a complete solution of the problem of the application of the three-phase-current system to coal cutters operating under widely different conditions of service. Where the system of supply is open to choice, direct current will be found to fulfil every requirement, and it is free from disadvantages which are inherent to the alternating-current system when used on a small scale. For plant of large size, the three-phase system has much to recommend it; but each case should be viewed in the light of its special requirements, and with the knowledge that equally satisfactory results can be had from direct-current or alternating-current coal cutters.

The question of the risk involved in carrying electricity to the working faces in fiery mines frequently arises. It cannot be pretended that a coal-cutter motor can be made gas-tight. In working the motor, it becomes heated and the air that it contains expands, a portion being expelled through the bearings or otherwise. When stopped the motor cools, the contained air contracts, and air equal in volume to the portion expelled is slowly inhaled from the surrounding atmosphere, and if gas is present during the cooling period it will be drawn into the motor. Assuming the mine temperature to be 70°F. and the rise of the machine temperature during working to be 80°F., giving a temperature in the motor of 150°F., about one-sixth of the contained air will be exhaled, and while cooling an equal portion will be inhaled, which in the motor will be mixed with five times its volume. If there is a sufficient proportion of gas in this diluted mixture to make it liable to ignition, it may be ignited within the motor; but, as this is completely and strongly enclosed, the flame is confined to the interior. So far as liability to ignite gas is concerned, there is nothing to choose between a direct-current motor and an alternating-current motor with slip rings; such liability as exists in the switch box is also common to both types. Even with equal temperature and pressure, gas will, if present in the atmosphere surrounding the motor, gain access to its interior by diffusion, if sufficient time is allowed. It is therefore desirable, after a coal cutter has been standing for some hours in a situation where there is the slightest reason to suspect accumulation of gas, that it and its switch box be opened and swept out with fresh air. The alternating-current squirrel-cage motor, with the switch submerged in oil, affords the greatest security. The use of oil in coal-cutter switch boxes should, however, be avoided if possible.

The chief risk associated with the use of electric coal cutters lies in the cables, and especially in the liability to damage of the trailing cable. This risk, which cannot be avoided, is minimised by the fact that the cable trails on the floor, where gas is least likely to be present, and the risk is probably limited to the contingency of a sudden outburst of gas, synchronising in time and place with such damage to the trailing cable as would cause a spark. The responsibility for carrying electricity to the working faces rests on the manager, and the most that the machine maker can do is to submit the facts to his judgment, and accept in each case the manager's verdict as final. Wherever electricity is admissible, it should be adopted on the ground of efficiency of transmission and convenience; but one of its chief advantages, as compared with compressed air, lies in the facility and accuracy with which the power delivered from the generator, and absorbed by the coal cutters, may be measured. Extravagance and unobserved losses by leakage or otherwise are impossible, and the maintenance of the initial efficiency is an absolute condition of the operating of the plant. It may be worth noting that, if in fiery mines a system is to be adopted by which the working sections shall be isolated, in order to restrict the area of disaster in case of explosion, machines by producing a large output from a relatively small area, and thereby simplifying ventilation and isolation, may be a useful factor.

The advantages of electric transmission of power may be combined with the use of air-driven coal cutters, by the adoption of a portable electrically-driven air compressor placed in the intake airway, and as near to the coal face as possible. Where circumstances permit of the compressor being placed within such distance from the face as will enable direct advantage to be taken of adiabatic compression, it is probable that, with air pipes covered with non-conducting material, air leaving the compressor at a temperature of, say, 250°F., might be delivered to the coal cutter at a distance of between 200 yds. and 300 yds. at a temperature of about 150°F., effecting a gain in economy of 15 to 20 per cent.

The following table is given of the costs of working electric coal cutters in two cases:—

COST OF ELECTRIC DRIVING OF COAL-CUTTING MACHINES.

Colliery.	A.	B.
Holing material	Coaly band.	Coal.
Position of holing	16 in. above pavement.	At pavement.
Depth of cut	3 ft.	3 ft.
Thickness of coal	25 in.	25 in.
Distance cut per shift	110 yds.	115 yds.
Lineal cutting speed per minute	21 in.	14 in.
Power exerted by motor	9 B.H.P.	13 B.H.P.
Energy lost in cables	2½ per cent.	3 per cent.
Energy expended per square yard cut	0·212 unit.	0·290 unit.
,, ,, ton produced	0·330 ,,	0·450 ,,
,, ,, shift worked	23·500 units.	33·300 units.
Rate of charge for electrical energy	1d. per unit.	1d. per unit.
Cost of energy per square yard cut	0·212d.	0·429d.
,, ,, ton produced	0·330d.	0·450d.
,, ,, shift worked	1s. 11·500d.	2s. 9·300d.

An interesting Paper was also read on

CONSIDERATIONS ON DEEP MINING.

BY GEORGE FARMER.

In the section on mechanical appliances in the mines, the author deals with the question of the use of electric motors in fiery mines as follows :—

Although electric power transmission offers so many advantages for mining operations that its use is widely extending, yet it possesses one feature which must be a serious drawback to its application in deep mines which are, in all probability, subject to discharges of explosive gases—namely, the danger of ignition of fire-damp from the sparks and the arcs which are apt to occur. The prevention of the ignition of mine gases from electric apparatus has been made the subject of exhaustive experimental investigations in Germany. As long ago as 1885 the subject was studied in Prussia by a special commission ; in 1890 a series of investigations were made for the French Government ; while more recently, in Belgium and in Great Britain, this important matter has been investigated by eminent specialists. The recent investigations were conducted in connection with the work of the Bismarck colliery, in the Dortmund mining district, by a special commission. The appliances subjected to test included direct and alternating-current motors, switches, starters, resistances, transformers, &c., the motors being operated up to 30 H.P., under conditions approximating as nearly as possible to those of actual service. In order that the appliances should be subjected to as great dangers as exist in the worst cases in mining practice, the experiments were made in the testing gallery constructed at the Bismarck colliery for trials upon safety-lamps and experiments with mining explosives, some modifications being made to adapt it for this special purpose. The gas used consisted of about 70 per cent. of methane and 27 per cent. of nitrogen, the balance being oxygen (corresponding to about 12 per cent. of air) and a small amount of carbon dioxide. The proportion of the gas delivered into the gallery was determined by passing it through an ordinary gas meter. Two methods, in general, have been employed by constructors to prevent the production of explosions by motors : The first aims at preventing the access of gas to any parts of the motor which are liable to produce sparks, thus preventing any ignition from taking place ; and the second method is to enclose the motor in such a manner than any flame, due to ignited gas within the enclosure, shall not be able to reach and ignite the general body of gas in the space outside. The first method has been carried out by enclosing the commutators in a closed chamber filled with oil, this acting at the same time as an insulator and as a protection against access of gas ; and the second method involves the enclosing of the motor in a case provided with openings for the circulation of air, these openings being fitted with coverings of wire gauze. Experiments with both these types of motor showed that absolute safety could not be secured by either method. The enclosed motors, while resisting various severe tests, ultimately failed, by reason of the gradual entrance of the explosive mixture within the case, and by the ignition of the mixture, blowing off the cover, and exposing the vicinity to danger. When the motor was enclosed in a casing in which the openings were covered with wire gauze any sparking caused the gas within to ignite, and the heat produced either caused the gauze to become red hot, or else small carbonaceous particles, adhering to the gauze, became incandescent to an extent sufficient to ignite the gases without. A number of tests were made upon gas-tight casings to determine the strength necessary to resist the force of a possible explosion within. Given a chamber of sufficient strength, however, the question then arises whether it is necessary to have it made absolutely gas-tight or not. According to experiments conducted by the commission it is not necessary. If the openings are not too large an explosion may take place within and the burned gases be discharged without their being able to ignite the gaseous atmosphere, and in this fact appears the best method of arranging electric motors for use underground. Although these experiments need confirming by more exhaustive researches, the results show that electrical machinery to be used in coal mines in which the presence of explosive gases is possible should be constructed with the greatest care, so as to reduce sparking to a minimum, and that such machines should then be enclosed in casings of sufficient strength to prevent the possibility of any bursting by explosion within, the casings being provided with openings of sufficient size to permit of the escape of the products of explosion, and yet not large enough to allow of the escape of flame.

Amongst the Papers discussed at the meeting on Friday, June 15th, was one on

A RATEAU EXHAUST-STEAM-DRIVEN THREE-PHASE HAULAGE PLANT.

BY W. MAURICE.

The exhaust steam of a continuously-running engine was first utilised by Mr. C. A. Parsons, who coupled a turbo-alternator of his design with the exhaust-steam from the low-pressure cylinder of a compound engine. In the case of winding engines the intermittent nature of the exhaust-steam renders impossible the direct coupling of a low-pressure turbine, because such a combination would possess inconvenient variations of speed. It is to Prof. A. Rateau that credit is due for having successfully overcome this difficulty. The problem is solved by intersecting between the reversible engine and the low-pressure engine a medium, the purpose of which is to take up the intermittent steam exhaust from the primary engine, to accumulate this, to keep it under practically constant pressure, and to supply it to the secondary engine just as it could only otherwise be done by direct supply from the boilers.

The steam escaping from the winding engine passes through a large steam reservoir. The latter is designed to accumulate the heat from the steam by the help of water or metal, and to evaporate the water again during the time that fresh exhaust steam cannot be supplied. This freshly raised steam is given to the secondary engine until fresh exhaust steam can go directly through it.

It is well known that metals have a very low temperature coefficient (that is, they take over heat very quickly and give it back very quickly), and so, if the metals assembled in the reservoir can be supplied during the exhaust-steam period of the primary engine with as much heat as will suffice to raise steam from the already boiling water during the time when the primary engine is idle, and the volume of steam so raised suffices to drive the secondary engine, then the purpose of the invention is achieved and the secondary engine can run under a constant speed driven by this artificial supply of steam.

In the Hucknall installation, which has been erected to the designs of Mr. P. J. Mitchell. The accumulator contains 50 tons of scrap-iron pit rails assembled horizontally and in parallel layers.

From this accumulator the steam passes to the admission side of the low-pressure turbine, which is provided with an injector condenser.

As the turbine cannot take all the exhaust steam yielded by the winding engine, the accumulator is supplied with an automatic relief valve, which is adjusted to open at an absolute pressure of 16 lb. per square inch. This implies $1\frac{1}{2}$ lb. of back pressure on the winding engine ; but it was necessary to so limit the escape of exhaust steam into the atmosphere in order to reduce as much as possible the volume of live steam required during the stoppages of the primary engine.

In order to prevent the turbine from slowing down in the event of the winding engine stopping longer than usual, a direct connection with the main boiler gallery is made through a reducing valve, which reduces the boiler pressure of 55 lb. per square inch to 16 lb. of absolute pressure. This reducing valve is worked automatically by levers as shown, and is set to admit reduced live steam from the boilers into the turbine whenever the winding engine remains idle for a longer period than 90 seconds.

The greater part of the power developed by the alternator is used for haulage in the mine where the plant is installed. Since, under the local conditions, no coal winding can go on without haulage, and no haulage can be done without winding, the plant works under circumstances favourable to economy.

Whilst power is wanted for haulage the turbine can be driven by exhaust steam, but if it had to run, say, for the purpose of operating electric pumps during the night shift, or to do other work during intervals between coal-turning shifts, it would then be necessary to run on reduced live steam. The efficiency of the plant would thus be reduced by nearly 50 per cent., as compared with that of a good type of compound engine.

Amongst the other Papers at Friday morning's meeting was the following :—

THE CAPACITY CURRENT AND ITS EFFECT ON LEAKAGE INDICATIONS ON THREE-PHASE ELECTRICAL POWER.

BY S. F. WALKER.

The question whether it was possible to show the leakage current from a system of three-phase cables as apart from the capacity current has often been raised. According to some experiments apparently the capacity discharge current masked the leakage current, and it would therefore appear to be impossible to comply with the special rules for the installation and use of electricity, as to the indication of leakage.

Leakage from any cable is caused by deterioration of the insulating substance. The deterioration, whatever its cause may be, reduces the capacity of that cable, and upsets the balance between the capacity-currents of the three cables. Hence, any instrument that will denote a difference between the capacity-currents of the three cables will fulfil the requirements of the special rules, inasmuch as it will indicate that there is a leak on one of the cables ; and if each cable be tested for discharge, that cable, the discharge of which is less than it should be, will be generally the faulty cable, the phenomenon usually being accompanied by an increase of the capacity-current of the other cables. There is the case, however, in connection with leakage-indications on continuous-current services of an equal leakage upon each cable. It is possible that such a case might occur, the most likely cause being damage of the whole of a cable by a fall, each of the three being equally injured ; and the condition might also arise if the three cables had deteriorated equally by time and electrolytic action. The case where the three cables are damaged to an exactly equal extent, so far as leakage is concerned, and where the insulation is not so far damaged as to cause short circuits between the cables (and the consequent "blowing" of the fuses), is hardly likely to occur. If the case did occur, if the three cables deteriorated equally, or developed a leak of identically equal resistance, the instrument designed to show leakage by indicating the difference in the capacity-current would show no indication. But this part of the matter is easily provided for by arranging that each cable shall be tested for its capacity-current periodically, the results being recorded ; and that the indications should form a valuable record, by which it should be possible to judge of the condition of the cables themselves. If the capacity-currents of all the cables suddenly fall considerably, the earliest opportunity should be taken of testing the whole of them with a proper insulation-testing apparatus. Also, if the leakage-indicator shows a deflection at any moment, the three cables should be tested for capacity-current as soon as possible after the indication shows itself, the faulty cable being indicated as mentioned above, and proper insulation-tests carried out upon it at the earliest possible opportunity.

Almost any one of the appliances on the market will do all that is required in the matter of indicating leakage.

In the diagram of the Ferranti instrument (Fig. 1) which the writer exhibits because it illustrates the case of "mesh" connection of the generator, it will be noticed that a connection is taken from the cable of each phase to one terminal of a lamp, and the other terminals of the lamps are connected together, thus forming the neutral point. From this a connection is taken to a stop on the switch, which, when the apparatus is in use under normal conditions, is connected by the switchboard to a wire leading to the milliammeter. When the apparatus is to be used to test an individual cable, the switch-arm is moved from the neutral point to the stops marked 1, 2 or 3, and from the switch-arm a connection then leads through a resistance to the milliammeter, and thence to earth; each cable showing its own capacity current in turn.

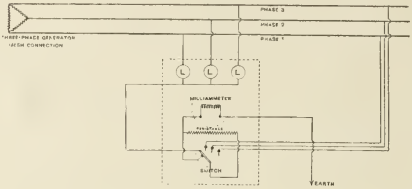

Fig. 1.

There is another method of meeting the difficulty of eliminating the capacity current by imposing a continuous current upon the alternating-current system, and employing the continuous current to indicate the leakage by means of instruments which only respond to continuous currents. One apparatus on these lines, made by Messrs. Nalder Bros. & Thompson (Fig. 2), is arranged as follows: There is a small continuous-current generator, constructed to give a pressure of 500 or 1,000 volts, and a low-reading ampere meter constructed to respond only to continuous currents; and in circuit with these are what is termed an inductive resistance and a fuse. The inductive resistance consists merely of a coil of wire wound on an iron core, the length and dimensions of which are calculated in accordance with the periodicity of the alternating circuit to which it is to be applied, so that any alternating current passing into the circuit of which it forms a part is automatically neutralised or choked, and is not able to reach the ampere meter referred to above, the fuse protecting the meter from accident. One terminal of the circuit, made up of the small generator, the ampere meter, the self-inductive resistance and the fuse, is connected to earth, and the other end of the circuit is connected to any convenient point in the alternating-current system. As the three cables of the three-phase system are connected at the generator, and also, when the apparatus is working, at the motors and lamps, a connection to any one of the cables is practically a connection to all, and so long as the insulation of all three cables and all parts of the system from earth is above a certain figure no current will pass through the testing circuit. If a leak arises at any part of the three-phase system the circuit with the testing system is completed by way of earth, and the ampere meter will show the leakage or the resistance of the whole system, according as the instrument is graduated in milliamperes or ohms. In place of the small generator, which must, of course, be driven during the whole time that the testing circuit is in use, it is proposed by the makers to use a battery of dry cells, giving a pressure of 125 volts. One great advantage of this testing apparatus appears to be that it avoids the complaint made against other apparatus, in that, if an equal leak occurs in each of the three cables, provided that the leak is in each case to earth, the ampere meter will show the resistance of the whole of the leaks by the fact that each leak will increase the current passing through the instrument and will increase its deflection. It also has the advantage that it is applicable to two-phase services, in which the algebraical sum of the capacity currents, when the capacities of all the cables are equal, is not equal to 0.

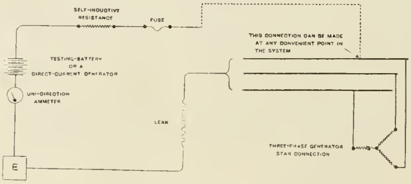
SELF-INDUCTIVE RESISTANCE
FUSE
THIS CONNECTION CAN BE MADE AT ANY CONVENIENT POINT IN THE SYSTEM
TESTING-BATTERY OR A DIRECT-CURRENT GENERATOR
UNI-DIRECTION AMMETER
LEAK
THREE-PHASE GENERATOR STAR CONNECTION
E

Fig. 2.

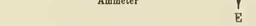

Fig. 3.

Mr. WALKER made a few additional remarks to explain that there were cases in which there was a large capacity current due to the machines having been badly designed. The remedy for such cases was to indicate the machines with an oscillograph and have them put right if possible. The chances of such cases occurring, however, were very remote indeed. Mr. Walker illustrated the point by a diagram on the board to show that under such circumstances the second phase coincided with the third harmonic, and this produced a very powerful capacity urrent.

Mr. P. C. POPE (Lancashire Electric Power Co.) said that although the leakage indicators in the Paper appeared to him to be very ingenious they all failed in one detail, viz., they would not act in the case of a three-phase system with the neutral earthed. The Home Office regulations with reference to the use of electricity in collieries said that the neutral *may* be earthed, but the Board of Trade told the power companies that they *must* earth the neutral to prevent danger from a transformer breaking down, and the extra-high-tension side coming into contact with the low-tension side. He did not know of any system that would work upon a system with the neutral earthed and yet give accurate indications of the value of any faults on mains. He thought, however, that a very simple arrangement could be made which would, at any rate, tell whether there was a fault in the mains system where the neutral was earthed. The Board of Trade only asked for the neutral to be earthed at one point, and this fact, he thought, allowed of the arrangement in Fig. 3 being put into force for indicating a fault, if not its value. The lower values of the shunt could be used for testing purposes after the bell had indicated that a fault existed.

Mr. A. F. HARRIS (Messrs. Nalder Bros. & Thompson), referring to the possibility of using direct current for indicating faults on three-phase systems, said he thought this method could be quite accurate. This could be obtained from a battery or an extra generator and put it through a continuous-current instrument and choking coil. Then the current on the fault would pass through the continuous-current ammeter and the reading would show the sum of all the currents. This system would also show whether the maximum leakage current exceeded that required under the Home Office regulations. With regard to the system proposed by Mr. Pope, the current read on the instrument would always be less than the amount actually flowing. On the other hand, the direct-current system simply added up the currents and the total value was known exactly.

Mr. POPE suggested that Mr. Harris should elaborate his suggestion and send it in to the Institution for publication in the proceedings. With regard to his own proposal, he had merely mentioned it because the continuous-current system referred to in the Paper could not deal with a case with the neutral earthed. Referring once more to Mr. Harrris' proposal, he said that there must be a separate service. If the Board of Trade would permit it he did not see why a low-reading instrument should not be put direct into the earth connection. Mr. Harris said that care must be taken to keep alternating current from going through the direct-current system. This could be effected by a high-resistance choking coil.

Mr. WALKER, in reply, stated that the arrangement proposed by Mr. Pope, which seemed to be an adaptation of the ammeter system, struck him as a very simple arrangement, and it might be used if the Board of Trade sanctioned it.

Electric Lighting of Euston Station.—The new electric lighting of Euston station and of the offices, hotels, carriage sheds and junctions of the London & North-Western Railway, which comprises some 4,000 incandescent lamps and about 250 arc lamps, is supplied from the Railway Company's own generating station at Camden, which also supplies power for the electrically-worked points and signals. According to the *Railway News*, the plant consists of "Dowson" suction gas producers fed by anthracite coal, five 150 H.P. and two 75 H.P. Westinghouse vertical three-cylinder gas engines, together with the necessary air compressors, &c. Continuous current is generated at 460 to 500 volts, and is distributed from the power house through booster balancers at 230 volts for working and lighting the points and signals. Separate mains carry the current, also at 460 to 500 volts, to a balancer and switchroom at Euston, where it is distributed for arc lighting at 460 volts, and, by a three-wire system, for the incandescent lighting at 230 volts.

THE BRIGHTON CORPORATION'S NEW ELECTRICITY WORKS.

(Continued from page 329.)

Fig. 9 is from an interesting photograph, kindly lent us by by Mr. Arthur Wright, which was taken at the moment of firing a charge during the blasting operations to form the trench for the cables in the harbour. Fig. 10 is a general view of the Southwick station, from which it is seen that the works are situated right on the water's edge, and Fig. 11 is a block plan showing the proportion of the 10 acre site which the existing power house occupies. The harbour is sufficiently deep to accommodate 750 ton steamers, and coal is conveyed from them by means of a Pirrie transporter, which is capable of dealing with 30 tons of coal per hour. The coal is whipped up in 1 ton skips, and after it has been weighed in an automatic integrating Denison weighing machine it is tipped into a hopper and travels along a belt conveyer (Fig. 12) to the coal bunkers above the boilers. The position of these is seen in the cross section (Fig. 13). This latter figure shows the position of the two boiler houses, one on each side of the engine room. Only one of these is equipped at present, and it contains six B. & W. water-tube boilers with an evaporative capacity of 20,000 lb. to 25,000 lb. per hour at a steam pressure of 200 lb. per square inch. The boilers are fitted with inclined chain grates, and there is a separately-fired superheater, also with a chain grate, for each set of three boilers, which furnishes about 150° F. of superheat. Fig. 14 is a view of the boiler room, in which one of the three Ingrey travelling hoppers and automatic weighers is seen. These travel along the boiler room and weigh 3 cwt. of coal at a time from the bunkers above the boiler house and shoot it into one of the hoppers of the chain-grate stokers. These machines are electrically driven, as are also the chain-grate stokers and the scrapers of the two 480-tube Green economisers. The bunkers above each boiler house contain 1,500 to 2,000 tons each.

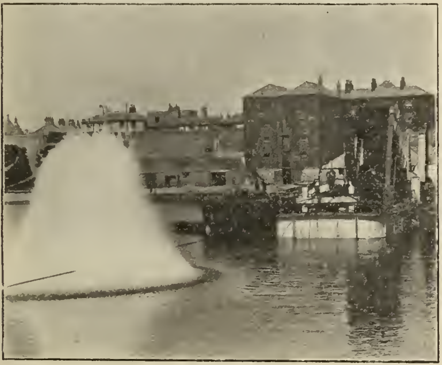

Fig. 9.—Firing a Charge in Shoreham Harbour.

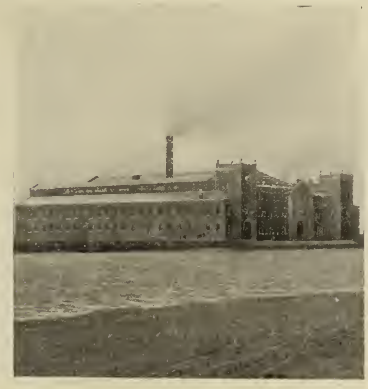

Fig. 10.—View of the Southwick Electricity Works.

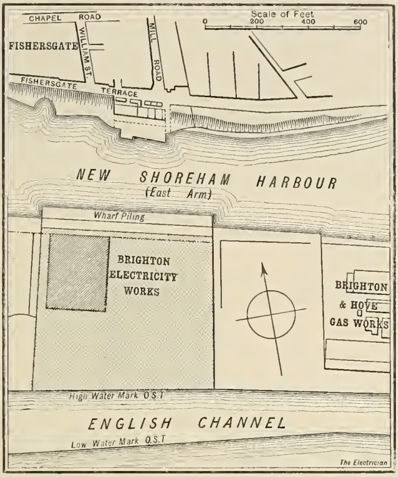

Fig. 11.—Block Plan showing Position of Southwick Electricity Works.

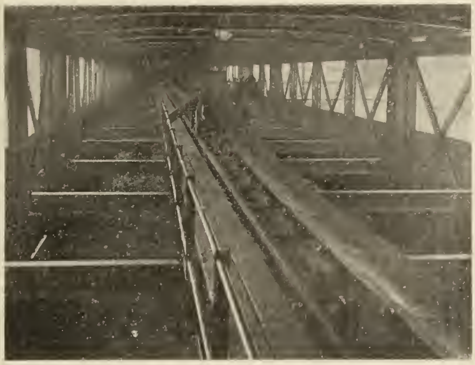

Fig. 12.—The Coal Conveyor.

Feed tanks and water softeners for the town water employed as make-up feed are placed on the roof of the building. The tanks have a storage capacity of 200,000 gallons, and the softener is of the Reissart (lime and soda) pattern. Two Hall steam-driven feed pumps are employed, the exhaust from which is taken to a Royle feed heater.

The chimneys are only 100 ft. high, and induced draught is employed with electrically-driven fans.

Fig. 15 is a plan of the boiler house and engine room. As is seen, there is sufficient room for three more boilers, so that when the west boiler house is also equipped there will be 18 boilers in all. The arrangement of the steam range is distinguishable on this drawing. The steam pipes are of mild steel and they are lagged with micanite non-conducting compound.

(*To be concluded.*)

The official opening ceremony took place on Saturday, June 16, when Mr. John Burns, M.P., President of the Board of Trade, was present. At the luncheon, which was held in the Royal Pavilion, the Mayor (Alderman James Colbourne, J.P.) presided, and among those present were the two Parliamentary representatives of the town (Messrs. Villiers and Ridsdale), Mr. Arthur Wright (consulting electrical engineer), Mr. J. Christie (resident engineer), Mr. J. R. Bridges (borough electrical engineer, Eastbourne), and Mr. W. C. P. Tapper (borough electrical engineer, Stepney, London) in addition to the representatives of many of the neighbouring towns. The Mayor proposed the toast of the President of the Local Government Board, whom he referred to as the Right Hon. "Robert" Burns, M.P. In his reply to the toast Mr. Burns dealt but little with the electrical undertaking, reserving his main speech for the opening of the works, which took place later. In reference to the large amount of criticism and opposition which has been shown to the electricity supply undertaking in Brighton both by the local press and by anonymous persons, Mr. Burns advised the Electricity committee to "go on" and progress, for he was quite sure that in years to come the action of the committee to-day would receive credit and eulogium from the general body of the ratepayers. It was impossible, he said, to have all the advantages of modern local government without

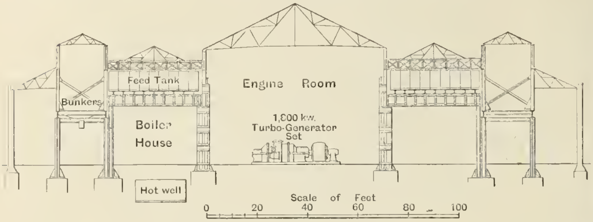

Fig. 13.—Cross-section of Building.

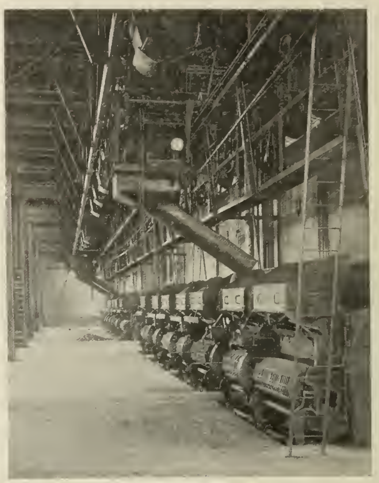

Fig. 14—Part of the Boiler House.

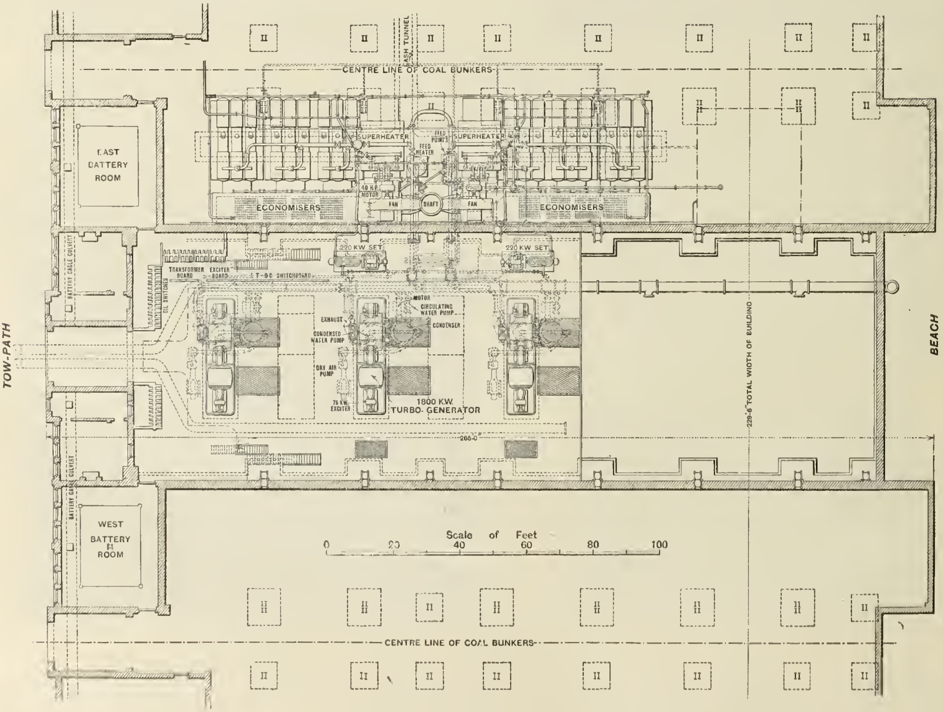

Fig. 15.

having to pay for them. Thirty years ago ratepayers, with oriental submission and ox-like submissiveness, grumbled at nothing, but nowadays the ratepayers knew more than the engineer, and then grumbled when they had to pay for the reforms which tyhe agitated for.

At the starting up of the machinery, which took place at 5 o'clock, the Mayor again presided. Mr. Butt Thompson, the chairman of the Electric Lighting committee, first described the history of the electricity undertaking, details of which we gave at the commencement of the first instalment of our description of the works in *The Electrician* last week.

Mr. Burns said he would make a few remarks in reply to the critics. There was no fear for the future of electricity either for light, traction or power, provided there was good management. It was better than gas from the point of view of price, whilst from the point of view of health and domestic hygiene there was no comparison. Similarly, no one could say that an electric tramway was not superior to a horse or motor 'bus. Probably much of the anonymous abuse that had appeared in the local press came from gentlemen who were shareholders in big electrical monopolies in London, and all he could say to them was that if they would only use as much electricity as they gave off heat as opponents to the scheme, then there would be no fear for the future. He would suggest to the Brighton Corporation that instead of charging on the present system, which worked out to about 2½d. per unit, they should have a flat rate of 2d.; in fact, to pursue the policy of charging the lowest possible price to consumers rather than to attempt to make large profits. And on this point his advice was not to worry about making a loss of a thousand pounds or so during the first few years; profits would undoubtedly come if the price was low enough. Suggestions might soon be heard that the undertaking should be bought up by a syndicate, but he advised them not to listen to the proposal. There were far-seeing men who worked in London, and who occasionally came to Brighton for the benefit of their health, who would be only too pleased to pay perhaps £300,000 more than the undertaking cost; in fact, if he were a member of such a syndicate he would be pleased to offer £1,500,000 for the undertaking and then make a profit five years hence. He had never yet had an explanation of why, when a company asked for money it was called capital, whereas it a local authority asked for money it was called "debt." Opposition had also been made on the ground that the accounts were not properly kept. All he could say was that they could leave this to him. He was determined that the departmental committee which he had appointed to enquire into municipal accounts should draw up such a form of accounts that he who runs may read, and Brighton would have to toe the line and comply with the standard form of accounts in common with every other local authority; it would be imposed upon every municipality whether they liked it or not. Complaints were heard that the rates were high, but he could only say that the rates were lowest where there was most municipal enterprise, and highest where the companies were in the field. And, after all, what did the municipal debt of England amount to? Merely £500,000,000 spread all over the country. He wished the Brighton electricity undertaking good luck and God speed, for he was convinced that it would be to the benefit of the ratepayers, and if they would only take his advice and reduce the price to a flat rate of 2d., he predicted that within five years the works would have to be extended, and he would take the very greatest pleasure in coming down again and opening those extensions.

ELEVENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The eleventh annual convention of the Incorporated Municipal Electrical Association opened in Kingston-on-Thames on Tuesday. After the Association had been welcomed in the Royal County Theatre by Councillor H. C. Minnit, J.P., mayor of Kingston, and Ald. Collins, the deputy mayor, Mr. J. E. Edgcome (chief electrical engineer, Kingston) delivered his presidential address:

Mr. Edgcome explained that although he had decided practically to limit his remarks to matters concerning the Association, he proposed to deal to some slight extent with one matter which might perhaps be regarded as a distinctly debatable question. It referred to municipal trading; and although he did not propose to set forth any opinion as to the merits or demerits of municipal trading as a whole, still there was one phase of this question which he thought might be touched upon with some advantage—viz., the question of municipal wiring of consumers' premises. It must be evident than any scheme of a local authority which fostered an increased consumption of electricity within their district must be beneficial to the municipality supplying such energy, and he could not, therefore, see what objection could be taken to local authorities doing all in their power to encourage their consumers to make an increased use of electricity for various purposes.

Wiring of consumers' premises might be carried out to the satisfaction not only of the local authorities, but also to the complete satisfaction of the general body of contractors, if the local authorities, having obtained powers for carrying out such work, were content to act only as what might be described as bankers to their electricity consumers. Local authorities, having entered into an agreement with new consumers to enable them to spread the cost of the work over a number of years on the basis of a deferred payment system, and having ascertained the requirements of such consumers, should prepare a specification of the work required, and, instead of then proceeding to carry out the work, should obtain tenders from suitable contractors, and having supervised the carrying out of such work, should be prepared to make the necessary payments to the contractor on the completion of the work.

This arrangement was obviously to the advantage of the consumer, as he was enabled to spread the cost of the installation over a period of years. He knew that his work had been carried out to a satisfactory specification, under proper supervision and probably at a lower cost than would otherwise be the case, as obviously no extra sum on account of risk of bad debts need be included in the contractor's tender to the municipality for the work to be carried out on the consumer's behalf; whilst, on the other hand, the contractor would have no reason to complain that the municipality were entering into direct competition with him, as might be the case if the staff of the local authorities were to carry out the work themselves.

If local authorities decided in all cases to carry out their schemes of assisted wiring on these lines, he felt assured that contractors would soon cease to complain of what they now alleged was the unfairness of municipal trading, and, on the other hand, would welcome such a scheme as a means of promoting the growth of electrical work throughout the country.

In the remainder of his address, Mr. Edgcome dealt with matters affecting the Association itself. After referring to a table which showed the growth of the Association year by year (from a membership of 114 in 1896 to 394 in 1906), Mr. Edgcome alluded to the comparatively small number of associates in their ranks. Out of about 800 assistant engineers who were eligible for election as associates, only 61 belonged to the Association. The assistant engineers were unable to attend the annual conventions during the absence of the chief engineers who were themselves attending the meetings, and as difficulties had arisen in carrying out the suggestion of holding a second convention annually for associate members and associates, the Council were compelled to consider other matters likely to prove of advantage to the class of members whom they wished to encourage. Mr. Edgcome then explained the scheme, which is outlined in the annual report of the Council, printed on a later page of this issue.

The address next dealt with the usefulness of the annual meetings of the Association, and the benefit which municipal electrical engineers and members of committees could derive from them. In this connection the President said:—The attendance at these conventions of the chief engineers and the representatives of committees results, of course, in a certain amount of expenditure to the local authorities, and it has been sometimes suggested that this expenditure of public money is an unnecessary one, seeing that copies of the Papers read and of the discussions upon them can be obtained for a nominal sum. Personally, however, I cannot agree with this suggestion, and I am sure that those members of committees who have attended the conventions of the Association will readily agree that the valuable experience obtained by attendance at these gatherings far outweighs the comparatively small cost incurred; and it must be borne in mind that this experience is not obtained only from the Papers read and the discussions raised upon the Papers, but in a much greater degree from the discussions which take place among the members at other times during the conventions, and from the information which is obtained during the visits to various works which are included in each year's programme. . . . Unfortunately, there is a tendency on the part of the Government authorities to disallow, in certain instances, the payment of expenses incurred by the representatives of local authorities and their engineers when attending these conventions. I certainly fail to understand on what grounds this expenditure should be disallowed, seeing that, although the experience gained by the engineers and members of the committees is an experience which is useful to them individually, yet it cannot be gainsaid that it must be of still greater value to the authorities which they represent and to the undertaking which they control, and I trust that in due course this may be fully recognised.

Mr. Edgcome concluded his Address with the following suggestions for widening the sphere of activity of the Association:—

I have dealt very briefly with some of the work which the Association is doing, and I now propose to deal somewhat more fully with a work which, in my opinion, the Association can usefully carry on. As you are all only too well aware, it is a habit among electrical engineers to send out inquiries from time to time to one another in respect to the many and varied matters relating to the generation and distribution of electricity. If I were to hazard a guess on the subject, I should say that on an average every municipal engineer in the country receives perhaps thirty inquiries annually, and these inquiries embrace practically every subject which is or can be of any use to electrical engineers, and range from the modest request for information upon perhaps three points to one set of queries which I remember went into a formidable total of 52; and although these 52 queries, which modestly filled two sheets of foolscap, were, as queries, fairly harmless, they involved, if the work of answering them were conscientiously carried out, the writing by each municipal engineer of a small treatise on the design and management of central stations in general.

Doubtless from a literary point of view the compiling of answers to these queries is very good practice for the engineer, but unfortunately the majority of station engineers find their time fully occupied with other work; and although they invariably respond cheerfully to these too frequent calls made upon their time, still they cannot but have a feeling of regret that the available data collected in this manner throughout the country is not tabulated for future reference, and I certainly think that this is work which lies clearly within the scope of our Association, but which can only be satisfactorily carried out by means of a central bureau.

I should like to state that this idea is one which has been presented to me on many occasions by municipal men and others interested in the matter, although for some years I have in my own mind seen the necessity of some such institution. There are, of course, many difficulties in the way of its successful inception; still, I am sure that engineers as a body will readily agree that difficulties exist only to be overcome.

If the majority of the members of the Association consider that such an institution would be of benefit to the Association, there should be no difficulty in carrying their wishes into effect.

Doubtless the feature which will present itsely most prominently to the hon. treasurer will be the question of expense, and it will be necessary to devise some means of meeting the enhanced expenditure which will be incurred by the necessary provision of a central office and the clerical assistance requisite for tabulating the data obtained, data which must be carefully collected and edited if it is to serve any useful purpose.

If under the present procedure the cost to the different authorities of obtaining information upon various matters was ascertained, it would be found that a very considerable amount is spent yearly on this work; and if an equal sum were paid as fees to a central bureau for similar information, although more complete of its kind, it would go a considerable way towards paying the cost of the collection and tabulation of such information, although for some years the expenditure must of course very largely exceed the possible revenue, and some provision would have to be made to meet this cost.

Under our present constitution the same subscription is paid by all municipalities, irrespective of their size—that is to say, the subscription of the largest city whose electricity committee is a member is the same as that paid by the smallest urban district council. I would suggest that an equitable source of revenue would be obtained by increasing the subscription payable by the larger undertakings, such increase being based on a sliding scale; but whether the amount of the subscription should be based upon the rateable value of the municipality, upon the capital expenditure of its electricity undertaking, or upon the profits derived from such undertaking, is a matter of detail for further consideration.

I need hardly point out that for some years the collection of the requisite information will be a considerable tax upon the time and good nature of the members of the Association; but they will doubtless appreciate the fact that the work which they are called upon to do in giving information to the bureau will be work of an exceedingly useful and lasting character, from which permanent records will be made, and they will feel that the result of their labours is being collected for the general use of the members, instead of being, as in most cases at present, put aside after it has served the temporary purpose for which it was collected, and they will realise that in a few years they will be able upon receipt of a budget of inquiries to refer the applicant to the central establishment, which will then be fully qualified to deal with the matter.

The central bureau might also be used as a meeting place for the members when in London, and a comprehensive technical reference library should be considered as a likely feature of the scheme.

It might also be thought advisable to arrange for the keeping of a register of assistant engineers, so that chief engineers could make enquiries at the bureau when desirous of filling vacancies on their staff.

Councillor T. Lyne, J.P. (chairman of the Kingston Electricity committee), proposed a vote of thanks to Mr. Edgcome, which was heartily responded to by the members. The following Paper was then taken. The author read an abstract of it in the form of a lecture, illustrated with over 100 slides:—

STEAM TURBINES.*

BY SYDNEY W. BAYNES.

(Chief Electrical Engineer, St. Pancras.)

We are accustomed to look on the turbine as an invention of recent times, but it is of considerable interest to note that its origin dates back to a period some 200 years B.C. In these far-off days the first crude attempts in small turbines of the reaction wheel pattern seem to have been used in connection with various working models and mechanical toys, and then comes, probably through the lack of chroniclers, a long blank of nearly 2,000 years in turbine history, bringing us up to the year 1629, when Giovanné Branca, an Italian architect, suggested the employment of a wheel with a number of pockets surrounding its periphery, into which a jet of steam was directed, and this apparatus was further improved by Kircher, who applied two steam jets. In 1694 a car fitted with a boiler was propelled by a jet of steam directed against a wheel of the shape of a windmill and geared to the driving axle of the carriage. This also was devised by Italians. Coming closer to modern times, the reaction turbine was experimented on by Segner and described by Sadler in 1791, and in 1853 Tournaire gave the French Academy an exceedingly lucid description of a many-stage reaction turbine, stating that it worked chiefly because of the differences of pressure between the entrance and exit from the blades. In 1870 Hanssen constructed a many-stage reaction turbine, and Cutler in 1879 presented a well-made radial many-stage machine. De Laval appears to have made the first application of a steam turbine to practical work in 1883, but the very large number of revolutions greatly restricted its application and prevented it attaining any importance. It was at this juncture Parsons stepped in, evidently realising "there is a tide in the affairs of (turbines) which taken at the flood leads on to fortune."

It should be a matter of some pride for us as Englishmen that, while other nations were nibbling ineffectively over the production of steam as a motive power, Watts came to the front with his reciprocating steam engine, causing a profound and ever-widening revolution in its effect over commercial enterprise. Then, again, as time rolled on, Parsons' achievements with the turbine add further laurels to our status as an inventive people, and allows us to claim that English ingenuity indirectly drives the machinery of the world.

We will now proceed to consider the different methods of turbine construction by the various makers and endeavour to elucidate the leading features of each.

THE PARSONS TURBINE.

Fig. 1 is a sectional elevation. The moving and fixed blading of the shaft and casing is pretty clearly shown. The steam balancing pistons or dummies are seen at CEG. The thrust of the high pressure steam on the first stage of expansion is balanced by C. Passage D in the casing communicates the steam pressure from point J to the inside face of the dummy pistons E, thus balancing for the intermediate expansion, and F in communicating with the face of G balances for the remaining section. This completes the balancing so far as the steam pressure is concerned; the action of the vacuum on the exhaust end of the rotor is compensated for through a passage not shown, which brings the vacuum to the outer face of G.

A passage conveys a supply of steam to the packings at each end of the shaft, the steam sealing the packing against air admission into the vacuum. The supply of steam to this packing is adjusted so as to provide an excess of pressure over the vacuum, sufficient to show a small escape to atmosphere at the ends of the packing. The exhaust steam from the pilot valve belonging to the governor provides sufficient steam for this purpose. Leakage of steam past these dummy pistons and also at the ends of the shaft is prevented by a number of grooves cut around; corresponding projections in the turbine casing fit these grooves, there being only a small clearance of a few thousandths of an inch permitted, and the adjustment of the clearances is maintained by a thrust block in the bearing at the steam admission end of the turbine. The power is delivered from the low-pressure end of the shaft to the alternator or other machinery through a claw-shaped flexible coupling.

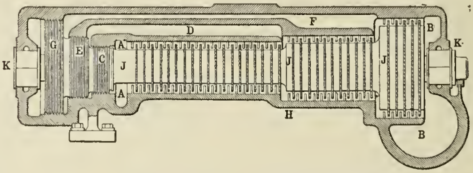

FIG. 1.—LONGITUDINAL SECTION OF PARSONS STEAM TURBINE.

Forced lubrication is provided to all the bearings by a pump driven direct from the shaft by worm gear, and the heated oil leaving the bearings is led through a cooler back to the pump. Water from the cirulating pumps is led through the cooler.

The rotor is of steel and of hollow construction, carefully turned and bored inside and out. Short ends of shafting are forced in and locked by screw pins at the high and low-pressure ends. The diameter of the rotor increases, as already seen, in small stages throughout its length. Under-cut recesses are turned in the surface at the required intervals to accommodate the blades. The blades are shown in plan and elevation Fig 2. A small caulking piece determines the spacing between the blades round the circumference. These blades are inserted round the rotor in the under-cut grooves with a distance piece between each; the distance piece and edges of the grooves are caulked over, securing the blades in position. Each ring of blades of the low-pressure and intermediate stages are stiffened by a ring of metal fitting the groove and soldered in with silver solder. The blading of the turbine casing or stator is effected in a similar manner.

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* Although the Paper, as we give it, is somewhat abridged, we have retained the same figure numbering as in the original Paper to facilitate reference.

The governor is very complete in its operation and control. It is a most sensitive apparatus, so much so that when a turbine shares the load with a reciprocating engine in the majority of cases the variations of load are taken almost wholly by the turbine. The turbine is either controlled by an electric or mechanical governor; in any case steam is admitted in a series of puffs by the periodic operation of a double-beat valve. This valve in turn is moved by a steam relay connected by a lever to a centrifugal governor, driven from the worm gear on the turbine shaft. The lever is periodically raised and lowered by means of an eccentric driven by the same gear. This eccentric also drives the oil pump for the forced lubrication to the turbo bearings. The duration of each puff of steam is controlled by the position of the balls of the mechanical governor, or, if an electric governor, then by the position of the solenoid. An emergency governor is tripped by the reciprocating lever should the speed become excessive. This trip gear releases the main valve, which is of the mushroom type.

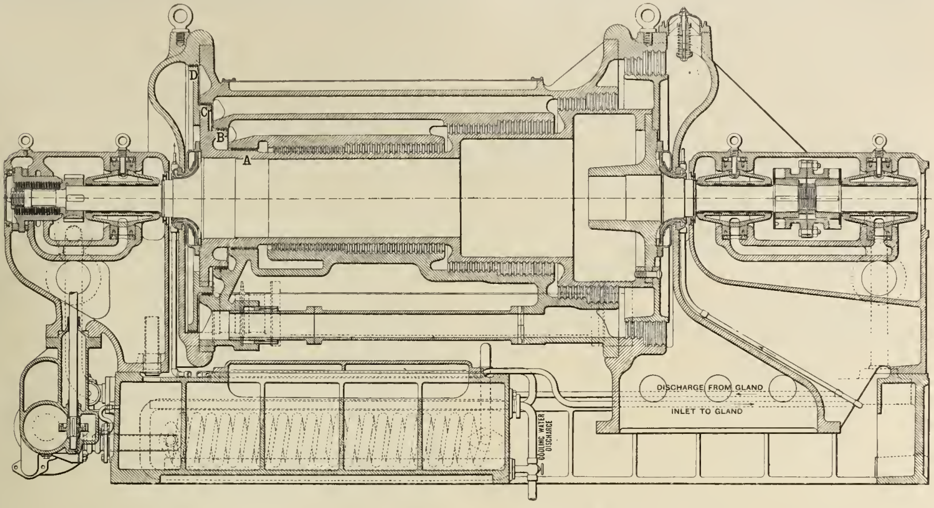

Fig. 4.—Longitudinal Section of 1,000 kw. Brush-Parsons Steam Turbine.

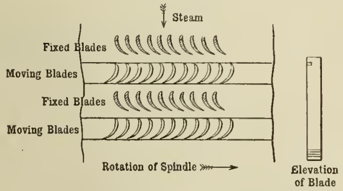

Fig. 2.—Diagram of Moving and Fixed Blades.

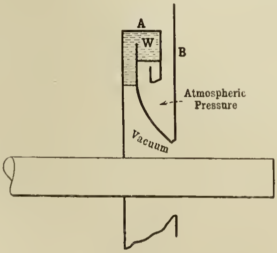

Fig. 5.

A number of engineering firms are now building Parsons turbines under license, and with a view to shortening this Paper the modifications claimed by each as improvements will only be dealt with.

The Brush-Parsons Turbine.

Fig. 4 shows a sectional elevation of the Brush Parsons machine as now being placed on the market. The rotor is built up with a combination of mild steel castings and forgings, the larger sections being forgings. The stator or cylinder is built up in six castings and bored in three sections. The makers claim that by boring the rotor and stator in shorter sections more accurate work can be accomplished, as shorter and stiffer boring bars are available. The top half of the cylinder may be swung back on the hinges provided, and the interior thrown open for inspection.

Four steam balancing pistons are provided; the inner one, A, compensates for the first and second expansions from the high pressure end, and piston B for that of the third and fourth expansions piston C for the fifth and sixth sections, and the inner side of piston D for the seventh and eighth. The labyrinth packings at each end of the shaft as used by Parsons have been replaced by an ingenious centrifugal water seal which prevents the inrush of air into the vacuum.

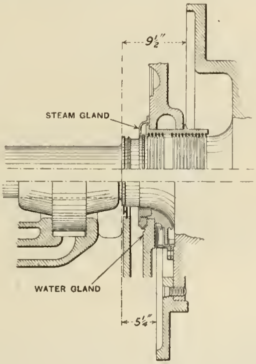

Fig. 6.—Water Gland v. Steam Gland.
Length saved at each end of Turbine by use of Water Gland = 4¼ in.

Fig. 5 shows this device; A revolves with the shaft, and is provided with small vanes inside the water space. B is a stationary diaphragm carried by the casing and dipping into the rim of water W. A small supply of water is led into the rim and is caught up by vanes and held in the rim by centrifugal force. This force is sufficient to hold up against the vacuum at all speeds down to within 60 per cent. of full speed. In practical working with vacuum there is a difference in the level of the water on either side of the fixed diaphragm of from ¾ in. to 1 in. Fig. 6 shows the water seal in detail as applied by the makers. The half labyrinth packing seen in the same figure shows the gain in the shortening up of the shaft at each end.

The blading is secured similarly to that described in the Parsons machine, excepting that the tips are shrouded by a single rim passing through the tips and soldered at each point with silver solder. See Fig. 7.

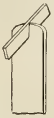

Fig. 7.

The Willans-Parsons Turbine.

Fig. 8 shows a sectional elevation of this machine wherein the steam balance is effected with only two instead of three balancing pistons. Balancing piston C counteracts the thrust of the steam on the blades on the first three sections AA, piston D that of A′A′, the steam pressure finding its way through passage E to its inner face. Holes GG through the rotor bring the steam pressure from A′ into chamber F, thereby balancing the steam thrust on the blades in sections A″A″. The steam brought to F through GG is at about atmospheric pressure. Passage HH communicates the vacuum to the outside of piston D, completing the steam balance. The shortening and stiffening of the shaft by the omission of balance pistons is a step in the right direction. To avoid the possibility of damage to the blading, and to facilitate inspection of the interior, the upper half of the casing is hinged. Those who have handled turbines unprovided with this important detail will realise the advantage of this provision.

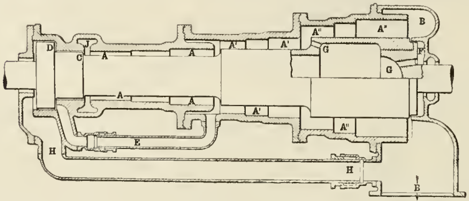

Fig. 8.—Longitudinal Section of Parsons–Willans Turbine.

Blading.—The rotor and casing are grooved in a similar way to the description given of the Parsons design. The blading, however, both for the stator and rotor, is built up in rigid sections, two or three sections usually completing the circle for the rotor, and two or four sections for the stator. The blades are dropped into the channels provided for their reception, and a caulking ring running circumferentially is slipped in by the side. This ring when down in position stands up above the surface about ⅛ in. or more, according to the size of the blading. The blades are finally secured by caulking this projecting portion down flush to the face, so that the metal is expanded out into the under-cut, making a very secure job. In the event of an accidental strip the advantage of this method is obvious, as a complete section of blades can be replaced in an exceedingly short time.

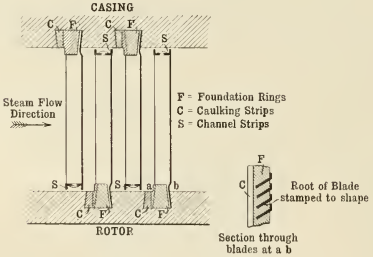

Fig. 9.—Section of Blading.

Shrouding.—The whole of the blading is stiffened and held together by a channelled rim, each blade passing through this channelling, and the tips of the blades being securely riveted over. This method undoubtedly lessens the chances of a strip, and it is claimed that it also reduces the leakage of steam past the blade tips by the labyrinth resistance which the hollow chambers present to the steam at each set of blades. Fig. 9 will explain clearly this method of blades. This blading has been chosen for the Cunard turbine steamers now being built.

Governor.—Governing is secured by throttling the steam through a double-beat valve operated by a powerful centrifugal governor of the well-known Wilson Hartnell type. An emergency governor is also provided.

The improvements introduced by Messrs. Willans & Robinson, the Brush Engineering Company and others, tending to shorten the length of the shaft are to be hailed with satisfaction, as the more rigid the shaft of this type of turbine the less chance there is of disablement through stripping of blades, likewise better economy becomes possible as the clearances may be reduced.

The Westinghouse Turbine.

The early turbines manufactured by the Westinghouse Company were to the Parsons design; latterly they have introduced considerable modifications in their more recent machines combining Parsons' double-flow turbine and an impulse type. This form has been adopted particularly with a view to shorten the shaft and increase the stability of the rotor, also to overcome the difficulties encountered when dealing with high-pressure superheated steam. The impulse wheels are in the centre of the shaft. Suitable nozzles direct the steam on to two rotor wheels carried by the shaft; each wheel has a double rim of impulse blades with a set of guide or stationary blades in the centre, similar to the rotor wheel of the Curtis turbine.

This high-pressure impulse section handles above 25 per cent. of the energy in the steam, and, as with the impulse principle, considerable clearances are permissible, the troubles likely to occur due to distortion when working with a high degree of superheat are avoided. The reaction sections are on either side of the impulse wheels and are fitted with the Parsons blading. The steam, after leaving the impulse wheels, has been reduced in pressure to about 60 lb. per square inch, with a corresponding increase in volume; consequently larger clearances may be allowed over the tips of the blades than when dealing with high-pressure steam. The thrust being equal in both directions, no balancing on account of the action of the steam is necessary. At each end of the spindle the vacuum is sealed by a water gland similar to that employed in the Brush-Parsons design.

Speed is controlled by Parsons governors. An emergency governor is also provided. The blading of the reaction portion is stiffened by threading through the blades a strip of comma-shaped metal and bending the tail over. In the spacing between each blade suitable saw cuts are made in the comma shaped piece before threading to enable the bending over to be accomplished.

The Curtis Turbine.*

This turbine may be described as an impulse turbine and the steam is dealt with in some four stages or more.

Blading.—An interesting feature in the blading of its rotor wheels lies in the fact that it is cut up from the solid round the periphery of each revolving wheel. Intermediate diaphragms are inserted between each rotor, and the steam is expanded through nozzles and directed into the blades of each revolving wheel; these nozzles are drilled through the diaphragm rim and expanded by a special drilling apparatus. As in the Rateau turbine the number and size of the nozzles employed round the periphery of each separating disc is increased from the high-pressure to the low-pressure end, where, generally speaking, nozzles are employed round the whole of the circumference. In the general construction of the rotor wheel, two sets of blades are mounted round its circumference, and between these is provided a fixed set of blades. The steam leaving the expansion nozzles is directed against the first set of revolving blades and delivers its motion by impulse. On leaving these blades there is a reaction against the fixed blades, whilst the steam is again deflected into the direction of rotation and enters the second set of moving blades, finally, arriving in the space provided by the diaphragm partition which carries a further set of nozzles; here it is again expanded through these nozzles and directed into a seris of moving and stationary blades of larger dimensions, and so on. The number of stages is governed by the degree of expansion together with the peripheral velocity practicable. The nozzles and blades are so proportioned in number and size that the steam is expanded and maintained at uniform velocity throughout the various stages between its delivery at the high-pressure end and exit from the exhaust end of the turbine. The stationary blading is also cut out of the solid and fitted into the turbine case in sections. The sections may readily be removed and replaced should an emergency arise. Where the revolving shaft passes through the fixed diaphragms a special form of labyrinth packing is provided somewhat similar to that employed in the Rateau turbine and here again the same remarks apply as to there being a minimum of leakage in the direction of the shaft.

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* We have omitted the illustrations of this turbine, as a full illustrated description of it has appeared in *The Electrician* at a fairly recent date (Vol. LV., p. 162).

The whole weight of the revolving part is supported on a footstep bearing, which is placed in the base and is removable from below, provision being made in the foundation for this purpose. The bearing is made up of two circular bearing blocks of cast iron, one of which revolves with the shaft, the other remaining stationary. Water is employed as the lubricant, and is forced through a passage in the centre of the stationary bearing block, a film of water separating the two surfaces. The water is maintained at a pressure of 400 lb. per square inch, by an accumulator which is kept supplied with water by a suitable pump automatically controlled. This lubricating plant is in duplicate. The accumulator is further capable of maintaining the supply of water under pressure for several minutes, and devices are provided to give ample warning, should the supply of water under pressure be threatened with failure. A guide bearing also receives its lubrication from the water as it passes upwards and finally overflows into the condenser which forms the base of the low-pressure end of the turbine. This lubricating water is drawn away along with the condensed steam by the air pump. The step bearing may be raised or lowered by the application of a screw bolt, and this screw bolt, for convenience, is operated by a worm gear bringing the movement to a convenient position for manipulation. By this means the rotor may be raised for the purpose of adjusting the clearances between the rotating and fixed blades; small inspection holes are provided in the turbine casing to enable these clearances to be accurately gauged. All the bearings are arranged so as to be easily removable without disturbing the rotor or generator.

The upper part of the shaft at the high-pressure end is kept steam tight by metallic packing somewhat similar to that used in the Rateau turbine.

The regulation of the steam is effected by opening or closing individual nozzles at the entrance from the steam chest into the first rotating wheel. The flow of steam through the other series of stages is not individually controlled except in case of above three-quarter or some pre-determined load, when an automatic arrangement is provided for bye-passing the steam into a further series of nozzles at the third stage, this becoming necessary and desirable in order to maintain a uniform velocity and to add further to the economy. By this method of control the flow of steam enters the expanding nozzles always at the initial pressure, successive nozzles being called into play in proportion to the amount of work required to be done. It is claimed for this method that, inasmuch as the steam is not in any case throttled down, the full benefits of high pressure steam are available throughout a wide range of loads.

At first sight it would not appear that a delicate control of speed could be derived by this form of steam admission, but a careful study of the operation of the governing gear proves that the reverse is the case. Assume that three nozzles are in operation, and that the amount of admission is slightly under the requirements; the fourth nozzle will then come into play, but only for a short interval (possibly during 15 or 20 revolutions) and instantly close, and a repetition of puffs of steam at intervals will supply the deficiency, bringing about the necessary uniformity of speed.

The controlling governor is of the centrifugal pattern, and is devised to regulate the speed to within a margin of 2 per cent. between no load and full load. It is placed on the shaft between the turbine and the generator, and is provided with a supplementary spring and controlling arrangement to allow the speed of the governor to be varied some 3 or 4 per cent. above or below the normal for the purpose of paralleling. A hand wheel placed in a convenient position near the main throttle valve controls this adjustment. In some cases this adjustment is operated by a small motor, which may be controlled from the switchboard or other convenient place. The governor is connected to an electric controlling device which directs the current to a series of electric magnets, and these in turn operate pilot valves, each of which open or close the main admission valves of the nozzles already mentioned. These main admission valves are of the balanced type and are opened or closed by the difference in pressure of the steam which is admitted on either side of them. An emergency governor is also provided which comes into operation should the speed of the turbine reach a given limit.

These turbines were originally made in the small sizes, of horizontal construction, but the makers now give preference to the vertical form described.

The Rateau Turbine.*

The Rateau turbine is designed on the impulse principle. Where high-pressure steam is used it consists of a high and low-pressure section separated by a bearing. The makers contemplate building future turbines for high pressure in one section to facilitate economy in production.

Each moving wheel is built up of steel plates pressed into a conical dish shaped form and twice bent over at the rim. A second steel plate dished in the opposite direction supports and stiffens the whole, and they are finally riveted together and secured to a steel sleeve, which fits the main shaft of the rotor. The rim is spaced off and drilled to receive the steel blades, which are securely riveted thereto. The tips of the blades are shouldered off to carry a steel stiffening band, secured by riveting over the central portion of the tips, which project through for that purpose.

Each rotor wheel is accurately balanced on a special machine having a beam mounted on knife edges and provided with scale pans on each end. The beam is about 5 ft. long and operates an index pointer which magnifies the movement considerably and indicates the slightest out of balance. As a result of this individual balancing, no further adjustment is found necessary in the completed rotor.

The blades are of nickel steel pressed up in one piece of semicircular form. They are ground to a cutting edge on the steam admission side and every care is taken to reduce the surface friction to a minimum. The length of the blades, likewise the diameter of the moving wheels, are increased to accommodate the increasing volume of steam to be dealt with in its passage from the high to the low-pressure end of the turbine.

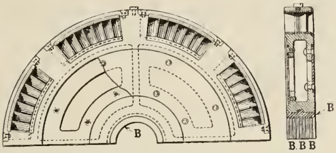
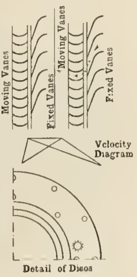


Fig. 21. Fig. 22.

Rateau Turbine: Diaphragm with Distributors.

Fixed diaphragms are placed between each rotating wheel and fit accurately into recesses turned in the turbine casing, making a steam-tight joint therewith. Fig. 21 shows an elevation of a half section of this diaphragm and Fig. 22 shows a sectional view of same. It will be seen that the main body of the diaphragm is of rigid construction, being of cast steel and filled up with thin steel plating. The nozzles through which the steam is expanded and directed into the moving blades of the rotating wheel are seen round the periphery. These nozzles are built up of special bronze and fitted into the diaghragm with suitable cover plates, secured with screws, and may be replaced in the very unlikely event of their becoming damaged.

Fig. 23.



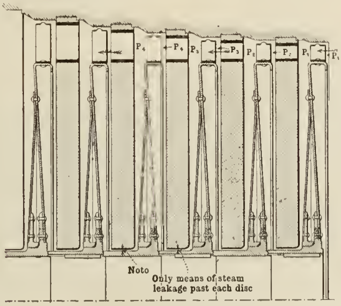


Fig. 24.

Where the revolving shaft passes through each diaphragm a soft metal bush is provided; it is bored and grooved to accommodate the shaft, the grooves operating as a form of labyrinth packing resisting the passage of the steam along the shaft. It will be observed that this is the only point of leakage which occurs in the design of this machine and that the ring of possible leakage being near the shaft is of small circumference in comparison with that of the turbine casing, consequently the losses to be anticipated from this source are greatly minimised. At the high-pressure end a small number of nozzles direct the steam, a portion of the diaphragm being blank; as the steam expands from stage to stage the nozzles are increased in number and radial depth until arriving at the last diaphragm the nozzles are ranged around the complete circumference.

Fig. 23 shows a plan of the blading and nozzles from which their forms will be easily understood. The arrows indicate the passage of the steam, and it will be seen that care has been taken to avoid shocks, the passages being well rounded off to this end. The smaller fixed diaphragms are somewhat slighter in construction than those described. Fig. 24 is a half-sectional elevation showing the rotor wheels in their positions between the fixed diaphragms.

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* A full description of this turbine appeared in *The Electrician*, Vol. LIII., pp. 307 and 349.

Since the steam pressure is practically equal on either side of the revolving wheels in each stage, no provision for balancing against the steam pressure is found necessary. For these reasons considerable clearances are permissible between the blades and the fixed portions. These clearances over the blade tips vary from $\frac{1}{8}$ in. to $\frac{1}{4}$ in., and on the exhaust side of the blades from $\frac{3}{8}$ in. to $\frac{5}{8}$ in. is allowed, whilst between the fixed diaphragms and the moving shaft, where the circumference of the possible ring of leakage is comparatively small, 0·008 in. only is allowed.

For the purpose of coupling the turbine to the generators, or other machinery to be driven, a rather novel form of flexible coupling is employed. It consists of two discs drilled near the circumference with a large number of small holes through which pass small steel rods of about $\frac{1}{16}$ in. diameter, bridging a gap between the two discs of some 3 in., the power being transmitted through the steel rods from one disc to the other.

The governor is driven through the medium of a worm gear, from the turbine shaft, and its construction is somewhat novel. A horizontal shaft runs in gear with the vertical governor shaft carrying suitable bevelled gearing; any variation in speed of the governor operates a lever which raises or lowers a vertical shaft (provided with an upper and lower bevel wheel) until one or the other engages with the revolving shaft, the effect of setting in motion this shaft being to traverse a screw either forwards or backwards, according to the direction of revolution, and thereby operating by means of suitable transmitting gear a double beat valve which is either opened or shut according to the adjustment of speed required. A tension spring is provided with the usual screw adjustment for the purpose of adjusting the governor, and gives a margin of adjustment in speed of about 15 per cent. This governing arrangement seems to answer every requirement in an admirable manner.

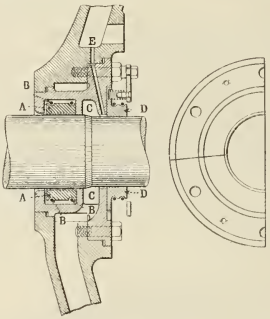

Fig. 25.—Steam Packing of Rateau Turbine.

Stuffing boxes are provided at either end of the shaft of the form shown in detail in Fig. 25. AA are two semi-circular gun-metal blocks, provided with labyrinth grooves and held close to the shaft by the steel springs BBBB, which surround the packing. Between these and the outside packing rings DD will be seen an annular space, CC, which is fed with steam at a pressure of about 40 lb. per square inch in order to make the sealing complete. It will be noticed that the outside packing referred to is held firmly up to the smooth and steam-tight face by springs pressing in the direction of the axis of the shaft, also that it is drawn together by similar springs lying round the circumference in grooves in a similar way to those provided for the inside packing. The packing is, of course, in two semi-circular halves to provide for it closing on to the shaft. Lubrication is provided through the channel E under pressure sufficient to overcome that of the steam in the cavity.

The Rateau low-pressure turbine has been installed with some degree of success in conjunction with regenerative heat accumulators. The use of exhaust steam from reciprocating engines was originally proposed by the Hon. C. A. Parsons, and we are all familiar with the Druit-Halpin system of steam storage in conjunction with boilers. The application of steam storage for use in steam turbines has been carried out with beneficial results in connection with large engines operating rolling mills, winding engines, and other auxiliary machinery, particularly where it had been hitherto usual to run such engines exhausting to atmosphere. It is not within the province of this Paper to enter into the various methods of steam storage; but, briefly, the author would state the exhaust steam from the reciprocating engines is carried on its way to the turbine through a suitable regenerative apparatus, which contains a large mass of metal in contact with water, so arranged that a portion of the heat of the steam passing through is stored by the metal and water and given out to the turbine at intervals when the rolling engines come to a stand for reversing, or other occasions when the supply of steam temporarily ceases for short intervals. The turbine is thus able to continue doing duty under circumstances of considerable variation in the supply of steam from the reciprocating engines. In some instances a suitable automatic valve is fitted so as to admit steam from the boilers in cases where the main reciprocating engines are likely to cease operation for a period beyond the power of the storage apparatus. Obviously, such an arrangement can readily be applied to any make of low-pressure turbine.

The Zoelly Turbine.

This is another example of the many-stage impulse turbine. Two casings are usually employed, a high and low pressure, and there are five rotating wheels placed in each. A bearing lies between each casing, and is an advantage in securing greater support to the shaft. The bearings are fixed to the bed-plate independent of the turbine casing and are not affected by the heating of same. Figs. 26 and 27 show the low-pressure portion in cross section. Details of the blading of the rotor, also the stationary diaphragms with the directing nozzles or vanes, are shown sufficiently clear without further description. The blades and nozzles are increased in length as the steam expands from the high to the low-pressure end. Polished nickel steel is used for the blades, and the cross section decreases from the base to the tips. This is a distinguishing feature in the Zoelly design, and Zoelly appears to be the first to introduce a distinct departure from the usual De Laval form of blade employed for the impulse turbine.

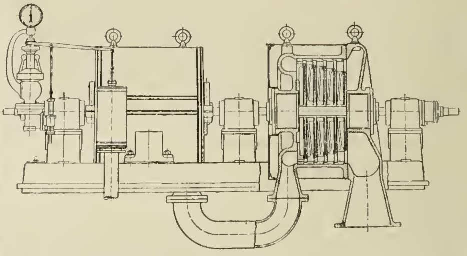

Fig. 26.

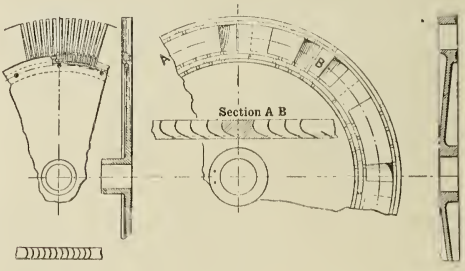

Fig. 27.

The wheels are of forged steel, machined and polished all over to reduce skin friction and obtain good balance. The fixed diaphragms are in halves and are secured in grooves in the half casing, making a steam-tight joint. Thus the stator consists of a complete upper and lower half casing, with its complement of diaphragm segments, and this can be readily removed for inspection. Labyrinth grooves are provided in each diaphragm to check the steam leakage at the point where the revolving shaft passes through.

The De Laval Turbine.*

In this turbine the steam is expanded in fixed nozzles down to the pressure of the exhaust before it issues forth at maximum velocity into the buckets of a single velocity wheel; several nozzles are placed close together with an angle of 17 to 20 deg. between the plane of rotation of the wheel and nozzles. In order to obtain the best efficiency the peripheral speed of the wheel should be about half the velocity of the steam leaving the nozzles, and this results in a great number of revolutions per minute, a 300 H.P. wheel revolving at 10,600 revs. per min. Reducing gear on the double helical system is employed to bring this speed within practical limits. The velocity of the teeth is calculated at 1,000 ft. per second. The pinion on the flexible shaft is machined out in one piece and is of hardened steel; the gear wheels are somewhat softer than the pinion. The countershaft is speeded to 750 revs. per min.

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* A fuller description of this turbine will be found in *The Electrician*, Vol. LII, p. 777.

With such high speeds the turbine wheel revolves about the centre of its mass and not its own geometrical centre. To permit of this the wheel is mounted on a flexible shaft of considerable length, so as to bend freely and allow the wheel to centre when at speed. The shaft for a 300 H.P. turbine is only $1\frac{5}{16}$ in. in diameter. No attempts are made to allow further give in the bearings. Settling seems to occur when the revolutions bear some definite ratio to the periodicity of the vibrations of the combined shaft and wheel, and the speed at which this takes place is known as the critical speed of the wheel.

Centrifugal governors control the speed, and the steam is throttled through an equilibral valve before entering the chamber leading to the nozzles; these are provided with valves which may be operated by hand. By opening or closing these nozzles a high efficiency is obtained throughout a great range of loads, as the adjustment may be so arranged that the steam entering the nozzles is nearly at boiler pressure. This adjustment is desirable to get the best results; since the nozzles are designed to suit a predetermined working pressure, their efficiency falls off with any variation from this pressure.

GENERAL REMARKS.

In starting up turbines with small clearances such as those of the Parsons type to avoid a strip it is of vital importance that the whole machine should be heated up uniformly. Diversity of opinion exists between the makers as to the most effective means of accomplishing this, so much so that two well-known makers issue quite contrary instructions on the point. One firm requires that the turbine shall be warmed up for a considerable time by passing through a large amount of live steam before allowing the rotor to revolve; another firm directs that after draining the pipes and steam chest from water the turbine should be at once set in motion at the instant of admitting steam. The author is of the opinion that the latter is the safer and certainly the more economical of the two methods, as it should ensure the whole of the rotor and casing absorbing heat uniformly.

Another point open to debate is whether or not shrouding contributes to economy. It is suggested that even if leakage is reduced the increased skin friction counteracts this advantage. A further argument is to the effect that the steam passing the tips of the first blade does useful work on the second series of blades as it expands downwards into the succeeding blades.

The size of continuous-current high-speed dynamos for turbines seems limited to about 1,000 kw.; it would be interesting to know if there is any prospect of this limit being exceeded and in what manner difficulties in commutation are likely to be overcome.

It is obviously impossible within the scope of a Paper to review every design of turbine, and those dealt with are well developed and on the market in good commercial form. The steady advance of the steam turbine in marine practice is a large subject in itself, and those interested in this branch of engineering are referred to a valuable Paper read recently by the Hon. C. A. Parsons. The scientific principles underlying turbine construction are discussed at length by Dr. Stodola, W. Gentsch, and others, and much interesting subject matter bearing on this point will be found in their works.

In an appendix a number of tables of results of tests of various types of turbine are given and also some figures for a 450 kw. triple-expansion reciprocating engine at St. Pancras Corporation works, and by comparison with turbines of equal size it will be seen that the reciprocating engine has the advantage in economy of steam, at least for small units. The importance of applying a good vacuum cannot be too strongly emphasised. Every fraction of an inch is well worth securing, and the condensing plant must be maintained at a high degree of efficiency.

We give below a selection of the tables:—

Test of 1,000 kw. Brush-Parsons Turbine Alternators. Speed, 1,500 r.p.m.

Load. Kw.	Pressure. Lb. per sq. in.	Superheat. °F.	Vacuum. In.	Consumption. Lb. steam per kw.-hr.
250	160	..	27·2	27 3
250	160	150·0	27·5	26·5
500	160	3·5	27·2	22 0
500	160	150 0	27·5	19·5
750	160	10·0	26·4	20·4
750	160	150·0	27·5	17·1
1,000	160	22 0	25 5	19·5
1,000	160	150·0	27·5	16·0

Parsons Turbine for Newcastle-on-Tyne Electric Supply Co. 1,500 kw. Three-phase Alternator, 6,000 volts, 40 periods.

Pressure of steam above atmosphere at stop valve. Lb. per sq. in.	Superheat at stop valve. °F.	Vacuums in turbine cylinder Bar = 30″. In. of mercury.	Revs. per Min.	Load. Kw.	Steam used	
					Lb. per hour.	Lb. per kw.-hr.
196	76	27·45	1,200	1,442	25,962	18·00
194	78	26 95	1,199	1,484	26,880	18·10
196	85	27·45	1,201	1,153	21,456	18·60
197	84	27·35	1,200	1,015	20,124	19·80
197	83	27·75	1,200	692	14,874	21·50
196	76	27·95	1,200	714	15,288	21·40
199	77	28·35	1,200	360	9,114	25·20
200	68	28·45	1,200	0	2,948	0
203	92	26·11	1,210	1,823	32,431	17·70
207	66	26·46	1,208	1,513	27,582	18·23

The last two tests were made 16 months after the former ones.

Tests of 3,500 kw. Parsons Turbo-Alternator for Carville Power Station. February 5, 1906. Speed 1,200 revs. per. min. Barometer 30·25.

203	148·0	29·63	..	1,750	..	17·00
203	150·0	29 40	..	2,625	..	16·08
199	150·0	29·12	..	3,500	..	15·64
194	149·5	28·60	..	5,000	..	15 72
192	149 5	27·90	..	6,050	..	16·46

Frankfort. 3,000 kw. Three-phase Alternator, 3,000 volts, 45 periods. (By Brown, Boveri & Co.)

Steam pressure. Lb. per sq. in. above atmosphere.	Superheat at stop value. °F.	Vacuum. In. of mercury in turbine cylinder.	Revs. per min.	Load. Kw.	Steam used.	
					Lb. per hour.	Lb. per kw. hr.
138·5	235	27 00	1,350	2,995	44,200	14·74
170·5	187	27·50	1,350	2,518	39,300	15·59
142 0	120	27·20	1,350	2,600	41,200	15·80
139·0	114	27·20	1,360	2,600	41,400	15·90
168·5	184	27·90	1,350	1,945	30,800	15·84
146·5	120	27·60	1,350	2,000	32,600	16 30
137·0	101	27·40	1,350	1,442	25,400	17·60
138·0	52	25·70	1,350	644	18,700	29 00
142 0	30	28 30	1,350	0	4,700	0
142 0	30	28·30	1,350	0	3,560	0

Tests of 1,500 kw. Curtis Steam Turbine No. R102. April 26 and 27, 1905.

Load. Kw.	Steam pressure. Lb. per sq. in.	Steam superheat. °F.	Vacuum. In.	Consumption. Lb steam per kw.-hr.
375	150	Steam dry	28	25·5
375	150	200	28	21·2*
750	150	Steam dry	28	21·8
750	150	200	28	18·24*
1,125	150	Steam dry	28	19·78
1,125	150	200	28	16·6*
1,500	150	Steam dry	28	19·0
1,500	150	200	28	16·0*

* These figures are corrected for 28 in. vacuum pressure, 150 sq. in. and 200°F. superheat; also figures have been corrected for dry steam.

Low-pressure Rateau Turbine.—Tests on Steel Co. of Scotland's Low-pressure Turbine, January, 1906.

Amps.	Kw.	Vacuum at turbine's exhaust. In.	Absolute pressure.		Steam consumption.	
			On entering turbines. Lb. per sq. in	Exhaust. Lb. per sq. in	Total per hour. Lb.	Per kw. hour. Lb.
300	69 0	28 7	2 90	0 5830	4,590	66 4
700	161 0	28·4	4·49	0·7394	7.170	44 5
865	196·5	28·4	5 35	0 7394	8,290	42·1
925	212 5	28 4	5 65	0·7394	8,750	41·1
1,050	241 0	28 4	6·11	0 7394	9,480	39·3
1,160	267 0	28 4	6 51	0 7394	9,920	37·1
1,120	278 0	28 6	6·68	0 6399	10,250	36 8
1,300	299 0	28·6	7·25	0·6399	11,130	37·2
1,400	322·0	28 6	7·82	0 6399	12,080	37·5
1,500	345 0	28 5	8·25	0 6825	12,790	37 0
1,600	368 0	28·4	8 25	0 7394	12,800	34·8
1,700	391·0	28·3	8 82	0·7821	13,600	34·8
1,800	414 0	28·2	9·53	0·8247	14,500	35·1
1,800	414·0	28·0	10·10	0·9243	15,400	37·2
1,900	437·0	27·9	10·70	0·9811	16,300	37·3
1,690	389·0	27·9	9 53	0·9811	11,500	37·4
1,825	420·0	27·9	9·95	0·9811	15,300	36·4
1,950	450 0	27·9	11·40	0·9811	16,480	36 6

Tests at the Oerlikon Machine Works with 1,000 kw. Rateau Turbine.

Load. Kw.	Boiler pressure. Lb. per sq. in.	Press. at entrance to 1st guide wheel.	Pressure in condenser.	Temp. °F. at entrance to 1st guide wheel.	Steam used per kw.-hour Lb.
194	186·32	30·44	1·11	298·4	31·97
425	155·03	57·74	1·18	311·0	24·91
659	162·72	85·30	1·99	323·6	23·81
871	180 64	112·22	3·15	347·0	24·69
1,024	179 21	116·49	2 43	348·8	21·98

The beneficial effect of varying the nozzles in use according to the load as mentioned in describing the De Laval turbine is seen in the following tests. The nozzles in use are recorded in each case.

De Laval Turbines.—Results of Tests with De Laval Steam Turbines, at Different Loads.

Turbine machine.	Pressure of admission steam. Lb. per sq in.	Vacuum in. of mercury	No. of nozzles open.	E.H.P.	Lb. steam per E.H.P. per hour.
50 H.P. turbine dynamo. Test made April, 1895*	113·8	26·3	6	49·4	24·6
	113 8	26·3	5	40·2	25·2
	93·9	26·9	4	25·0	27·9
	74·0	27·5	3	12·7	32·5
100 H.P. turbine dynamo. Test made June, 1897.†	103·7	25·8	5	92·7	22·6
	103·8	26·4	3	55·6	22·7
	107 4	26·8	2	35·0	24·7
	106 7	27 9	1	15·5	27 8
				B.H.P.	per B.H.P. per hour
150 H.P. turbine motor. Trial made Nov., 1897.†	113·8	26·4	7	163·0	17·6
	116 9	25·9	6	138 4	18·2
	113·8	26·2	5	114·5	17·9
	114·3	26 5	4	88·3	18·7
	112·4	27·0	3	64·1	19·0
	116·2	25·7	2	37·5	22·3
300 H.P. turbine motor. Test made Dec., 1899.†	192·7	27·3	7	303·6	14·1
	196 3	27·6	6	255·5	14·7
	196·3	27·6	5	216·9	14·4
	196·3	27 6	4	172·6	14·5
	190·6	27·8	3	121·6	14·9
	196·3	28·1	2	74·2	17·2
	213·3	28·5	1	31·5	21·6
300 H.P. turbine motor. Test made June, 1900.†	126·6	26·98	8	337·45	15·68
	126·4	26·99	7	293·7	15·76
	125·0	27 24	6	249·1	15·92
	125·0	27·62	4	162·7	16·25
	125·0	27·91	3	118·9	16 70
	125 0	28·16	2	73·5	18 00
	125·0	28·25	1	30 4	21·77

* Work for condensing included. † Work for condensing not included.

In the first of these tests the work for condensing is included, as the machine drove its own condenser pump; in the other tests the work for condensing is not included, as is usual on high-speed machinery.

Tests with a 30 H.P. Steam Turbine working with Saturated and Superheated Steam respectively.

NON-CONDENSING.—Steam pressure: 7 atmosphs. abs. = 88·2 lb. Speed of driving shaft: 2,000 r p.m. Speed of turbine wheel: 20,000 r.p.m.

—		Half Load.		Full Load.	
		Saturated steam.	Superheated steam.	Saturated steam.	Superheated steam.
Temperature of steam	Centigrade	164	460	164	500
	Fahrenheit	327	860	327	932
Power developed	Metrical B.H.P.	21·4	24·5	44·1	51·9
	English B.H.P.	21·1	24·2	43 5	51·2
Steam consumption per B.H.P per hour	Kilogrammes per metrical B.H.P.	21·6	14·1	17 7	11·5
	Lb. per Eng. B.H.P.	48 3	31·5	39·6	25·7
Heat consumption per metrical B.H.P. per hour in metrical heat units		14,160	11,270	11,610	9,390
Temperature of exhaust steam	Centigrade	100	309	100	343
	Fahrenheit	212	588	212	649

Table of Results of Tests for Steam Consumption of 450 kw. Zoelly Turbine, Mather & Platt.

Useful output, kilowatts	132·19	208·21	291·52	391·13	463·22
Revolutions per minute	3,061	3,050	3,040	3,030	3,020
Pressure at inlet, lb. per sq. in..	126 83	124·63	125·07	124·92	125·36
Temperature, °F.	339	339	339	339	339
Pressure before 1st guide, lb. per sq. in.	39·83	55·85	73 48	95·97	111·84
Vacuum, per cent.	95·3	94·5	93·8	92·7	91·7
Steam consumption per kw. hour, lb.	31·19	26·28	24·5	23·43	22·9

Reciprocating Engine—450 kw.

Triple expansion Browett-Lindley engine. P. No.—1,553. Tested on site. Diam. cylinders.—H.P. 15, I.P. 23, L.P. 35. Date.—September 20, 1904. Stroke.—12 in., coupled to A.E.G. shunt-wound dynamos. Present at test. – Messrs. Baynes, Gibbons, Hadley and Lloyd.

—		Kw.	Efficiencies combined %	Steam press.	Vac. in.	Water.				Stm temp'rature. °F.
						Total lb.	Per I.H.P. hour.	Per E.H.P hour	Per kw. hour	
Full load consumption	No. 1	450·0	84·7	165·0	25·0	8,800	12·2	14·5	19·5	518
	No. 2	446·0	84·7	164·5	25·0	8,848	12·25	14·6	19·6	566
¾ load consumption	No. 1	338·0	80·5	126·0	25·5	6,850	12·18	15·1	20·2	500
	No. 2	344·5	80·5	129·0	25·2	7,000	12·18	15·1	20 3	500
½ load consumption	No. 1	235·0	77·0	89·0	25·5	5,006	12·2	15·9	21·4	494
	No. 2	222·0	77·0	85·0	25·5	4,887	12·5	16·3	21·9	481

Guaranteed steam consumption with 100°F. Superheat 25 in. vac.

	Full load.	¾ load.	½ load.	¼ load.
Lb. per I.H.P.	12·3	12·6	13 0	14·0
Mechanical efficiency	91%	88·5%	85%	76%

Pressure at stop valve, 190 lb.

DISCUSSION.

Mr. S. E. **FEDDEN** (Sheffield) opened the discussion. He regretted that Mr. Baynes had not said anything about the stripping of blades, corrosion of blades and other things of that sort. He had heard that there were a great many "strips" going on, and people did not believe him when he said that he did not have any himself. He had had a 500 kw. turbine five or six years ago, and it had been running continuously without stripping or corrosion of the blades up to the present. A second turbine—300 kw.—stripped about three blades two years ago through no fault of the turbine nor of the superheat, but through the foundation coming away. That only took one night to repair, and the machine was going the next day. A bigger set he had run for two years and then stripped about four sets of blades immediately on starting up on one occasion. From the look of the high-pressure blades it appeared that it had had a little too much superheat, although there was only about 100 degrees. The turbine had been made some years ago without shrouding, but when these blades stripped Messrs. Parsons took the opportunity of shrouding the blades, and the machine had been running ever since without any sign of breakdown. The views he had expressed in a Paper he had read before the Association some years ago on this subject had been amply borne out by the turbines under his charge. Even if turbines were not more economical than condensing engines it would pay to put them in because the saving in oil was so great that they could afford to lose 2 lb. or 3 lb. of steam over the reciprocating engine and still have a saving in the works costs. The oil bill for his big turbines at Neepsend was 0 0001. With regard to the corrosion of blades, there was apparently some action in his machines, but it did not look like corrosion; it was more like bombardment with particles of water, and did not appear to be serious. When running at very high vacuum, water could possibly get into the end blades, but he did not think they need be afraid of corrosion from this. The makers stated that 5 per cent. was lost in efficiency for steam consumption for every inch in vacuum. He had had occasion this year to test this. The vacuum fell very considerably, partly through hot water and partly through dirty condenser tubes. The vacuum fell to 24, and the steam consumption, on the weekly tests, with a load factor of 17 per cent. increased from 19·63 to 21·96. He took advantage of the opportunity to bring up the vacuum inch by inch by cleaning so many tubes, and he found that instead of losing 5 per cent. only 3·3 per cent. was lost in the efficiency per inch of vacuum. The steam consumption that he now got was very good and was the same as that which had been obtained at Messrs. Parsons' works. He had taken the opportunity recently also of taking the clearances on his machines. In the first expansion the clearance of the rotor was 0·052 in., and to the case 0 058 in.; second expansion: rotor 0·062 in., case 0·058 in.; third expansion: rotor 0·057 in., case 0·059 in. These were practically the same as two years ago when the machines were first put in. The wear on the bearing was about 0·011 in. on the side towards which the rotor revolved.

Mr. F. M. **LONG** (Norwich) said he had only had charge of a turbine since last December, but he had a strip not very long afterwards which was clearly proved to be caused through the manner of starting up. This was done by turning on a little steam and warming up the machine first, and getting the exhaust end pretty well as hot as the steam end, after which the rotor was started and the stripping took place, for the top of the rotor had become a good deal hotter than the bottom, as condensed steam ran to the bottom and kept it cooler. Since then he had always made it a practice to set the rotor running as soon as possible after letting in steam and to allow it to run round slowly for 10 minutes or a quarter of an hour before running up to full speed, and there had been no stripping since. A certain amount of trouble had been experienced with the generator end, but he hoped to get over this very soon.

Mr. E. J. FOX (Messrs. Willans & Robinson) suggested that rather too much importance was being attached to the question of steam consumption. The relative merits of the results obtainable from one type of turbine as against another were fairly generally known and appreciated, but the possibilities of obtaining very much better results from two turbines of the same make were not very great. In other words, steam consumption was very largely dependent on clearances, and by forcing manufacturers down to the very lowest limits in the matter of steam consumption they were undoubtedly doing it at the expense of clearance, and of this they had to take the risk afterwards. With a reciprocating engine, if it was possible to get a pound better out of one engine than another it was a distinct gain, without any corresponding loss, but in the case of a turbine this was not the case.

Mr. IZARD (Messrs. Willans & Robinson), on the question of blade stripping, asked why they should worry about this. He knew a case on the Continent where there were several 5,000 kw. turbines running. It was wanted to extend the plant and the people who put in the turbine had suggested that if the owners of the station were dissatisfied with turbines they should have reciprocating engines. The answer was that turbines were wanted in spite of a few stripped blades. All that was wanted was more spare plant in this particular case, and the owners were quite content with the possible stripping of blades, for even with this disadvantage turbines were found to be more satisfactory than reciprocating engines. Therefore, he said, why worry about stripping when the cost of repair was so trifling. He had made experiments on blades with the idea of finding out a better material than brass. He had tried every mixture, every velocity, every superheat, and every degree of saturation steam, but brass had come out better than anything else. With regard to Mr. Baynes' point of warming up turbines, his firm had made some experiments in this direction, and these showed that the trouble was due to the hot water running along the base of the turbine. The way he now started up was to close the runaway valve and get full boiler pressure behind it. This valve was then lifted and the full boiler pressure let into the turbine. Messrs. Brown, Boveri & Co. used this system and found it most satisfactory.

Mr. H. FARADAY PROCTOR (Bristol) said he had not had very much trouble although he had several turbines running—namely, four 750 kw. and two 1,000 kw. But there was one trouble that he would like to refer to which was not mentioned in the Paper. Some of the earliest troubles with turbines, especially in connection with parallel running, were due to driving a reciprocating oil pump and a governor from the same shaft. There was a certain amount of blacklash which acted back on the governor and gave trouble with parallel running. He took five minutes to start up and found no trouble with stripping. He had carried practically all his load for two years on turbines with only one strip and then they did not know that it had happened. They knew something had happened in the turbine, but it was in the winter and they could not afford to stop. The machine was kept running for four days and then opened when it was found that seven rows of blades had gone. With regard to shrouding, it might perhaps be of interest to have a little testimony as to the shrouding of the Westinghouse Company referred to in the Paper. He started in Bristol with Parsons turbines, then he had some Willans, and recently a favourable tender was received from the Westinghouse Company. He was a little nervous, however, as to the lashing of the blades, but the company carried out a most interesting and successful experiment on this point. The Westinghouse Company, instead of having a continuous ring as the Willans Company did, perforated the blade and through that was threaded a piece of wire, not circular, but in the shape of a comma, which went through all the blades, and then the tail of the comma was bent over, thus separating one blade from the other. In the experiment referred to they had a ring of blades made up with this kind of lashing, which was run inside two halves of cast-iron something like the straps of an eccentric, so arranged that these straps could be screwed together. Thus one ring of blades was run up to full speed by a motor, and the cast-iron casing was gradually screwed together until it came into contact with the blades. There was a speaking tube coupled to the strap, so that by listening they could tell when the shell of the casing touched the ends of the blades. They were brought into contact, and allowed to run for several minutes. When they were unscrewed there was no regular distortion, and the only blades where there was the slightest distortion was where the comma lashing ceased. As a consequence of these experiments, it was now proposed to fill up the space where the two ends of the comma lashing met by a secondary comma lashing.

Mr. J. H. BOWDEN (Poplar) said he had two 1,000 kw. turbine sets with which he had experienced a great deal of trouble, having had four or five strips. Messrs. Parsons had not given him any satisfactory explanation for any of them. He would also like to know if Mr. Baynes had had any trouble with the governor. He had had repeated troubles through the automatic governor coming into action without any cause whatever, and he had been obliged to fasten them up on the peak of the load.

Mr. F. S. SAMUELSON (British Thomson-Houston Co.), in connection with the Curtis turbine, said he had not had any trouble with the stripping of buckets and blades. It was necessary, however, in the working of this turbine that the steam should be very free from water in the low-pressure end of the turbine. If not, it was found that bubbles formed very quickly on the blade, which it was necessary to clean every few months. He advised anybody who had a turbine to put in a water separator. With reference to the continuous-current dynamos, Mr. Baynes limited the size of these to 1,000 kw.; his firm had had a 2,000 kw. machine of this type running for some weeks very satisfactorily. It was a 10-pole compensated machine running at 750 revs. per min.

Mr. SYDNEY BAYNES asked Mr. Samuelson to say something about the effect of running Curtis turbines with the whole of the nozzles open but throttled, as compared with running them with a certain number shut off.

Mr. SAMUELSON replied that the 750 kw. turbine tested had 12 nozzles at full load, which, of course, would be three for quarter load. He had carried out an experiment, however, in which instead of having three nozzles open at full pressure he had the 12 nozzles open at a quarter pressure, and it was found that there was a 30 per cent. greater steam consumption.

Mr. Baillie WILLOCK (Glasgow) said that the Tramway committee at Glasgow, under the advice of an American engineer, put down 4,500 H.P. reciprocating engines a few years ago which cost £102,000. Recently in the lighting station in Glasgow, two Willans turbines with all accessories having the same capacity as two of the reciprocating engines were put in for £30,000. This had to be compared with £51,000 for two of the reciprocating engines in the tramway power station giving 9,000 H.P., so that there had been a saving of £21,000. It was all very well for engineers to discuss savings on the coal and oil and other minor matters, but all these costs amounted only to 25 per cent. of the whole, and he wished to impress upon them the necessity of reducing the remaining 75 per cent. which was chiefly made up of capital charges.

Mr. J. F. L. CROSLAND (Vulcan Boiler & General Insurance Co.) asked Mr. Izard what the cost of stripping would be? If this could be given as a percentage of the total cost of the machine it would be useful to know it.

Mr. C. D. TAITE (Salford) said that they all knew that turbines were much more economical, especially in big sizes, than reciprocating engines. There were so many different classes of turbines now on the market that anyone who could say authoritatively whether the impulse turbine or the Parsons turbine was the most economical would be doing a public service. The impulse turbine had great advantages with regard to clearances. He recently had an opportunity of visiting the works of Messrs. Escher, Wyss & Co., where he had seen a Zoelly turbine made from start to finish, and it seemed to him that if this machine was economical in steam consumption it had a very great future before it. Its mechanical simplicity was very marked, and the clearances were ample in every direction. There seemed to be no possibility of stripping, and if it was economical he could not think that the Parsons turbine would have a very much longer life. The turbine was being taken up by such people as Krupp in Germany, Schneider in France, and Musgrave and Mather & Platt in England. He had also had an opportunity of visiting Messrs. Brown, Boveri's works, where continuous-current machines up to 1,500 kw. were being made. In recent tenders within the last few years steam consumptions were given by various makers varying no less than 15 per cent. for the same type of machine. Mr. Izard had referred to the matter, and it seemed to him a very curious thing that turbines of one type, such as the Parsons, could possibly have a difference in steam consumption of anything like 15 per cent.

Mr. SYDNEY BAYNES, in reply, first dealt with the question of stripping of blades. He said he had had several instances of stripping at St. Pancras, and so much so that he was surprised when Mr. Izard had told them not to worry about it. He had found himself sometimes in the position that out of the two turbines installed neither one of them was fit for running, which was exceedingly awkward. Mr. Bowden, he believed, had also been placed in a similar position, although he had not mentioned it. No real explanation had ever been given to him by the makers as to the cause of this stripping, but he thought the real trouble had a good deal to do with the starting up, and possibly it might be also due to the method of building the rotor spindles in the case of the Parsons machine. The strippings that he had had invariably occurred at the high-pressure end and ran down to about the middle expansion. By increasing clearances his machines had been made to run, but he was afraid that the steam consumption had gone up. Somebody had said why trouble about steam consumption, but his opinion was that this was a matter worth troubling about. If any engineer would sit down and figure out he would find that it did not stop there. It meant increase of boiler plant, increase of maintenance of boilers, increase of fuel, increase of wages, and so on. Therefore it was desirable to keep down the steam consumption within a reasonable limit. On the question of capital cost steam turbines were decidedly better than reciprocating engines. In the lower sizes this was not so. In the latest designs of the Parsons turbines the blades had been thinned down at the tips, so that in the event of them touching the casing they did not grind to such an extent as previously, and this seemed to avoid stripping, because at St. Pancras he had known instances in which the blades had touched the casing without damage. Mr. Proctor had made reference to having run turbines of the Parsons make after some of the blades had stripped. He had tried it at St. Pancras, but it had ended in the whole of the turbine being stripped and the machine coming to a dead stop. With regard to the running away of the governor, he could endorse Mr. Bowden's experience; in fact, on one occasion it had given him a great surprise, because it had cut off the only turbine that was on the load, and the supply was shut off altogether. Now it ran with the safety release blocked up. This was absolutely necessary, but he believed improvements were being made, and the makers promised to put this in order.

The PRESIDENT proposed a vote of thanks to Mr. Baynes for his Paper, which was heartily responded to.

After a luncheon at Nuthall's, a river trip was made to Richmond and Hampton Court, and the Palace at Hampton Court was inspected.

Continued on page 381.

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Among the many topics dealt with by Mr. J. Edgcome, in his presidential address to the Incorporated Municipal Electrical Association on Tuesday, was a proposal of a somewhat novel nature. In municipal circles it is customary, when an official desires information as to existing practice and recent experience on any particular point, for him to send out a list of inquiries to those holding similar positions to himself but in other towns. Such is the spirit of fellowship among these officials that enquiries of this nature are willingly answered, even in cases which involve no little labour on the part of those who furnish the information. Although this system answers fairly well, and valuable information is disseminated by this simple means, it has two serious disadvantages. One is that some seekers after truth are so earnest in their quest that, in their avidity for knowledge, they are apt to make abuse of the generosity of those who so freely hold it at their disposal. Mr. Edgcome, in fact, cited one instance in which no less than 52 questions were put, filling two sheets of foolscap, and he stated that each set of answers to these, if scrupulously set out with the necessary explanatory detail, would have furnished a small treatise on the design and management of central stations in general. The second disadvantage is that the valuable collection of information assembled in this manner from several sources remains in most cases in the sole possession of the original enquirer, who may put it on one side after it has served his particular purpose, so that it is not placed permanently on record, and there may be constant repetition of practically the same inquiries. The results of some of this postal research are, it is true, frequently assimilated into Papers read before the Incorporated Municipal Electrical Association and other institutions, but this is rather the excep-

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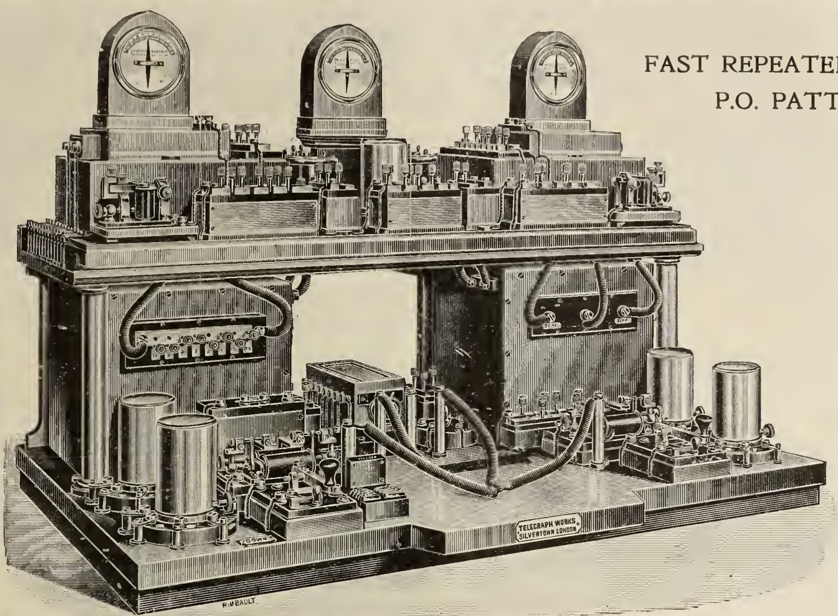

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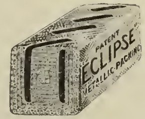

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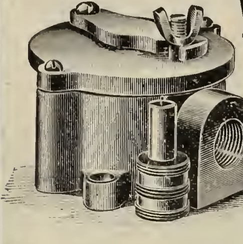

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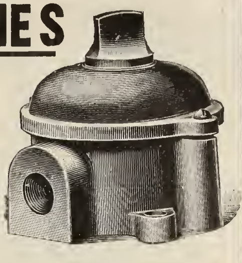

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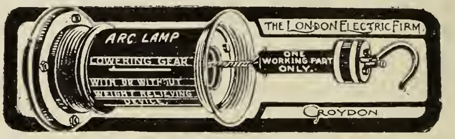

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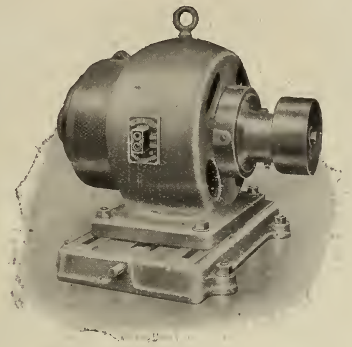

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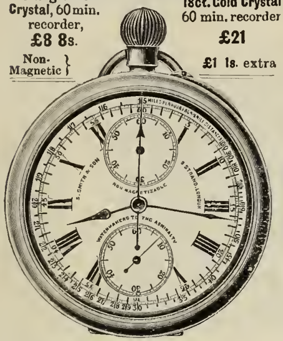

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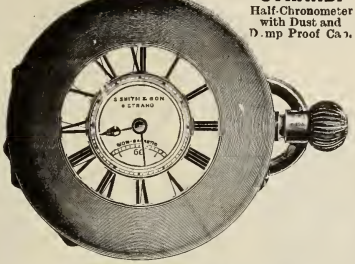

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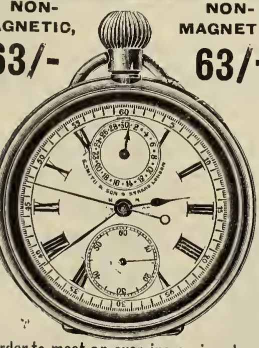
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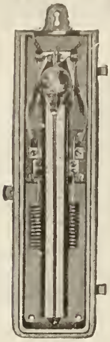

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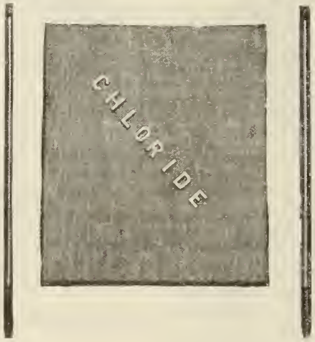

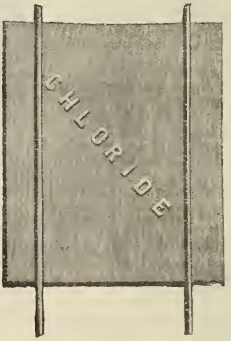

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tion than the rule; the large bulk of the information collected is not published either to the general public or to the members of the associations who would derive benefit from it.

Mr. EDGCOME'S proposal is that a Central Information Bureau should be established in connection with the Association, and that this might at the same time serve as a *rendezvous* for municipal electrical engineers visiting London, and as an employment agency for assistant engineers. There is no doubt that such a bureau might do useful work, and it would certainly be a more efficient method of obtaining information than the requisition by circular, which we have already referred to. Its realisation is not, however, merely dependent on obtaining the necessary funds, as Mr. EDGCOME apparently believes. The bureau must collect its information in more or less the same way as the member does nowadays—viz., by circular. There is room for considerable doubt, however, whether the same free response would be given as at present. Mr. A., we will say, will readily give Mr. B. any information in his power, as they are good friends, but if he furnished this information to the bureau it would also be at the disposal of Mr. C., D. or E.—or even to such "outsiders" as Mr. X. or Mr. Z.—to whom Mr. A. might not like to impart the information with such freedom. In fact, in most cases it would come to this: Mr. A. would send his list of questions to the bureau, and the bureau would send out its inquiries. The reply, if response were made at all, would be in most cases a request to know for whom the information was sought. On receipt of this information the majority of those who sent in replies to the questions would do so with the reservation that their replies were only to be used for the information of the particular inquirer, but must otherwise be regarded as confidential. Or, on the other hand, answers would be given of such a general nature that the inquirer would after all have to resort to writing directly to the engineers in order to supplement it. In fact, the management of the bureau would be a matter of extreme difficulty, and it would require at the head of it a man with so much tact and patience, as well as a good general knowledge of electricity supply engineering, that his salary alone would constitute one of the largest items in the expenditure of the Association. The present system may be inefficient, but it would hardly be adequately replaced by a Central Information Bureau; we may almost consider this idea as Utopian, or, at any rate, outside the realm of practical politics for the present.

I.M.E.A. MEETING.

(*Continued from page 379.*)

Wednesday, June 20th.

Two Papers on "The Commercial Development of Electricity Undertakings" were read in Abstract by the authors and then discussed together.

THE COMMERCIAL DEVELOPMENT OF ELECTRICITY UNDERTAKINGS.

(THE DEMAND FOR ELECTRICAL ENERGY, ITS CULTIVATION AND DEVELOPMENT UNDER COMPETITIVE CONDITIONS.)

BY S. E. FEDDEN.

(Chief Electrical Engineer, Sheffield.)

Introduction.—Undoubtedly a low tariff and a progressive policy in dealing with mains extensions, together with a comprehensive system of street lighting, will do more than any canvassing and advertising to develop a supply system, but the author considers these points outside the scope of this Paper, and intends to deal rather with what may be described as artificial methods for stimulating a demand. So far, the author believes, very little has been done to advance the sale of electricity by those advertising methods with which we are so familiar in connection with most commodities.

Advertising.—The author thinks that no engineer need consider it beneath his dignity to use ordinary business methods to make known the advantages of his commodity; it must be remembered that we have not to induce the public to take something of doubtful value by misrepresenting its qualities, but only to make people familiar with the scope and progress of electrical work, so that our advertising is but a form of education. The extent to which advertising and canvassing should be carried must depend upon the size of the undertaking, and whether any trading powers are exercised or the operations confined to the supply of energy. In the latter case—which at present, at least, is the more frequently met with under municipal management—the operations of the publicity department will benefit the local contractors to a considerable extent, and probably they can be induced to assist in some way. The out-of-pocket expense is, of course, chargeable to revenue account, although the writer ventures to think that it would not be unreasonable to put a proportion of it to capital account as being expenditure incurred in securing goodwill. The good resulting, although generally obvious, is hardly capable of proof, and so it would seldom be possible to induce the controlling committee to grant any considerable amount for this purpose. In the various public offices and municipal buildings of the City printed matter relative to the electric supply can be displayed, and a combination of show room and inquiry office may be established with advantage, an assistant in charge sufficiently intelligent to answer ordinary inquiries and forward complaints to the proper quarter. This representative can act as a time-saver to more responsible officials by intercepting the verbiage which accompanies so many trivial applications, and which must be respectfully listened to by someone to afford relief to the client. In some businesses this "Human Buffer" is a recognised institution. Where the supply department exercises the power to sell and fit electrical apparatus, a more ambitious scheme can be carried out, as a part of the cost can justly be debited to this trading department.

Printed Matter.—Printed advertising matter should be particular rather than general—narrow down the subject to be dealt with, make the sheet attractive in design, brief and pointed in diction, and then, if distributed at an opportune time, it is likely to leave the maximum impression on the mind of the recipient. A small leaflet or slip attached to the monthly or quarterly accounts is a useful form of printed advertisement; in this way periodical reminders to change lamps can be given—the praises of fans can be sung in summer and radiators can be advocated when the almanack leads us to expect cold weather. Some local authorities have issued booklets dealing with motive power or light and power generally, and these, if well got up with attractive illustrations, are of real value, but it is advisable to keep the book small and restricted in scope, and to issue them frequently with changes of illustrations and revision of text. In some cases the expense of production appears to be partly borne by letting certain pages for advertisements, and in cases where the supply department does not carry on any trading work such a course might be possible with the assistance of the local contractors.

Canvassing—The successful personal canvasser should be acquainted with the people on whom he has to call and the local conditions of business. A canvasser needs training like a missionary, and filling with terse and judicious replies to all the stock objections of the unbeliever; he must never be staggered by the inventive perversity of the gas man; must have a thorough belief in the commodity that he is selling, and a good knowledge of the common principles of lighting, decorating, &c., and the peculiarities of the various classes of businesses will often enable him to point out the remedies for big bills or bad lighting.

Local Exhibitions.—Local exhibitions are undoubtedly of value, although somewhat expensive. They have the objection that they frequently do not attract the right kind of visitor except at the commencement of the undertaking; and the author fears this also applies to popular lectures.

Demonstrating Table.—The author has sometimes been induced to give lectures before societies and the public, and has on these occasions found a small collection of apparatus in actual use to be much appreciated, and together with a few lantern slides of great assistance in helping to hold the attention of a non-technical audience, but it is frequently difficult and always expensive to instal the necessary wiring at short notice. With a view of getting over this difficulty he has had a demonstrating table made, which is very useful in the show room, and can be carted to any public place and connected in a few minutes to the nearest supply point. It consists of a well-finished oak table with a couple of wood columns supporting a brass rail, from which different types of electric lamps hang, and other convenient parts of it are plentifully studded with holders, switches and plug receptacles, the whole being wired to a pair of fused terminals with a low-reading ammeter in series. This instrument is graduated in pence per hour at 1d. per unit and at 200 volts pressure. In this way all kinds of lamps, radiators and electric cookers can be shown in operation by the turn of a switch, and their current consumption and cost of running noted by the audience themselves. The apparatus also includes a common photographer's clock, which enables the time of operation of the cookers to be measured.

Street Lighting.—This is generally admitted to have a good advertising value to the supply department, and the author does not think that any other illuminant than electricity should be used in any street, corporation building, or other property where a supply is available.

Use of the Press.—The aid of the local press is very useful, and the periodic references which are made to the finance of the department and its progress should be amplified as much as possible, and supplemented with notices of important extensions, work done, and any notable success which may be attained in the struggle with rival light and power supplies.

Trading Powers.—The question of trading powers for electric supply departments controlled municipally, is still very controversial, although no one seems to question the right of private companies—gas or electricity—to assist their supply business by selling and fitting consuming apparatus. That such a course is of considerable assistance, experience has proved in the City of Sheffield, where the old electric light and power company created the business of electrical contracting, and it devolved upon the corporation to acquire this department when it purchased the plant and goodwill of the supply undertaking. The supply department carries out a considerable portion of electrical work in the city, and the remainder is shared amongst the local contractors, who are now fairly numerous. Few corporation engineers have yet undertaken installation work, but the author feels sure many have had occasion to consider the advisibility of doing so. In Sheffield the contracting and supply department is under the management of a superintendent, who is responsible to the chief engineer for the satisfactory and profitable carrying out of all sales and contract work and the preparatory work of special supply negotiations. This department is treated in the same manner as an outside firm of contractors, and has to conform to the wiring regulations for connecting, testing, &c. The staff consists of several engineers who are engaged under the superintendent in dealing with inquiries, giving advice and preparing tenders for work in the City. These officials have also to assist the superintendent in checking time and material booked against the works in hand, and also the invoices for goods supplied, finally inspecting the prime cost and deciding the charge to be made, where no quotation has been given. The routine bookkeeping in connection with this department is carried out in the general offices and forms a considerable proportion of the work therein. One or more canvasser-salesmen are employed, whose duty it is to do the spade work of development, look out for new buildings, works extensions, engine breakdowns, &c., and follow up any inquiry, take orders for lamps, &c. Attached to the wiring department is a show room, well decorated and supplied with a good stock of fittings, heaters and cookers, which can for the most part be changed at intervals if unsold, by arrangement with the manufacturers. The usual procedure is for the wiring department to quote for wiring to points only, and allow the consumer to choose fittings from the stock or catalogues on view. The show-room sales account form a considerable part of the profit of the trading department. The show-room attendant cannot be counted upon for any great amount of routine work beyond the care of the room and its contents when business is at all good. This man should be capable of exercising certain discretionary powers with regard to discounts, credits, &c.

Stores.—The standard material, which is bought in bulk, requires a considerable amount of space for its orderly accommodation and for convenient unloading from the carriers and serving out in small parcels to the workmen with a minimum of delay. The man in charge is required to watch keenly that every article entering or leaving is debited or credited to the correct works order.

Factory.—A small factory is one of the legacies of the old Electric Light & Power Co. This has proved very useful to the undertaking, and has been developed to enable us to undertake all the mechanical work needed by the mains department and most of the station repairs, and this work constitutes the bulk of its output. The workshops are electrically driven and lit, and in the earlier stages of our development proved a useful object lesson to intending consumers. Part of the accommodation is reserved for workmen representing the several trades which are required by the installation department, a few gas-fitting hands developed into electrolier makers well able to adapt gas fittings for electric work. These men make up some of the special electric light fittings which are required, and do a little ornamental smiths' work. There is also a certain amount of renovating, bronzing and lacquoring in the ordinary styles, which it is most convenient to be able to carry out promptly in a city where these trades are not much practised.

A Good Light.—This is an advertisement which we must have, and the blackened lamps which are kept in use by many consumers do our lighting business more harm than anything else. Although the trouble can to some extent be remedied by using high-efficiency short-life lamps, yet few consumers appreciate the gain to themselves in the reduction of energy consumed, and are annoyed when the lamps fail; moreover, the high-efficiency lamp is more sensitive to over-running, and the percentage which fails before their normal short life is reached is rather large under general working conditions. The gas company have been forced by the fragile nature of the incandescent mantle to tackle the problem of maintenance, and the good results they achieve are largely due to the regular care of burners and frequent renewal of mantles. A similar arrangement is needed between consumers of electricity and the supply authority, but in most cases the author fears it would be difficult to induce consumers to pay adequately for this service, and it rather behoves engineers to consider if a system of free renewals should not constitute their next price reduction. The writer believes that those undertakings which exchange old lamps for new at the rate of one lamp against so many units consumed and paid for, have found a great improvement in the general standard of lighting; but he would wish to go further, and take over the upkeep of a consumer's lamps entirely free of charge. This would avoid the necessity of dividing and metering separately the arc and incandescent circuits, which course is necessary where the lamp exchanges are based upon consumption. It would also be desirable to make the reservation that the account be paid within a certain brief limit of grace, and that for every new lamp fitted an old lamp or cap be forthcoming. A consumer would thus have to purchase his first equipment of lamps and would not be able to obtain a lamp free until he had consumed energy approximately equal to its full life. In the author's own case the sale of lamps represents about 7 per cent. of the turnover of the contract department. It may be suggestive to examine the probable details of a hypothetical case, taking the probable intervals for lamp changing as follows:—Lamps used in offices may be taken to be alight only 300 hours per annum, and they would last two years without requiring to be changed. Lamps used in churches would last as long, only being used on Sundays Lamps used in shops open up to 8 p.m. would need to be changed at intervals of nine months. Lamps used in theatres would need to be changed at intervals of five months. Lamps used in public-houses would need changing every four months. Lamps used in hotels and clubs would need changing every three months. Lamps used in private houses should be changed three times in the year, viz.: at the September, December and March quarter days, thus ensuring a good light during the dark part of the year, while in the summer time the lamps could be left for six months without having to be changed.

Estimated Figures.—Then consider the case of a lighting area having 2,800 consumers and the equivalent of 118,000 16 c.p. lamps connected with an annual consumption of 4·5 million units. Reducing the 118,000 recorded lamps by, say, 10 per cent. to give an approximation for the effective connections we obtain the following values:—

16 c.p. lamps or equivalent in use, 118,000. 10 per cent.—106,200, say, 105,000 Average lamps per consumer .... $\frac{105,000}{2,800} = 37·5$

Average units per lamp per annum .... $\frac{4,500,000}{105,000} = 42·75$

Average burning hours per lamp per annum $\frac{42·75 \times 1,000}{60} = 712$

From this it appears that the average frequency of changing will be three times in two years or once in eight months.

Analysing the consumers into classes according to the preceding list of lamp life, we find a more frequent renewal called for. 2,800 consumers with 105,000 lamps approximately made up as follows:—

				No. of times to be changed in two years.	
1,500 private houses	23	lamps each	34,500	6	206,000
300 shops (early)	65	,,	19,500	2·7	52,600
700 shops (late)	65	,,	45,500	5	228,000
50 halls and churches ..	100	,,	5,000	1	5,000
4 theatres	500	,,	2,000	4·8	9,600
20 public-houses	50	,,	1,000	6	6,000
450 offices	20	,,	9,000	1	9,000
10 clubs and hotels	150	,,	1,500	8	12,000
			118,000		528,200

$\frac{528,000}{2} = 264,100$ lamps per annum required for the upkeep of 105,000 connected, giving an average frequency of changing of five times in two years; once in five months.

The quantity of lamps now sold in this area is estimated to be between 40,000 and 50,000 per annum. Taking the latter figure, the actual average life period is

$$\frac{105,000}{50,000} = 2·1 \text{ years} = 25 \text{ months},$$

and the consumers' expenditure on lamps, about 50,000 at, say, 11d. each, £2,291; on energy about 4,500,000 units at 3·75d. = £70,312.

Cost of lamps 8·2 per cent. of cost of energy.

As this figure is an average it is obvious that many consumers must spend very little indeed in renewals.

Having seen what it would be necessary to provide with a universal free-renewals scheme, let us examine its possible organisation and cost to the supplier :—

Of the 264,100 lamps to be handled each year, 105,000 × 1·5 = 157,500 will be new and 10 per cent. only of them need to be tested as they come from the makers.

Tested samples, 10 per cent. of 157,500	15,750
Repeated tests on samples, 1 per cent. of above	157
And possibly half of the remainder handled would be evidently good enough to use again without test, leaving— $\frac{264{,}100-157{,}500}{2}$ =	53,300
	69,207

Say 70,000 per annum to test.

Then allowing 30 per hour as a fair rate of working, and 300 working days of 8 hours per annum, we find that one photometer will handle 300 × 8 × 30 = 72,000 lamps in the year, so on this rate of working one set of apparatus and operators will suffice. It would be necessary to learn the methods of the makers and use very simple and automatic apparatus, and possibly girl labour. The changing staffs would require to be made up of men and lads of respectable class and appearance, as they would have to go through every part of a consumer's premises, allowing, say, half a mile (go and return) as the average distance to be travelled to visit each of the 3,000 40 lamp unit consumers who are to be changed twice per annum, it may be expected that each case will occupy an average time of two hours, whence :—

3,000 × 2 × 2 = 12,000 hours ÷ 300 × 8 = 2,400 working hours = 5 pairs of man and lad.

Allow one man and lad for internal handling, booking, &c,, and we have something like the following :—

One girl at 12s.	£0	12	0
One assistant at 6s.	0	6	0
Five travellers at 25s.	6	5	0
Five assistant travellers at 8s.	2	0	0
One indoor man at 25s.	1	5	0
One indoor lad at 8s.	0	8	0
Salary or part salary of supervisor at 40s.	2	0	0

£12 16 0 × 52 weeks =	£665	12	0
Capital expentiture—say £200 at 6 per cent.	12	0	0
Current, 900 hours at 60 watts, 54 kw. at 0·5, heating, lighting, &c.	7	0	0
Rent	No charge.		
	684	12	0
157,500 lamps at 8d.	5,250	0	0
	£5,943	12	0

Say $\frac{\pounds 6{,}000}{5{,}000{,}000}$ per annum = 0·288d. per unit.

ANNUAL COSTS AND RESULTS OF WORKING, PREPAYMENT AND ORDINARY METERS COMPARED (OMITTING ITEMS COMMON TO BOTH).

Prepayment Meters.

Sixty in use (various makes). Average price £4. 10s. each.

Average price of ordinary meters (3 amperes) £2 each.

Excess capital expenditure, £2. 10s. × 60 = £150.			
Interest and sinking fund, 6 per cent.	£9	0	0
Cost of reading and collecting—			
Clerk 1½ days at 40s. per week, 11s.			
Assistant (tech.) 25s. per week, 6s.			
17 × 12 (3s. 5d. per annum per meter)	10	4	0
Loss of meter rents—			
60 × 5s.	15	0	0
	£34	4	0

$\frac{\pounds 34.\ 4s.\ 0d.}{60}$ = 11s. 8d. per meter per annum.

The average annual consumption of the prepayment meter consumer is found to be about 90 units = £1. 10s., so the freedom from meter rents constitutes a reduction of :—

$\frac{5}{30 \times 5}$ = 14·25 per cent. over ½d. per unit to these consumers.

Taking the cost of such a service at £6 in the case of tenement buildings, interest and sinking fund at 6 per cent. = 7s. 3d. per annum, the revenue from the first 22 units is absorbed in paying the capital charges.

Ordinary Meters.

3,600 in use (various makes) :—

Cost of reading £7. 6s. per month × 12	£87	12	0
Office work (three clerks, various grades)	237	4	0
Secretarial work	160	0	0
Collection and receipt of payments	120	0	0
Postage	70	0	0
Stationery	26	0	0
Agreement stamps	7	10	0
Bad debts	150	14	0
	£799	0	0

Say $\frac{800}{3{,}600}$ = 4s. 6d. per meter per annum.

Leaving a difference of 7s. 2d. per meter per annum against the prepayment meter which must be met by its "business-earnings" advantages.

THE COMMERCIAL DEVELOPMENT OF ELECTRICAL UNDERTAKINGS.

BY H. COLLINGS BISHOP.

(Borough Electrical Engineer and Tramways Manager, Newport, Mon.)

1. *Advertising.*—The author considers the first step is to compile a good "brochure," which will put before the public, in a simple way without technicalities, the advantages to be derived from the use of electrical energy. Newport has been especially successful in this respect, having published, a few months ago, a book which has met with universal approval. It contains from 70 to 80 pages of reading matter. A number of pages are taken up with views of various premises belonging to consumers of electricity in the district. The brochure was compiled by the secretary of the electricity department, and is partly original and partly derived from information given by engineers of various electrical stations. The revenue from advertisements paid all publication expenses, and enabled the department to distribute some thousands of free copies to likely consumers. Another good form of advertising, in the author's opinion, is to send out picture postcards containing photographs of new additions to the consumer's register. Yet another means of advertising and one that serves a canvasser as an introduction is a series of letter circulars, dealing with the supply of energy for power, lighting, heating and cooking.

2. *Canvassing.*—For this purpose a man must be found who, if possible, is well known in the town, and who possesses a thorough knowledge of his subject. He should be a good talker, and should be one who does not easily accept a rebuff. His mode of operation might be as follows : To make himself well acquainted with all the details of the consumption of current and the type and size of installations of all the most important consumers ; to be thoroughly conversant with the relative costs of current used by the different classes of consumers ; to be able to give the cost of current per hour of the various forms of illuminants, and to compare the other ways of obtaining power with that of electricity. A canvasser should have sufficient technical training to be able to give a prospective consumer some idea of his own requirements

3. *Exhibitions.*—These the author has found to be of the utmost value in promoting the development of an electrical undertaking. In the autumn of last year the local gas company at Newport, which is a keen rival of the electricity department, held what they called a gas exhibition. This, in effect, appeared to be a demonstration of inverted and intensified incandescent gas light and cooking stoves, accompanied by an almost unbearable heat, which amply demonstrated the heating power of gas. This heat was to some extent lessened by the introduction of electric fans. Shortly after the gas exhibition, a resolution was passed to hold an exhibition of electrical apparatus especially suited to the requirements of consumers of current derived from the central station. The committee obtained the use of the largest hall in the town, in which they were able to erect 19 stands. These were allotted to the various contractors of the district, several being retained for the Corporation's own exhibits. In view of the decision of the Manufacturers' Association regarding country exhibitions, the author was at first rather afraid of the response he would receive when asking for the loan of apparatus ; he, however, found the majority of the manufacturers extremely willing to help. In only a few cases was a refusal given, and in most cases the only condition imposed was that the carriage of the goods sent should be paid by the committee. The exhibition was opened in January, a small string band during the afternoon and evening being provided as an extra attraction to visitors. There was also a tea room, in which all the tea and coffee was made in electrically-heated vessels. The exhibits mainly consisted of electrical fittings, various types of radiators and convectors, and many different forms of incandescent lamps, arc lamps, flame lamps, &c. There were also decorative devices for tables and shop windows. Amongst the exhibits which can be classed as especially interesting were the following :—

(1) A practical laundry demonstrating the uses of electrical flat-irons, gauffering irons, &c. ; (2) a stall devoted to domestic heating and cooking utensils : these were shown in use, and were under the charge of the Corporation electricity staff ; (3) a demonstration of incandescent lamp making ; (4) an "ozonair" apparatus ; (5) an electrical lift ; (6) organ blowing by electricity ; (7) several furnished rooms, fitted with various electrical apparatus for lighting, heating and decorating.

The exhibition lasted for a week, and the building was packed during the whole time it was open. No charge was made for admission. The total cost of the exhibition, after deducting the proceeds from the letting of spaces, and the small sum derived from the sale of current, was under £250. The effect of the exhibition was immediately felt in a large increase in the connections to the mains. The author can conceive no better means for the development of an electrical undertaking than such an exhibition.

4. *Inspection.*—The development of an electrical undertaking is very greatly retarded by the want of some efficient system of forcing a certain class of contractor to carry out the work he undertakes for

consumers, in a proper manner. The author has come across curious examples of the ideas of some contractors as to the size of cables necessary to an installation of electric light, as the following two instances will show. In the first case, the consumer was having a good deal of trouble caused by the blowing of fuses, and on several occasions it was the Corporation fuse that went. Upon investigation, the author found the sub circuits very heavily fused consequent on the placing of some 15 or 16 lights on single circuits. These circuits, which were put in after the building was completed, were attached to 3/20s cable. In the second case, a prospective consumer invited three contractors to tender for the following work, which was to be an addition to his existing installation: One circuit of six incandescent lights, one complete radiator installation (without radiators), consisting of 10-ampere plugs in nine rooms, a main switch, cutouts, and circuit cutouts. The maximum current on the mains being possibly 40 amperes. Firm A tendered about £18 for the job; firm B about £12; and firm C about £8. The consumer, not understanding why there should be such a variance in prices and feeling inclined to give up the whole thing, before deciding to do so, referred the matter to the author for explanation, and he found that firm A had tendered for a first-class job with cables of ample size. Firm B proposed three circuits of 7/20s cable and one pair of mains 7/18s, to carry a possible 40 amperes. Firm C proposed three circuits of 7/22s cable and one pair of 7/20s mains, the current density in this case working out at something like 6,000 amperes per square inch on the main leads.

5. *Charges.*—As one of those who some years ago adopted the Brighton system of charging, the author has, after several years' trial, come to the conclusion that (equitable system as it is) it is not one that tends to further the development of an electrical undertaking. The system is difficult to explain, and one that, even if understood, is not appreciated. A charge by a sliding-scale rate seems to the author to be the correct solution of the problem, and the load factor of the various classes of consumers should be taken into consideration in the arrangement of this scale. This being so the following scale of charges would be most likely to induce an increased demand:—

Private lighting consumers to be charged a rate of 3d. per unit where the whole of the lighting is electrical and 4d. per unit where the lighting is only partially electrical. The current used by these consumers, during the hours of light load, to be charged 2d. per unit. Such charges to be ascertained by a two-rate meter.

Public lighting to be charged, where the light is in use all night, 1d. per unit, and where it is in use for a shorter time, 1¼d. per unit.

As regards the charges for power, the author would make a maximum rate of 3½d. per unit for current used during the few hours of maximum demand, and 1d. per unit during the whole of the rest of the day or night. This system has been used with conspicuous success in Newport; consumers of a large amount of current who have a load factor of not less than 20 per cent. should be charged 8d. per unit. Consumers of power should be given a specially low lighting rate, so arranged that it becomes possible for the largest consumers to have a uniform rate for both lighting and power. With reference to the charges for heating, the author considers the rate of 1d. per unit the most satisfactory.

Show Room.—Now that so many electrical undertakings have powers to sell, lend on hire and hire-purchase, &c., a very necessary adjunct is a good show room. A representative selection of goods for show purposes can be made from the following:—

(*a*) For ventilating purposes: Desk fans, exhaust fans, blowers, &c. (*b*) For motive power: Sewing machine motors, a selection of stationary motors, and photographs depicting the various uses of motors. (*c*) For heating: A number of lamp radiators, convectors, &c. (*d*) For domestic heating and cooking: Flat irons, gauffering irons, stew pans, hot plates, saucepans, kettles, grills, coffee machines, milk warmers, &c. (*e*) Wiring fittings: A series of table and desk fittings, ceiling fittings, switches and other accessories, &c. (*f*) For lighting: A selection of incandescent lamps of various makes. Nernst lamps of various capacities, several types of arc lamps, flame lamps, &c. Every fitting on show, which can be put into working order in the show room, should be clearly marked with the actual cost per hour of working. And in all cases, such as in heating and cooking, the cost should be worked out so as to give the correct figures for each particular piece of work that is being done, such as:—So much for boiling a pint of water from, say 60 deg.; so much for cooking one pound of steak; cost of making one pint of coffee, &c.

The show room could be put in charge of the official canvassor who has in all probability already enlisted the consumer's interest.

7. *Hiring Department.*—Those who are fortunate enough to have the necessary Parliamentary powers to undertake this class of business are equipped with a means, if properly worked, of greatly furthering the success of electricity supply. Although lending on hire or selling on hire-purchase has already been undertaken, as regards motors, by some manufacturers, from the author's point of view he has not found it a success, and considers it essential that such matters should be in the hands of the suppliers of the current. In the first place, a manufacturer will not hire out a motor on lower terms than he would sell it on the hire-purchase system on a four or five years' basis. And as the cost of the hiring would amount to from 20 to 25 per cent. per annum, it becomes almost prohibitive. With the hiring out in the hands of the electricity suppliers, interest, sinking fund, depreciation and maintenance can be easily covered on a 12½ per cent. basis, and at this figure the author has found no difficulty in obtaining customers. The author considers that the management of a supply station should undertake to supply the consumer with lamps; and in the case of Nernst lamps tantalum, or osmium lamps, should do so under a definite guarantee. In the case of Nernst lamps this is easily given at the present time, as the manufacturers are prepared to enter into firm guarantees with electricity undertakings. A good business should be done in the supply and maintenance of arc lamps for shop lighting purposes; the lamps being lent on hire at a fixed rate per annum, which sum should include repairs. As arc lamps in use form a definite and approximately unvarying load the author is of opinion that the best way of charging for them is by a fixed sum for each series of lamps per hour. Such rate to include the cost of carboning and the number of hours' use to be ascertained by an hour meter.

The question of the supply of wiring and fittings on the hire or hire-purchase system is one that is fraught with a good many difficulties, owing to the fact that it is often hard to make a mutual agreement with both tenant and landlord; such an agreement being very necessary in order to facilitate the removal of fittings, should the hiring agreement be cancelled. It is also very important that some system of wiring, that is unobtrusive and at the same time easily removed, should be adopted for use where there is a hiring agreement, and the author hopes some new suggestions on this point will be forthcoming. At present the most feasible and simple system seems to be that of surface wiring by twin lead-covered cables; such cables to be protected where they come within 6 ft. of the floor. If painted to match the colour scheme of the room, they would not be unsightly or very noticeable. Another system, which is both simple and perfect as regards insulation, is that in which the whole of the wiring is done with twin flex, excepting the vertical mains. It is, however, a question whether insurance companies will pass the latter scheme.

DISCUSSION.

Mr. F. A. NEWINGTON (Edinburgh) said that in Edinburgh he had not yet felt the need of pushing the sale of electricity very much. The connections had come along very readily. The best form of advertisement to his mind was a cheap price. With regard to looking after consumers' lamps, he was not sure that this was a good thing to do. He believed that the consumer would sooner have the price reduced by ¼d. per unit or something of that sort, which Mr. Fedden showed was about the cost of inspection, &c. He did not at all agree with Mr. Fedden's figures as to the renewal of lamps. For offices he took 300 hours per annum, which might be right, so that the lamps would last two years. Churches, the author stated, would last as long, but his own opinion was that these would only light 100 hours per annum. In shops, without splitting them up into early and late shops, the average was about 500 hours. Therefore shops would require to have about five-sixths of their total lamps changed every year. Theatre lamps he himself would put at 640 hours a year, or a change once a year instead of every five months. Public houses would probably burn five hours a day, or three changes a year. Hotels would not be so often owing to the large numbers of bedrooms. Private houses, with judicious changing of the lamps from room to room according to the amount of use, should not want changing more than once in two years. These longer lives of the lamps would very much alter Mr. Fedden's figures, so that the cost of renewals would be about half or one-third that given in the Paper. Mr. Bishop referred to a system of two-rate meters for charging a higher rate during the peak load, and he would be very glad if further information were given about this in Mr. Bishop's reply. There were two or three kinds in use but he did not know that they were very satisfactory. They certainly were very complicated and expensive. Such a system, or by getting consumers not to use any energy during the peak, was very satisfactory if it could be put into practice. In Edinburgh the time switch disconnected them during the time of the peak, and a large number of consumers availed themselves of it. One penny per unit was charged for energy consumed under these conditions. The cost of wiring was a very serious hindrance to the small consumer, and he quite agreed that the cost of this might be reduced if external wiring were adopted, although he did not approve of ordinary flexible such as was recommended, because generally it was very poorly insulated and would create trouble. The ordinary vulcanised rubber-covered wiring would be not unsightly, and could be used fairly cheaply.

Mr. E. E. HOADLEY (Maidstone) said that although Mr. Newington seemed to be in a happy position, there appeared to be a large number in the less fortunate position of Mr. Fedden. He could confirm what Mr. Bishop had said about the benefits of exhibitions. There had been a most successful one in Maidstone, and he hoped to repeat it on a larger scale next year. On the question of lamp changing, he said it had to be decided whether the lamp should be changed absolutely free, or whether they should be changed for an inclusive sum per lamp per annum. At Maidstone they had adopted the latter system, the corporation taking the old lamps back. But in consequence they were faced with a very serious difficulty, for the local contractors had gone to the National Electrical Contractors Association, and the Corporation was threatened with a writ unless the changing of consumers' lamps were stopped. He did not know what the upshot of the matter would be, probably the corporation would have to change the lamps for nothing. Anyway, he did not mean to be beaten by any contractors' association on this matter. There was very keen competition in many of the smaller towns where the gas company was usually a powerful one. Immediately the local authority went to a consumer and offered him electric light, the gas company came along and offered to pipe his house free. Something had to be done to meet this competition. He had lost custom on several occasions for this reason. With regard to outside shop lighting, the gas company in Maidstone had a new form of outside gas light, which had two 4 ft. Kern burners with a special reflector shade with which they had been doing a terrific business. The ordinary bracket arm lamps with three burners were being taken down wholesale and replaced by this other lamp which was called the Maidstone lamp. To meet this he had obtained samples of all the small arc lamps on the market and tested them for about a month, finally selecting one which would burn two in series across 230 volts at $2\frac{1}{4}$ amperes. The light was a good deal better than that of the Kern lamps already mentioned, and it was such a simple lamp that even if the consumer did his very worst it could be returned to the test-room and made into a new lamp for 2s. 6d. He now hired out these lamps, charging consumers 6s. per annum for each lamp including the cost of carbons, cleaning and trimming. These lamps could either be connected through the ordinary meters, and a time-clock was put in series, or each pair of lamps was charged at the rate of 2d. per hour, *i.e.*, at 4d. per unit, as each lamp took $\frac{1}{4}$ kw. This scheme had been running for 14 months and nearly 200 of the lamps were in use. This showed that there was a field for that sort of thing. There was a good many Nernst lamps in use in Maidstone; at the commencement there was some dissatisfaction owing to the unreliability of the burners. Now, however, the consumers bought the lamps, and the Corporation maintained them for a fixed charge per annum. The Corporation received a guarantee with the burners and covered themselves. A lad was sent round to renew the burners, and the charge was 9d. per quarter for each $\frac{1}{4}$-ampere lamp, and 1s. for each $\frac{1}{2}$-ampere lamp. He believed there would be a great future for the tantalum lamp. There were about 700 in use in Maidstone and they were guaranteed to the consumer, as this was the only means of securing customers for these new things. At Maidstone motors were hired out, and if it were not for this he would not have done one-tenth the business that he had. The charge was 15 per cent. per annum on the net cost of the motor or 10 per cent. on the list price. The reason this part of the business had prospered was that a motor was put in for three months, and the person had only to say he did not want it and it was removed, he paying the quarter's hire. He could get motors guaranteed on these conditions from the makers. In no case, however, out of the 800 H.P. installed, had a motor been sent back. The price for power was 2d. down to 1d. Competition with the gas company was becoming acute, and although most electrical undertakings were doing well, there was no gainsaying the fact that they could do a good deal better, and he hoped that this discussion would lead up to this result.

Alderman SMITH (Liverpool), in the course of a long speech, in which he urged the necessity for dealing with municipal electrical undertakings upon commercial principles, referred to the influence which local gas companies usually had. He gave the advice which Kipling had given, viz., "If you want to win your battles you must work your bloomin' guns." He would like to see the question of lamp changing thoroughly thrashed out. Mr. Hoadley had stated that he would not be beaten by a contractors' association, but he would be beaten because they were free men. Every corporate official was tied in some shape or another and was subjected to a lot of influence which free men were not. However, there were ample opportunities for good progress if the business was developed upon the right lines.

Baillie WILLOCK (Glasgow) spoke to the same effect and pointed to the fact that in Glasgow every municipal committee managed its affairs independently of the others. He did not believe in the principle of keeping the price up in order to help the rates. Every consumer should be helped in the matter of price, no matter how long he took the energy. As an example of this he mentioned that recently in Glasgow the tariff had been rearranged in order to attract and assist the one-hour consumer. He said there was the keenest competition between the Gas and Electricity committees in Glasgow, and as convener of the Electricity committee, as well as convener of the Finance committee, he did all he could to encourage this. In some incidental remarks upon systems of charging, Baillie Willock suggested that the most appropriate name for the maximum demand system should be the "maximum bedamned system."

Mr. T. P. WILMSHURST (Derby) said he could not understand the argument that a Corporation should not, or could not, canvass. As engineers they had nothing to do with the merits or demerits of municipal trading, but having gone in for trading, he did not see why they should show less energy than a private concern would show. The suggestion of Mr. Fedden's, that literature should be exhibited in the various public offices, was an excellent one, and one which he hoped to copy. He was surprised that the authors had not laid more stress upon the value of a permanent show room. In large towns the electricity department could afford to pay the heavy rent and engage the necessary staff, but in smaller places this was not so, and he suggested a sort of middle course—viz., to make arrangements with the local contractors, where they had central premises, to give them a certain amount of current either absolutely free or at a nominal price on condition that they exhibited apparatus in working order, and especially during the hours of darkness. He had a further extension of that idea in contemplation for such premises as uphlosterers and furniture shops, where such apparatus as radiators might be hired out on similar terms. Mr. Fedden, rather curiously, did not mention the hiring out of motors, although Mr. Bishop had gone rather fully into it. He did not agree with Mr. Bishop that $12\frac{1}{2}$ per cent. was sufficient to charge as a rental on a motor. In his own case, and in other towns, 15 years was the period for the repayment of such loans, and the interest and sinking fund alone came to 10 per cent., leaving only $2\frac{1}{2}$ per cent. for the cost of renewal of starters, a monthly inspection and possibly contingencies. $17\frac{1}{2}$ per cent. was the amount charged by him, and he had had no complaints. He should like to hear from Mr. Bishop what was the period of his loan. Would Mr. Fedden mention the system upon which he paid his canvassers? He paid his canvasser a small fixed salary and a commission on every additional lamp installed, irrespective of whether the canvasser had influenced the particular connection. He also made it a point to keep in touch with the building plans deposited with the borough surveyor, so as to get advance information of the building that was going on, and endeavour to make arrangements for wiring, &c., before the buildings are completed. Mr. Bishop's fixed charges should not go unchallenged as being applicable to every town. The output, load factor, price of coal and many other things influenced this. He had received a letter from Mr. Hamilton Kilgour, late of Cheltenham, who was now visiting America. A portion of the letter dealt with the very complete organisation for canvassing which the Chicago Edison Co. possessed. One of the most striking features there was the success which had attended the use of the electric sign. The revenue from that source, in the case of the Chicago Edison Co., exceeded £100,000 per annum. He (Mr. Wilmshurst) thought this a very important point bearing on the present discussion.

Mr. W. C. C. HAWTAYNE suggested that the Continental system of wiring could be utilised here if proper regulations were drawn up, viz., the wires run round the outside of the walls of the rooms on button insulators. This system had the advantage that in small property a change in the disposition of the lamps, &c., could quickly be made at the instance of a new tenant; tenants in such houses were frequently removing. He saw no difficulty in a code of rules and regulations being drawn up.

Alderman WEST (Coventry) said he had followed the gas department and now maintained and renewed lamps at 9d. per lamp. This did not work, however, and in order to prevent fraud, this had now been changed to 2s. 6d. per quarter for 25 lamps, 4s. 6d. for 50 lamps, and 8s. for 100 lamps. Even this showed a slight loss, but he thought the department gained in the end. The chief trouble at present was to find a reliable lamp at a cheap price. The Coventry Corporation hired out motors at 15 per cent. of the invoice price, and for this purpose had had two loans of £5,000 and one of £2,000, the period being 15 years. 15 per cent., however, was not quite sufficient, and it would probably be increased.

Mr. F. M. LONG (Norwich) said at Norwich 1,700 to 1,800 consumers out of 3,600 were wired on the assisted wiring principle. Originally they charged 1d. per unit extra for all current consumed. This proved unsatisfactory, because a number of people were only too pleased to have their houses wired in this way and then used but very little current. A quarterly rental was now charged of 3d. per lamp wired. He found no difficulty in getting agreements with landlords that all wiring should remain the property of the corporation. In Norwich also there was a system of lamp maintenance, the price varying with the class of premises. He thought there was a much simpler method of arriving at the result given by Mr. Fedden for the different number of lamps to different premises for maintenance given at the end of the Paper. If they took it on the basis of 16 c.p. lamps, at 500 hours, burning 30 units, and divide the output by 30, this would give the number of lamps per annum for maintenance. He estimated that Mr. Fedden would require 173,000 lamps instead of 264,000. He did not think, on the other hand, that sufficient had been allowed for the man's time, and that sort of thing, for renewing the lamps, especially if the work were to be done thoroughly.

Ald. WEST (Coventry) supplemented his previous remarks by stating that the lamps in Coventry were changed quarterly. All the renewed lamps were tested at the station, and all 16 c.p. lamps giving 14 c.p. were sent out again, the remainder being scrapped.

Mr. J. K. BRYDGES (Eastbourne) had doubts as to the usefulness of holding exhibitions, at any rate the one in Eastbourne was not at all well supported. This was chiefly owing to the fact that the manufacturers had lent most of their best apparatus to the wiring contractors, and only a few of these were willing to come in. At Eastbourne the motors were purchased out of the surplus revenue, as they had not any Parliamentary powers. It had been mentioned that two-rate meters were expensive, but this could be got over by charging a higher meter rental. He was using a few motor meters of the two-rate type which were quite satisfactory. A form of advertising which had been found useful was the supply of energy to lamps hanging outside business premises at a reduced rate. Although these came on the peak of the load, the advertising value was very great. He was also supplying to local wiring contractors at a reduced rate when they devoted one of their windows to exhibition purposes. He had the question of starting a show room in mind, and would be pleased to have information from anyone as to the fitting up, &c.

Mr. J. F. C. SNELL (Sunderland) said that in Sunderland there had been a series of conferences with the wiring contractors which had had a very good effect upon the electrical department. He agreed with Mr. Brydges as to the difficulty of a corporation undertaking the replacement of lamps, but in Sunderland they had effected the same thing by adopting Mr. Wilkinson's idea of the certification of lamps, and had arranged with the contractors for the replacement of them. This had worked very agreeably to all parties. Another point was to introduce an intelligence department. As a matter of good generalship they ought to know what the enemy was doing, and so in Sunderland, when any new gas lamps were introduced they bought them and tested them. In this way they knew the exact life and candle power, and consequently, when competing knew exactly what they had to deal with. He commended this to other towns. On the question of Acts of Parliament to authorise assisted wiring or the hiring of motors, he said that most towns could not afford to spend the necessary money, for it cost £2,000 or £3,000 to get a bill through Parliament. He therefore suggested that if the present Government could be induced to bring forward the electricity supply bill which was formulated by the Board of Trade two years ago it would be a good thing if clauses were introduced into it similar to those in the Gas Works Clause Act of 1847, so as to enable every town, if it so wished, to borrow money legally in order to assist consumers with fittings and motors and apparatus generally. The gas companies already had these powers, and he did not see why their competitors should not be put in precisely the same position.

Ald. COATES (Hanley) said there was a great need for better lamps, both arc and incandescent, and if it was a fact that Mr. Hoadley had a lamp that could be repaired for 2s. 6d., he thought that great economies would be effected by its extended use. What was wanted was a new illuminant in order to compete with gas. The Association seemed to have very little Governmental influence, but if it were to put itself into communication with the Local Government Board and endeavour to wield some influence in order to get what they wanted in relation to borrowing money for wiring or any other purpose. then the sooner would the Association realise one of the main objects for which it existed.

Mr. A. H. SHAW (Ilford) said that very satisfactory results have been obtained at Ilford, where there was a very middle-class population. When they first started, four years ago, there were four arc lamps outside shops, but they were down in three months because they had been left to a boy to look after. They at once introduced a system to supply arc lamps for outside shop lighting at a fixed rate, and 200 such lamps were now used. They are now extending that system to deal with smaller arc lamps, and he anticipated that this would be a considerable source of revenue. The Ilford Council had also considered the maintenance and renewal of lamps, but a firm of contractors having taken the matter up, the Council had decided to drop it. They had always inspected private installations whenever asked to without charge. Both the maximum demand and flat rate systems were in use. They had also had a loan in the early days for free wiring which was soon spent and another obtained. This latter was partly spent on motors, but when the accounts came to be audited the latter amount had been disallowed. He would like to know if any other town had been treated similarly, and also asked the question as to where the money for motors was to come from—namely, capital or revenue. They had been prohibited from going for an Act of Parliament on account of the cost. The Ilford Council had also made an effort, in coming to terms with the L.C.C. concerning their electric power bill, to get the County Council to introduce clauses empowering any authority which they supplied with energy to undertake free wiring, &c. In this they had been unsuccessful, and he thought it would be a very good thing if the Association could induce the Local Government Board to introduce legislation of this nature.

Mr. R. B. LEACH (Farnworth) suggested that those small towns which could not afford to pay for exhibitions should make arrangements for lectures with lantern slides, such as he himself had given in Farnworth. This answered the purpose very well. With regard to two-rate meters—*i.e.*, a time switch and meter, he thought that these were too expensive to instal for small consumers having only a few lamps. He agreed with the suggestions that had been made as to a cheaper form of interior wiring, such as the Continental system, although he feared that trouble would be experienced with the insurance people. He also agreed that 10 and 12 per cent. for motors was too low. At Farnworth a municipal wiring department has been in operation for 18 months most successfully, and the competition of the wiring contractors had been warded off.

Mr. C. C. ATCHISON (Rochdale) said that the gas papers at the present time were impressing upon their engineers the importance of not only being engineers, but also making themselves commercial men, and it behoved electrical engineers to do likewise. With regard to canvassing he made the suggestion that the canvasser should also be utilised as a meter reader. He thought this would be to the benefit of the undertaking, as troublesome customers were then brought into contact with a man whom they knew. He referred to the American system of canvassing, by which all the canvassers sent in periodical reports to the head of their department describing their methods of getting over difficulties, and these were published afterwards for the benefit of the staff. He agreed that a local man was the best as a canvasser.

Mr. S. L. PEARCE (Manchester) said the commercial development of electricity undertakings was very largely bound up with the question of the supply of cheap power. This could be facilitated by getting wiring powers, &c., and he advised every corporation to make an effort in this direction. The only really successful electric power company in the country owed its satisfactory results to the very elastic powers which they had in this direction. He advocated a system of registration of local contractors to ensure satisfactory wiring.

Owing to shortness of time the replies of Mr. Fedden and Mr. Bishop will be communicated to the *Transactions* of the Association.

A hearty vote of thanks was accorded on the motion of the President.

The morning's proceedings concluded with a Paper by Mr. J. F. C. Snell (Sunderland) on "Relative Economics of Electric Supply from Small Local Stations and from Power Companies." After a discussion in which Messrs. A. B. Mountain (Huddersfield), Leonard Andrews, J. N. Shoolbred, H. B. Maxwell (Partick), R. M. Carr (Leek), C. C. Atchison (Rochdale), A. F. Berry, H. L. Boot (Tunbridge Wells) and G. Wilkinson (Harrogate) took part, the meeting adjourned at 1 p.m. In the afternoon visits were made to the Lot's-road power house of the Underground Electric Railways Co. of London and to the Chiswick power house of the London United Tramways Co.

Thursday, June 21, 1906.

The Annual General Meeting was held in the morning at the Hotel Great Central, and the eleventh annual report of the Council (from July, 1905, to June, 1906) was presented. The following is an abstract of the report :—

Your Council has pleasure in reporting a further increase in the membership, which has reached a total of 397, made up as follows : Committees (members) 153, chief electrical engineers (members) 167, honorary members 2, assistants (associate members) 13, assistants (associates) 62; total 397. Of these, 11 committees, 17 chief electrical engineers, 1 chief assistant and six assistants have been elected since the last meeting.

Changes on the Council.—Mr. Hamilton Kilgour having withdrawn from the Council on leaving municipal employ, your Council in pursuance of its usual custom of co-opting the nominee for the Council who at the last annual general meeting received the greatest number of votes, appointed Mr. H. Boot, of Tunbridge Wells, to fill the vacancy.

Electric Power Bills.—At the last annual general meeting your Council was instructed to send a circular letter to all local authorities in order to enlist their sympathies towards securing the support of their members of Parliament in opposing the second reading of the Administrative County of London Electric Power Bill. This was accordingly done, with the result that a number of municipalities took the step suggested, others intimating that they were already in touch with their Parliamentary representatives with a view to opposing the measure.

Wiring Rules.—Mr. H. Faraday Proctor and Mr. R. A. Chattock, having resigned their places on the I.E.E. Wiring Rules committee, your Council has appointed Mr. Edgcome (your president) and Mr. J. Christie to represent the Association on such committee with the consent of the I.E.E.

Carbon Filament Lamp Specification.—In your Council's report for the year ending 1905, the testing and certification of carbon filament incandescent lamps is referred to at some length, and a promise was made of a standard specification at an early date; in fact, such a specification was drawn up by the sub-committee appointed by your Council, and has received the Council's approval. This specification in deference to the wishes of the Engineering Standards committee was not published; and at the invitation of the Standards committee two members of your Council—viz., Messrs. Taite & Wilkinson—were elected upon the sub-committee on physical standards with the object of co-operating in the drawing up of a standard specification which could be adopted by all users and manufacturers of carbon filament lamps. During the past 12 months this sub-committee on physical standards has devoted much time and attention to the subject; they have held nine meetings; had three long conferences with the lamp makers; and one conference with manufacturers and users. A draft standard specification has now been drawn up and is being carefully considered by a sub-committee of the manufacturers and by the Standards committee. The preparation of this specification has been a much more difficult and delicate matter than was anticipated, largely owing to the fact that with the exception of Government departments there existed no recognised specification for carbon filament electric lamps. Your representatives on the committee have done all in their power to expedite matters, but it is doubtful whether the specification will be ready and completed until after the present convention. It is hoped, however, that arrangements will be made in the near future for the printing and issuing of this specification to all the members of the Association, together with such other recommendations as your Council may deem necessary.

Supply of Electricity Bill.—Your Council has approached the Association of Municipal Corporations with regard to certian clauses in the Supply of Electricity Bill which, as stated in the last annual report, it considers ambiguous.

A deputation, consisting of Mr. Newington, Mr. Christie, Mr. J. F. C. Snell, Ald. George Pearson, Mr. H. Faraday Proctor, and the Secretary, waited upon the Law committee of the Association of Municipal Corporations, at the Westminster Palace Hotel, on July 27, 1905, when the various points were discussed at considerable length.

Local Government Board Loans.—At the last Annual General Meeting your Council drew special attention to the action of the Local Government Board in curtailing the periods allowed for the repayment of loans and in conformity with the resolution relating to this matter passed at such meeting, a deputation from the Association, consisting of the members previously mentioned, waited upon the Law committee of the Association of Municipal Corporations with a view to securing their co-operation in approaching the Local Government Board on the subject. Subsequently your Council was asked to place before the Association of Municipal Corporations in writing its reasons for asking that the equated period of 25 years usually granted should not be reduced. A schedule was thereupon prepared, setting forth the opinion of your Council as to the periods which should be granted in respect of the various classes of work embraced in an electrical undertaking, together with a table showing the term of years which the Council had reason to believe the Local Government Board is prepared to grant local authorities for the repayment of loans for such work. The Association of Municipal Corporations, having given this their careful consideration, intimated that they did not at present feel justified in taking further steps. Under these circumstances your Council decided to approach the President of the Local Government Board on the subject and asked for an interview for that purpose, receiving a reply to the effect that the question did not appear to the President to be one which he could discuss with a deputation, but that a statement in writing would be considered.

The Council—Financial Year.—Your Council is of opinion that the "Proposed Revision of Articles of Association" as already published will give effect to the wishes of the members generally, and recommends them, as amended, for your adoption. The result of such revision may be briefly summarised as follows: The Association's financial year will end on March 31st in each year. Members of the Council will take office immediately after the convention at which they are elected. All "ordinary members of the Council" (whether "municipal representatives" or "engineer members") will hold office for two years—all other officers retire annually. As regards the constitution of the Council, your Council recommends that it should consist of a president, a senior and a junior vice-president, an hon. treasurer, hon. solicitor, hon. secretary, and 14 ordinary members of the Council, eight being engineer members and six representatives of municipalities. No member of the Association to be eligible for election as president other than an engineer member who has previously served as a member of the Council for two years or for the office of a vice-president except an engineer member who has previously served as an ordinary member of the Council.

Expenses of Delegates to the Convention.—The question of the Local Government Board sanctioning the payment by local authorities of the expenses of their delegates to the annual convention of the Association was raised at the last annual meeting, and your Council has since been urged to take some action in regard to this and also with reference to the Local Government Board legalising the payment of the annual subscriptions of local authorities. Your Council thereupon invited those local authorities affiliated with the Association which were affected, to pass a resolution embodying the principle referred to and send it to the Local Government Board. The suggestion was acted upon in many cases, and your Council also sought an interview with the President of the Local Government Board on this matter with a view to securing legislation on the subject, but without success.

Electrical Exhibition, 1905, at Olympia.—Your president (Mr. Edgcome) represented the I.M.E.A. on the Executive committee of the Electrical Exhibition held in the autumn of 1905, and your Council circularised the members of the Association recommending the exhibition to their notice for financial and general support. The exhibition proved very successful, and the results were gratifying both to the exhibitors and to the Executive committee.

Board of Trade Regulations.—It will be remembered that the Board of Trade kindly took into consideration the views of the representatives of your Association as regards the new "B.O.T." regulations. One of the amendments sought was not, however, adopted. Your hon. secretary has had occasion since the last convention to take up this matter with the Board of Trade in connection with a specific example, and the result having been satisfactory, such is deemed worthy of your notice,

The Board of Trade regulation No. 1A (*a*) (3) reads as follows: "The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch, resistance or other device in connection therewith."

The Board of Trade have, however, given expression to the following opinion: "In the event of an overhead travelling crane equipped with three motors (controlled from a cage fixed to the crane) it is sufficient that there should be one switch only."

Associates' Privileges and Prize Scheme.—It was decided early in the year to reduce the subscription of associates to the nominal sum of 5s. per annum, and at the same time to enlarge the *Proceedings*, and, increasing their value proportionately, raise the price of such *Proceedings* to 5s. Your Council has also adopted a scheme initiated by the secretary for the founding of "Travelling Studentships," in place of the present "Associates Prize Scheme" which does not meet with the support necessary to justify its existence. For instance, this year only one entry was received and no award was made.

Competitors for the travelling studentship will be required to prepare Papers on a subject approved by your Council, the successful candidate being entitled to make a tour of inspection of electricity and engineering works at the expense of the Association. The winner may map out his own tour, but the same must be approved by your Council, and a report or account of the visits to works must be submitted; as far as possible originality will be encouraged and aimed at. The number of studentships offered will be proportionate to the number of associates connected with the Association.

The subjects suggested for the 1907 competition are Photometry; the Organisation and Equipment of Test Rooms; Localisation of Faults on Cable Systems; and Plant Efficiency Tests.

Before the report, given above, was discussed, the election of officers and Council for 1907 took place.

On the motion of Mr. Talbot (Nottingham), seconded by Mr. S. J. Watson (Bury), Mr. S. E. Fedden, of Sheffield, was elected president for 1907, and Sheffield was selected as the place of meeting for that year.

The nomination for vice-presidents resulted in the election of Mr. H. Talbot (Nottingham) and the re-election of Mr. C. D. Taite (Salford).

Mr. J. H. Rider (London County Council Tramways) having resigned the position of honorary treasurer, Mr. J. E. Edgcome, of Kingston-on-Thames, was elected in his place. The hon. sec. (Mr. H. Faraday Proctor, Bristol) and the hon. solicitor (Ald. G. Pearson, Bristol) were re-elected.

The following were elected as members of the Council: Bailie Willock (Glasgow), Councillor Sinclair (Swansea), Ald. Smith (Barrow-in-Furness), Ald. Bruce (Sunderland), Ald. Dowson (Doncaster), Wm. Bates (Birkenhead), J. Christie (Brighton), J. K. Brydges (Eastbourne) and J. F. C. Snell (Sunderland).

Mr. Snell at first declined to be nominated, as he would be leaving municipal employ next year, but as he is only retiring from Sunderland next June in order to devote himself exclusively to his consulting practice, he finally consented to his nomination.

The remaining members of the Council, whose term of office has not yet expired, are: S. L. Pearce (Manchester), C. E. C. Shawfield (Wolverhampton) and G. Wilkinson (Harrogate), who retire in 1907, and R. A. Chattock (Birmingham), A. A. Day (Bolton) and W. W. Lackie (Glasgow), who retire in 1908.

The annual report was then taken as read. Discussion took place under the various headings.

On the question of the carbon filament lamp specification, Mr. A. B. Mountain (Huddersfield) asked when the report and specification was to be presented. If it did not come soon they would all probably be forgetting the use of carbon filament lamps. In reply to this, Mr. G. Wilkinson (Harrogate) said that practically speaking the specification had been quite ready for some time, but had not been published in deference to the expressed wish of the Engineering Standards Committee. Since then difficulties had arisen with the lamp makers, who had formed an association, but it was confidently expected that the specification and a report upon it would be issued with the report of the proceedings of the convention.

With regard to the Supply of Electricity Bill, Mr. A. H. Shaw (Ilford) asked for any information as to the Government's action in this matter. Mr. H. Faraday Proctor (Bristol) said he thought it was dropped for the time being, and did not anticipate that it would be revived this session. The President said it had been suggested that a communication should be sent to the Board of Trade urging that the bill should not be dropped, and this was agreed to, a formal resolution to this effect being passed.

The Council's remarks in the report with regard to Local Government Board loans evoked considerable discussion. Mr. C. C. Atchison (Rochdale), suggested that the Council should not leave this matter where it at present stood—namely, that the President of the Board of Trade did not see his way to receive a deputation, but would consider a statement in writing. Many of the periods for loans were ridiculously small, a case in point being five years for meters. Many of these meters had been in use for six years. Mr. Collings Bishop (Newport, Mon.) said that the Local Government Board had what was called an "equated" period of 25 years but he failed to see how this was arrived at, for they seemed to allow 25 years for machinery, 5 years for meters, 30 years for buildings, and 12 years for mains. With regard to the latter, the Local Government Board had informed his Corporation that a longer period was never granted, but that if any instance could be referred to they would consider the matter. Mr. Faraday Proctor (Bristol) said that the Council of the Association had formed a special sub-committee to go into this matter, and a list of periods had been drawn up, but at the last moment a little disagreement had occurred with regard to underground mains, which had been set down for 15 years. This was now being reconsidered. Mr. A. S. Blackman (Bradford) hoped that the Council would do nothing so disastrous as to prescribe 15 years for mains. He had been granted 25 years for these some years ago, but this period had been reduced to 15 years about three months ago, and he was making representations to the President of the Local Government Board for an increase. There were mains in Bradford which which had been laid for 16 or 17 years, and the whitewash upon the serving was still there. Bailie Stevenson (Edinburgh) said that his Corporation had always been granted 30 years irrespective of the use to which the money was to be put, and he thought that this was a better system than having varying periods for various parts of the equipment. He believed Glasgow had been granted a loan repayable in 50 years, although the Secretary for Scotland had suggested recently that it should be paid off at the same time as the other loans—namely, 25 years. Alderman Bruce (Sunderland) said that for arc lamps they had recently been granted only 10 years, and the extra cost of interest and sinking fund had made a difference of £4 per lamp on a scheme which they had in hand, and which had had to be dropped in consequence. He said that financiers and company promoters throughout the Kingdom had brought all the pressure possible to bear upon a Conservative Government and upon the Local Government Board to reduce the borrowing powers of municipalities, but now they had got a progressive government and a man at the head of the Local Government Board who understood municipal government, steps should be taken to get back to the old state of affairs. Alderman Coates (Hanley) was of opinion that neither Mr. John Burns nor any other President of the Local Government Board understood local conditions as well as the people on the spot, and it seemed to him that every case should be considered on its merits. Personally he would suggest 100 years for land, 50 years for buildings, and an equated period of 25 years for the equipment.

Councillor Chatterton (Huddersfield) said he was altogether opposed to the general tenour of the remarks that had been made on this matter. Everyone seemed to wish to get into debt as fast as possible, and get out of debt only at the last moment. He believed in shorter loans, but with a suspension of the interest and sinking fund for the first few years. Quite a number of speakers retaliated upon Councillor Chatterton. Ald. Smith (Barrow) said the only point upon which he agreed was with respect to the suspension of the sinking fund, &c., for the first few years. Thirty years would be a fair equated period, although many of them would be satisfied with 25 years. The effect of present methods was to force municipalities to start their undertakings upon too small a scale, which was false economy, and had to be paid for in the long run. Bailie Willock said that the opinion of Mr. Chamen (the late electrical engineer at Glasgow) was that one-third of the plant would last from 50 to 100 years. If longer periods were granted, the profits would be so increased that something could very often be paid to the rates where a loss was now made. Ald. Pearson (Bristol) hoped that no one would be led away by the remarks of Mr. Chatterton. Personally, he entirely disagreed with him, and hoped to be able to induce the President of the Local Government Board to receive a deputation, when he was quite sure they would convince him that longer periods were desirable in the interests of the industry. He moved a resolution to the effect that the Council should petition the President of the Local Government Board at once upon this matter. Ald. Hey (Halifax) seconded the resolution. Mr. J. E. Edgcome (the president), having quoted instances of loans which he said were absurd, put the resolution to the meeting and it was carried unanimously.

Concerning the legalisation of the expenses of delegates to the annual convention, it was announced that the Council did not intend to let this matter drop

With regard to the Associates' Privileges and Prize Scheme, Alderman Smith (Barrow) explained this much in the terms set out in the report. He thought it would be a distinct advantage to juniors, and no committee or engineer would refuse the week's holiday that would be necessary to carry out the conditions of the travelling scholarship.

Votes of thanks were then passed to the President and honorary officials.

A special general meeting was then held to consider the proposed changes in the Articles of Association as set out in our issue of May 25. These alterations have been made to carry out the terms of a resolution passed at the Convention of 1906. Their effect are that chairmen of committees on the Council as well as engineer members shall serve for two years each instead of one year and three years respectively, that new members of Council shall take office immediately instead of in the following January as heretofore; and finally, the financial year of the Association has been altered for December 31 to March 31.

The alterations were unanimously agreed to.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

(Continued from page 345.)

Thursday, June 14th.

Sir RALPH LITTLER, K.C., presenting the case against the bill for the City Corporation, said that in 1913 the City Corporation had the option of purchasing portions of the electric generating stations of the companies now supplying there, and this in itself was sufficient to show that nothing should be done to prejudice the City in this matter. Apart from this, he contended that the City could gain no benefit under the bill, and inasmuch as the City did not want the supply offered by the Council, he asked that the City should be excluded from the operation of the bill. On general grounds, he argued that the L.C.C. was not the proper authority to undertake such a scheme, largely on account of the duties which it already had in hand.

This closed the opposition to the bill.

Mr. FREEMAN then replied to the whole case against the bill. He said the broad principle to be considered in this matter was the consideration of the consumer, and from this it followed that if the existing companies and authorities could not generate on a large enough scale, then it must take assistance from outside sources. And here was the vital difference between the Administrative Co.'s Bill last year and the Council's Bill this year. The Company proposed to supply to individual consumers, and the Council did not. Although some of the witnesses for the electric lighting companies now preferred to link up the existing stations, he argued that the companies' action last year in coming to terms with the Administrative Co. conceded the principle that a supply in bulk from a central authority could be obtained much more cheaply than any of them could supply themselves now. From this he could not help saying that the attitude taken up by the opponents was somewhat inconsistent, for the Council's bill only aimed at assisting distributors who could not generate at such a low rate as that offered by the Council.

The CHAIRMAN: Supposing that you offer to supply a distributor with energy cheaper than they are generating at themselves, and this particular station is scrapped, who should bear the still unpaid capital and interest—the consumer or the ratepayer?

Mr. FREEMAN, in the course of a series of answers, thought the consumer would be able to bear it, and yet he would receive some benefit from the cheaper supply.

Mr. RUTHERFORD asked why the L.C.C. itself should not take over the financial burden of such a case.

Mr. FREEMAN said he thought it highly inconceivable that a station would be so uneconomical that it would have to be scrapped. The idea was that the distributors should generate as much energy as they could economically and afterwards, instead of extending their works, to take the surplus from the Council.

Mr. RUTHERFORD expressed the opinion that any distributor offered a very cheap supply would take all his requirements at the cheap rate rather than only a portion.

The CHAIRMAN said he thought any loss such as he had mentioned ought to be borne by the consumer and not by the ratepayer.

Mr. FREEMAN said this would be so undoubtedly, but, at the same time, the consumer would get a benefit anyway.

Continuing his general argument, Mr. FREEMAN dealt with the objections of the Administrative Co., which, broadly speaking, were that the supply of electricity ought not to be in the hands of a municipality. He met this with the statement that the obvious intention of Parliament, from the Act of 1888, was that all electrical undertakings should pass into the hands of the municipalities; in fact, the Administrative Co. itself inserted a purchase clause last year in its bill, which purchase was to be at the hands of a representative body. Again, the Adminstrative Co. explained the speculative nature of the business. On this point he could only point to the fact that numbers of promoters, the strongest financially in the world, could be found to promote an electrical undertaking for London. The financial case for the Administrative Co. was so strong last year that it was not challenged. All the suggestions made as to the great risk were the usual ones made against every municipality asking for powers of this sort, but in fact the risk did not exist except for the purposes of opposition. There were, in fact, elements which reduced the risk in the case of the L.C.C., for on the one hand, they could borrow money more cheaply than a company, and further there was the nucleus of the tramway load. He claimed that on Mr. Merz own evidence, the dispute came down to the one point—viz., that the local authorities could not canvass as well as a company, for Mr. Merz had admitted that the Council from the engineering point of view, could even get out a better scheme than the Administrative Co. But the Council did not need to canvass; it was only wishing to supply to the very authorities which did the canvassing. Dealing with Mr. Balfour Browne's argument on Wednesday as to monopoly for the electric lighting companies, he disclaimed the assertion that the Electric Lighting Acts gave a monopoly to any authority granted a provisional order. With regard to the linking-up scheme outlined yesterday, Mr. Freeman characterised it as odd that this had not been introduced in form of a bill, for Mr. Conacher had stated that the idea had been in the minds of the companies for several years. Probably the true object of that scheme, which was not yet matured, was to prevent the purchase clause being put into operation against the companies in the future. As to the merits of the proposal, it was evident that the difficulties of supply to the various distributors would be enormously increased by the fact that the eight stations which it was proposed to link up all supplied at different periodicities, whereas the L.C.C. scheme would supply at only one periodicity. In view of these facts he contended that the scheme could not in any way be considered as an alternative proposal. With regard to the Metropolitan Borough Councils, very few of them had opposed on preamble, but the same objections had been made this year as last against the Administrative Co.'s Bill when, however, the bill was passed in spite of them. Concerning the objection to clause 35, he submitted that as it had been amended by the Council it was an entirely fair one in the interests of the trader. The object of the clause was to prevent the distributor from taking a cheap supply but yet to keep up the price to the trader.

Sir FRANCIS LOWE: Is it only by means of that clause that you can make your scheme a success?

Mr. FREEMAN said he should not go nearly so far as that. The clause was not to create competition, but to ensure the trader securing the benefit of the cheap supply given.

Continuing: The opposition of the boroughs outside London was to be wondered at, because they would not have to bear any loss on the undertaking and the supply could not be forced upon them.

Sir FRANCIS LOWE: But you cannot economically supply the whole of the outside area with your scheme as it stands. You would want another bill for spending more money on another generating station.

Mr. FREEMAN said that the scheme as it stood was quite able to deal economically with the whole of the area in its present condition. When the district developed, a new station could be erected, the capital for which could be included in one of the bills which the L.C.C. had always before Parliament.

On the question of the voltage, Mr. FREEMAN pointed out that the Council's engineers were not bound to any particular voltage or periodicity, and there was ample margin in the estimates for any contingency that might arise. There was a great difference of opinion on these points on the part of the experts, and it must be left to the responsible engineers to decide.

In conclusion, Mr. FREEMAN appealed to the Committee to pass the L.C.C. bill, if possible, this session, as it was agreed on all sides that further delay would be most serious to London. The chief opposition was that of certain vested interests, for which some protection was claimed. He failed to see that any harm would be done them—in fact, an advantage would be theirs. Of course, if he had failed to convince the Committee that the bill would be advantageous to London, then it must go, but if on the other hand, an advantage had been proved, then he asked most earnestly that the bill should be allowed to proceed.

Tuesday, June 19.

The Committee to-day heard evidence from some independent experts who had asked to be allowed to express their views.

Mr. ARNOLD LUPTON, M.P., who is connected with several of the power companies, including the Cumberland Electricity & Power Gas Co., which is being promoted this year (and which proposes to generate electricity by the employment of blast furnace gas), submitted a scheme which he said has been prepared in collaboration with Mr. B. H. Thwaite and Mr. W. H. Booth. The principle of this scheme was that generating stations should be erected on the coal-fields 120 miles from London, from which electrical energy should be transmitted to the metropolis by means of overhead cables. One of the most important advantages of such a scheme, he said, would be the elimination of the smoke nuisance. The proposed voltage would be 60,000 volts, and the intention was to use gas engines in conjunction with producer gas. By this means he claimed that the consumption of fuel would be half that required for steam in producing the same energy. Cheap slack would be used, and it was estimated that the by-products would be sold for a price that would reduce the cost of coal by 2s. 6d. per ton. He assumed a plant of 120,000 kw., which would enable 104,000 kw. to be delivered in London, or 320,000,000 units. He also estimated there would be a saving of £25,405 in transmitting in this manner, as compared with generation in London, the comparison being between the cost of transmission and the cost of the carriage of the necessary coal to London. It was pointed out that as the load-factor increased the interest on the electrical transmission remained stationary, whereas the cost of coal carriage increased with the load. The Nottinghamshire coalfields had been selected as the spot for the erection of the generating station. For a capacity of 120,000 kw., the land, building, and equipment was set down at £2,310,000, whilst the transmission system was put at £1,170,000, a total of £3,480,000. The loss in transmission was estimated at 10 per cent., and in transportation 6 per cent. The total saving as compared with the L.C.C. scheme was £120,255 per annum, and he was prepared to promote a company to carry the project into effect.

In answer to the Committee Mr. LUPTON said it was proposed to have duplicate routes for the overhead mains, the posts carrying 6 ft. transverse supports, the posts themselves being 50 ft. high and 25 to the mile. In the main, they would be erected by the roadside. The intention was to have single wooden poles, upon which it was proposed to erect cables carrying 25,000 kw.

Mr. W. H. BOOTH, in giving corroborative evidence, went into the history and growth of the gas engine. He said that the efficiency of gas-engine plants was much better than steam plants from the thermo-dynamic standpoint. The figures he gave as to the efficiency of steam plant were 12½ to 13 per cent., whilst for a gas-engine plant he mentioned 25 per cent. as the efficiency; in fact, it had been 31 per cent. in some instances. Among the many advantages of gas driving he instanced the sale of the by-products.

Questioned by Mr. FREEMAN, on behalf of the L.C.C., Mr. Booth admitted that he had not had any practical experience of large power undertakings in England, and, pressed as to the exact work of this nature which he had carried out, he mentioned a tramway 3 miles long in the Birmingham district for the British Electric Traction Co., and also the fact that he had been employed generally on most of the tramway lines in that vicinity. He said he was not a member of the Institution of Electrical Engineers. There had been a large amount of experience, however, in America with long-distance transmission, and he did not think that we could go far wrong by copying the methods adopted there. His idea was to supply in bulk to authorised distributors in London, and to railways, &c., and also to works along the line of route of the overhead mains. This latter point, however, he had not gone into very fully.

Mr. B. H. THWAITE gave similar evidence, and stated that he had had a scheme such as this in his mind since 1892. The estimated price at which electricity could be delivered in London under this scheme was 0·249d. per unit with a load factor of 35 per cent.

Mr. W. DOIG, who had also asked the committee to hear him, said he attended as a member of the public, and his suggestion was that the supply of electricity should be taken in hand by the Government and administered by them through a special department, such as the Post Office. In his opinion $\frac{1}{10}$d. per unit was the maximum price that should be charged for electricity in London.

Mr. ROBERT HAMMOND was then called on behalf of the L.C.C. to give rebutting evidence. In his opinion, and in this he was confirmed by Mr. Merz, Mr. Arnold Lupton's scheme would be absolutely unworkable. He strongly commented upon such an unprecedented proposal as to carry more than one circuit at such a high voltage upon one pole. No precaution had been taken to guard against danger from storms, and as far as he understood the scheme, if any of the poles were blown down a large portion of the supply would be stopped. He also was of the opinion that the wooden poles would be far too weak to carry such heavy cables as would be required, and generally speaking he earnestly hoped that such a scheme as that would be brought before the Institution of Electrical Engineers for discussion and criticism. A curious fact in connection with the Niagara power scheme was that, although originally it had been intended to supply works many miles away, at the present time the greater percentage of the energy was distributed to works within a mile of the power house, these works having found it cheaper to establish themselves there rather than to remain at the other end of the transmission line. Even if coal was only 1s. per ton at the pit's mouth and 9s. 6d. in London, he was still of the opinion that a cheaper supply could be given to London by having the generating stations on the spot.

On Wednesday the Committee visited the Greenwich generating station of the L.C.C., and yesterday (Thursday) evidence was heard from the Board of Trade.

ELECTRIC RAILWAY WORKING.

In answer to a question in the House of Commons last week,

Mr. KEARLEY said that the question of there only being one man in the motor cars on several of the electric railways had been considered by the inspecting officers of the Board of Trade, but no accident could be traced as having arisen from this cause, and there was no reason for regarding the present system as dangerous to the lives of the travelling public.

REJECTION OF THE LONDON OUTER CIRCLE RAILWAY BILL.

The opposition to this bill, which has been considered by Sir George Doughty's Committee of the House of Commons, has been continued since our last issue. In the main it has consisted of railway evidence, first directed to show the complete facilities which now exist in the area proposed to be touched by the new railway, and secondly to disprove the estimates of the promotors as to possible traffic receipts. During the course of the proceedings the chairman gave indication that the financial evidence was quite sufficient. The railway companies opposing were the Great Eastern, the Midland, London & North-Western, South-Eastern & Chatham and Great Western. Throughout the proceedings no criticism has been passed upon the electrical engineering portion of the scheme. Yesterday (Thursday) the chairman announced that the Committee had with great regret come to the conclusion that the preamble of the bill was not proved.

MISCELLANEOUS.

In the House of Lords on Thursday last week, the North & South Shields Electric Railway Bill, the Ascot & District Gas (Electric Lighting) Bill, the Brixham Gas (Electric Lighting) Bill, the Corporation of London (Blackfriars and other Bridges) Bill, and the Folkestone & District Electricity Supply Bill were read a third time and passed.

LEGAL INTELLIGENCE.

Chitty v. British Westinghouse Electric & Mfg. Co. (Ltd.)

On Thursday last week Mr. H. M. SAYERS said he had been practically employed in electric lighting and electric traction since 1881 and had large practical experience in the purchase, testing and working of a large number of dynamos and motors of different manufacture and type. In January of this year he saw two of the plaintiff's dynamos and they were tested in his presence. Both in respect to the load which they carried, without heating or sparking, and their ability to work sparklessly with very large currents and small excitation, they represented a great advance on any other machine within his knowledge. Comparing these dynamos with ordinary dynamos of similar dimension, speed and number of poles, he estimated that their output was three or four times as great as could be usually obtained. From the size and speed he should have judged the plaintiff's dynamos to be of from 15 to 20 kw. rating, but they ran up to 65 or 75 kw. The heating of the armatures was moderate and the excellence of the performance in that respect was due to the excellent ventilation. Under the test the commutation of the machines was excellent. In his opinion the division through the centre of the pole pieces checking the cross-magnetic lines combined with the auxiliary poles affected the result.

Mr. M. A. ADAM, said he examined the stampings of the ventilating plates of the machines supplied by defendants to the Savoy. and also plaintiff's provisional specification of 1903 showing slots. The inventor told them that a varied distribution in the pole-gap might be produced either by varying the areas of the sections, or by varying their relative lengths, or by both; and in the Savoy Hotel machines the variation was produced by the different width of the columns and the different areas underneath those columns.

In cross-examination Witness said he did not know what was exactly known with regard to slots for the prevention of distortion in 1902.

This concluded the case for the plaintiff.

Mr. CRIPPS, K.C., in opening the case for the defence, said that a serious allegation had been made against defendants. It was suggested that, having got information from plaintiff under conditions of secrecy, they had utilised it for their own purpose in their business. They absolutely denied that they had obtained or used that information. The issue between them fell under three heads: ventilating vanes, slots, and auxiliary poles. His Lordship might also have to determine the effect of the two agreements. Plaintiff alleged that they took information from them with regard to the method of attachment of the ventilating plates to the armature plate, and the only question was as to whether a certain form of attachment was first told them by plaintiff and whether they used it for the purpose of their own business. They never denied that the two original machines made at Sir Hiram Maxim's works worked well. Those machines comprised three features so far as ventilation was concerned, and with none of them had defendants anything to do. It was not alleged that they had taken any information from plaintiff with regard to the relationship of weight and output, or with regard to the attachment by riveting. They had not made use of any of the special features of the two original machines, but all those features were perfectly well known. The ventilating vane was attached by riveting in the machines given to defendants in October, 1902, but at a later date (in February, 1903) a drawing was sent to them showing rectangular vanes of a curved form attached by lugs punched on that of the armature plate. That method of attachment gave no new information, and plaintiff admitted that in 1900 a similar method of attaching vanes by means of punched-up lugs had already been disclosed to the public. Before plaintiff's sketch came to his knowledge at all, Mr. Maclean had been struck by the method of attachment of rails to steel sleepers, which he thought would have been an improvement on the method of attachment used by them. There was nothing new in the punched-up lugs. Defendants had perfect knowledge of it, and Mr. Maclean and others of the company were inquiring as to a form of attachment with a flange. As a matter of fact it was not found as satisfactory as was expected, and defendants had gone back to having merely punched-up lugs, which themselves acted as vanes. Defendants had never used curved vanes; they had always used radial vanes. When curved vanes were used they had to be held in place by means of punched-up lugs, and therefore they could not use that form of attachment with radial ventilating vanes. Defendants did not believe in the curvature of the vanes; they believed the radial vanes were better. When it came to the question of taking out a patent, plaintiff was shown that they were not new, and he withdrew the idea of making any application. What was there to prevent the defendants from using a well-known and simple form of attachment? The correspondence showed the extreme care they took to make certain they were not infringing any of plaintiff's rights. In regard to auxiliary poles, plaintiff made no claim in regard to them per se; his claim was in respect of the combination of an auxiliary pole with slots in the ordinary pole. It was common ground that the object of the slots was to prevent distortion of the lines of force and thereby sparking in the commutator, but their use was common long before Mr. Chitty became known to defendants in 1902. Mr. Miles Walker (one of the defendants' engineers) would tell the jury that the Westinghouse Co. had made hundreds of dynamos before they heard of Mr. Chitty in which they had this slotting in the pole in order to prevent distortion of the lines of force; and, if anything turned on the actual arrangement of the slots, they would be told that in the Savoy Hotel machines they did not use the slots as specifically denoted by Mr. Chitty, because defendants produced a uniform distribution of flux on the pole when there was no load, Mr. Meyer designing it with that intention. Then, again, the combination of slots and auxiliary poles was suggested to plaintiff by Mr. Miles Walker, when it was found that the slots alone in the machines made by defendants for Mr. Chitty were not sufficient to prevent sparking. Moreover, Prof. Silvanus Thompson would tell them that in substance they got the combination for which Mr. Chitty claimed in his book. There was, in fact, nothing to prevent defendants from using knowledge known to them long before they knew Mr. Chitty. They submitted that they did know of all these matters long before they knew Mr. Chitty. There was not a shadow of ground for the suggestion that Mr. Chitty either gave them any information under the three heads he had named or that they had used any information derived from him for the purpose of their business in the construction of the dynamos.

Mr. M. A. MACLEAN said that while in the employ of the Westinghouse Co. in America he gave considerable attention to ventilating plates in armatures. The form of ventilating plate used by the company in the States was cast metal plates. One form very largely used had vanes made of rectangular section soldered or riveted on. He entered the service of the British Co. in 1902, and he then continued his researches in connection with ventilating plates. During the winter of 1902 a scheme occurred to him which was simply a copy of the construction used on light railways, where a thin piece of metal with a stamped projection held the tram lines in place. He took the matter up with the head of the purchase department, Mr. Crumpton. A specification was afterwards drawn out. He had no recollection of seeing Mr. Chitty's drawings of Feb. 3, 1903, showing the lugs striking up. As the company's draughtsman, Mr. Chitty's drawings would pass through his hands in a formal way. He did not take the method of attachment shown in his drawing from Mr. Chitty's design. He examined Mr. Chitty's design of 1904, after the dispute had arisen. In 1902 the system of attachment by punched-up lugs was known to him, but he had never seen a system of attachment like Mr. Chitty's. He knew of the method of attaching vanes by means of punched-up pieces. He did not know whether it was common practice in America, but it was common, he understood, on the Continent. He saw the Hiram Maxim machines plaintiff had sent to the works. Mr. Chitty made no communication to him regarding ventilating plates.

In cross-examination Witness said the use of ventilating plates in the armature was an important matter. He and others had been interested for a long time in getting the best and cheapest form of ventilating plate. Mr. Letall, a member of the Westinghouse patent bureau staff, had suggested to him that he might patent his invention. If his invention had been patented it would have belonged to the company.

His LORDSHIP: In your opinion would this specification which was drawn up by Letall have ever come into existence if Mr. Chitty had not been on the premises?—It certainly would.

I am drawing your attention to the specification Letall drew out. You know all the circumstances of the case in that particular connection, and I want to know from you your opinion, whether that specification would have ever come into existence if it had not been that plaintiff came on to the premises with information as to ventilation?—It would.

Mr. W. D. CRUMPTON said he was purchasing agent for defendants at their works. He remembered the last Witness asking him to procure materials for the ventilating plates. The first written communication was dated April 24, and the first communication was he thought at Christmas, 1902.

Mr. M. B. MOUNTAIN said in March, 1902, he joined the staff of defendants and he left in October, 1904. He remembered a discussion taking place between himself and Mr. Maclean with regard to certain sections in December, 1902. Mr. Maclean told him he had in his mind some improvements in ventilating plates. They had great difficulty in getting anything like the sections they wanted. The only thing Mr. Maclean asked him to get were those sections of steel.

Mr. MACLAREN, electrical engineer of defendants at Trafford Park since its formation in 1899 to 1904, and previously in the service of the American company, said that on Nov. 5, 1902, he received a letter from plaintiff that the intermediate magnets and communicating coils were quite an afterthought, and were merely added to enable him to use copper or additional copper brushes. Those coils were the same as the auxiliary poles, and in the test on which he based his report when the machine was supposed to be under the best operating conditions carbon brushes were always used. Plaintiff also said in his letter that the subsidiary coils, which again were the same as the auxiliary coils, were by no means indispensable. On Nov. 14 witness made a report on the Chitty machine, and found that the method of ventilating the armature was practically the same as that employed by the British Westinghouse Co. They now knew that the method of attachment in the two Sir Hiram Maxim machines was by riveting, but there was nothing new in that in 1902. He further reported that "the armature reaction had been further reduced by placing auxiliary poles between the main poles of the machine, but they (the Westinghouse Co.) accomplished the same result in a much simpler and cheaper manner by saturating the pole tips." "Mr. Chitty," he concluded in his report, "has not developed any special features in the design of his machine which would be of service to us." Mr. Chitty had never subsequently disclosed anything to him which had caused him to alter that opinion. On March 27, 1903, witness made a further report on the same two machines, and to that report plaintiff, on April 18, 1903, made strong objection and specific answers. He then reported that plaintiff's method of ventilating was not nearly so good as defendants, and, in reply, plaintiff claimed that his method rendered the ventilation of the armature completely effective. Further, he reported that the test showed that there was no appreciable difference when the compensating windings were connected so as to assist or oppose commutation, and that plaintiff had abandoned the use of such windings in his latest design. Plaintiff, in reply, said that was a most astounding mis-statement, no such test ever having been made. He did not abandon the auxiliary poles because he had any doubt as to their value, but because he had developed his system of controlling the flux distribution which rendered the employment of any other compensating device unnecessary. That, witness explained, was the slot system combined with what plaintiff called his bridge pieces between the poles. Personally he did not see the tests, but he directed Mr. Wilson, the head of the testing department, to have them made. He had never got any information from plaintiff as to the method of the construction of a dynamo with reference to any subject matter with which he was not acquainted. He attached no importance to the method of attachment of the vane to the armature plate. He was aware, before 1902, of the use of slots in the pole pieces for the purpose of preventing distortion, and a large number of machines (probably several thousands) had been so constructed by the defendant company in America. It was quite a common form of construction well known to him. The figures in plaintiff's specification showed slots to give a concentration of the flux at the sides of the pole, whereas defendants' slots gave a concentration of the flux at the centre of the pole. The Savoy Hotel machines would give a uniform distribution of the flux over the pole piece at no load, but plaintiff's design would not do so. It was not until this case was instituted that he first saw the diagrams attached to plaintiff's specification for slots, and the combination of auxiliary poles and slots was known to him in 1899, long before he knew plaintiff. In Prof. S. P. Thompson's book there was an illustration of a Thomson-Ryan machine, giving a combination of auxiliary poles and slots. That was a machine which had been constructed and used largely. There was nothing in the letterpress nor in the diagram of the Thomson-Ryan machine to indicate that the object of the slots was to prevent distortion, but if the machines were of proper proportions the slots would have that effect.

By his LORDSHIP: The windings, the auxiliary poles and the slots all went to prevent distortion.

Continuing, Witness said he engaged Mr. Beyer early in July, and he came on August 1st. Mr. Beyer showed him a design of a combination of auxiliary poles and slots, and at that date he had never seen any sketch or design by plaintiff showing that combination, nor had he had any information on the subject given him by plaintiff. Mr. Beyer designed the Savoy Hotel machines. Mr. Chitty's method of attachment of the ventilating plates by punched-up lugs was applied to curved vanes, and it would not keep radial vanes as used by defendants in place. The centrifugal force would be too great.

In cross-examination Witness agreed that defendants' 219 machines were constructed in accordance with one of Chitty's diagrams, but he could not state the full number of machines in which his ventilating plates were used. They had no appreciable bearing from an engineering point of view on the cost or performance of the machine. It was a manufacturing question.

Mr. Justice BIGHAM: Do you mean it is a question of cost?—Yes.

Sir E. CARSON: Can you tell me the difference in cost between our type and defendants' cast metal type?—I do not think it could possibly exceed half of 1 per cent. That would be a very outside figure.

They cost about £228,000?—Yes.

Further questioned, Witness said that a difference of cost amounting to £20 in a machine worth £1,000 was not worth his consideration as a designer of machines.

Mr. Justice BIGHAM said someone should obtain for Sir E. Carson the exact number of machines fitted with these ventilating plates.

Mr. HUME WILLIAMS undertook to do his best to supply the information.

Witness admitted that there was a marked difference between the Chitty dynamo and the Westinghouse dynamo. The object of the Chitty machine was to attain lightness with cheapness, but he did not understand that one method by which that was attempted was by auxiliary poles. The Westinghouse machine was not an auxiliary pole machine, but defendants had manufactured machines with slots in the pole-piece in this country.

Sir E. CARSON: Will you show me any drawing in possession of defendants prior to the Chitty specification with slots and auxiliary poles?—I have said we did not manufacture such machines. They had been used, but not by the Westinghouse Company.

Were the Savoy Hotel dynamos the first machines made by defendants with slots and auxiliary poles?—I believe so.

Do you seriously tell his Lordship and the jury that it was mere coincidence that Mr. Beyer and Mr Chitty were by accident designing machines at the same time for the same place with slots and auxiliary poles?—I do.

Can you give me any reason why in November the Patent Bureau should suggest that Mr. Chitty should be paid for a licence?—No, I cannot.

Mr. Justice BIGHAM: Can you explain why the Westinghouse Company should require a licence from Mr. Chitty with reference to the machines ordered for the Savoy Hotel contract?—We received an order from the Savoy Hotel for four machines. They were quite experimental, Mr. Beyer was designing one or more, and Mr. Chitty was designing one or more. They thought it was desirable to get out a licence for Mr. Chitty, so that, in case his machine was a success it could be applied to this order.

By Sir E. CARSON: Mr. Beyer was engaged by correspondence, but he was not engaged to make machines with auxiliary poles and slots.

Mr. Justice BIGHAM: Are you suggesting that they brought in Beyer so that it might not be said they were inventing this thing?

Sir E. CARSON: No, my case is that the idea of this combination was first suggested to defendents by Mr. Chitty. I do not care whether anybody ever did it before. It was Chitty who brought it to commercial advantage.

Cross-examination continued, Witness said when Beyer was brought in Chitty's machine was actually in process of construction, but they could not wait to see if it turned out a success, because they had their customers to meet. The Savoy Hotel contract was not for machines with slots and auxiliary poles. They could not have supplied them with their ordinary machines, because they were high-speed machines—turbo-generators—which they had never manufactured before. He was acquainted with slots before 1902, and, broadly speaking, they were of the same nature as Mr. Chitty's. There was a figure on page 389 of Prof. S. P. Thompson's book showing slots in the pole piece to reduce distortion. Mr. Chitty's drawings showed auxiliary poles and slots were intended to produce an unequal distribution of the flux, whereas Mr. Beyer's design, on which the Savoy Hotel machines were built, was made to produce an equal distribution of the flux. The distribution of the flux depended upon the proportion and position of the slots.

Mr. MILES WALKER said his first knowledge of slots and auxiliary poles was obtained from Prof. Thompson's book in 1896, and whilst he was in the United States defendants manufactured machines with slots. The object was partly to control the distribution of the magnetic flux to prevent sparking, but that was not the object aimed at in the Savoy machines. According to their arrangement, they produced either an even or an uneven distribution of the flux over the face of the pole. He came over from the States in 1902, but he did not see plaintiff until 1903, when they were testing the Hiram-Maxim machines. Plaintiff made no discoveries to him or taught him anything. Mr. Chitty pointed out that the ventilation was very good, and that the big slot through the centre of the pole-piece allowed the air to pass through. That system of ventilation had never been used since then by the defendants. He saw the drawings plaintiff had made for the experimental machines. Plaintiff told him his method of distribution would prevent sparking. Witness pointed out to plaintiff that it would not prevent sparking, because they would not affect the magnetic field outside the pole. Plaintiff said they would be sufficient to stop the sparking. Witness said that to stop the sparking he would have to introduce the auxiliary poles, but with that plaintiff did not agree. In consequence of that the experimental machine was constructed without auxiliary poles, but it had bridges between the poles. The idea of proceeding without auxiliary poles did not succeed. There was no room to get the auxiliary poles on, but plaintiff said he could have a pole of a certain size. Witness said he must have as many turns on his poles as he had on the armature, but plaintiff said he would not require that, because his slots would go far towards helping him out. When the machine was tested it was found that it would require as many turns as were required on an ordinary machine. Afterwards the drawing was changed and it worked very well. Plaintiff's experimental machine did not disclose to him anything novel in electrical science. The first conversation about the poles occurred a week or two after he came from the States. There was no dispute that plaintiff was well acquainted with auxiliary poles. He was aware that defendants did not use auxiliary poles, but that was for a very good reason. They knew they were expensive, and that they could get on without them, as they could in ordinary small speed machines. He had himself designed machines and some in which there were slots without coils. Plaintiff had never the right principle in using the slots. He did not know really what they were for.

Mr. HARRY ROTTENBURG said he had a conversation with plaintiff as to the experimental machine. He could not recollect any definite conversation in which both the plaintiff, Mr. Miles Walker and himself were concerned. The conversation he remembered definitely was a conversation with plaintiff when he dined with him at the hotel and when he explained to him the principle on which he was designing the slots. He told plaintiff he was much surprised that he was leaving out the auxiliary poles in the machine he was designing. Either Mr. Walker, or he, or both, raised the point that the absence of the auxiliary poles was bad. He told plaintiff that his opinion was that the machine would not work without auxiliary poles. Plaintiff said that the machine would work quite well without them. He had had many conversations with plaintiff on the subject.

Mr. ALBERT BEYER said when first employed by defendants he was asked to design a turbo-generator for the Savoy Hotel. That was some time in August. His sketch showed a combination of slots and auxiliary poles. He had known of them for quite a number of years before. What he had shown in that drawing was well known years before to continental engineers. It showed a combination of auxiliary poles and slots. At the time he made the sketch he had never seen Chitty or talked to him. The Savoy machines were made from those drawings. In doing what he did at the Savoy he was not trying to have some difference between his arrangement and Chitty's. He saw Chitty's machine at the Savoy hotel, but did not copy it. Nobody in defendant company assisted him with the design. It was not true to suggest that the auxiliary poles and the slots were suggested to him by MacLaren.

The case had proceeded thus far up to Wednesday, when Mr. HUME WILLIAMS informed the Court that 27 additional machines were constructed in the same way as the 219 machines objected to, and, after consultation between counsel, it was agreed that their value should be taken as the average of the 219 machines.

Mr. WELLS, manager for defendants, said that on Nov. 13 he had an interview with plaintiff. Prior to that date plaintiff had not given him any information about the ventilating plates, but he could not remember whether he mentioned them on that date. He had an interview with plaintiff prior to the agreement of Oct. 15, 1902, but he did not discuss with him the method of his construction of the Hiram Maxim machines. In fact, plaintiff declined to give any information about them. He arranged that plaintiff should have every facility for carrying out their agreement. The machines which plaintiff sent to them did not give results which impressed witness, and he was disposed to drop the matter, but plaintiff urged that he had not been able to get the machines properly constructed and that if they would build a machine from his design they would be able to get the results he wanted. He recollected interviewing plaintiff with reference to the Savoy Hotel machines on several occasions, and at the interview on Nov. 12 plaintiff expressed anxiety that his turbo-generator, then well in course of construction, should be installed at the Savoy Hotel. He told him it would be impossible to decide that until the machine had been tested and proved to have merit, and that, in any case, they would have to proceed with their machines, because they could not put his machine in, even if it had merit, without an agreement with him giving them the right to use it. He further said that they would have to make arrangements with him for the use of such machines outside. Plaintiff undertook to let them know his terms, but these proved to be quite out of consideration. He was informed that there were instructions in the Patent Bureau to apply for patents for ventilating plates for both Mr. Chitty and Mr. Maclean, and he directed that the application for Mr. Maclean's patent should not be proceeded with, because the company could not approve of its staff applying for a patent of any similar construction unless it could be clearly shown to have been invented prior to the date of Chitty's disclosure to the Patent Bureau. Chitty declined to give them any information till they had signed the agreement not to divulge anything he disclosed. He did not claim the right to use anything that was new and that was Chitty's invention.

Sir E. CARSON: Do you claim the right to use or divulge matters which Chitty brought to you in the course of your negotiations, if they were not patentable?—My impression is that we should have the right to use them.

That is what you are claiming to do?—I am stating my impression, but I should expect to get advice upon every point.

Information might be given of great commercial value, although not patentable?—It might. When Chitty wrote complaining of their having adopted his designs, he sent for him and told him that they could not go on doing business with him if he took that course.

Sir E. CARSON: You did not proceed with Mr. Maclean's patent?—No.

But you proceeded to manufacture machines on Maclean's design?—I do not know that we did.

Sir E. CARSON referred to a letter written with regard to the suggested supplemental agreement with Mr. Chitty and asked: You at that time evidently thought there was such novelty in Mr. Chitty's design that you could not use it without his consent?—I did not know whether his design was good, bad or indifferent, but I could not allow his machine to go into the Savoy Hotel without full authority if he was understood to be the designer, and also if it proved to be a machine of merit we must have had authority to sell outside.

Sir E. CARSON read the postcript to the letter: "It is perhaps desirable that Mr. Chitty does not know that this letter has come from the Patent Bureau, as we have endeavoured all along to impress upon Chitty that we have nothing to do with the negotiations between the company and him." Do you think that an honest thing to do?—Yes, entirely honest.

Is it honest to get information out of a man on the pretence that you were not in communication?—There was no reason why the Patent Bureau, who were our agents, should not make communication to us without any breach of confidence to Chitty. They were making application for Chitty's patent, and it was necessary that he should have full confidence in them. It was, therefore, very natural that they should not want me to tell him this.

Sir EDWARD CARSON read further: "As we find by so doing Mr. Chitty talks more freely to us, and we are enabled to get more information than we should otherwise do. This is of considerable value to the company, as it would be a pity if anything arises to cause an alteration in the relations between us." What was of considerable value to the company?—The considerable value to the company would be that Chitty would disclose to the Bureau information for the purpose of getting patents for him. There was possible merit in Chitty's invention, and, in order that the company could get the benefit it was necessary that all information should be put before the Patent Bureau, so that the invention could be patented in the broadest possible manner.

Witness was further cross-examined respecting the machine which was scrapped and the object of it having been scrapped. He said that they did not want plaintiff to take their machine to other people, and make unkind comments about its construction.

Mr. Justice BIGHAM asked what value the machine was to defendants.

Mr. HUME WILLIAMS: None, except the material in it.

His LORDSHIP thereupon suggested that they should allow plaintiff to have it, and Mr. Hume Williams said that if that was thought the right course Mr. Chitty should have it by all means.

Mr. REGINALD BELFIELD said the Patent Bureau was distinct from defendant company, who were one of their clients, numbering about 20. He had nothing to do with the negotiations between the company and Chitty. Under the agreement of Nov. 14, 1902 they received instructions from the British Co. to take out patents on Mr. Chitty's behalf. His letter of Nov. 11 was written to protect the company and Mr. Chitty.

Mr. CAICHEMAILLE said he first saw plaintiff in 1902 (he thought in April), when plaintiff gave him an outline of the results he had attained with his machine. Chitty never explained the Hiram Maxim machines, but he thought from time to time Chitty explained his inventions to him, and said that these inventions were in the machines. Chitty had disclosed to him what was termed the divided pole-piece, and that, so far as his knowledge was concerned, was a novelty to him in electric construction. Chitty's construction of ventilating plates was also new to him. Part of his duty at the Patent Bureau was the preparation of specifications, As far as he knew, Maclean's specification received by the Bureau about April 20, 1903, was not proceeded with.

Mr. LETALL said that on April 20 he paid a visit to defendants' works at Trafford. He saw Maclean and asked him if he had anything new. Maclean said he had a new design of ventilating plates, and he showed him a drawing of the plate. As a result of the conversation, he took notes of it and asked the British Co. whether they would like to apply for provisional protection. The specification was drafted, but not proceeded with.

Mr. JAMES SWINBURNE said that at the dates material in the case the question of getting rid of heat was practically well known. As far back as 1886 he was engaged in the construction of dynamos. He had seen the drawings of plaintiff's apparatus of February, 1903 (the Chitty drawing with curved vanes on the face of the plates.) The difference in methods of attachment was exceedingly minute. If it was necessary to get as much ventilation space as possible, a T or H section was best. He knew the shape of the poles of the old Chitty machines. With regard to the question of the slots these were put into the pole-pieces of machines chiefly to prevent the armature getting hot, due to the field being badly distributed. So it was a good thing to have the pole-pieces saturated by removing parts of them. Plaintiff had some idea that by this method he could get rid of sparking. The specimen showed that he had not considered that question properly. He did not think that slots would prevent sparking. When reversing pole-pieces were used slots had no effect on the sparking. Reversing pole pieces were known 20 years ago. He was familiar with the Savoy machines, and he could not say that anything had been taken in the design of those machines from anything suggested by Chitty. He had seen plaintiff's Hiram Maxim machines and that they worked exceedingly well.

Prof. SILVANUS P. THOMPSON said sparking, commutation, distorting the magnetic field and conducting down the flux and auxiliary poles were matters which had been under his notice for years. They were perfectly well known to electrical designers and others interested in electrical machinery. The ventilation of dynamos was a question which had been before them ever since dynamos were made, but more prominently during the last 20 years. All sorts of contrivances were adopted to get rid of the heating, and one of the commonest ways of doing it was by circulating air in the machines. Plaintiff's system was perfectly well known in the industry. Auxiliary poles were used for getting good commutation without sparking. They were an advantage in certain types of machines, but a disadvantage in others. In high-speed machines they were a necessity. The slotted pole in itself had nothing to do with the question, because if the auxiliary pole was used and did its duty there could not be any sparking. The distortion had been already stopped by reason of the auxiliary poles. When the auxiliary poles were there the slots were superfluous for that purpose. The use of the slots in the poles by themselves was to provide an equal distribution of the magnetic flux in order to keep down the heating of the armature. That was a perfectly known thing.

Yesterday (Thursday) Mr. CRIPPS and Sir EDWARD CARSON addressed the Court on behalf of their respective clients, and

Mr. Justice BIGHAM summed up the evidence. He asked the jury to dismiss from their minds any consideration about Mr. Chitty being a poor man and the Westinghouse people being a rich company. They had to try and be fair to both, and to try and find out from the evidence what the truth was. Mr. Chitty thought he had information in his possession of a kind which might be of considerable use to people in the position of the Westinghouse Company. He was not at first disposed to put the information at their disposal, but after some negotiations he determined that he would take them into his confidence in the hope and expectation of being able to turn his information to account for himself. At the outset he said to the company that he must have from them a covenant that they would not divulge his secrets for their own profit, and he obtained the document which was the foundation of the present action. Defendants covenanted "that they would not, either by their servants, agents, experts or nominees, at any time hereafter, directly or indirectly disclose or give information to any person or persons whatsoever as to the said improvements, the method of construction of machines or any special technical information communicated or ascertained in the course of the investigation and testing of the said machines or use the same in any way whatsoever." Mr. Cripps had attempted to put upon the promise a limitation that it only constrained defendants to keep secret information which they might acquire in the course of the testing of the machines. It appeared to him (his lordship) that Mr. Cripps was right in saying that the information, whether as to ventilating vanes or as to the slots and auxiliary poles, was not given to the defendants in the course of their tests or investigations of the two Sir Hiram Maxim machines; but he was not going to leave that narrow issue to the jury; he was going to ask them to say whether in substance defendants had, in violation of their agreement, disclosed or used for their own benefit information which was conveyed to them during their business connection with Mr. Chitty, and, if they found that they had, he was going to ask them to say what damages Mr. Chitty ought to be paid in respect of those disclosures. He was going to deal with the case under two heads, one relating to the 240 odd machines and the other to the four Savoy Hotel machines. The original Sir Hiram Maxim machines, though they had auxiliary poles, had the vanes riveted on to a plate, and, inasmuch as the invention which Mr. Chitty said he discovered to defendants consisted of the upturned lugs on that of the plate itself, it was clear that those two original machines disclosed nothing to defendants. He did not know that it was alleged that they disclosed anything new to defendants. What plaintiff said was that he began in Feb. 1903 to give defendants information as to how ventilating vanes could be put into the machine in a better and cheaper way than they had hitherto known. It was said, and apparently with truth, that that system of fastening the vanes was not new. It was matter of common knowledge, but it was also said that defendants had not utilised them and not turned the information to account. His Lordship said it was for the jury to say whether defendants had broken their bargain with plaintiff or not. His Lordship then dealt with the evidence referring to that part of the case as to the auxiliary poles and slots for distorting the lines of force. He said the question was whether defendants had utilised the information given to them by plaintiff in violation of their promise not to utilise it. If the jury thought they had, then it was for them to say what damages plaintiff was entitled to.

The jury, after an absence of 25 minutes, returned a verdict for plaintiff for £1,600 damages.

Judgment was given accordingly, with costs.

Mr. HUME WILLIAMS applied for a stay of execution pending the consideration by defendants of an appeal, and objected to defendants having to pay the costs of the motion and application for an injunction until they had decided whether they would appeal.

His LORDSHIP agreed to stay the order as to costs for ten days, and said if defendants had not lodged their appeal by that time the whole of the costs would be taxed.

Dudley Corporation v. Dudley, Stourbridge & District Electric Traction Co. (Ltd.)

On Tuesday Mr. Justice Swinfen Eady delivered his reserved judgment in this case.

His LORDSHIP said: The question is whether a light railway (of over two miles of single line) which is being purchased by Dudley Corporation from the company is to be valued upon the basis of a structural valuation regarded as a railway fixed in position capable of earning a profit, or upon the basis of the value of the railway to the company as an income-earning concern—that is, upon the capitalised value of the net profits which have been earned by the railway. By the Dudley & District Light Railway Order, 1898, the local authorities in whose districts railways Nos. 1, 2, 3, 4, 6 and 7 are situate, may require the company to sell to them the railways situated in their respective districts upon terms of paying a fair market value thereof as a going concern, but without any allowance for compulsory purchase, and as regards railway No. 5—the one in question—the Corporation may purchase the same at the time and in the manner provided by the agreement between the company and the Corporation dated October 17, 1898. That agreement provides that the Corporation shall purchase and the company shall sell "the said railway No. 5" at a price to be settled in case of difference by the Board of Trade. The agreement does not contain any stipulation or provision as to the principle upon which the price is to be arrived at. It was urged on behalf of the company that the railway was to be sold as a going concern—as an income-earning concern, and therefore the sale must include the equipment—that the case differs from that of a tramway, as sec. 19 of the Tramways Acts, 1870, prohibits the local authority from working a tramway which it had purchased, whereas in the present case there is no such prohibition. Accordingly it is said the expression, "the said railway No. 5" in the agreement between the parties must include the rolling stock and powers to work or rights attached to the structure. I am of opinion that such contention is not well founded. All that the Corporation are purchasing is the "said railway No. 5," which includes the railway in situ and the stationary electric equipment or works, such as posts and wires, which form part of the "said railway No. 5," and have been duly erected or placed in position, but not the rolling stock nor the "undertaking." It is "railway No. 5" and not "the undertaking" which the Corporation are acquiring. Several sections of the provisional order follow closely the provisions of the Tramway Act, 1870. The "said railway No. 5" cannot be read as "the undertaking of the company so far as relates to railway No. 5." The price to be paid is the price for railway No. 5—not for the undertaking nor for powers to work the railway, nor for rolling stock, nor as compensation to the company for the loss of their right to work the railway. The proper basis of value is that put forward by the Corporation, upon which the arbitrator awarded £16,548.

The company were ordered to pay the costs.

F. A. Glover & Co. (Ltd.) v. Delta Metal Co. (Ltd.)—On Friday Mr. Pollock, Official Referee, after hearing a great deal of detailed evidence in this case, reserved judgment The facts of the case were reported in our issue of 18th ult.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Heston and Isleworth Urban District Council invite applications for the position of electrical engineer. Salary £300, rising by four annual increments of £25 to £400 per annum. Applications to the clerk of the Council (Mr. H. J. Baker), Council House, Hounslow, by 10 a.m., July 2. See an advertisement.

The Sanitary Commissioners of Gibraltar require the services of an assistant electrical engineer. Commencing salary £200 per annum, rising by annual increments of £10 to £250 per annum. Applicants must have had experience in high-tension alternating distribution with transformer stations, in laying h. and l.-t. concentric cables, installing a.-c. and c.-c. motors, street and private lighting, &c. Applications to the secretary and engineer to the Sanitary Commissioners (Mr. Wm. Wallace Copland), Gibraltar, by June 30. See also an advertisement.

The governing body of Northampton Institute, St. John-street, London, E.C., invite applications for the following appointments:—Drawing office and lecture assistant in mechanical engineering department (salary £120 per annum), two demonstrators for electrical engineering laboratories (£100 and £80 per annum respectively), demonstrator and lecture assistant in technical chemistry department, and instructor in moulding in mechanical engineering department. Further particulars and forms of application (which should be returned by 10 a m. June 25) from the principal, Dr. R. Mullineux Walmsley. See also an advertisement.

A junior demonstrator is required in the physical laboratories of Birmingham Municipal Technical School. Salary £80 per annum. Particulars from the secretary, Mr. Geo. Mellor, Suffolk-street, Birmingham. Applications by July 4. See an advertisement.

Portsmouth Corporation require an inspector and canvasser for their electricity supply department. Salary £104 and commission. Applications to the Engineer and Manager by June 27.

An additional assistant is required in the electrical engineering department of the Central Technical College, Exhibition-road, London, S.W. Salary £150 per annum. Applications to Prof. W. E. Ayrton.

An assistant is required in the department of electrical engineering of Glasgow and West of Scotland Technical College to teach dynamo design. Salary £100 per annum. Applications before 28th inst. to Prof. Magnus Maclean.

Monmouth Corporation require a resident electrical engineer. Applications by 25th inst.

Whitehaven Council have appointed Mr. T. Bell as temporary electrical engineer at £3 10s. per week.

EDUCATIONAL NOTICES.

Research Scholarship.—The council of University College, Nottingham, offer a scholarship for scientific research (tenable for one year) of the value of £50, together with free admission to the college. The scholarship is open to any graduate of a British University, and candidates will be required to give evidence of suitable training and capacity for conducting original research. Applications (on forms to be obtained from the registrar) by Sept. 1.

Liverpool University.—Liverpool City Council have decided to continue the grant of £10,000 to this University for 1906-7.

Australasia.—The "Australian Mining Standard" says it is anticipated that the Essendon-Flemington (Victoria) electric tramways will be opened in a few months. Mr. Jas. Walker is superintending the work of construction on behalf of the contractors, J. G. White & Co.

Sydney Electric Light committee recently decided to recommend the Council to adopt the proposals of the city electrical engineer (Mr. T. Rooke) to purchase £10,000 worth of distributing cables for further extensions, and to reduce the charges for current for power, heating and cooking from 2d. to 1½d. per unit.

A report from our Australian correspondent states that there are many persistent demands for extensions of the Sydney municipal tramways. Amongst the extensions recently suggested to the Minister for Works are one on the North Shore from Blue's Point to Crow's Nest; another (3 miles) from Spit to Manley (at a cost of £29,000), a third from the Cook's River route to Brighton-le-Sands (cost £17,750), a fourth from Marrickville to Canterbury and Forest Hill, and, lastly, a route to Gore Hill and Longeville. The Minister has promised to obtain reports from the Railway Commissioners on some of these proposals.

Sydney Council have voted £150 to their assistant electrical engineer (Mr. J. E. Donoghue) as extra remuneration for additional work during Mr. Rooke's recent absence of six months abroad.

Austro-Hungarian Electricity and Tramway Undertakings.—We have received a copy of the 1906 edition of the "Jahrbuch der Osterreichischen Elektricitäts-Gesellschaften sowie der Strassenbahnen und elektrischen Kleinbahnen Osterreich-Ungarns." The book, which has been edited and brought up to date by Herr Rudolf Hanel, contains about 200 pages of very useful commercial and technical statistics of Austro-Hungarian electrical engineering firms, electricity supply works, tramways and light railways, along with their engineers and chief officials. The work is published at 3s. 3d. by the Compassverlag, I. Maria Theresienstrasse, 32, Vienna.

Bangor.—The borough electrical engineer (Mr. Price White), having been offered another appointment at £300 a year, the City Council unanimously offered Mr. White an additional appointment as assistant gas engineer at the expiration of two years, the present gas manager (Mr. Smith) to be appointed consulting engineer, and Mr. White manager of both undertakings at that time, Mr. White to receive a salary of £250, to be increased by £10 per annum up to £300, and Mr. Smith as consulting engineer to receive £100 per annum. Mr. White has accepted the Council's offer.

Batley.—The total income of the electricity department for the year ended March 31 was £4,484. 12s. 10d., including £1,554. 13s. 7½d. from the sale of current for lighting and power, £2,459. 18s. 7½d. for traction and £400 for public lighting.

The gross profit was £2,105. 15s. 6d. Interest absorbed £1,269. 1s. 5d., and sinking fund £898. 1s. 2d., leaving a net deficit of £81. 7s. 1d. Total capital expenditure is £40,949. 10s., an increase of £4,880. 15s. 8d. on the year. 730,773 units were generated; 393,587 units were supplied for traction, 44,500 to public lamps and 154,810 to private consumers. Works costs were 0·69d. per unit, and total costs 0·96d. per unit. Total cost per unit sold (including interest and sinking fund) 1·84d. The average price obtained per unit was 2·41d. for lighting and power (lighting 3·44d., power 1·57d.), public lighting 1·76d. and traction 1·5d. The equivalent of 14,460 c.p. lamps is connected.

Bridlington.—The capital expenditure of the electricity undertaking to March 31 was £29,942. 11s. 7d.

The total revenue for the past year was £3,230. 9s. 10d., and, after paying all expenses, there was a small deficit. 222,195 units were generated; 132,642 units were supplied for public lighting, 50,100 for private lighting and 3,092 for power. There are 191 consumers, representing an equivalent of 14,331 8 c.p., connected, and the private motors connected are equal to 21 kw. The maximum load on the feeders was 215 kw.

Canterbury.—The capital expenditure of the electricity department for the past year was £3,050, bringing the total to £62,944.

The year's revenue was £8,122, including £5,675 from private and £2,109 from public lighting, and the working expenses £3,412. Gross profit was £4,710 (against £2,994), interest absorbed £1,448 and instalment of repayment of capital £1,812. £118 has been placed to sinking fund and £1,300 to reserve, £577 being carried forward (against £545), the difference in the last two sums and the amount placed to reserve constituting the year's net profit of £1,332. 664,608 units were generated, 180,858 supplied to public lamps and 369,330 to private consumers. There are 12 arc and 552 incandescent public lamps. The maximum supply demanded was 433 kw. Charges for current to private consumers have been reduced, making the flat rate 4½d., and the maximum demand rates 7d. and 1½d., with a graduated scale of discounts for power consumers.

Cardiff.—The total net income of the electricity department for the year ended March 31 was £35,962. 3s. 4d. (against £32,698. 9s. 1d. in 1904-5), including £24,575. 3s. 6d. for current supplied for private lighting, £2,768. 19s. 6d. for heating and power, and £7,954. 16s. 4d. for public lighting.

The total working expenditure was £21,221. 11s. 3d., against £20,181. 4s. 10d.; and the gross profit was £14,740. 12s. 1d., against £12,517. 4s. 3d. Interest required £8,339. 12s. 1d., and repayment of loans £4,770. Interest on consumers' deposits £22. 11s. 4d., leaving a net profit of £1,608. 8s. 8d. 3,898,436 units were generated, 2,067,780 being sold to private consumers, 1,107,584 for public lamps, and 20,810 were supplied by "minimums." There are 578 arc and 129 incandescent lamps for public lighting, an increase of 60 arc lamps on the year. The total maximum supply demanded was 2,076 kw. on Dec. 14 last. The load factor per unit sold was 17·58 per cent., against 15·51. There are 1,237 consumers, an increase of 109 on the previous year, with the equivalent of 147,725 8-c.p. connected, an increase of 18,363. The works and distribution costs came to 0·82d. per unit, a decrease of 0·11d., and the total costs were 1·07d., a decrease of 0·18d. There are 220 motors of the equivalent of 1,179 H.P. connected (213 H.P. of a.c. and 966 H.P. of d.c.).

In the exhaustive report of the engineer and manager of the electric lighting and tramways department (Mr. Arthur Ellis) it is stated that, in addition to the past winter being a bad one, from the lighting point of view, a large amount of additional plant has been installed at the power station involving heavy expenditure upon which loan charges had to be paid but from which full benefit had not yet been derived. The demand for energy for power is increasing rapidly, several consumers being connected during the year and there are several more likely to take current. The Electrical and Lighting committee recently made a considerable reduction in the scale of charges for current and this is likely to further stimulate the demand for power and lighting. Last year's balance (£1,608. 8s. 8d.) has been carried forward. During the past five years the net profit has been £10,774.

Customs Decisions.—It has been decided that, under the United States Customs Tariff, carbon rods for electric lighting but requiring the ends shaped are subject to duty as electric lighting carbons of 90 cents per 100 rods. This reverses a decision given early in 1904.

Colchester.—The accounts of the electricity department for the year ended March show total capital expenditure £67,537, an increase of £7,416.

The year's revenue was £12,814 (against £11,433), including £8,801 from private consumers, £909 from public lighting and £2,818 from traction. Working expenses were £7,192 (against £5,671) and gross profit £5,621 (against £5,285). Interest required £1,782 (against £1,582) and sinking fund £2,082 (£1,747) and the net profit is £1,758 (£1,955). The maximum load was 801 kw. (692) and the load factor 15·48 per cent. (13·22). 1,086,083 units were sold (799,807), including 535,453 to private consumers, 99,761 to public lamps and 450,869 to tramways, and the average prices received were 3·94d. per unit from private consumers (4·36d.), 2·19d. for public lighting (2·39d.) and 1·5d. for tramways (the same as in previous year). The equivalent of 36,919 8 c.p. lamps is connected (against 31,761).

The year's income of the tramways department was £10,588 (7·916d. per car mile) and working expenses were £8,194 (6·127d. per car mile). The gross profit was £2,394. £2,871 was required for capital charges, leaving a deficit of £533. 320,788 car miles were run, and 2,457,553 passengers carried.

Devonport.—The Council last week adopted the accounts of the electricity department, abstracted in our issue of May 18.

Duty on Catalogues.—It is announced that a new duty of 2d. per lb. has been imposed upon catalogues sent from abroad by post in bulk to British South Africa in order to avoid the payment of separate postage on each catalogue, in addition to a duty of 6d a packet as clearance fee.

Dundee.—The Tramways committee have decided to convert a further portion of the tramway route to electric traction at an estimated cost of £1,500.

A report of the acting burgh engineer (Mr. James Thomson), recommending the committee to obtain parliamentary powers to carry out further extensions of the tramway system at £14,500, will be considered at the next meeting.

The receipts of the Tramways department for the past year were £50,154. 1s. 9d., and the working expenses £31,112. 6s. 1d., leaving £19,041. 15s. 8d. Interest amounts to £6,666. 12s. 7d., income tax £100. 19s. 7d., bank interest £511. 10s. 10d., sinking fund £5,120, renewal account £5,000, depreciation account £1,400. 17s. 5d., and reserve fund £241. 15s. 3d. There now stands at the credit of the accident fund account £535. 6s. 4d., renewals account £13,213. 6s. 6d., depreciation account £6,942. 19s., and reserve fund account £300. 2s. 2d.—a total of £20,991, 14st

Electrical Contractors' Association.—The annual meeting of this Association was held at Leeds last week, Mr. J. McDermott, the retiring president, in the chair.

The officers for the next 12 months are: President, Mr. Thomas Wright, Glasgow; hon. treasurer, Mr. H. Marryat, London; hon. secretary, Mr. L. G. Tate, London.

The CHAIRMAN, in reviewing the work of the past year, said that up to a few years ago there was no trade in which a greater amount of jealousy was displayed than in the electrical contracting trade. Five years ago it would have been a most extraordinary thing to have seen two electrical contractors talking together. Now, however, in consequence largely of the influence of the Association, a much better feeling existed. He gave particulars of negotiations which the Association had had with municipalities. He wished to dispel the idea that they were banded together simply to get the better of municipal trading. The fact was that their trade was attacked more than any other, and they only desired to defend themselves.

Mr. T. WRIGHT, in moving a vote of thanks to the retiring officers, said that, in order to combat municipal trading, they ought to strive for a higher and, so far as was compatible with their interests, a cheaper standard of workmanship.

Factory Lighting.—A Paper on the "Lighting of Factories" was read by Mr. A. Pollitt at the meeting of the Textile Workers Managers' Association on Saturday.

Mr. Pollitt confined his attention to a comparison of the illuminating power and cost of the various systems of lighting by electricity and gas. Taking the provision of 20,000 c.p. as the basis of calculation, Mr. Pollitt gave the following estimate as the total cost per hour for the several forms of lighting most commonly used: Ordinary flat gas burner 18s. 3d., incandescent mantle 4s. 9·18d., Welsbach self-intensifying burner and mantle 4s. 4·6d., compressed gas 4s. 0·19d., incandescent electric 13s. 2·68d. and electric arc lighting 4s. 6·44d. Gas is reckoned at 2s. 6d. per 1,000 ft. (a very low estimate), but the price of electricity per unit is not given.

Gloucester.—The capital expenditure on the electricity undertaking increased during the year ended March last from £75,240 to £84,083.

The year's revenue was £11,832 (against £10,411), including £5,859 net (against £5,351) for current taken by private consumers, £2,616 (against £1,876) for public lighting, £216 (against £194) meter rentals, and £2,888 (against £2,694) for current supplied to light railways (at 1d. per unit.) Working expenses were £5,807 (against £4,872), the gross profit being £6,024 (against £5,539). Interest on loans required £1,922 (against £1,813), bank interest £1,041 (against £1,035), instalment of repayment of loans £1,659 (against £1,600), the net profit being £1,402, of which £768 was required to meet adverse balance from previous year, and £635 has been carried forward. £1,412,035 units were generated, 195,738 supplied to public lamps, 693,165 to light railways, 403,706 to private consumers for lighting and 19,928 for power. The maximum demand was 920 kw. Private consumers have increased from 455 to 503 and the total equivalent of 8 c.p. lamps connected from 37,276 to 41,344. The motors connected have increased from 95 H.P. to 138 H.P. Total expenses (exclusive of capital charges) were 1·06d. per unit sold (against 1·11d.) and the average price paid, by all classes of consumers, was 2·16d. Extensions to station buildings have been completed, new boilers put in and new generating plant is being put down.

Govan.—The total income of the Electricity department for the past year was £14,034.

Working costs were £6,363, leaving £7,681, out of which £3,545 was paid for interest, £2,366 for sinking fund, and £159 for depreciation of motors, leaving a net profit of £1,611, which has been carried to reserve. The past year's record is regarded as very satisfactory by the Council, and the engineer (Mr. T. C. Parsons) has been congratulated upon the result.

Grimsby.—The L.G. Board have sanctioned the borrowing of £16,000 for extensions of the electricity undertaking, but have disallowed £277 scheduled for the time of permanent employés of the electricity department. The item had been debited to capital account, but the Board notified that all such time must be paid for out of revenue.

Huddersfield.—The National Telephone Co.'s offer to reconstruct the telephone system provided the Corporation allow the wires to be put under ground has been referred to a sub-committee.

Ilford.—The accounts of the Electricity department for the year ended March show capital expenditure £142,443, increase £11,419.

Revenue was £22,690, including £12,571 for current charged to consumers' accounts, £640 supplied through slot-meters, £5,004 for public lighting and £3,851 for tramways. Working expenses were £11,531, the gross profit being £11,159. Instalments of repayment of capital absorbed £3,708, interest £5,023 and instalment of interest on cost of machinery used for generation of electricity charged to tramways capital account £557. Balance from last year was £5,768 and the balance in hand, after payment of all charges, is £7,638, the net profit being £1,870. 3,088,644 units were generated, 964,493 supplied to private consumers, 658,526 for public lighting and 739,322 for traction. The average prices received for current were 3·29d. per unit from private consumers, 1·82d. for public lighting and 1·25d. for traction. The works cost per unit sold was 0·83d. and the total cost 1·17d. The maximum loads were 1,150 kw. for lighting and 300 kw. for traction. The net available balance (£6,195) has been carried to reserve. Current is to be supplied to the tramways in future at 1¼d. instead of 1½d.

Inquest.—An inquest was held at Edinburgh last week into the circumstances of the death of Alexander Munro, a coal-cutter's attendant.

Deceased had been working an electric coal-cutting machine in the Emily Pit of the Arniston Coal Co., and had taken hold of a wire haulage rope to adjust it. Immediately after he shouted for the current to be switched off, and then said that there was something wrong with him. He collapsed, and despite the fact that artificial respiration was carried on for over an hour, he never recovered.

Medical evidence was given to show that death was due to electric shock, and the jury returned a verdict to this effect.

Lancaster.—The Council have refused to entertain the offer of Messrs. W. J. Kershaw & Co., of Birmingham, to lease the local tramways.

The chairman of the Tramways committee (Ald. SMITH) said that the negotiations with the Lancaster & District Tramways Co., owning the horse lines to Morecambe, having failed, they proposed to afford an opportunity for reopening the negotiations for the electrification of the line, giving those who were prepared to do so powers to run into the borough upon conditions which would enable them to run the Corporation cars to Skirton, a mile on the road to Morecambe.

Large Water Power Station in Japan.—In our issue of May 18th, p. 162, we extracted from the "Electrical Review," of New York, a description of a large water power station, built and equipped for the Tokio Electric Light & Power Co., on the Tamagawa river, about 20 miles from Tokio. The Locke Insulator Mfg. Co., of Victor, N.J., inform us that the insulators and insulator pins for this installation are practically the only American apparatus used, and are being supplied by the Locke Company. Outside the switch gear and transformers there are used 16,000 insulators of the design illustrated and described in *The Electrician* for July 14, 1905, pp. 502-4.

Leyland.—The period of the Council's Electric Lighting Order (1902) has been extended by 12 months.

Lincoln.—The accounts of the electricity department for year ended March show capital expenditure £55,215, increase of £3,882.

The income was £8,695 (against £6,832), including £6,442 from private lighting, £810 from public lighting, £868 for power and £527 for current for tramways. Working expenses were £3,582 (against £2,904). Coal cost 0·378d. per unit (against 0·43d.), total working expenses 1·350d. (against 1·61d.) and total costs, including capital charges, 2·462d. (against 3·15d.) Gross profit was £5,113 (against £3,928). Capital charges required £2,948 (against £2,767) and net profit was £2,165 (against

£1,160), 777,451 units were generated (against 560,572), 66,680 supplied to public lamps (against 74,878). 506,097 to private consumers (against 356,595), and 63,252 for tramways (first year of electrical working). There are 481 private consumers (against 445) and the total connections are equivalent to 40,688 8 c.p. lamps (against 33,181).

The accounts of the tramways department for the year to March (the first eight months of electrical working) show capital expenditure £49,739, against £16,115. Receipts on electric cars were £1,069 and on horse cars £1,993, total receipts being £3,185. Total working expenses were £2,651, and gross profit £535. Capital charges absorbed £1,191, with the result that the balance in hand last year of £934 is reduced to £279.

Manchester.—The abstract of the accounts of the electricity department for the year ended March 31 was approved by the Electricity committee on Friday.

The sales of current for lighting and power produced £197,903 (compared with £182,560 in 1905), for traction £128,570 (against £117,590) and for public lighting £493 (against £675). Other items of income came to £2,233, against £1,375, the total income being £329,199, compared with £302,200. Working expenditure (including provision in 1905 of £25,000 and in 1906 of £40,000 for future renewals) was £181,118, compared with £174,320; and the balance £148,081, against £127,880. After making deductions for interest, sinking fund and repayment of loan (£131,862) the net surplus is £16,219, compared with £4,544. The amount carried forward is £34,836. The total output of electricity from the three generating stations during the past year was 55,025,966 units, against 47,170,721 units. Nearly 303 miles of mains are laid, an increase of over 10 miles on the year.

The report of the chief engineer (Mr. S. L. Pearce) on the working of the electricity undertaking, states that during the year some progress was made in the street lighting department. A contract was entered into with Gorton Council for lighting three thoroughfares, and 41 Gilbert arc lamps were installed of a similar type to those in the city. The results had been satisfactory to all concerned. No progress could be chronicled as regards the further lighting of any portion of the city. Experiments and tests were being conducted on all the modern types of "flame" arc lamps, and valuable information was being obtained. A substantial improvement had taken place in works costs, the largest item being the reduction in repairs and maintenance costs. Although 0·12d. had been knocked off works costs, they were still at a figure which left plenty of room for improvement. Present prospects are encouraging. A feature of the past year's working was the number of contracts that have been entered into for large power demands with several firms for additional power requirements. It is estimated that the supply to these works will increase the output by from seven to eight million units a year.

Marylebone (London).—According to a report issued by the Electric Supply committee on Tuesday, old plant had been sold in 26 lots, and the total amount realised was between £4,000 and £5,000.

Everything (the report states) has been sold except the switch gear, tenders for which were not considered sufficiently high.

Motherwell.—The electrical engineer (Mr. S. Williams) reports that for the past year 98 new consumers were connected (representing 15,572 8 c.p. lamps), making a total of 484 consumers and 60,986 8 c.p. connected. 1,168,038 units were sold (against 730,177).

The cost per unit sold was 0·82d., a decrease of ·09d. 21 additional public lamps were erected, making a total of 645. Total working expenses came to £3,937. 19s. 3d., compared with £2,934. 9s. Income was £9,264. 14s. 3d. compared with £7,452. 4s. 5d. Gross profit was £5,326. 15s. Interest came to £2,039. 18s. 8d; sinking fund, £2,100, leaving nett profit £1,186. 16s. 4d. The Electric Lighting committee agreed to clear off expenditure on free wiring account, amounting to £491. 16s. 10d., out of the profit, and to carry the balance to reserve. The charge for lighting is to be reduced from 3½d. to 3d. per unit, and for power to a flat rate of 1d. per unit up to 40,000 units per quarter, and ¾d. per unit for any quantity in excess. Any consumer using not less than 15,000 units per quarter for power is to receive energy for lighting at the following rates, provided the energy used for lighting shall not in any quarter exceed 20 per cent. of energy supplied: 1½d. per unit for first 5,000 per quarter, 1¼d, for second 5,000, 1d. for next 15,000, and ¾d. for any quantity over 25,000.

The salary of the engineer is to be increased by £50 per annum to £250.

Municipal Telephony.—The accounts of Portsmouth municipal telephone department for the year ended March show capital expenditure £44,533, increase £5,293.

The revenue was £10,668 (increase £1,278), including exchange rentals £8,402, private rentals £156, local tolls £910, public telephones £171, terminal fees (from National Telephone Co.) £72, and trunk and telegram fees (from subscribers) £897. Working expenses were £6,804 (increase £1,130), and included line repairs £707, instrument and exchange repairs £692, salaries and wages £1,886, Post Office royalty and commission £969, terminal fees payable to National Co. £163, printing and stationery £289, rents, rates, taxes and insurance £524, and trunk and telegram fees (payable to Postmaster-General) £897. Gross profit was £3,865. Instalment towards repayment of capital absorbed £946, and interest £1,114, the net profit (including £45 interest on deposit notes) being £1,849. The net profit is £124 less than last year, due to payment of £129 as compensation for an accident and the provision of £200 for bad debts compared with £50.

Swansea Telephone committee on Monday considered the amended plans and estimates to be submitted at the adjourned L.G.B. inquiry into the application for sanction to a further loan of £7,000 for extensions of the municipal telephone system.

Porto Rico.—There are now two electric railroads successfully established in Porto Rico, one running from San Juan to Rio Piedras and another from the town of Ponce to the harbour. The latter line of electric railway has been extended during the past year, and a service of parcel and general merchandise carriage has been established.

Presentation.—Mr. H. G. McHaffie, electrical engineer at Hoylake, who is leaving to take up an appointment at Para, has been presented by the staff with a fitted travelling bag.

Provisional Order Revocation.—The Board of Trade have revoked the Paignton Electric Lighting Order, 1902.

Provisional Order Transfers.—Tamworth Corporation and Stourbridge District Council give notice of intention to transfer to the Shropshire, Worcestershire & Staffordshire Electric Power Co. their provisional orders of 1904 and 1899 respectively, the consideration being £200 and £500. Objections to Board of Trade before July 16.

Railroad Signalling.—The Miller system of electric signalling has been installed on a section of the main line of the Belgian State Railway between Haren, Diegheim, Savanthem and Nasseghem. The engineer-in-chief in Belgium for the Miller system (which was described in *The Electrician* Vol. L., p. 547) is Mr. Douglas Wells, M.I.E.E., under whose supervision the work was carried out.

Railway Accounts.—The Board of Trade have appointed a departmental committee consisting of Mr. A. Clayton Cole (chairman), Sir Chas. J. Owens, the Hon. George Peel, and Messrs. W. M. Acworth, W. Bailey, G. Stapylton Barnes, A. Wilson Fox, C.B., G. Paish, and Mr. G. J. Whitelaw, with Mr. H. Fountain (Board of Trade) as secretary, to consider and report what changes, if any, are desirable in the form and scope of the accounts and statistical returns rendered by railway companies under the Railway Regulation Acts.

Rathmines (Dublin).—An inquiry was held here on Monday into the application of the Council to borrow £23,000 for electric lighting extensions.

The clerk (Mr. F. P. Fawcett) gave particulars of the loans already sanctioned, the accessible value and other statistics.

The chairman of the Lighting committee (Mr. R. Bolton) said that for the year ended March there was a net profit of £393, after paying all expenses, interest and sinking fund. They did not propose to spend the money asked for all at once. They were reducing the scale of charges for electric current.

The electrical engineer (Mr. Geo. F. Pilditch) gave technical details and particulars of the progress made by the undertaking. There are, he said, now 80 consumers, and the demand for current was steadily increasing.

Mr. G. W. Spencer Hawes (Robert Hammond & Sons) also gave evidence.

There was no opposition.

Rochdale.—The accounts of the electricity department for the year ended March show capital expenditure £71,866 (increase £5,452).

The receipts were £14,400, working expenses were £6,707 and gross profit £7,693, interest required £2,106, income tax £100, instalment towards repayment of loans £1,200, and contribution to sinking fund £592, leaving a net profit on the year's working of £3,695. Adding £1,118 from last year and contributing £1,000 to relief of rates, the balance carried forward is £4,513. 2,521,432 units were generated, 1,463,488 were supplied for traction and 646,376 to private consumers. The maximum demands during the year were 474 kw. for lighting and 825 kw. for traction.

Shanghai.—The opening of the ground for laying the rails in connection with the first portion of the Shanghai electric tramways was performed towards the end of April by Mr. Cecil Holliday, chairman of the English Municipal Council.

The contractors for the construction work are Bruce Peebles & Co. (represented locally by Mr. W. Jamieson and Mr. W. G. Hamilton) and the Shanghai Electric Construction Co. The system is being constructed to the metre gauge on the overhead system and when complete there will be about 23 miles of track. Electric current will be supplied from the municipal works.

Southend-on-Sea.—Mr. R. Birkett, borough electrical engineer and tramways manager, has tendered his resignation.

Spain.—The two electric lighting companies supplying the Corunna district of Spain with current for lighting and power now generate their electric energy at a water power station erected at Puente deume, about 15 miles from Corunna. The old steam plant has been disposed of.

At Corunna an electric loading and discharging tip is being built on the quay, and is expected to be in operation by the beginning of next year.

A project which has long been under consideration for extending the Corunna tramway lines by some 4 miles, to facilitate traffic in market garden produce, still awaits commencement. This forms part of a scheme for electrifying the horse tramway system of the city of Corunna.

Shoreditch (London).—At the meeting of the Borough Council on Tuesday it was decided to purchase motors and demand indicators to meet the requirements of the ensuing year at an estimated cost of £250. The Lighting committee reported to the Council on Tuesday that they had considered a letter from the Finance committee of the L.C.C. asking whether there is any immediate necessity for the Borough Council to provide extensions of plant.

The borough electrical engineer (Mr C. Newton Russell) reported that during last winter the whole of the generating plant at both stations was running at one time to cope with the demand, and that the additional plant on order was required to enable the council to perform its statutory duty of providing for all demands for electricity for lighting and power.

Sunderland.—The total capital expenditure of the tramways department to the end of the past year was £285,845. The traffic revenue for the year was £67,847 and the total revenue £68,566.

Working expenses were £38,838. Instalment of repayment of capital required £9,165 and interest, £9,140, leaving £11,011 net profit, of which £6,292 has been placed to reserve and renewals fund, £400 paid (on account) for erection of offices. £778 devoted to car covers account and £3,541 applied to relief of rates. 16,103,482 passengers were carried and 1,508,879 car miles run. 1,742,114 units of electrical energy were used, or 1·154 per car mile. The average revenue was 10·845d. per car mile and the average working expenses 6 161d. including cost of power.

Telephone Operators' Scale of Pay.—A circular has been issued by the secretary of the "National Association of Telephone Operators" announcing that the National Telephone Co. have adopted the following scale of pay for Sunday duty :—

All operators earning 13s. or less are to be paid at the rate of 2s. 4d. per half-day or 4s. 8d. per day for Sunday duty ; operators earning 14s. and upwards, 2s. 6d. per half-day or 5s. per day ; and operators in charge and supervisors, 3s. per half-day or 6s. per day. In future no operator will be required to take Sunday duty oftener than one half-day in four weeks or one day in eight weeks.

Torquay.—The Council have voted £800 towards cost of removing a dangerous bend in Babbacombe-road, on the route of the Dolter Electric Traction Co.'s tramways, now in course of construction.

Uruguay.—The "Review of the River Plate" says Monte Video municipality have approved the amended scheme of Senor A. Menditeguy for a system of electric tramways which will partly cover routes already occupied by other tramways.

Wath.—The Council have asked the Yorkshire Electric Power Co for terms for a supply of electric current in bulk.

Wireless Telegraphy.—It is reported that the Bavarian Minister of Public Works has decided to adopt wireless telegraphy between stations and trains in order to minimise the risk of collision on single track railways.

Dinner.—A complimentary dinner was given at Shanghai on April 25 by the American Association of China to the general manager of the Commercial Pacific Cable Co. (Mr. George Gray Ward). The president of the Association (Dr. Gilbert Reid) presided over a company numbering 46, and the Consul General for the United States (Mr. James L. Rodgers) was in the vice-chair.

In addition to Mr. Ward those present included His Excellency Lü Hai-huan (Treaty Commissioner), His Excellency Yang Shih-chi (Director-General of Chinese Imperial Telegraphs), Taotai Chou Wen-pang (of the same service), Mr. I. O. L. Berner (Great Northern Telegraph Co.) and Mr. James M. Beck (of the Eastern Extension Telegraph Co.).

After the toasts of the Empress-Dowager and Emperor of China and of President Roosevelt had been honoured, Dr. Reid said it was an important event which they had met to celebrate, the completion of the first submarine telegraph cable across the Pacific. Even the great European cable companies, whose representatives met with them on that occasion, would rejoice in the further exhibition of modern inventive genius and commercial energy, forming one more link to bind the nations and to make the whole world kin. After referring to the part played by Samuel Morse, Cyrus Field and John Mackay in developing submarine telegraphy, Dr. Reid alluded to the difficulties encountered by the latter, but he was ably seconded by their guest, Mr. George Gray Ward.

Mr. Berner, of the Great Northern Co., thanked the association for inviting him as representative of the oldest cable company in China to be present to welcome the guest of the evening (Mr. Ward), the representative of the youngest cable company (the Commercial Pacific Co.). He took the invitation as a proof that the American association had realised that although the Commercial Pacific Co. had occupied a territory which for about 30 years had been in the undisputed possession of the old cable companies, they looked upon the newcomer more as a co-operator than as a competitor in the field of telegraphy. Of course they did not object to healthy competition—the competition which inspired them to exert and improve—and in that respect he felt sure that both the old and the new cable companies might mutually benefit one another and thereby also the public. For years past they had realised that the Pacific cable idea—almost as old as the electric telegraph—would some day materialise by the Americans laying an American cable to China, and that in the natural course of things the American traffic would fall to that cable. Now that that day had come, they might console themselves with the consideration that the new and old lines would naturally act as feeders to one another, as the more branches to a tree so the more fruits. Furthermore, the new cable would necessarily ease their own lines and allow them to concentrate all their efforts on the improvement of their service through Europe and elsewhere. Finally, through the new cable a new string had been added to their bow, so that in case of accident the one line might serve as a reserve to the other. At that very moment the advantage was proved by the sad calamity which had stopped, quite temporarily they hoped, the regular cable communication with America via San Francisco. The Northern Co., at least, might find some cause for welcoming the new company in the thought that there was a certain, although remote, kinship between the two. He referred to the fact that the origin of the Great Northern and Far Eastern system might in reality be traced back to one of the earliest plans for establishing telegraphic communication between the continents of Asia and America—namely, the project of an American citizen, who in the middle of the last century (about 1854), before the Atlantic cables had been laid, planned the connection of Europe with America by means of an overland wire through Siberia to the Behring Strait, with a submarine cable across to Alaska. The building of the line was actually commenced. The Russians carried their line nearly to the coasts of the Pacific, and on the American side a landline was also laid towards the Arctic regions. He believed part of the same old line was still standing. This project, however, had to be abandoned owing to natural obstacles and lost its raison d'être by the ultimately successful laying of the first Atlantic cables. In the meantime the Siberian line was there, and the desire to utilise it led to an extension by cable to Japan and China—that was to say, the system of the Great Northern Telegraph Co. and that of China and Japan. Thus they were entitled to claim some kind of cousinship with the company which had now been so successful in carrying out the Pacific Cable idea. Both from practical and sentimental reasons, they joined in welcoming the representative of that company.

Mr. James M. Beck, of the Eastern Extension, Australasia & China Telegraph Co., cordially joined with Mr. Berner in wishing success to the new company.

Speeches followed from his Excellency Lü-hai Huan, Chou Wen-Pang and the Shanghai Taotai (Jui Chang).

Mr. Ward (in reply) thanked them most cordially for the honour they had done the company he represented by inviting him to that beautiful banquet to celebrate the completion of the American cable between the United States and China, a connection that he was confident would prove of great advantage to both countries. Their late and much lamented president (Mr. John W. Mackay), to whose enterprise they were indebted for that great work, was always desirous of seeing submarine telegraphy established across the Pacific, and they were no doubt aware that for many years schemes were put forward to carry out the project, but each one failed to materialise, and it was not until the Philippines became an American colony that the matter assumed definite shape. Bills were introduced in Congress, from time to time, for both subsidised and Government-owned cables, but nothing was accomplished until Mr. Mackay took up the matter himself. Mr. Mackay believed the Pacific had a great future, and felt a cable would develop its trade and prove of great service to the country. He communicated his views to the President of the United States and stated that he was willing to assume the responsibility of the undertaking himself, without any subsidy or bond whatever from the Government, but, unfortunately, he did not live to see the work completed. His son (Mr. Clarence H. Mackay), however, had ably carried out his father's ideas. They had overcome all opposition, and were that day an incorporated company, with a cable from Shanghai to San Francisco, 10,000 miles in length. He need not remind them of the immense value of submarine telegraphy, what it had done for the world, and they might depend upon it that that American cable, touching, as it did, only United States territory between Shanghai and San Francisco, would prove, both politically and commercially, of the greatest possible advantage to both countries. He was delighted to hear the remarks of the representatives of the Great Northern and Eastern Extension companies. Those companies saw that an American cable had to come, and that the United States business would naturally go to the American company. He could assure them that the Commercial Pacific Cable Co. would do its best to give them a first-class service, which they trusted would result in a large increase of trade and prosperity.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

London County Council invite tenders for the manufacture, delivery and laying of (*a*) about 33 miles of high-tension three core lead covered cable, telephone cables, &c. ; (*b*) about 25 miles of low-tension lead covered cables, telephone cables, &c. Specifications and other particulars at the County Hall, Spring-gardens, S.W., where tenders (addressed to the clerk of the London County Council, Mr. G. L. Gomme) by 10 a.m. July 10. Further particulars are given in an advertisement.

London County Council also require tenders by 10 a.m. July 3 for supply of tramcar fittings, motors and fittings and insulating materials.

Loughborough Electricity committee invite tenders for the annual supply of stores to the electricity department, including oils, engine-room stores, cables and all accessories, house-service meters, motors and turbo-generator brushes. Forms of tender and schedules from the borough electrical engineer (Mr. Walter H. Allen), Corporation Electricity Department, Loughborough. See also an advertisement.

Portsmouth Town Council invite tenders for the supply, delivery and erection of water softening plant, water storage tank, steam, feed and exhaust piping, and sundry ironwork. Tenders to the town clerk (Mr. Alexander Hellard) by noon June 27th.

Edinburgh Corporation invite tenders for supply of lead-covered paper-insulated copper cables for the year ended May 15, 1907. Tenders to the Town Clerk, City Chambers, Edinburgh, by June 25.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

Wallasey Council want tenders by July 16 for two years' supply of a.c. transformers. Specification from Mr. J. A. Crowther, Seaview-road, Liscard.

Rotherham Corporation want tenders by 30th inst. for 12 months' supply of cable and meters.

The Deputy Postmaster General, *Melbourne*, Australia, wants tenders by noon Aug. 7 for 20,000 Western Union pattern double-shed single-groove glass insulators (5,000 each at Sydney, Melbourne, Adelaide and Brisbane), and 5,000 double groove glass insulators, in equal proportions, at the same four towns, at whose General Post Offices specifications, &c., may be obtained.

The time expires at mid-day to-morrow (Saturday) for sending in tenders for the supply and delivery of 32,400 kilos of bronze, steel and iron wire and 3,333 yds. of insulated single-conductor wire for a public telephone installation in the Faroe Islands. The tenders have to be sent in to the magistrate, Mr. Baerentsen, Hotel King of Denmark, *Copenhagen*. The condition of tenders (in Danish) can be seen at the Board of Trade Commercial Offices, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Correction.—In our last issue we stated that Wallasey Council had accepted the British Thomson-Houston Co.'s tender for 12 months' supply of a.c. electricity meters. We now learn that the contract for the meters for Wallasey was divided between the British Thomson-Houston Co. and Ferranti Limited.

The following tenders have been received by the Nuneaton and Chilvers Coton Electric Light committee for the supply of a 200 kw. steam dynamo :—

Ernest Scott & Mountain (E.S. & M.)	£2,335	0
British Westinghouse Co. (Belliss-Westinghouse)	1,725	0
Electric Construction Co. (Belliss-E.C.C.)	1,655	0
Bumsted & Chandler (Bumsted)	1,578	0
C. A. Parsons & Co. (Parsons)	1,568	0
Browett, Lindley & Co. (Browett-J. & P.)	1,496	0
Mather & Platt (Brush-M. & P.)	1,418	0
James Howden & Co. (Howden-Phœnix)	1,412	0
Crompton & Co. (Howden-Crompton)	1,404	10
John Fowler & Co. (Howden-Fowler)	1,387	0
Dick, Kerr & Co. (Belliss-Dick Kerr)	1,365	0
British Electric Plant Co. (Howden-B.E.P.)	1,341	0
Reavell & Co. (Reavell)	1,313	0
Brush Co. (Brush)	1,250	0
P. R. Jackson & Co. (Willans-Jackson)	1,201	0
General Electric Co. (Willans-G.E.C.)	1,120	0
Vickers, Son & Maxim (Willans-Vickers)	1,118	0
Thomas Parker (Ltd.) (Willans-Parker)	1,094	0
Phœnix Dynamo Mfg. Co. (Willans-Phœnix)	1,085	0
Siemens Bros. & Co. (Willans-Siemens set)	1,082	10
Willans & Robinson (Willans-Parker)	1,080	0
Johnson & Phillips (Willans-J. & P.)	1,049	10

The above prices are those included in the tenders. Each firm sent in eight or nine alternatives.

Fulham (London) Council have accepted the following tenders :—Ferranti Limited, h.t. gear, £244. 10s.; J. Fowler & Co., l.t. gear, £186; British Westinghouse Co., transformers, £353. 8s. The Council have also placed an order with the Westinghouse Co. for 300 meters for the ensuing year.

Leyton Council received on Tuesday the report of the Electricity committee on the tenders for electric tramcars :—

Car Bodies.

Milnes, Voss & Co. (*accepted*)	£12,240 and **£12,400**
Hurst, Nelson & Co.	16,400
Dick, Kerr & Co.	13,960
Brush Co.	12,600
British Thomson-Houston Co.	12,600

Messrs. Milnes, Voss & Co.'s original tender was £12,240, and their amended tender has been accepted.

Radial Axle Trucks.

Mountain & Gibson (*accepted*)	**£3,667**
Peckham Engineering Co.	3,848
Brush Co. ... for 40 cars, £27,368;	3,715
British Thomson-Houston Co.	3,715

Electrical Equipment and Assembling of Cars.

British Westinghouse Co. (*accepted*)	**£11,213**
Raworth Traction Patents	15,939
Dick, Kerr & Co.	12,238
Brush Co.	11,853
British Thomson-Houston Co.	10,893

Messrs. Dick, Kerr & Co. have recently received orders for the following plant :—

New South Wales Government, two 450 kw. rotary converters similar to those supplied by the same firm under the original contract.

Bolton Tramways committee, one 1,600 kw. alternator.

Stoke-upon-Trent Tramways committee, one 250 kw. generator.

Glengarnock Iron & Steel Co., one 300 kw. generator.

Kilmarnock Tramways committee, one 275 kw. steam generator.

The Underfeed Stoker Co. have received the following orders for the equipment of water-tube boilers :—

Charing Cross, West End & City Electric Supply Co., two Nesdrum boilers (claimed to be the largest boiler units in the world); Poplar Electricity Works, one Stirling boiler; Stepney Electricity Works, one Babcock & Wilcox boiler; Spiers & Pond's Generating Station, three Babcock & Wilcox boilers; South Wales Electrical Power Distribution Co., nine Lancashire boilers; Hull Corporation Electricity Works, eight Lancashire boilers; Falkirk Electricity Works, one Lancashire boiler; and the Army & Navy Auxiliary Co-operative Supply Co., two Lancashire boilers.

Hastings Council have accepted the following tenders :—

Babcock & Wilcox, boiler (£772) and two superheaters (£305); Joseph Wright & Co., Berryman feed-water heater (£79); Willans & Robinson, Willans-Parsons steam turbine coupled to Dick, Kerr alternator and Mirrlees, Watson condensing plant (£5,418); G. & J. Weir, feed pump (£80); Ferranti (Ltd.), h.t. switchboard (£537 15s.).

Scunthorpe Council have accepted the tender of D. Adamson & Co. for a boiler at £445.

Marylebone (London) Council have accepted the tender of the Lancashire Dynamo Co. for the supply of battery-charging boosters, switchboards and accessories for the Rathbone-place battery at £2,557. 10s. Siemens Bros. & Co. also tendered at £3,330.

The Postmaster-General's Department, Perth (W. Australia), has accepted the tender of the General Elec. Eng. Co., Perth, for 1,280 4 in. Meidinger cells at 2s. 11½d. each.

BUSINESS NOTICES.

Mr. A. C. Eborall informs us that during the present month he is resigning his seat on the board of Witting, Eborall & Co. (Ltd. for the purpose of becoming managing director of Brown, Boveri & Co. (Ltd.), London. This latter company, which was registered on Tuesday with a capital of £50,000, is in course of formation, its main objects being to take charge of the interests of the well-known Swiss company in Great Britain, the British colonies and various other countries. The other directors of the English company will be Messrs. Charles Brown, W. Boveri and C. Baumann, who are also directors of the parent company in Baden.

The English Brown, Boveri Co. has arranged to purchase, carry on and develop the contracting business of Witting, Eborall & Co. (Ltd), and, as a result of this arrangement, we understand that the latter company has ceased trading, so far as new work is concerned, while their work and contracts in hand and their various British and colonial branch offices and agencies are being taken over, as far as is practicable, by the new company, whose offices will be (after to-morrow, 23rd inst.) at Caxton House, Westminster, S.W., to which building Witting, Eborall & Co. (Ltd.) are also removing their offices. The English Brown, Boveri Co. will have the whole of the resources and experience of the Swiss company behind it. This is a joint-stock enterprise, with a capital of £640,000, with works in Baden (Switzerland), Mannheim, Paris, Christiania and Milan, employing altogether 5,000 men and about 500 engineers and officials.

Mr. A. C. Eborall was on the staff of Brown, Boveri & Co., Baden, 10 years ago, hence the advantageous proposal recently made to him by the Swiss Co. to take charge of their British interests. As Mr. Eborall had a long contract with Messrs. Witting, Eborall & Co. as technical director, it became necessary to make special arrangements in order that he might be released, and these arrangements have taken the form of Brown, Boveri & Co. purchasing the goodwill, connection and certain other assets of Witting, Eborall & Co. In the seven years during which Mr. Eborall has been connected with Witting, Eborall & Co. and its predecessors a business has been built up which is represented by about half a million pounds worth of machinery, &c., running in different parts of the world, and an acquired reputation for good work. The pioneer labours of Brown, Boveri & Co. in high-pressure transmission work, and the development of polyphase plant and apparatus in connection with it, are well-known throughout the electrical world, and in recent years the large amount of d.c. and a.c. turbine work they have done has been a notable feature of their trading. At the end of 1905 about 600,000 H.P. of Brown Boveri turbine machinery was running in different countries. The turbine and condensing plants, as well as the generators, are made in Brown, Boveri & Co.'s factories. A fine example of recent work in this direction is the new station at St. Denis, Paris, which will have shortly a capacity of 70,000 kw. The first four sets (each of 6,000 kw.) are already running.

Witting, Eborall & Co. (Ltd.) ask us to state that, as a consequence of the above mentioned purchase of their business, all future inquiries should be addressed to Brown, Boveri & Co. (Ltd.), Caxton House, Westminster, and all correspondence for them should also be sent to the same address. The working arrangement which has existed between them and Ferranti Limited for some time past, in respect to switchgear and other manufactures of that firm, has come to an end as a result of the new arrangements, and, in consequence, all enquiries for Ferranti material should in future be addressed direct to Messrs. Ferranti, Hollinwood, Lancs.

The Newcastle depot of Veritys Limited has been removed to 26, Eldon-square. In addition there is a show room of art fittings. The Liverpool depot of the firm has been removed to 64, Stanley-street. The two branches remain in charge of the managers (who have been with Messrs. Verity for several years), Mr. J. L. Miller at Newcastle and Mr. T. C. Welding at Liverpool.

Mr. E. C. Amos, M.I.Mech.E., has removed to 22, Walbrook, E.C. His telegraphic address and telephone number remain as before.

Mr. S. J. Ebbutt, who recently resigned his position as manager of the telephone, telegraph and signalling department of the Birmingham branch of the General Electric Company, has joined the staff of Eckstein, Heap & Co.

The Linolite Co., sole licensees and manufacturers of linolite under Patents Nos. 202 of 1901 and 9488 of 1902, give notice that legal proceedings will be taken against any person manufacturing, selling or using any infringement of the said letters patent.

Messrs. Jay, Broll & Co., 31, Old Queen-street, Westminster, S.W., have been appointed London managers and agents for Messrs Truswell & Son, Newcastle, Staffs.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the failure of Thos. Hudson Hunter, electrical engineer, &c, York-road, West Hartlepool, the first meeting of creditors will take place on 25th inst. at 3, Manor-place, and the public examination on 28th inst. at the Court House, John-street, Sunderland.

Theodore Ferd. Levy Rene, electrical engineer, 9, Plum Tree-court, Farringdon-street, London, E.C., has been adjudicated bankrupt.

The International Electric Traction & Power Synd. (Ltd.) is being wound up voluntarily. Mr. J. Morris, 33, Brazennose-street, Manchester, is liquidator.

The Sol Mfg. Co. (Ltd.) is being wound up voluntarily. Mr. E. Hobbs, 27, Old Jewry, London, E.C., is liquidator.

A meeting will be held on July 20 at 35, Brown street, Manchester, to receive an account of the winding up of the British Prism Globe Electrical Co. (Ltd.)

Plant, &c., for Sale.—Messrs. Watson, Laidlaw & Co., 98, Dundas-street, Glasgow, advertise for sale a shunt-wound Mavor & Coulson dynamo, giving 75 amperes at 110 volts.

Messrs. J. Travers & Sons (Ltd.), 119, Cannon-street, London, E.C., have for sale some surplus electricity generating plant, including dynamos and electric motors by well-known makers, boilers, gas engines, tanks, pulleys, shafting, &c. Further particulars are given in an advertisement.

Messrs. Wm. Denny & Bros., Dumbarton, N.B., invite tenders for the purchase of the whole or part of the electric lighting plant at the Kirkton-hill electric lighting station, comprising two Paterson & Cooper dynamos and two Hornsby-Akroyd oil engines, main switchboard, battery of 60 D.P. cells, &c. See also an advertisement.

A quantity of electric light wire and cables, 300 megohm grade and English make, is advertised for sale in another column.

Factory Premises, &c., for Sale and to Let.—Messrs. George W. Dawes & Co., 12, Basinghall-street, London, E.C., advertise that they have available many factories, workshops, &c., suitable for the engineering trades, &c.

Messrs. Fuller, Horsey, Sons & Cassell have a large number of eligible factories, warehouses, &c., for sale and to let detailed in their register.

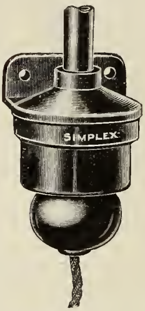
Mr. Sills, architect, 30, Norfolk-street, Strand, London, W.C., has for sale foundry works at Bury St. Edmunds, suitable for engineers or other works.

A factory or motor garage in the west end of London is advertised to be let in another column.

Messrs. B. R. Vickers & Sons, Gascoigne street, Leeds, advertise for sale (or for letting) conveniently situated works on navigable river and near three goods stations, with good water supply, cheap coal, &c

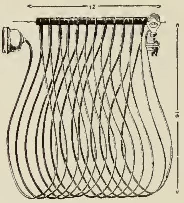
Business for Sale.—A traction business with patent rights is advertised for sale in another column.

"Simplex" Watertight Wall Plug.—This ironclad type of wall plug (which is clearly shown in the illustration) is of an entirely novel design, and combines great mechanical strength with high insulation. The vertical pattern is arranged for fixing upright on the wall, and is specially adapted for workshop or outside use. The plugs are manufactured in both the two pin or concentric types, and in the latter design a locking device is employed. The plugs are easily wired and unbreakable, all the parts being enclosed in a cast-iron case. A horizontal pattern is also listed by the Simplex Company. This has three lugs for fixing, and is made for ¾ inch screwed conduit.

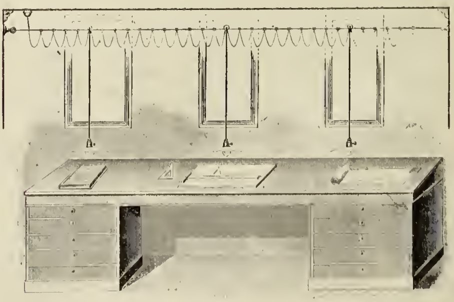


"Simplex" Watertight Wall Plug.

Electric Travelling Lights and Stretching Pendants.—Messrs. Thomas Laurie & Co., of Falkirk, are the makers (under the Laurie & Inglefield patents) of a device which enables an electric lamp to be travelled along a defined distance without the slack flexible wire being in the way on the floor. The accompanying illustrations will sufficiently show the several appearances of the device when in use. Along a stretched steel wire a number of bobbins are made to slide, to which the flexible cord is attached about every 3 feet, when not in use, these bobbins and wire fold up into a festoon at one end of the stretched wire. An ingenious part of the system is the stretching pendant, which consists of a rubber core, made of laminated rubber strips and braided. Around this core is wound spirally the flexible conductors, which terminate in an adapter at one end with hand lamp at the other. This hand lamp when pulled stretches the rubber core and the conductors, owing to their being wound spirally, stretch out to double the normal length of the pendant. This pendant, combined with the travelling flexible, allows the lamp to be carried easily along distances up to 150 ft. or more, and the pendant can stretch sideways to double its length. This combination in the first place saves considerable current, especially where only one lamp is necessary for the looking out of goods in long lanes of shelving. It is also clear that the light can go with the searcher to any point he may wish to reach. Considerable numbers of these stretcher lamps have been fitted in large warehouses, dockyards, at the General Post Office, for the Telephone Company, in foundries, &c.



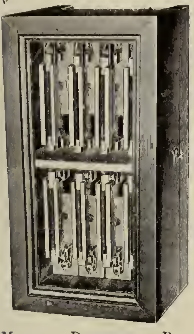
Travelling Fitting extending to 40 ft.



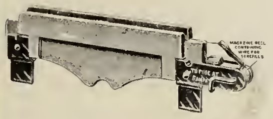
Example of Multiple Travelling Electric Lights and Stretching Pendants.

Catalogues, &c.—The wide range of switches, plugs, ceiling roses and other specialist apparatus and accessories which are comprehended in the Lundberg manufactures, are well displayed on a huge postcard which is being sent out by the enterprising firm of Lundberg & Sons.

A new trade list is issued by the British Electric Calibrated Fuse Co., of London and Harpenden. In this list the merits of "Pyrotin" and other special types of fuse wires, fuse strips, enclosed fuses, strip fuses, &c., are described, the Mordey type forming a prominent section of the catalogue. A form of magazine fuse manufactured by the company is shown in the first illustration herewith, and it is pointed out that the advantages of having a magazine of the correct size wire on the fuse-carrier on the ordinary lighting distribution board are obvious, and enables non-technical persons to replace the fuse in an instant. A description of the fuse follows, and it is announced that the magazine fuse can be obtained in all sizes up to 50 amperes. The magazine fuse-carrier is shown in our second illustration. There is also listed a very useful flexible-arm electric light fitting, so constructed that should the joints work loose the whole arm can be tightened by means of the wing nut shown at the lower end of the arm. We have found this a very useful lamp in actual use, and more truly flexible than any lamp of the kind which has yet come under our notice.



Magazine Distribution Board Fuses.



B.E.C.F. Magazine Fuse Carrier.

Flexible-Arm Electric Light Fitting.

Messrs. Mather & Platt have ready a revised list of polyphase induction motors. The general design of the motor is compact and substantial and both squirrel-cage and slip-ring types are listed. The sizes range from 3 H.P. to 50 H.P. and they are made for standard voltages of 110, 220, 440 and 500 volts for a frequency of 50 cycles per second. The starters shown in the list include the oil-cooled and liquid types for slip-ring motors and an auto-transformer starter for the squirrel-cage type. A reversing controller for slip ring motors is also listed.

Ernest F. Moy (Ltd.) have ready a new supplement list (No. 10) of tumbler switches and distributing boards and bridge fuse boards made up at low prices in cast-iron cases and teak fronts.

The Electrical Co. have ready a number of cards relating to their special types of meters for various purposes, time switches and a neat pocket list of electric fans and ventilators.

Two very useful pamphlets, well illustrated, dealing with enclosed type and open type arc lamps, have been issued by Messrs. Crompton & Co. These are respectively numbered 25 and 27. Both pamphlets contain full particulars of the lamps listed and of the special arc lamp fittings which Messrs. Crompton & Co. supply. The lists are got up in good style, and form part of the excellent series of three pamphlets which the firm are circulating from time to time.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from June 13 to June 19, with the ports of destination :—

Africa—Alexandria, £172; Cape Town, £332; Delagoa Bay, £3,385 (including £3,175 telegraph material); Durban, £4,524; East London, £74 (including £64 telegraph material); Port Elizabetb, £67. *Argentina*—Buenos Aires, £4,926 (including £1,900 telegraph material). *Australasia*—Auckland, £123; Brisbane, £171; Christchurch, £1,157; Fremantle, £376; Launceston, £61; Lyttelton, £183; Melbourne, £1,621; Otago, £83; Perth, £541; Sydney, £2,080 (including £118 telegraph material); Wellington, £398 (including £275 telegraph material). *Belgium*—Brussels £8; Ghent, £45; Ostend, £124. *British Guiana*—Demerara, £45. *Burma*—Rangoon, £58. *Canada*—Halifax, £1,900 (telegraph cable); Montreal, £68. *Ceylon*—Colombo, £54. *Chili*—Valparaiso, £599. *China*—Shanghai, £439 (including £151 telelegraph material). *France*—Paris, £94. *Gibraltar*, £72. *Holland*—Amsterdam, £235 (including £160 telegraph cable); Rotterdam, £25 (telegraph material). *India*—Bombay, £352; Calcutta, £1,016 (including £30 telegraph wire); Madras, £38 (including £11 telegraph material). *Japan*—Yokohama, £1,405; Yokosuka, £2,939. *North Atlantic*, £3,200 (telegraph material). *Peru*—Iquique, £8. *Portugal*—Lisbon, £20. *Russia*—St. Petersburg, £807. *Siam*—Bangkok, £7. *Straits Settlements*—Penang, £86; Singapore, £354. Total £34,272 against £18,399 for six days last year (June 15 to 20).

COMPANIES' MEETINGS AND REPORTS.

India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.)

The half-yearly general meeting of this company was held at the offices on Tuesday, Major L. Darwin presiding.

The SECRETARY (Mr. A. P. Crouch) having read the notice calling the meeting,

The CHAIRMAN said: At these half-yearly meetings you are aware you are called together to sanction the payment of an interim dividend only. No accounts or report of the directors is presented for your consideration. The remarks from the chair are usually of a brief character, because the board, although able to form some idea as to the results of the trading during the first six months of our financial year, yet are unable to report from exact knowledge. This information can only be obtained when stock is taken and the company's books are made up, which, as you are aware, only takes place every twelve months. During the six months just elapsed the prices of raw material have maintained their high standard and competition prevents us from taking orders at what were formerly considered fair prices. The only way we have been able to meet these drawbacks in recent years has been to increase our turnover, and this we have been successful in doing on the average of years, although the high selling prices forced upon us by the advances in the value of raw material have somewhat checked this increase for the last three years. I cannot well lay before you where the increases come from and where the decreases occur, as the making public of such a statement would be giving our competitors more information as to our affairs than your board think they should possess. I may say, however, that, taking things as a whole, your board have no reason to be dissatisfied, and do not hesitate to recommend the payment of an interim dividend. At the general meeting in December you were informed that we had in hand the manufacture and laying of a cable between Manila and Shanghai, some 1,300 miles in length. I have to report that our cable steamer "Silvertown," which was charged with the laying, completed her work without the slightest hitch, and is expected to arrive in the English Channel towards the end of the month. This vessel on her voyage home grounded on a shoal near Suez and again in the Suez Canal. This caused a delay of a few days, but the vessel is practically uninjured, and is now on her voyage to Holland, to which country she is carrying a cargo of some 4,000 tons of rice shipped at Saigon. The "Buccaneer" has had successful employment on one or two occasions, and the skill of our staff and the convenience of the vessel have gained for her an excellent reputation for executing quick and effective cable repairs. We have spent a not inconsiderable amount on our vessels during the year, so as to keep them in a very efficient state. The work in connection with the electric power station we have been erecting at our works in France is well in hand, the machinery is on order, and the foundation of the new buildings is being proceeded with. At the Silvertown works things are in a satisfactory state. £300,000 of 4 per cent. debentures and £100,000 4½ per cent. debentures fell due for repayment on March 25 last, and your Board, on advice, decided to make a fresh issue reducing the interest payable on the second of these by ½ per cent. This operation was completed without difficulty, although the state of the money market at the time of issue was a little unsettled. With these remarks I beg to move the payment of an interim dividend of 2½ per cent. (5s. per share), tax free.

The motion was carried unanimously, and the proceedings terminated.

BIRMINGHAM & MIDLAND TRAMWAYS (LTD.)—Mr. C. S. Hilton stated at the meeting last week that although they would lose the line inside Birmingham this year, they had been able to make arrangements with Birmingham Corporation for through services from Dudley and Oldbury right into the heart of the city. They had no option but to go into the motor omnibus business. Competitors came into the field and it was necessary to take it up vigorously. For the first time the parcels traffic appeared in the accounts. So far their system of collection and delivery had given good results. The Rowley Regis tramways had not been as successful as the directors hoped, but traffic was gradually improving. Dudley Corporation had now bought all the tramways and light railways in Dudley, and the Company would be the lessees of the Corporation. It had not been yet determined whether they were to be paid under the Tramways Act or the Light Railways Act, the judge having reserved his decision. [This decision is given on p. 392 of this issue.—Ed. *E.*] The South Staffordshire Company had been passing through a difficult time, but there was a satisfactory improvement on the opening up of the line between Wednesbury and Darlaston. Their investments in all their subcompanies were of a progressive nature.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.)—It was reported at the meeting yesterday that, subsequently to the statutory meeting in February, 1905, the work of construction and equipment was proceeded with vigorously, and a portion of the system was opened for traffic on July 31 and a further section on Aug. 24, 1905. The entire length of these lines is 10·58 route miles. The power house and substation at Beaufort-road, although not then entirely finished, were able to operate the service. They are now complete and the whole work has been carried out in a satisfactory manner by the contractors. The line from Bo Peep to Bexhill was opened on April 9. The line from Bexhill to Kewhurst will be finished shortly. As regards the front line, between the Memorial and Bo Peep, the directors regret that they have vainly endeavoured to persuade Hastings Corporation to agree to the equipment of this line on the overhead system, and the directors have, after careful consideration and in consultation with their engineers, decided to recommend the Dolter surface contact system, which the Corporation accepted at their meeting on May 18. The chairman, Mr. E. C. Morgan, said the line had continued to work regularly since the report was issued, and the number of passengers had averaged 90,000 per week.

LAKE COPPER PROPRIETARY CO. (LTD.)—The chairman (Mr. Jas. Swinburne) stated at the meeting on Tuesday that the company were making arrangements to have the mine developed by electricity. Work on the Vingnas property would be actively resumed after the electric plant had been installed.

PFLUGER AKKUMULATOREN-WERKE AKT.-GES., BERLIN.—For the year ended March the receipts on trading account were 45,392m.(£2,269), and as working expenses were 109,497m. (£5,475) and 284,700m. (£14235) had to be written off, the total loss is 348,805m. (£17,440), which with former losses makes the accumulated adverse balance 871,420m. (£43,571). The company has gone into liquidation, and the undertaking is being taken over by the Akkumulatorenfabrik Akt.-Ges., Berlin-Hagen.

SHANGHAI MUTUAL TELEPHONE CO. (LTD.)—This company's meeting was held recently at Shanghai. Mr. P. Brunat, who presided, said the subscription fees received were 89,432·67 taels, increase, 22,000 taels; working expenses increased by 27 per cent. (26,800 taels); new telephones installed were 2,285, against 1,764. A dividend of 8 per cent. was declared.

R. WAYGOOD & CO. (LTD.)—At the meeting on Monday Mr. H. C. Walker said that during the year they had completed some important jobs, including three lifts for H.M. the King at Buckingham Palace and another at St. James' Palace; also five for the new buildings of the Hearts of Oak Benefit Society and another at the King Edward VII. Sanatorium at Midhurst. They had supplied lifts for the steamships "Amerika" and the "Kaiserin Augusta Victoria," of the Hamburg-American line, and they had also received orders for fitting passenger, baggage and several service lifts on the new Cunard steamer "Lusitania." They had nearly completed 21 lifts for the new War Office, and they had executed work for H.M. Office of Works, the Admiralty, Post Office and other Government departments. Amongst other important contracts they had received this year were two electric passenger lifts for Bournemouth Corporation, to travel from the sands to top of cliffs, 21 electric lifts for Victoria Station extension (S.E.&C. Railway) and 14 electric lifts for Caledonian Railway station extension, Glasgow, eight electric lifts at St. Bartholomew's Hospital. They had also in hand several electric cranes. They had felt for some time that though hydraulic power had many advantages for quick-lifting cranes, electricity at the present low prices for power prevailing in London was bound to be largely used, and they had designed and were fitting up several electric cranes on the river, including some of the big luffing type. Their profits showed a small increase, and in view of the recently depressed state of the building trade that might be regarded as highly satisfactory.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

ALBERT DICKINSON (LTD.) (89,096.)—Reg. June 12, capital £2,000 in £1 shares, to carry on the business of electrical engineers and contractors, electricians, suppliers of electricity, manufacturers of electrical apparatus and machinery, &c.

BEESTON ACCUMULATOR SYND. (LTD) (89,105.)—Reg. June 13, capital £500 in £1 shares (300 10 per cent. preference), to adopt an agreement with S. Halford and E. Shoals, and to carry on the business of electric storage battery or accumulator manufacturers, chargers of accumulators, electric engineers, motor and car makers, &c. Reg. office: Post Office-square, Beeston, Notts.

ELECTRIC STERILISING, CARBONISING & STRIPPING CO. (LTD.) (89,087.)—Reg. June 11, capital £10,000 in £1 shares, to acquire, work and develop certain patents, rights and interests relating to the carbonising of wool waste, rags and other fibrous substances and the sterilisation of anthrax and other infectious diseases, and a process for discharging dyes from textile fabrics. First directors: I. Ickringill, I. Holmes, A. D. Smith, H. Hey, H. A. Fleet, G. H. Briggs and S. Briggs. Reg. office: Vulcan Works, Keighley, Yorks.

INTERNATIONAL TELEGRAPHIC APPLIANCES (LTD.) (89,123.)—Reg. June 14 capital £3,000 in £1 shares (1,000 6 per cent. cumulative preference), to acquire the benefit of a certain agreement relating to Gell's patents for telegraphic appliances, to adopt an agreement with W. J. van Hoytema, and to develop and turn to account the rights and benefits referred to therein. First directors W. J. van Hoytema (manager) and A. Strahan.

MORTGAGES AND CHARGES.

SIR HIRAM MAXIM ELECTRICAL CO. (LTD.)—Lien reg. June 2, for £4,500 3 per cent. debentures, part of £10,000 authorised; no trustees; charged on undertaking, property and uncalled capital.

THOMAS PARKER (LTD.)—Lien reg. June 2, for £5,000 4 per cent. debentures, part of £75,000; amount previously issued, £60,000; no trustees; charged on undertaking and all property, present and future.

CITY NOTES.

MEMORANDA (June 21).—Bank rate 3½ per cent. (June 21, 1906). Price of silver $30\frac{5}{16}$d. per oz. Consols $88\frac{9}{16}$—$88\frac{11}{16}$ for money, $88\frac{11}{16}$—$88\frac{13}{16}$ for account; 2½ per cent. annuities $97\frac{3}{8}$—$97\frac{5}{8}$. Consols Pay Day, July 4; Stocks and Shares Continuation Days, June 26 and July 10; Ticket Days, June 27 and July 11; Pay Days, June 28 and July 12; Mining Share Carry-over Day, June 25.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—The coupons on this company's 4 per cent. mortgage debentures to bearer, due July 1, will be paid on and after 2nd prox. at Parr's Bank, Bartholomew-lane, London, E.C. The debenture register will be closed from 25th to 30th inst. inclusive.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors of this company are offering to the existing shareholders 7,500 cumulative 6 per cent. 2nd preference shares of £10 each at £11 per share. Application forms must be forwarded to the company's bankers, the London City & Midland Bank, 5, Threadneedle-street, E.C., on or before 25th inst.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors recommend a dividend of 3 per cent. on the ordinary shares for the year ended March 31. Last year the dividend was 6 per cent.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have declared the following dividends on account of the year ending Dec. 31, 1906:—On the preference shares: 6s. per share (at the rate of 6 per cent. for half year ending June 30). On the ordinary shares: 5s. per share (at the rate of 5 per cent. for half-year ending June 30, *i.e.*, 2½ per cent. for the year). The above dividends, less tax, are payable on 17th prox.

ELECTRICAL ENTERPRISE IN RUSSIA.—The Russian Westinghouse Co. has acquired the works of the Central Electricity Co. of Moscow for 4,000,000 roubles. The Central Company was formed in Belgium in 1896, and has a share capital of 3,750,000 and obligations of 3,000,000 roubles; deficit on the company's operations is 675,000 roubles, together with book debts of over 3,000,000 roubles. The purchase of the Moscow works has, it is stated, been necessitated by the fact that the Westinghouse Co. recently, in competition with the Siemens-Schuckertwerke, Berlin, secured the contract for the electrification of the St. Petersburg tramways. As the Westinghouse St. Petersburg works were not equipped for manufacturing all the material required, the negotiations for buying the Belgian company's works were set on foot.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Subject to completion of audit, the directors recommend payment of the following dividend, &c., for year ended May 31:—A dividend of 2s. per share (10 per cent.) for year on the ordinary shares (of which 1s. per share was paid in January), leaving 1s. per share to be now distributed. The trustees for the ordinary shares reserve fund also propose to distribute (out of dividends received) 1s. per share. The trustees for the founders' shares reserve propose to distribute (out of dividends received) £10 per share. The payments are subject to deduction of income tax. The dividend will be paid on July 4.

INTERNATIONALE ELEKTRICITATS GESELLSCHAFT, VIENNA.—A dividend of 8 per cent. (the same as in the previous year) has been declared for 1905 6.

ROYCE LIMITED.—After allowing for depreciation, charging to revenue repairs and replacements and providing for interest, the profit on the past year's working was £3,918. Deducting debit balance of £3,161, there is £754 to be carried forward.

SAO PAULO TRAMWAYS, LIGHT & POWER CO. (LTD.)—The directors have declared a quarterly dividend of 2 per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed June 27 a special settling day in 168,365 vendors' ordinary £1 fully paid shares and £58,333 vendors' 5 per cent. first mortgage debenture stock of *Johnson & Phillips (Ltd.)*, and 10,000 £5 fully-paid 6 per cent. cumulative preference shares of the *London Electric Supply Corp. (Ltd.)*, and have ordered the last-mentioned shares to be quoted in the official list. The committee have also appointed July 5 a special settling day in fully paid scrip for 22,900 5½ per cent. cumulative preference shares and £200,000 4½ per cent. first mortgage debenture stock of the *Manx Electric Railway Co. (Ltd.)*. The Committee have been asked to appoint special settling days in and grant quotations to a further issue of 100,000 £5 fully paid ordinary shares of the *Anglo-Argentine Tramways Co. (Ltd.)* and scrip certificate (fully paid) for £150,000 5 per cent. debentures of the *Compania de Gas y Electricidad de la Habana*, and to appoint a special settling day in 100,000 £1 fully paid shares (Nos. 1 to 100,000) of the *Anglo-Portuguese Telephone Co. (Ltd.)*.

WESTERN TELEGRAPH CO. (LTD.)—The coupons of this company's second issue of 5 per cent. bearer debentures, due 30th inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane London, E.C

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	June 8	236	+ 38	23	4,936	+ 517
Anglo-Argentine	,, 17	13,686	+ 1,435	24	359,269	+ 68,505
Ashton-under-Lyne Corp.	,, 9	509	+ 207	11	3,808	+ 495
Ayr Corporation	,, 16	358	+ 33	5	1,391	- 119
Baker St. & Waterloo Ry.	,, 16	1,489	...	14	20,336	...
Barnsley	,, 8	219	+ 55	23	3,687	+ 94
Barrow	,, 8	443	+ 195	28	5,200	+ 450
Bath Electric Trams, Ltd	,, 13	899	+ 70	21	17,565	+ 2,670
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 16	567	+ 166	11	6,430	+ 2,322
*Birmingham & Mid.	,, 8	2,050	+ 51	23	32,326	- 8,914
Blackburn Corporation	,, 13	1,122	- 213	¶11	12,171	+ 660
Blackpool Corporation	,, 14	2,180	+ 57	10	10,726	+ 1,857
Blackpool and Fleetwood	,, 16	889	- 633	24	9,102	+ 977
Blackp'l, St. Anne's & Lytham	,, 14	1,068	+ 201	§32	8,283	+ 1,410
Bolton Corporation	,, 17	2,315	- 17	11	24,055	+ 1,621
Bournemouth Corporation.	,, 13	1,702	- 104	†11	17,514	+ 5,162
Bradford Corporation	,, 16	4,603	- 1,349	11	51,432	+ 2,485
Brighton Corporation	,, 17	957	- 485	11	10,633	- 436
Bristol Trams & Carriage	,, 15	5,278	- 1,195	18	83,340	+ 4,153
Buenos Ayres & Belgrano	,, 17	3,344	- 15	¶25	85,842	+ 5,770
Buenos Ayres Elec. Trms	May 19	1,275	+ 173	20	28,140	+ 5,680
Burnley Corporation	June 16	1,207	- 79	11	13,563	+ 369
Burton Corporation	,, 17	286	+ 115	§11	3,341	- 258
Bury Corporation	,, 17	1,040	...	11	11,178	...
Calcutta Tramways Co.	,, 16	R42,612	- R1,923	24	R1,042,822	+ R100,348
Camborne-Redruth	,, 16	212	+ 77	...	...	...
Cardiff Corporation	,, 9	2,914	+ 895	10	20,579	+ 313
Carlisle Tramways Co.	...	...	...	...	...	...
Cavehill	,, 8	136	+ 63	23	1,607	+ 446
Central London Railway	,, 16	6,557	+ 141	24	161,376	- 5,593
Chatham & Dist. Lt. Rys.	,, 14	653	- 145	†23	14,715	+ 32
*City of Birm'gh'm Tram Co	,, 8	7,112	+ 1,180	23	121,661	- 5,712
City & South London Rly.	,, 17	2,604	+ 217	24	67,420	+ 84
Colchester Corporation	,, 14	212	+ 119	42	8,598	- 1,087
Cork Electric Trams Co.	,, 14	605	+ 8	24	10,615	- 210
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 8	619	+ 180	23	9,851	- 302
Croydon Corporation	,, 15	1,514	- 220	2	3,816	+ 557
Dover Corporation	,, 16	242	- 35	11	2,650	+ 330
Dublin & Lucan Railway	,, 15	126	- 67	§24	2,523	- 149
Dublin United	,, 15	5,659	- 862	‡24	114,164	+ 1,001
Dudley—Stourbridge	,, 8	1,694	+ 805	23	18,849	+ 854
Dundee Corporation	,, 13	1,140	+ 271	§4	4,459	+ 877
East Ham Council	,, 16	922	- 150	11	10,435	+ 1,152
Exeter Corporation	,, 15	305	- 105	11	3,127	- 866
Gateshead & Dist. Trams.	,, 8	1,132	+ 196	13	21,347	+ 1,188
Glasgow Corporation	,, 16	18,372	+ 2,119	3	48,676	+ 6,997
Glossop	,, 16	139	+ 1	24	3,080	+ 303
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 8	386	+ 153	23	5,632	+ 342
Gt. Northern & City Rly.	,, 16	1,743	+ 201	21	43,028	+ 2,349
Greenock & Port Glasgow	,, 8	823	+ 94	23	14,179	+ 786
Halifax Corporation	,, 13	1,833	- 743	11	18,410	+ 1,030
Hartlepool Tramways	,, 8	452	+ 198	23	6,213	+ 620
Hastings Elec. Trams Co.	,, 14	633	...	24	12,306	...
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 16	2,264	- 197	11	24,538	+ 443
Ilford Dist. Coun.	,, 16	485	- 197	11	5,636	+ 205
Ilkeston Dist. Council	,, 13	126	- 50	11	1,411	+ 18
Ipswich Corporation	,, 16	407	- 234	11	4,669	- 85
Isle of Thanet Co.	,, 16	605	- 324	26	12,064	- 885
Keighley Corporation	,, 14	154	- 46	49	7,084	...
Kidderminster & District	,, 8	289	+ 169	23	2,431	+ 130
Kilmarnock Corporation	,, 16	160	- 1	5	721	- 41
Kirkcaldy Corporation	,, 13	235	+ 20	...	...	...
Lanarkshire Trams Co.	,, 14	950	+ 251	†24	20,451	+ 4,698
Leamington	,, 8	339	+ 296	23	3,497	+ 1,921
Leeds Corporation	,, 16	6,372	- 1,340	9	69,802	+ 8,888
Leicester Corporation	,, 16	2,327	- 678	24	51,201	+ 4,209
Leith Corporation	,, 9	567	+ 332	‡4	1,926	+ 1,048
Liverpool Overhead Rly.	,, 17	1,440	- 379	24	33,952	- 2,466
Liverpool Corporation	,, 9	12,505	+ 1,696	23	241,066	+ 7,058
*London County Council	,, 9	30,719	+ 16,304	10	266,228	+ 123,986
London United	,, 15	6,998	- 1,757	†24	137,050	+ 7,773
Lowestoft	,, 17	157	- 113	38	5,004	- 299
Maidstone Corporation	,, 14	108	- 48	11	1,196	- 150
Manchester Corporation	,, 16	13,970	+ 1,934	11	149,343	+ 7,995
Mersey Railway	,, 16	1,759	- 145	24	41,661	+ 2,812
Merthyr	,, 8	286	+ 87	23	4,365	+ 79
Metropolitan Dist. Railway	,, 17	8,309	+ 763	24	192,821	+ 13,350
*Metropolitan Elec. Trams	,, 8	5,442	+ 2,891	23	72,848	+ 21,359
Middleton	,, 8	593	+ 203	23	7,365	+ 408
Nelson Corporation	,, 16	146	- 12	12	1,507	+ 172
Newcastle-on-Tyne Corp.	,, 16	3,789	- 463	11	43,337	+ 1,871
Newport (Mon.)	,, 16	614	- 241	11	6,933	+ 321
Northampton Corporation.	,, 15	438	- 305	11	4,838	+ 30
Oldham, Ashton & Hyde	,, 8	724	+ 151	25	12,417	+ 556
Oldham Corporation	,, 17	1,728	+ 129	12	21,386	+ 1,779
Perth (N.B.) Corporation	,, 13	162	...	4	647	...
Perth (W. A.) Elec. Trams	,, 15	1,451	+ 219	†24	35,153	+ 1,964
Peterborough	,, 8	221	+ 83	23	2,581	- 103
Pontypridd District Coun.	,, 16	151	- 3	11	1,951	- 23
Portsmouth Corporation	,, 16	2,245	- 410	11	21,492	+ 139
Potteries	,, 8	2,155	+ 429	23	40,348	+ 2,601
Preston Corporation	,, 6	1,174	+ 510	...	...	...
Reading Corporation	,, 14	659	- 189	...	...	...
Rochdale Corporation	,, 16	1,103	+ 144	11	11,831	+ 4,651
Rotherham Corporation	,, 14	483	- 181	11	5,404	+ 514
Rothesay	,, 8	302	+ 135	23	2,348	+ 532
Salford Corporation	,, 18	4,318	- 1,428	11	51,180	+ 1,005
Sheerness	,, 6	88	+ 4	23	1,193	- 200
Sheffield Corporation	,, 17	4,987	- 570	12	63,036	+ 410
Southampton Corporation.	,, 13	1,023	- 174	†11	10,079	+ 105
Southend Corporation	,, 13	411	- 107	11	3,831	+ 194
Southport Tramways	,, 8	666	+ 367	23	6,374	+ 828
S. Staffordshire Trams.	,, 8	1,294	+ 583	23	18,442	+ 3,014

(a) These comparisons are with the corresponding period last year. † Minus 3 days ‡ Minus 2 days. § Plus 2 days ¶ Plus 5 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	June 15	1,263	+ 255	11	10,892	+ 4,132
Sunderland Corpn.	,, 17	1,274	- 597	11	15,225	+ 830
Sunderland & District	,, 13	436	...	24	8,871	...
Swansea Trams	,, 8	1,218	+ 433	23	17,752	+ 4,658
Swindon Corporation	,, 6	379	+ 187	¶10	2,158	+ 77
	,, 13	174	- 69			
Taunton	,, 8	64	+ 16	26	984	- 36
Tynemouth and District	,, 8	532	+ 257	23	4,636	+ 112
Tyneside Trams Co.	,, 13	472	- 198	24	9,530	+ 500
Wallasey District Council	,, 16	872	- 177	11	8,769	+ 319
Walsall Corporation	...	...	...	...	...	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 14	2,279	+ 358	11	25,119	+ 8,388
Weston-super-Mare	,, 6	349	+ 236	28	1,487	+ 152
Wolverhampton Corpn.	,, 13	827	...	...	...	...
* Wolverhampton District	,, 8	818	+ 439	23	9,340	+ 1,173
* Worcester	,, 8	465	+ 158	23	5,890	- 379
Wrexham	,, 8	145	+ 52	23	2,220	...
Yorkshire W.R. Trams	,, 17	768	- 595	24	18,733	...
Yorkshire Woollen District	,, 8	1,344	+ 661	23	19,847	+ 6,287

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., June 20.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 20. Highest.	Business, Week to June 20. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	6⅞—7⅛	5 12 0	Ap, Oct	7 1/16	6 29/32
5	2/9	Do. 5½% Cum. Pref.	5⅞—6⅛	4 10 0	—	6	5 15/16
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	140½	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	105¾	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	1 11/16	1 23/32
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—4½	5 11 0	—	4 13/32	4⅜
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	97 —100	4 10 0	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115 —118	5 1 6	—	..	..
St.	5%	Do. Pref. Ord. Stk	107 —110	4 11 0	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	108⅛	108½
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	8 5/16—8 9/16	4 18 0	—	8½	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5⅝—5⅞	5 2 6	—	5 11/16	..
5	8/0	Do. "B"	5 —5½	5 7 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	103 —106	4 14 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	102 —104	4 16 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	103 —107	5 3 0	..	105	—
100	6%	Do. 6% 1st Deb. Bonds	101 —106	5 13 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8⅝—9⅛	4 7 8	—	8 13/16	..
5	2/6	Do. Nos. 105,001 to 137,610	8¼—8¾	4 11 6	—	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	106 —108	4 3 8	—	..	..
1	0/6	Cape Electric Tram Shares	½—¾	6 13 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	97 —99%	5 1 0	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	94 —98	..	..	..	..
St.	..	Do. 6% "B" Ditto	90 —95	..	..	..	..
1	1/0	†Lisbon Elec. Trams Ord.	1⅜—1 9/16	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102 — 105	4 15 0	Ja, Jul	101½	.
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	107 —109	5 11 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	144 —147	..	..	145½	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	-	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	.	..
5	5/1	Calcutta Elec. (1-80,000)	8⅝ 8⅞	4 16 0	—	[illegible]	..
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbr.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½ - 3	..	..	..	—
St.	5%	Do. 5% Debs.	87 —91	5 10 0	—	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113 —116	5 6 0	..	115	114¼
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞—1	6 0 0	—	31/32	..
1	1/6	Rand Electric	1 3/16—1 5/16	—	—	..	..
1	..	River Plate Electricity Co. Ord.	7/16 - 9/16	..	..	..	..
1	1/2⅝	Do. 6% Non. Cum. Pref.	⅞ - 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4 17 0	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb.	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 —103	4 17 0	..	102	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., June 20.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to June 20. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11 –12	5 16 8	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 8	..	..	..
10	8/0	Do. 8% Cum. Second Pref.	11 –12	5 0 0	..	.	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –108	4 8 3	..	.	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	5⅞–6⅛	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 8	—	.	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 –9	5 11 8	—	..	..
5	3/6	Do. 7 per Cent. Pref.	7¾–8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 – 5	5 0 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅝– 4⅞	4 12 6	Feb, Aug	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	100 –103	3 17 6	—	—	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3⅞– 4⅛	5 2 6	—	4 3/16	..
5	2/3	Do. Do. (1903)	3⅞– 4⅛	5 2 6	..	4 3/16	..
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108 –110	4 2 0	Jn, Dec ..	..	—
10	7/0	City of London Electric Lighting Ord.	10½–11¼	5 0 8	Feb, Aug	..	..
10	8/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –128	3 19 4	Jn, Dec ..	125	122½
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 8 0	..	..	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	3 –3 1/32	4 0 0	April, Oct	—	..
5	5%	Do. Do. 5% non cum. pref.	5¼–5⅝	4 15 3	April, Oct	..	..
10	8/0	County of London Elec. Supply Ord.	8 –9	5 11 0	—	..	..
10	8/0	Do. 8 per Cent. Cum. Pref.	11¼–12¼	4 18 0	Mar, Sept	12	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109 –112	4 0 4	..	110¼	109¾
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	8/8	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	..	..
5	2/8	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 8	—	..	..
5	5/0	Hove Electric Lighting Ord.	8 –8½	5 8 0	—	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 –11	4 11 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	—	..	..
3	2/4½	London Electric Supply Ord.	2 –2½	4 0 0	—	..	..
5	8/0	Do. 8 per Cent. Pref.	5 –5½	5 7 0	—	5 7/32	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	97 –100	4 0 0	Mr, Jn, S, D	99	98½
5	10%	Metropolitan Electric Sup. Ord.	8 –9	5 11 0	April, Oct	8½	8⅜
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	Jan. July	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110 –114	3 19 0	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 3	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	100 –103%	4 7 4	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12 – 12½	5 11 1	Feb, Aug	12½	12⅛
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾–7⅞	5 2 6	Feb, Aug	8	7⅞
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞– 6	4 1 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	..
1	8%	Northern Counties Elec. Sup.	1 3/32–1⅛	2 13 3	Mar, Aug	1⅛	1 3/32
100	4½%	Do. 4½% Deb.	101 –102	4 8 9	Jan, July	—	—
10	9/0	Notting Hill Electric Ord.	13 –14	3 8 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅜– 6⅞	4 17 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99 –101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½– 11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96 –98	3 12 0	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼– 2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	78 –80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 8 0	..	..	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾– ⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1 3/16–1 5/16	5 9 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105 –106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3 - 3½	8 8 8	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100 –102	4 8 0	..	101	..
5	6/6	Westminster Elec. Sup. Ord.	10¾– 11¼	5 15 6	Mar, Sept	11⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16– 5 9/16	4 10 0	..	5½	5⅜
5	..	Do. Issued at 7/6 premium all paid	5 5/16– 5 9/16	..	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	94 –96	4 3 4	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16– 1 1/32	4 14 0	..	31/32	..
1	0/3	Do. 5% Cum. Pref.	31/32– 1 3/32	4 11 8	..	1 1/32	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 –104	4 6 6	—	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	100 –102	4 8 0	..	101	..
10	8½%	Bristol Tramways and Carriage Ord.	15¼–15¾	5 8 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 –10¼	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	103 –105	3 16 0	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	5⅞– 6⅜	4 14 0	—	6¾	6 1/16
10	6/0	Do. 6 per Cent. Cum. Pref.	9⅜– 9⅝	6 4 0	Feb, Aug	9 11/16	9¼
St.	5%	Do. 5 per Cent. Perpetual Debs	112 –115	4 7	..	114	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93 –95	4 14 9	..	..	..
St.	4%	Central London Ordinary Stock	84 –87	4 12 0	June, Dec	87	84¾
St.	4%	Do. 4 per Cent. Pref. Stock	99 –101	3 19 0	..	100¼	..
St.	4%	Do. Deferred Stock	74 –77	5 4 0	..	..	—
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 3	..	111¾	..
St.	4%	Charing X, Euston & Hmpstd. Per. Db. Stk.	91 –93	4 3 0	..	91	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞– 5⅛	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	40 –42	4 9 0	Feb, Aug	40⅞	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	114 –117	4 5 3	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1898) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½–15½	3 17 3	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾–4¼	9 8 0	..	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	12 –12½	4 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	105½–106½	4 4 6	Jan, July	..	..
5	2/8	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80 –85	4 14 0	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16– 8 15/16	8 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 – 102	3 19 8	Jan, July	..	.
10	5/0	London United Trams. 5% Cum. Pref.	8½–9½	5 5 0	—	8 15/16	8 13/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	96 –99	4 1 0	—	97½	..
St.	..	Mersey Con. Ord. Stock	4 –6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	—	⅛	..
1	0/3	Do. 5% Cum. Pref.	⅞–1	5 0 0	—	15/16	..
St.	4½%	Do. 4½% Deb. Stock	102 –104	4 6 6	—	103	..
5	—	New Gen. Tract. 3 per Cent. Cum. Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7 – 8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾–8¼	5 14 0	Feb, Aug	8 7/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 8	—	101¾	101½
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	96 –98	5 4 0	—	..	..
..	5%	Und. El. Rys. Co. of Lond. with Coup. No. 7	94 - 95	5 4 0	..	94¾	94⅜
St.	3½%	Waterloo and City Ord.	100 –103	3 3 0	June, Dec	100¼	100⅛
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	95 –97	4 13 0	..	..	..

Shre.	Last Dividend	Name.	Price Wed., June 20.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 20. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½– ⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	3⅞–4⅛	4 17 0	..	4⅛	3⅞
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6¾–7	5 14 0	July, Feb	6 17/32	..
5	3/0	Do. 6 per Cent. Pref.	6½–6¾	4 16 0	Jan, July	8	6 27/32
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104 –107	4 4 0	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1 –1½	..	..	1¾	1⅛
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80 –85	4 14 0	..	80	79½
1	1/0	Brush Electrical Engineering	⅝– ⅞	—	March	11/16	..
2	2/4½	Do. 3 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	1⅞	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 1 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	84 – 86	5 4 8	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	10⅝	..
5	2/3	Do. 5 per Cent. Cum. Pref.	7¾– 8	4 8 4	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	109 –111	4 1 0	Nov, May	..	..
1	1⅞d.	Castner-Kellner Alkali Co.	1 1/16–1 3/16	5 1 6	..	1 3/32	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	—	100	..
1	9⅜d.	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	—	1 5/16	—
1	7½d.	Do 8% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	—
3	1/8	Crompton and Co. (Nos. 1 to 54,000)	1⅞–2⅛	3 7 6	Jan, July	1⅞	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%– 99 %	5 1 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1¾–1⅞	5 8 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104 –107	4 5 0	..	..	—
5	1/8	Edison & Swan United ("A" Sh.)(£3 pd.)	1½–1¾	—	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½– 3	—	Feb, Aug	1⅝	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 – 88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	—	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾– 4¼	3 4 6	H'lf-yearly	4	..
5	3/0	Do. 3 per Cent. Cum. Pref.	4½– 5	3 0 0	..	4¼	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –108	4 5 0	..	104	..
2	1/7½	Electric Construction Co.	⅝– ⅝	11 4 0	July	½	..
2	2/9⅝	Do. 7 per Cent. Cum. Pref	2 –2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	88 –91	4 8 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9¼–9¾	5 2 8	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 – 97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 – 13	5 15 0	Feb, Aug	12	—
5	9/8	Do. 4½ per Cent. Pref.	5¼– 5½	4 1 6	Feb, Aug	5½	—
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 8	..	..	..
St.	22/8	Do. Do. Scrip (all paid)	107 –109	4 2 8	..	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wks.	17 –18	2 17 2	Feb, Aug	17 13/16	17½
100	..	Do. 4% Debs. Red.	99½–101½	..	..	101	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	—
1	1/2⅞	Richardsons, Westgarth & Co., Ltd. Ord.	29/32– 31/32	3 4 0	..	31/32	15/16
1	7½d.	Do. 6% Cum. Pref.	⅞–1	6 0 0	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	97 –100	4 10 0	..	..	..
12	24/0	Telegraph Construction & Mainten'ce.	32 – 34	5 6 0	Mar, July	33⅜	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102 – 104	3 17 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16– 2 9/16	5 15 0	..	2 17/32	2 15/32
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1¼	4 0 0	..	1 5/32	..
St.	5%	Do. 5% Non-Cum. Preferred	114 –117	4 5 4	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 –105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	104 –108	4 5 0	..	106	105¾
5	—	Willans and Robinson Ord.	1¼ –1¾	—	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾ 3¼	—	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	78 –83	4 16 8	May Nov	..	..
		TELEGRAPHS.					
100	4%	*African Direct Tel. 4% Mrt. Deb. (red.)	99 –102	3 18 0	Jan, July	..	..
10	—	Amazon Telegraph	8 –8½	—	Jn, Dec.	..	..
100	5%	Do. 5% Debs. (red.)	83 –88	..	..	..	..
St.	15/0	Anglo-American	87 –89	4 14 0	F, My, Ag, N	87½	87
St.	10/0	Do. Preferred	113 –114	5 3 0	F, My, Ag, N	113½	113
St.	10/0	Do. Deferred	20⅞–21⅛	..	F, My Ag, N	20 15/16	20¾
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–99½	4 0 6	Jn Ap, Jy, O	99½	99
10	5/0	Cuba Submarine Ord.	8½–9	3 1 0	Feb, Aug	..	—
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	..
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	100%–103%	4 7 8	Jan, July	..	..
20	4/0	Direct United States Cable.	10½–11	4 13 9	Ja, Ap, Jy, O	10⅞	10 11/16
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101 –108	4 7 6	Jn, Dec ..	..	..
St.	21/0	Eastern Ordinary	143 –146	4 18 6	Ja, Ap, Jy, O	145½	144½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 16 0	Ja, Ap, Jy, O	90½	90¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108½	108½
10	6/6	Eastern Extension	14 –14½	4 16 6	Ja, Ap, Jy, O	14⅜	14⅛
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 4	Feb, Aug	107½	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	100 –102	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) with coupon 67	39 – 41	5 17 0	Jan, July	41	39⅞
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101 –108	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57 –59	5 10 0	May, Nov	..	..
100	4%	Mackay Companies Common	76 11/16–77 3/16	5 3 0	Jan, July	—	..
100	4%	Do. Preference	75 15/16–76 1/16	5 5 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1 –1¼	..	..	1 1/16	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	101 –104	3 17 0	June, Dec	..	..
10	4/0	† West African Telegraph Shares	9½–10	5 0 0	..	..	..
2½		West Coast of America	¾– ⅞	..	—	¾	..
100	4%	Do. 4 per Cent. Debs.	101 –104	3 17 0	Jan, July	..	..
10	—	West India and Panama	7/16– 9/16	..	May, Nov	7/16	..
10	4/0	Do. 6% 1st Pref.	6 –7	8 11 4	May, Nov	6⅝	6½
10	—	Do. 3 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101 –104	4 16 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14⅝	14 7/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101 –103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104 –107	3 14 9	..	108	..
		TELEPHONES					
—	..	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	96 –98	..	..	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	8/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August	..	..
1	0/4	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	—	—	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 –112	5 7 0	—	111⅜	111⅛
St.	5%	Do. Def. Stock	108 –110	4 11 0	—	109	108½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 6	Feb, Aug	13½	13¼
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	11⅜	—
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	5⅝	5½
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	99½	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103½–105½	3 18 0	—	104½	..
1	0/9⅜	Oriental	1 1/16–1 3/16	4 8 8	April, Oct	1⅛	..
1	0/7½	Do. 8 per Cent. Cum. Pref.	1¼–1⅜	4 7 0	—	1¼	..
St.	24/7⅝	Do. 4% Red. Deb. Stock	99 –101	3 10 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	108 –100	4 4 9	..	104¾	..
5	8/0	United River Plate	7 –7½	5 8 8	July	7 5/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅞–6⅛	4 0 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110 – 113	4 8 4	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾– 5¼	5 14 0	..	..	..
10	5/0	Globe Telegraph and Trust	10⅞–11⅛	4 19 0	Ja Ap, Jy O	11	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅝–14⅞	4 0 6	Ja Ap, Jy, O	14⅞	14⅝
10	6%	Submarine Cables Trust (Cert.)	127 –130	4 12 8	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

AS reported elsewhere in this issue, the decision of the Hybrid Committee of the House of Commons to reject the London County Council Electric Supply Bill was made public yesterday afternoon. In making the announcement, the Chairman referred to the report on the subject which was presented to the House last night, without a full consideration of which it is impossible to duly appreciate all the causes which led up to the decision of the Committee.

AN enthusiastic reception has been given to the members of foreign electro-technical societies who have visited this country on the invitation of the Institution of Electrical Engineers. About 500 guests assembled to meet them at the Hotel Cecil on Monday, and the expressions of goodwill between the British and foreign electrical engineers were of extreme cordiality on both sides. The presentation by the Italian members of a fine bronze bust of VOLTA will be appreciated by every member of our Institution, and the gift will cement still closer the bonds of friendship which exist between the electrical brotherhoods in Italy and Great Britain.

THE visitors started their programme by attending the formal opening of the new buildings of the National Physical Laboratory on Monday, and the real work began on Tuesday morning, when visits were paid to the Lot's-road, Greenwich, Bow-road and Shepherd's Bush power houses and to see the telegraph and telephone work of the Post Office and National Telephone Co. This necessitated the division of the party into five groups, so that comparisons could not be made between the various works, but our guests have much ground to cover and have also to find time for social functions, for they include several ladies. Luncheons were partaken of at Greenwich and Earl's Court Exhibition, and afterwards a party visited the Brook Green lamp works, while others preferred sight-seeing in London. On Wednesday a trip was made up the river to Windsor, and yesterday the provincial tour began, when both Rugby and Birmingham were visited on the way to Manchester.

CONTEMPORANEOUSLY with the visit, the first meetings of the International Congress on Standardisation of Units, Nomenclature and Rating are being held in London, and delegates from the United States, Austria, Belgium, Canada, France, Germany, Holland, Hungary, Italy, Japan and Switzerland are taking part in it. The meeting is under the presidency of Col. CROMPTON, and no better occasion could have been chosen for it. So far the proceedings have been *in camera*, but we hope that we may be enabled in due course to publish the results of the Commission's deliberations.

WE are glad to see from the reply of Mr. LOUGH, speaking for Mr. BIRRELL, to a question in the House of Commons on Tuesday, that the establishment of a Technological Institution at South Kensington, on the lines recommended in the report of the recent Departmental Committee on the Royal College of Science and School of Mines, is not to be delayed pending a complete settlement of the vexed question of exact relationship of the new organisation to the University of London. As we pointed out in a leading article at the time the report was issued, it is of paramount importance that the scheme should be got under weigh as soon as possible, and the commencement of its activity should not be set back by the delays incidental to the appointment and deliberations of a Royal Commission.

THE first portion of the inquest on the three victims of the unfortunate tramway accident at Archway-road, Highgate, on Saturday last, was held on Tuesday. The circumstances of the occurrence are fully set forth in our report of the inquest in another column. The only matter that requires elucidation is, of course, the actual reason why the driver did not succeed in checking the speed of the car on the incline, and whether it was due to a mechanical defect in the brake equipments or to faulty manipulation. It is, of course, impossible to speak with any certainty as to the technical aspects of the case until Col. YORKE's inquiry on behalf of the Board of Trade has been concluded, but from such evidence as has been given at the inquest it would appear that from some cause or other the wheels began to skid and prevented the track brake from coming into action, while the greasy nature of the rails rendered it impossible to moderate the speed with the wheels locked. Whether this skidding of the wheels was caused by an error of judgment, as suggested by Mr. POTT, the chief engineer to the tramway company, or to a defect in the hand-brake gear, as might be gathered from some of the driver's statements, can only be decided after careful inquiry. As will be seen from our Parliamentary Intelligence columns, several questions have been asked in the House of Commons relating to this and the Swindon accident, to which Mr. LLOYD GEORGE will reserve his complete replies until the conclusion of the Board of Trade inquiry.

* * *

The Institution of Civil Engineers.—The annual Conversazione of the Institution of Civil Engineers, which was, as usual, divided over two evenings, concluded last night at the Institution in Great George-street. A number of the foreign visitors of the Institution of Electrical Engineers accepted Sir Alexander Binnie's and the Council's invitation to be present on the first of the two evenings.

Wireless Telegraph Notes.—The *Birmingham Post* states that reports are to be prepared at the German Embassy in London and forwarded to Berlin upon the utilisation of wireless telegraphy, not only for general commercial purposes, but also for use between the shore and lightships and for railway purposes. The German Government propose to deal with a German system of wireless telegraphy for all internal purposes.

Telephone Interruption at Liverpool.—A somewhat curious accident to the telephone system between Liverpool, Bootle and Warrington is reported in the *Liverpool Courier*. It appears that a subsidence of earth took place last week in Great Howard-street with the result that the pipe containing the National Telephone Co.'s main junction lines came into contact with the electric light mains causing a short circuit which burned through the pipes and fused the telephone cables. Altogether 612 wires were affected. The work of renewing the cables is progressing rapidly.

The Faraday Society.—The special meeting of the Faraday Society, to which the public is invited, will be held on Monday, July 2nd, at the Society of Arts, at 8 p.m., when Prof. Kr. Birkeland, of Christiania, who is at present on a visit to England, will read a Paper on "The Oxidation of Atmospheric Nitrogen in Electric Arcs." At the same meeting Mr. F. W. Harbord will communicate a Paper written by Dr. Eugen Haanel, of Ottawa, describing the recent experiments on electric iron and steel smelting that were made at Sault Ste. Marie on behalf of the Canadian Government.

Conversazione of the Institution of Electrical Engineers.—The annual Conversazione of the Institution of Electrical Engineers was held at the Natural History Museum, South Kensington, on Tuesday last. A large number of distinguished guests were present, including most of the foreign visitors to the Institution, who were received by the president, Mr. J. Gavey, and Mrs. Gavey, the president-elect, Dr. R. T. Glazebrook, and Mrs. Glazebrook, and the Council of the Institution. The musical attractions included the string band of the Royal Engineers, who performed in the Central Hall, and the Leoni Ladies' Quintette, who gave a selection of music in the Reptilia Gallery.

The Iron and Steel Institute.—At the joint meeting of the American Institute of Mining Engineers and the Iron and Steel Institute, which will commence in London on July 24th, a number of interesting Papers will be read, amongst which will be the following :—

"Belgian Practice in Large Gas Engines," by Prof. H. Hubert (Liège); "Electric Steel Smelting," by E. C. Ibbotson; "German Practice in Large Gas Engines," by K. Reinhart (Dortmund); and "British Practice in Large Gas Engines," by T. Westgarth.

A number of visits to works and places of engineering interest have been arranged, and the guests will visit Windsor, where a deputation will be received by the King. The London meeting will be followed by a provincial tour.

Electrical Equipment in a Cornish Mine.—The Tywarnhaile Mine, the unwatering of which commenced this month, is, according to the *Cornish Post*, the first mine in Cornwall to be equipped electrically. The generating plant consists of three 90 kw. alternators driven by Westinghouse gas engines, which draw their gas from three Dowson suction gas producers. A Worthington two-stage motor-driven pump, having a capacity of 1,000 gallons of water per minute against a head of 215 ft., has been installed in "Taylor's" shaft, and during the past fortnight the water level has been lowered through a vertical depth of 60 ft. A motor-driven capstan is used for raising and lowering the pump in the shaft, and several other applications of electrical power are contemplated.

Electrical Equipment of the Port of Amsterdam.—The supply of current for power and lighting purposes at the Amsterdam docks is obtained from the municipal generating station. According to *l'Eclairage Electrique*, the arc lighting is worked from a three-phase circuit through transformers, and continuous current is distributed for power purposes. A number of alternating 8-ampere flame arcs are used, in addition to ordinary 9-ampere lamps respectively, two and three in series on 110 volts. In order to reduce the consumption of current auto-transformers are provided, by means of which it is possible to run single lamps when required. These are contained in cast-iron boxes, together with the series resistances, fuses and a special switch of the controller type. The switch has three positions, one placing a single lamp in circuit with the auto-transformer, another lighting up the three lamps all in series, and the third forming an off position for extinguishing all the lamps of the series. The power equipment comprises four traversing tables, a pumping plant for working some hydraulic appliances, and a number of electric cranes.

Chambers of Commerce of the Empire.—The sixth annual congress of the Chambers of Commerce of the Empire will be held in the hall of the Worshipful Company of Grocers, Princes-street, London, E.C., on July 10th, 11th, 12th and 13th. Amongst the resolutions which will be discussed may be noted the following: The Montreal Board of Trade will move that the Imperial Government be asked to devise means whereby cable and telegraph news to and from all parts of the British Empire shall be furnished entirely through Imperial channels. The Chamber of Commerce of the City of Georgetown, Demerara, will propose a resolution having regard to the constant interruption of cable communication with the West Indian colonies, that the Imperial Government be asked to assist the colonies in providing an all-British cable to the West Indian colonies through Canada. Resolutions will also be submitted by various colonial Chambers of Commerce urging the necessity of adopting the metric system of weights and measures at the earliest possible date. The Canadian Manufacturers' Association will recommend that immediate steps be taken, through a joint conference of Government representatives, to establish within the Empire uniform and equitable laws respecting patents and copyright. The conference, which is held triennially, will be opened by Lord Elgin, Secretary of State for the Colonies, at 10 a.m. on Tuesday, July 10th. Mr. T. F. Blackwell, President of the London Chamber of Commerce, will preside during the Conference.

The Electrolytic Deposition of Nickel upon Nickel.—It is a well-known fact to all those engaged in the electroplating industry that it is not possible to deposit a fresh coating of nickel upon a surface which has already been nickel-plated, as the nickel invariably scales off immediately in the form of fine rolls or shavings. At the last meeting of the American Electrochemical Society, Mr. Ralph Snowdon describes a method for getting over this difficulty, and a process which, if found generally useful, will be one of great importance to the electroplating industry. According to Bancroft it is not possible by mechanical means to clean a nickel surface thoroughly, but, as is the case with aluminium invariably, a thin oxide skin remains behind, or, in other words, the nickel is passive. If, however, the nickel is polarised by making it the cathode for a few minutes, and is then quickly put into the plating bath, there is no difficulty in obtaining a fine and adhering coat of nickel upon its surface. The solution employed in the polarising bath was a three normal solution of hydrochloric acid (about 11 per cent. of acid) and a current of 8 amperes per square decimetre was passed for four minutes. The electrodes were then rapidly dipped into clean water, and then in the plating bath, containing 80 grammes of nickel ammonium sulphate to the litre. For plating, a current of 2 amperes per square decimetre at 3·8 volts was employed, the temperature of the solution being 18 deg. By this means a beautiful deposit was obtained, which was perfectly firm and adherent. Parallel experiments were tried with nickel cleaned by mechanical means but not polarised, and it was found impossible to deposit adherent coatings, as after a few minutes the new metal invariably exfoliated.

The Arc Works, Chelmsford.—The annual inspection of Messrs. Crompton's works at Chelmsford took place on Saturday and was followed by a luncheon and the annual athletic race meeting of the Arc Works Club. A large party went down from London. The works showed signs of great activity, and the large number of searchlights under construction was very noticeable, particularly those with electrical control.

At the luncheon, which was served in the workmen's mess room, reference was given to the efforts by the company in providing for the comfort of their workpeople, and to the relationship existing between the company and its employés. Mr. Mill Holland, who replied to the toast of the visitors, said that very few realised how valuable were the suggestions which Col. Crompton dropped at the infrequent visits which he had made to the United States, and he thought he might claim that although Americans were never slow in taking up the ideas of "the other fellow," yet if these ideas ever came back to England they were usually dressed up tolerably respectably. Referring to the arrangements made by Messrs. Crompton for the comfort and convenience of their employés, he said that for 25 years in the whole of Pittsburg there were no such facilities and the vast improvements in this respect now to be witnessed were due to a visit to the States by a Royal Commission from Great Britain, one of whose members, Sir William Mather, went to Pittsburg and pointed out to Mr. Carnegie the extraordinary lack of such facilities.

Col. Crompton said that one of the happiest things of the time was the relationship between the United States of America and Great Britain. We did not mind them taking our ideas, for we did sometimes borrow things from America ourselves. As an engineer, however, he did not think we had so much to learn from America as the daily papers would have us believe. He was able to make an important announcement. When he was in America two years ago it was decided that the electrical engineers of the world should attempt to form themselves into one nation for the purpose of standardising the units and expressions used in electrical engineering. Hitherto no permanent committee or tribunal had existed. At St. Louis the idea of an international commission was taken up, and correspondence had been carried on ever since with that object in view. Such an international commission had at last been formed, and the first meeting would be held in London on June 26th. As an answer to papers like the *Daily Telegraph* he would like to point out that England was the country, English was the language and London was the place of meeting of this international commission. The daily papers had not yet found it out because it had been kept dark, but probably a good many people would be surprised that England had, after all, stayed at the top of the electrical profession.

The sports were held in the afternoon in perfect weather and in the presence of a large number of spectators. A most enjoyable time was spent by the visitors, Messrs. Crompton having made very complete arrangements for their comfort both on the railway journey and during their stay in Chelmsford.

An Electric Test Car.—The engineering department of the University of Illinois has recently added a complete railway car to its experimental equipment which is being used for making various tests on the Illinois traction system. The car, which is described in the *Street Railway Journal*, is of the ordinary "interurban" type as used in the United States, 34 ft. long, but the interior is divided into two compartments, one of which is furnished with a desk and other office furniture, while the other contains an instrument table and some of the electric control apparatus which would usually be placed under the car. The equipment comprises two 40 H.P. motors controlled by the Westinghouse unit switch system. The switch group, circuit breaker, reverser, limit switch and line relay are hung in the smaller compartment for the purpose of observation under running conditions. The instrument equipment consists of an integrating wattmeter for measuring the total power supplied to the motors, an integrating wattmeter for measuring the power supplied to the compressor motor, a recording ammeter in the motor circuit, and a recording voltmeter which can either be used to record the trolley voltage or plugged on to either motor armature of field. Switches are also arranged so that an ammeter can at any time be inserted at either motor circuit. In addition to a mechanical speed and mileage indicator, the speed is also indicated electrically. This is accomplished by having a ½ kw. 10 volt generator driven from the axle by a chain drive and separately excited by means of a storage battery. In the generator armature circuit is connected a resistance coil of about 1 ohm resistance in series with the low-tension coil of a 1 kw. transformer, ratio 20 : 1, and a low-range ammeter. This ammeter has been carefully calibrated and a curve plotted which gives the miles per hour for all currents. The high-tension coil of the transformer is connected to a low-range voltmeter with a zero centre scale. This voltmeter has been calibrated for acceleration and gives excellent results. Both the speed and acceleration are recorded by means of pointers which are moved by hand and made to follow the movements of the needles, the pointers being connected by a small steel wire to pens on the recording tables. Pens time every five seconds and every fourth revolution of the axle, while another pen is operated from push buttons and is used to indicate special points, such as stations, &c. To obtain the degree of curvature on the curves a small drum has been bolted to each bolster, and these drums have been arranged to rotate with any relative motion between the car body and the trucks. These drums are connected by means of a small steel wire to pens on the recording table, and records of curves are automatically obtained.

ARRANGEMENTS FOR THE WEEK.

(To-day) **FRIDAY, June 29th.**

Institution of Electrical Engineers.
Foreign Visitors at Manchester.

SATURDAY, June 30th.

Institution of Electrical Engineers.
Foreign Visitors at Liverpool.

MONDAY, July 2nd.

Institution of Electrical Engineers.
Foreign Visitors at Glasgow.

Faraday Society.

8 p.m. Ordinary Meeting at the Society of Arts, John-street, Adelphi, W.C., when the following Papers will be read: (1) "The Oxidation of Atmospheric Nitrogen in Electric Arcs," by Prof. Kr. Birkeland; (2) "Preliminary Report on the Experiments made at Sault Ste. Marie on the Smelting of Canadian Iron Ores by the Electro-Thermic Process," by Eugene Haanel, Ph.D., to be communicated by Mr. F. W. Harbord, F.I.C.; (3) "Electrolysis of Dilute Solutions of Acids and Alkalis at Low Potentials: Dissolving of Platinum at the Anode by a Direct Current," by George Senter, Ph.D.

TUESDAY, July 3rd.

Institution of Electrical Engineers.
Foreign Visitors at Renfrew.

WEDNESDAY, July 4th.

Institution of Electrical Engineers.
Foreign Visitors at Edinburgh.

THURSDAY, July 5th.

Institution of Electrical Engineers.
Foreign Visitors at Newcastle-on-Tyne.

FRIDAY, July 6th.

Institution of Electrical Engineers.
Foreign Visitors at Leeds.

Finsbury Technical College Old Students' Association.

7 p.m. General Meeting at Finsbury Technical College, Leonard-street, London, E.C.

SATURDAY, July 7th.

Institution of Electrical Engineers.
Foreign Visitors at Leeds.

THE ELECTRICAL EQUIPMENT OF THE GREAT WESTERN RAILWAY.

(Concluded from page 364.)

Sub-station Plant.—The three sub-stations are designed on exactly the same lines, although they are of different lengths to suit the number of motor generators installed. A plan of the Shepherd's Bush sub-station is given in Fig. 3. Each sub station consists of three bays. The centre bay is for the motor generators, over which is a travelling crane. One side bay contains the H.T. switchboard and the other the L.T. switchboards. In this way the sub-station can be extended, the switchboards growing as additional motor generators are put in. The incoming H.T. feeders are carried directly to the H.T. board, which is generally similar to the Park Royal board already described. It is fitted with duplicate 'bus bars, and sectionalising switches to facilitate cleaning. The feeders are connected to the bars in the centre of the board with the motor generators at one end and the branch circuits, or feeders, to the H.T. distributing centres at the other end. All the H.T. boards at the sub-stations were supplied by the British Thomson-Houston Co. The L.T. switchboards, which are placed exactly opposite the H.T. boards, are separated, so that all switch gear and instruments for controlling the supply to the Hammersmith & City Railway are on the traction board, and the D.C. supply for arc lighting is controlled by a separate lighting board. Both these boards are of the usual type with single 'bus bars.

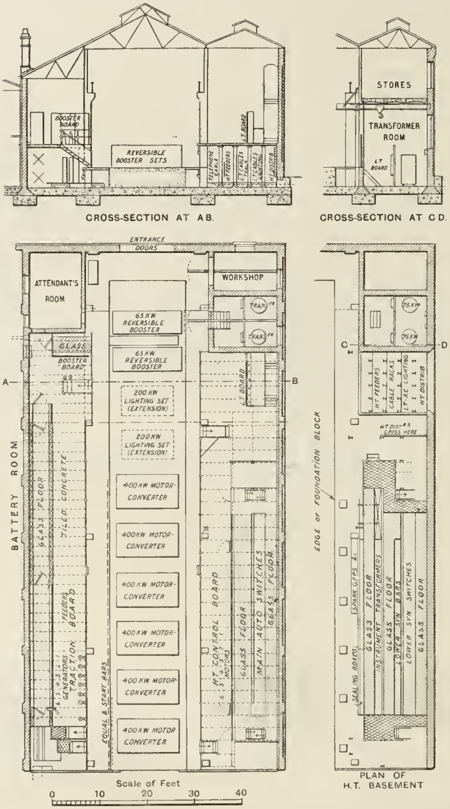

Fig. 3.—General Arrangement of Shepherd's Bush Sub-station.

One point of special interest is the use of large batteries at Shepherd's Bush and Royal Oak which will be worked in parallel with the motor generators on the traction board supplying the railway. The batteries are of the Tudor Company's make, that at Royal Oak having a capacity of 840 amperes for one hour, and that at Shepherd's Bush 1,680 amperes for one hour. Each battery is connected to the traction board through a Highfield automatic reversible booster. The batteries are intended primarily to equalise the load on the motor generators by taking the peaks when trains are starting, &c. It is, however, further intended to use the batteries in case of emergency for maintaining both the A.C. and D.C. lighting supply. This will be done by connecting the battery when required directly to the D.C. lighting board, and also by using it to run the motor generators inverted should the H.T. supply from Park Royal be at any time cut off. The motor generators would in this case take current from the battery on the D.C. side and deliver alternating high-tension current on the A.C. side to the H.T. switchboard, from which it would be transmitted as before to the distributing centres, where it is transformed down and used for incandescent and arc lighting. Under these conditions the drain on the battery might be too great, and it is therefore arranged that the supply to the railway is automatically cut off entirely should the current from the battery exceed a pre-determined amount. In this way the battery would be able to maintain the lighting supply to Paddington and the other railway stations and goods yards until the supply from Park Royal was restored. A short interruption to the running of the Hammersmith & City line would be a small matter compared to the extinction of the whole of the lights. The L.T. switchboards and Highfield boosters at the sub-stations have been supplied and erected by the Electric Construction Co.

The motor generators are of the La Cour Motor Converter type, built by Messrs. Bruce Peebles.* There are seven 400 kw. sets at Shepherd's Bush, four 400 kw. and two 200 kw. sets at Royal Oak, and one 400 kw. and two 200 kw. sets at Old Oak Common sub-station. The chief peculiarity of these machines is that they can be started on the H.T. side exactly as if they were induction motor generators, but they are capable of being inverted and generating A.C. current exactly as if they were synchronous motor generators. This peculiarity is of special advantage in the present instance where batteries are being used as a stand-by for maintaining the A.C. current lighting supply.

There are in all some 11 distributing centres supplied at 6,500 volts, three-phase, from the sub-stations. Each consists of a small brick room or chamber measuring about 20 ft. by 12 ft. by 9 ft. high. Two H.T. feeders enter each distributing centre. Each feeder is connected through a hand-operated oil-break switch to the primary windings of a group of three single-phase step-down transformers. The three transformers of each set are connected in delta both on the primary and secondary sides. The secondaries from each set are taken to an L.T. automatic switch which connects them to a set of L.T. 'bus bars. The two groups of transformers in each distributing centre are therefore only connected in parallel on the L.T. side. The ratio of transformation is from 6,500 to 110 or 220 volts, according to the pressure required for the incandescent lighting. The two pressures are required to suit the wiring of the buildings which has been done at different times. Gradually the whole of the wiring and lamps are being changed over to work at 220 volts.

The size of transformer used at the different distributing centres is chosen to suit the demand, each set of three transformers being of sufficient capacity to supply the maximum demand. The second set of transformers is provided as a stand-by. In order to avoid the expense of keeping a man at each distributing centre to change over from one set of transformers to the other in case of failure or other trouble, it is intended to control the whole of the distributing centres from one or other of the three sub-stations. This is accomplished in the following way: The two feeders carried from the sub-station to the distributing centre are connected independently one to each group of transformers, and the primaries of each group can therefore be switched on and off at the sub-station. At the sub-station end the feeders are always worked off the same 'bus bars, and the primaries and secondaries of the transformers must, therefore, always be in phase at the distributing centres. There is, therefore, no difficulty in paralleling at the distributing centre by means of an automatic cut-in switch between the transformers and the L.T. 'bus bars on the secondary side. As soon as one set of transformers is energised from the sub-station, the automatic switch is closed on the L.T. side by a solenoid supplied from the transformers themselves. As soon as the switch is closed, the solenoid is cut out of circuit and the L.T. switch held closed by a catch. The catch is tripped by a no-voltage coil, so that when the supply to the set of transformers is cut off at the sub-station and the transformer dies out the automatic switch is tripped. When the two sets of transformers have been switched into parallel, opening the switch at the sub-station in the primary circuit of one will not disconnect it at the distributing centre, because the secondary winding will be kept energised from the L.T. 'bus bars, so that the no-voltage coil does not come into action to trip the automatic switch. In order to overcome this difficulty, a discriminating transformer of Mr. Andrew's design and supplied by Messrs. Cowans is connected, so that when only one set of transformers is delivering power to the 'bus bars a relay circuit is brought into action which short circuits the tripping coil of the L.T. automatic switch of the other or idle transformers, and so disconnects them. With this arrangement it will be seen that it is possible to switch in or out from the sub-station either set of transformers in any order, paralleling them when required for changing over or for taking the peak load.

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* For a further description of this type of machine see *The Electrician*, Vol. LVI., p. 256.

The lighting and power circuits at Park Royal and sub-stations were installed by Messrs. the Westminster Engineering Co., and the telephone swithboards and instruments with which the stations are equipped, were supplied by the Sterling Telephone & Electric Co.

The buildings for the generating station and sub-stations were provided under the supervision of Mr. W. Y. Armstrong, the company's new works engineer. The whole of the rest of the work described above was carried out to specifications prepared by Messrs. Kennedy & Jenkin, consulting engineers to the Great Western Railway Co.

The extent of the line which has been electrified, and which obtains power from the Park Royal generating station, includes the Hammersmith and City line proper, and the Great Western additional lines between Bishop's-road and Westbourne Park and the branch line from Latimer-road to Uxbridge-road, as shown by the map in our last issue. From Uxbridge-road to Addison-road the trains run over the West London line, a portion of which has, in consequence, had to be electrified, together with two bays at Addison-road station.

The system adopted had to be the same as that already in use on the Metropolitan and Metropolitan District Railways, as the Hammersmith and City trains run over the Metropolitan Company's lines from Bishop's-road by the Inner Circle to Aldgate. There are two insulated conductor rails, the positions of which correspond exactly with those adopted on the Metropolitan and District lines, the positive being 3 in. above rail level and 16 in. outside the running rail, and the negative conductor being 1½ in. above rail level, and in the centre of the track. The two conductor rails are of an inverted channel section, resting on iron-capped porcelain insulators supplied by Messrs. Doulton & Co., as shown in Figs. 4 and 5. The insulator is fixed to the sleeper by small clamps and coach screws. This design leaves the conductor rail and insulator free to move up and down relatively to each other, as occurs when a train is passing owing to the spring in the sleepers and road bed. The rails weigh 102·8 lb. per yard, and have a cross-sectional area of approximately 10 sq. in. They are made of a special quality of steel having a conductivity equal to 15 per cent. of that of copper, and were supplied by the Frodingham Company. The rails are fished by a joint plate bolted on the underside, and are connected by four laminated copper strip bonds, supplied by the Forest City Company, which are practically protected by the joint plate. Long steel ramps, made from a bent section of the ordinary conductor rail, are used at all facing ends, and short cast-iron ramps at trailing ends. At points and crossings the different lengths of conductor rail are connected together by rubber insulated and lead-sheathed armoured cables, supplied by Messrs. Henley's Telegraph Works Co., buried direct in the ground, each end of the cable being scaled in a specially-designed porcelain terminal cap, from which a solid copper rod projects. To this projection two flexible copper bonds are clamped, the other ends of the bonds being expanded into the conductor rail. Any jumper cable can be in this way at once disconnected by the removal of two bolts in the clamp. The feeder cables are connected to the rails in the same way.

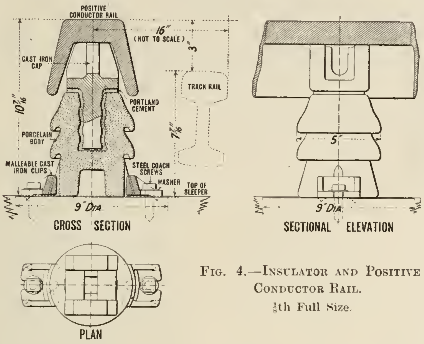

Fig. 4.—Insulator and Positive Conductor Rail.
⅛th Full Size.

The conductor rails are divided into the sections corresponding approximately to the distance between the stations. A section insulator is placed just beyond the cross-over at each railway station, so that in the event of a breakdown at any point it would always be possible to continue working the trains up to the next station by using the cross-over there for shunting the trains from one line to the other. Under normal conditions all sections will be connected together, the gap at the section insulators being bridged by switches which will be kept closed. The line is fed from the sub-stations at Shepherd's Bush and Royal Oak, eight feeders being carried from the former and four from the latter.

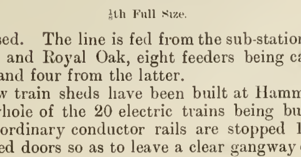

Fig. 5.—Insulator and Negative Rail.
⅛th Full Size.

Large new train sheds have been built at Hammersmith to house the whole of the 20 electric trains being built for this line. The ordinary conductor rails are stopped 15 ft. away from the shed doors so as to leave a clear gangway outside the sheds. Inside the sheds the trains will be supplied with current from overhead. A steel joist carrying a small trolley is supported from the roof principals above each line from end to end of the carriage shed. The trolley is fitted with two collectors which take current from two insulated trolley wires placed one on each side of the steel joist. A flexible cable from the trolley can be plugged on to a socket in the train. Inspection pits are provided throughout the car shed for the examination and overhauling of the trains, and in addition a repair shop is built at one side fitted with an electric crane and machine tools for carrying out all necessary repairs and renewals.

The car shed has been provided and the permanent way equipped under the supervision of Mr. W. W. Grierson, the company's engineer.

Twenty trains are being built for the Hammersmith & City Railway by the Metropolitan Amalgamated Railway Carriage & Wagon Co. at Saltley. Each train consists of two motor cars and four trailer cars, and has a total seating capacity of 320. The cars are similar to the Metropolitan Company's cars with closed vestibules, which were described and illustrated in *The Electrician*, June 1st, p. 248.

The whole of the electrical equipment of the trains is being supplied and fitted by the British Thomson-Houston Co., the greater part of the switch gear and motors being built at Rugby. Each motor car is fitted with four 150 H.P. motors, two on each bogie. They are designed for a schedule speed of 16 miles per hour including stops, and for a maximum speed of 30 miles per hour.

The control is on the Sprague - Thomson - Houston multiple-unit system with electrically-operated contactors, each pair of motors being operated separately in series parallel. One end of each motor car is partitioned off to form a driver's cab, and is fitted with a master controller and Westinghouse and hand brakes, in addition to the usual switchboards. Provision is made for fitting master controllers at other points throughout the train, should it be decided to split the trains for part of the day and so make it necessary to drive from a trailer platform. The whole of the contactors, reverser and motor-driven air compressor are placed beneath the motor-car floor, so arranged that they can be examined from beside the track. All connecting leads are run in metal pipes, and special precautions have been taken elsewhere to prevent the spread of fire. The trains are fitted throughout with the Westinghouse compressed-air brake.

The rolling stock was constructed to a specification prepared by Mr. G. J. Churchward, locomotive superintendent to the Great Western Railway, and Mr. Alfred Ingram, carriage and waggon superintendent to the Metropolitan Railway Co. The electrical equipment of the line and trains was carried out to a specification prepared by Messrs. Kennedy & Jenkin, as consulting engineers to the Great Western Railway Co., and Mr. Thomas Parker acted as consulting engineer to the Metropolitan Railway Co.

New Submarine Cable to the Far East.—The Tokio and Guam offices of the Commercial Pacific Cable Co. were on June 26th placed in communication by the new cable which has just been laid by the company, whose cables now extend from San Francisco to China and on to Japan. Congratulatory messages were exchanged between the Emperor of Japan and President Roosevelt on the occasion.

BANQUET IN HONOUR OF FOREIGN ELECTRICAL INSTITUTIONS.

On Monday evening the visitors from kindred institutions abroad were entertained by the Institution of Electrical Engineers at a banquet at Hotel Cecil. The gathering was in every way a brilliant one, and about 500 persons were present, including a number of ladies. Mr. J. Gavey, president of the Institution, was in the chair, and was supported by Lord Kelvin and Sir Joseph Swan. Mr. Sydney Buxton, the Postmaster-General, was unfortunately prevented from attending, but those present included men of note in electrical engineering and science too numerous to be mentioned individually. We were pleased to notice Prof. John Perry, who has practically recovered from the effects of his accident, to which we referred some weeks ago.

Bronze Bust of Volta presented by the Associazione Elettrotecnica Italiana to the Institution of Electrical Engineers.

In addition to the usual loyal toasts, which were duly honoured, the chairman, Mr. Gavey, proposed the health of "The Rulers of the Countries represented by the Visitors at the Banquet." Mr. Gavey, in the absence of the Postmaster-General, also proposed the toast of the evening, "The Visiting Delegates." Addressing the visitors in French, he spoke of the strong ties which bound together the engineering fraternity in all countries by a brotherhood which was, perhaps, more marked in that profession than in any other, as their work was so far-reaching and international in character. He was speaking in place of Mr. Sydney Buxton, who, from his official position, he reminded them, was the head of the electrical engineers of this country. He referred to visits which the Institution of Electrical Engineers had made to foreign hosts from time to time, and was glad that the opportunity had now presented itself of returning their hospitality. He had pleasure in coupling the toast with the following illustrious names: Prof. J. L. Farny (representing the Association Suisse des Electriciens), Mr. E. Hospitalier (Past President of the Société Internationale des Electriciens), Prof. Dr. E. Budde (President of the Verband Deutscher Elektrotechniker), Dr. Emil Naglo (representing the President of the Elektrotechnischer Verein), Mr. S. S. Wheeler (President of the American Institute of Electrical Engineers), and Mr. Guido Semenza (Honorary General Secretary of the Associazione Elettrotecnica Italiana).

The first to reply was Prof. J. L. Farny, who spoke as follows: Monsieur le Président et Messieurs les Membres de l'Institution of Electrical Engineers: Plutôt que d'estropier la langue de Shakespeare, permettez-moi de vous exprimer la gratitude de l'Association Suisse des Electriciens pour votre si aimable invitation, dans celle de nos trois langues nationales, qui est ma langue maternelle. Peuple heureux, qui n'a dans l'univers que des amis, nous estimons, mes collègues et moi devoir à celà l'honneur qui nous est fait d'être appelés en premier à prendre la parole dans cette noble assemblée. Nous sommes flattés de cet honneur et espérons ne faire aucun jaloux. Je vous apporte donc, Messieurs, le salut fraternel des Electriciens Suisses. Nous nous rappelons avec plaisir l'aimable visite dont vous nous avez honorés il y a quelques années. C'est pour nous une immense satisfaction de visiter en retour la Grande Bretagne sous la conduite de notre grande sœur aînée, dont nous admirons les travaux et l'organisation grandiose. La science électrique doit à la Grande Bretagne beaucoup d'hommes illustres. Inutile de perdre son temps à les enumérer tous. Je ne rappellerai que le plus génial expérimentateur Faraday et l'incomparable interprète mathématique de ses idées, Maxwell. Nous sommes heureux d'apporter nos faibles hommages aux dignes émules et continuateurs de l'œuvre de ces grands hommes: Lord Kelvin, Lord Rayleigh, ... Permettez-moi donc, Messieurs, de porter mon toast à la British Institution of Electrical Engineers. Je forme des vœux de prospérité bien sincères pour le développement et l'extension de l'œuvre de l'Association si éminemment utile au monde entier. J'invite mes collègues suisses à pousser au troisième temps un triple hourra en l'honneur de l'Association Britannique qui nous reçoit si cordialement.

The next speaker was Mr. E. Hospitalier, who responded instead of Mr. P. J. B. Auzépy (Consul-General of France). In his characteristically pleasant manner he referred to the previous visits which the Société Internationale des Electriciens had made to kindred institutions in various parts of the world, culminating in the present visit to London. The whole series, he said, had been so delightful that he could only say he was now ready to go through it all over again. Dr. Budde then rose, and, speaking in English, gave expression to the appreciation of members of the Verband Deutscher Elektrotechniker for the kind remarks of the proposer of the toast. He was joined on behalf of the German visitors by Dr. Naglo, who in most happy terms expressed his pride and pleasure at meeting amongst those present so eminent a father of electrical science as Lord Kelvin. The American contingent were represented by Mr. S. S. Wheeler, who excused himself for making a short speech by saying that he felt that as he came from a young country he ought to observe the maxim that children should be seen and not heard.

The last to respond to the toast was Mr. Guido Semenza. He regretted that Mr. Jona, the President of the Associazione Elettrotecnica Italiana, was unable to attend himself, and in a fluent speech in English reminded his hearers of the friendship which had so long existed between Italy and this country, and had found its expression in electrical circles on more than one occasion. In the name of his Association, he had brought over from Italy a present which he offered to the Institution of Electrical Engineers. Behind the chairman's chair was an object which he would ask Mr. Lloyd to uncover—a bronze bust of Alessandro Volta—of which he begged the acceptance of the Institution as a memento of the occasion. The bust, a fine bronze by Giuguo, is illustrated opposite. Volta, as they were aware, had made a long sojourn in England, and had been closely associated with many of the leading English men of science of his day.

The President then rose to convey the Institution's grateful thanks to their Italian friends for their kind gift. He spoke of the recent visit of some of the members of the Institution of Electrical Engineers to Italy, when they had made a pilgrimage to the tomb of the immortal Volta and paid their grateful tribute to the work of the great man whose bust would be handed down as one of the most cherished possessions of the Institution. He then requested Prof. Silvanus Thompson to supplement his remarks. Prof. Thompson, in a long and eloquent oration, recalled the scene a few years ago when a band of students of the Institution had paid a small tribute in the shape of a tablet in memory of Volta. The bust before them would be a precious addition to the treasured statues, portraits and medallions of past leaders in electrical progress which the Institution already possessed. He drew a rapid sketch of the early growth of electrical science, how Volta's fundamental ideas had been communicated in this country to Davy, and how the chain had been handed on by him to his disciple Faraday, upon whose work the whole fabric of electrical engineering was built.

Dr. Glazebrook proposed the toast of "The Ladies" in graceful terms, and took the opportunity of thanking the visitors who had been present in such large numbers at the opening of the extensions of the National Physical Laboratory that afternoon. The ladies response was entrusted to Prof. J. D. Cormack and the last toast—"The Chairman"—was proposed in felicitous terms by Sir William Ramsay, whose remarks were addressed to the various sections of those present in three different languages.

THE BRIGHTON CORPORATION'S NEW ELECTRICITY WORKS.

(Concluded from page 370.)

The plan which we published last week showed the general arrangement of the engine room, and Fig. 16 below is a general view. One of its noticeable features is the extreme height of the room. The buildings were originally designed for reciprocating engines, but, when the time was ripe for obtaining the generating sets, steam turbines were adopted. The turbines, which are rated at 1,800 kw., are of the double-flow Westinghouse-Parsons type in which steam, entering an annular chamber at the centre of the cylinder, first expands in nozzles and impinges against impulse blading of the compound Laval type. The steam then continues to flow towards either end of the turbine and enters the Parsons portion of the turbine, from which it finds its way to the condenser. Steam is supplied at 180 lb. pressure and with 150 deg. of superheat. Surface condensers are used which give a vacuum of not less than $27\frac{1}{2}$ in. (with barometer at 30 in.)

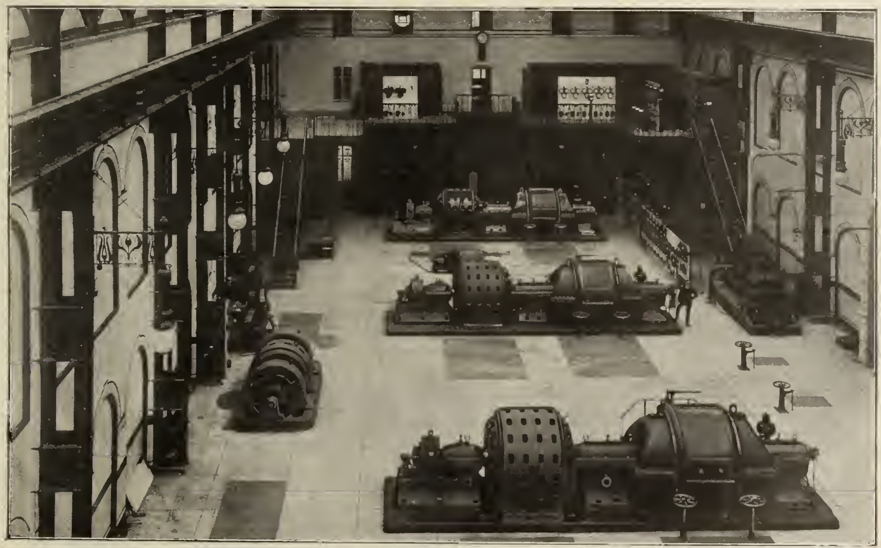

Fig. 16.—Engine Room showing three Turbo-generators, Motor-generator and Main Switchboard.

Fig. 19 shows a longitudinal section through the turbo-generator. The cylinders are of cast iron mounted on a bed-plate which also carries the generator. The rotating portion of the turbine is constructed entirely of high grade steel and consists of a drum mounted concentrically on a through-going shaft. Steel rings (a) carrying the impulse blades are fixed close to the centre and on the outside of this drum ; the drive between the drum and the shaft is taken through a specially constructed disc (*b*) firmly keyed to the shaft. The ends of the drum are stayed on to the through going spindle.

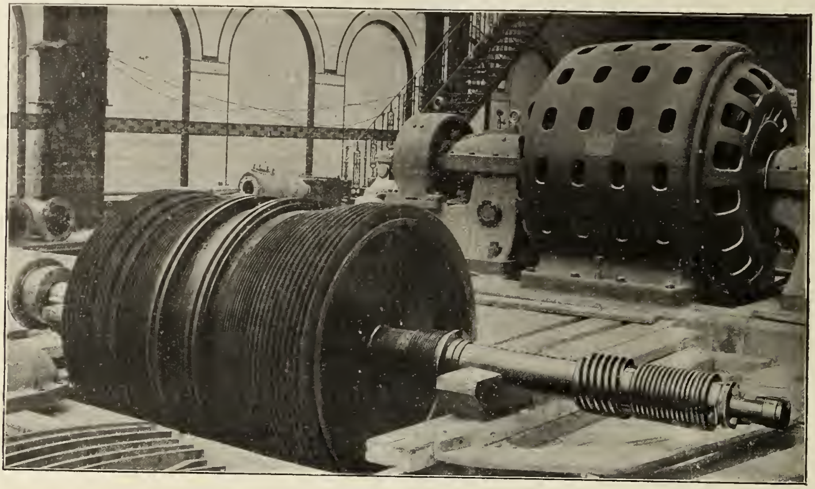

Fig. 17.—Rotor of one of the Turbines, with Generator in the Background.

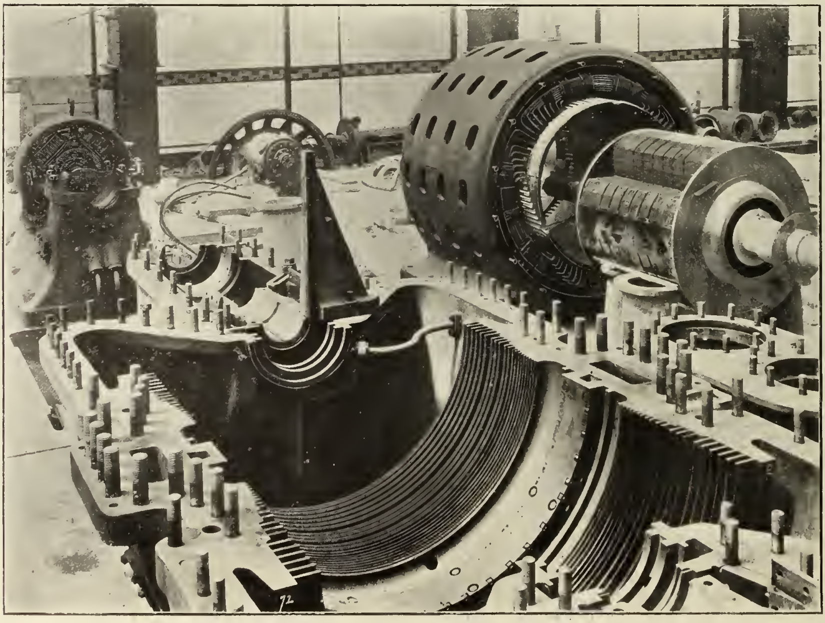

Fig. 18.—Stator of Turbine during Erection, and Stator and Rotor of Generator.

The main bearings are of cast iron lined with white metal and fixed in spherical housings to permit of easy alignment of the shaft of both generator and turbine. These bearings are enclosed and lubricated by means of a central oiling system supplying oil at a few pounds pressure from a tank in the roof, so that there is a continuous circulation of oil. An oil cooler and filter tank maintains this oil at a uniform working temperature and extracts from it any particles of dust or foreign matter which may by chance have got into it. As a proof of the high mechanical efficiency of the turbine, we are informed that the rotating portions will continue to run for 30 minutes after steam is shut off.

A flexible double-claw coupling between the turbine and generator shafts allows of slight differences in alignment between the shafts without causing trouble in running, and either shaft may be easily lifted away, the coupling sleeve being made in halves and bolted together for the purpose.

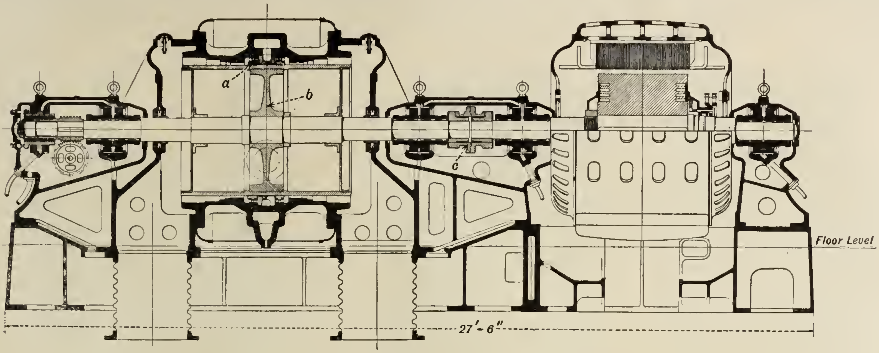

Fig. 19.—Longitudinal Section through Turbo-generator.

The operation of these turbines is as follows: Steam enters the steam chest, is led through the emergency stop valve to the main stop valve, from whence it flows to a strainer fitted with a perforated plate of moderate mesh; this ensures the stoppage of any solid material such as nuts, washers, &c., which may have been left in the steam pipes during erection. The steam then flows to a double-beat valve, which is opened and closed automatically by an eccentric on the governor gear and controlled in its lift by the governor itself reacting upon a balanced piston valve and altering the pressure underneath a piston attached to the double-beat valve stem. Opposed to this steam pressure under the piston is a strong spring, which tends to keep the valve on its seat. From this valve the steam is admitted direct into the annular nozzle chamber at the centre of the cylinder, and continues its course axially through the turbine to the condenser. The small amount of steam used to lift the double-beat valve serves also to pack the glands where the turbine shaft comes through the casing.

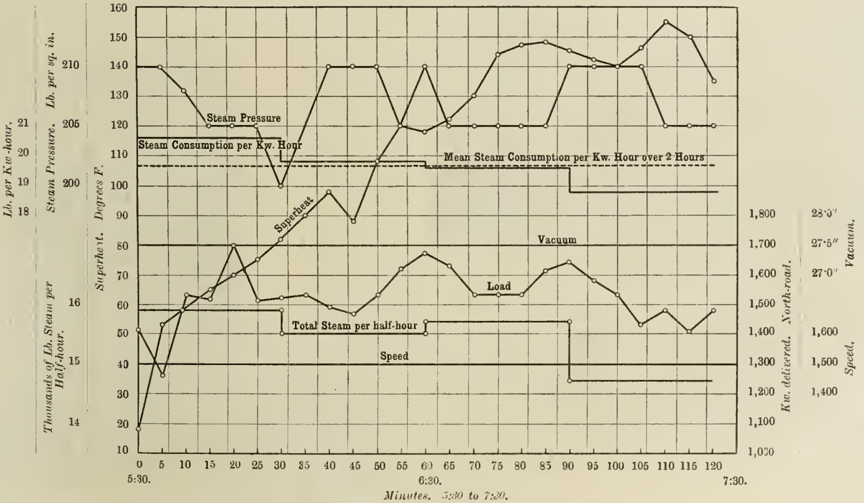

Fig. 20.—Graphical Results of Tests on the Turbo-generators.

A steel worm fixed on the main turbine shaft gears into a worm wheel on the shaft of which is skew gearing, used to drive the main governor; on the worm shaft is fixed the eccentric already mentioned for working the valve gear. The emergency stop valve mentioned above, through which the steam first enters, is provided for shutting down the turbine automatically in case by any chance it should attain a dangerous speed.

On the end of the turbine spindle is fixed a centrifugal unstable governor in which the centrifugal force of the weights increases at a very much greater rate than the force of the spring in opposition to it. The governor is set to operate at a certain speed of the turbine; below this speed it is inoperative but if it attains or exceeds this predetermined speed it instantly shuts down the turbine by closing the steam supply. The emergency stop valve consists of a piston valve held up by a differential piston fixed to its stem. By a trigger arrangement, it is so arranged that, as soon as the safety governor on the end of the turbine spindle operates, the supporting pressure underneath this differential piston is cut out, and as the pressure is maintained on the top, the valve is closed instantly. The generators give their rated output of 1,800 kw. at 8,000 volts and 50 periods per second, with an overload capacity of 33 per cent.

Figs. 17 and 18 are from photographs of a set during erection. Fig. 18 shows clearly the characteristic form of rotor employed in Westinghouse turbo generators in which the conductors are imbedded in slots in the sides of the poles.

Each turbine exhausts into a separate vertical condenser of some 5,800 sq. ft. cooling surface, capable of maintaining high vacuum under all conditions. Electrically-driven circulating, dry-air and three-stage centrifugal hot well pumps are provided, and arrangements made for delivery of hot well water into calibrated tanks for testing purposes. Sea water is used for circulating, and is obtained from the harbour by means of 60 in. suction and discharge pipes, which branch in the engine room into two 36 in. suction and discharge pipes. A pair of each runs down each side of the engine room in the basement, and each unit has a separate branch for its own condensing plant. The condensing plant being some 6 ft. below the level of the water in the harbour, only some 40 kw. are required for auxiliary plant when the turbines are doing full load of some 2,000 kw. Messrs. Cole, Marchent & Morley supplied the condensing plant.

An official test was made on one of the turbo-generators on October 20th last in the presence of Mr. Christie, borough electrical engineer. The conversion from high to low-tension current takes place at North-road sub-station, which is 4·7 miles away from the generating station at Southwick. The terms of the contract are for a consumption of 19·65 lb. of steam per kilowatt-hour, the current being measured at North road after transmission and conversion to direct current 440–480 volts, with the following conditions: Steam pressure 180 lb. per square inch, superheat 150°F., vacuum $27\frac{1}{2}$ in. (with barometer 30 in.), and full load carried during test.

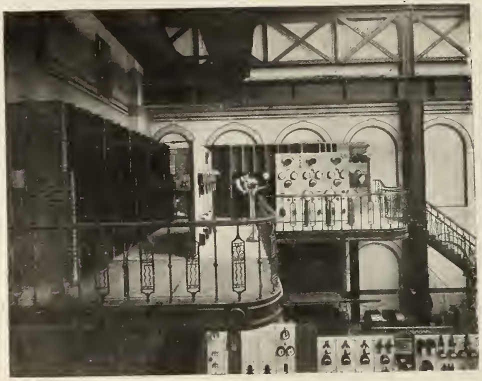

Fig. 21.—One Side of the Switchboard Gallery.

The actual conditions during test are shown graphically on Fig. 20. Averaged they are: Steam pressure 206 lb. per square inch, superheat 123°F., vacuum $27\frac{1}{2}$ in, load 1,710 kw., steam consumption per kilowatt-hour 19·67 lb. The load was taken on the towns mains on a lighting load, and the electrical instuments used for measuring the current were calibrated at Faraday House.

It will be observed that, whereas the steam pressure was somewhat above the guarantee, both the superheat and load are considerably below factors, which count much more than steam pressure in turbine operation. Estimating from the differences in all three conditions to the guarantee, the contractors compute the steam consumption per kilowatt-hour with guarantee conditions at 19·3 lb.

All auxiliary machinery, except where steam driven, is operated by continuous-current motors; the voltage at which they are supplied, and also for excitation, is 250. The plant for supplying this energy consists of three 95 kw. exciters coupled on the end of the generator shafts, a 220 kw. Willans-Siemens set, brought from North-road works, one 400 H.P. induction motor coupled to two 150 kw. generators, and one 1,000 ampere-hour Chloride battery. The battery is charged by a Highfield booster, made by Messrs. Siemens Bros. & Co. This plant is all common to the exciters, auxiliary plant, lighting circuits, and also for supplying the Hove Corporation with continuous current suitable for their Aldrington district.

Communication from the switchboard to the turbo drivers and to the boiler house is arranged by means of Chadburn's mechanical telegraphs, and from the Southwick works to the North-road sub-station by Messrs. Graham's loud speaking naval telephone.

A 20-ton electric travelling crane by the Glasgow Crane Co. spans the building, and was invaluable during the erection of the plant.

The high-tension switch gear is on three floors, the uppermost of which is the operating gallery. It is all of the British Westinghouse Company's latest remote control type, capable of dealing with three generators and five feeders, with all the usual instruments and oil switches. The feeder boards and generator panels are grouped on small separate boards, as shown in Fig. 21, which represents one side of the double switchboard gallery. The position and shape of the gallery is apparent from Fig. 16. Low-tension switch gear for the auxiliary and Aldrington supply was furnished by the British Thomson-Houston Co.

THE INTERNATIONAL COLLIERY EXHIBITION.

Second Notice.

In addition to the exhibits to which we referred in our first notice, the British Westinghouse Co. show several patterns of enclosed motor control boxes and switch boxes for mining work. The special control box for three-phase squirrel-cage induction motors is of substantial design, and contains an oil-immersed auto-starter, fuses and ammeter, all enclosed in a gas-tight case fitted with a circular glass window to allow the ammeter dial to be seen.

Trifurcating boxes are provided for the incoming and outgoing three-core cables. The operating handle moves progressively from the "off" position—through two starting positions—to the running position. The operating lever is interlocked with the door in such a manner as to render the opening of the latter impossible unless the switch is in the "off" position.

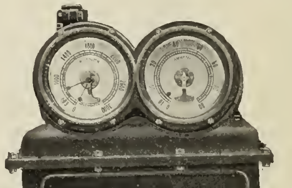

Fig. 1.—Single Control Pillar with One Cable-Connecting Box. Fitted with Voltmeter and Ammeter.

Figs. 1, 2 and 3 show various forms of the Westinghouse inverted type unit pillar switch gear for mining purposes, and in exposed situations generally. The 'bus bars, if used, are fitted at the base, as will be seen from the illustrations. The switches, &c., are completely enclosed in substantial cast-iron pillars which afford a very complete mechanical and fire-risk protection. A unit type of construction is employed, so that the pillars may be utilised either as single units (Figs. 1 and 2), or may be mounted together upon 'bus bar chambers to form distributing "boards" for any required number of circuits (Fig. 3). The whole of the interior fittings are accessible through the door at the front, so that the pillars may be placed against a wall ; the cables being run to the leading-in boxes on the top of the pillars. This arrangement reduces the necessary floor space to a minimum. These pillars are suitable for use on circuits up to 3,300 volts, and may be fitted with either ammeter or voltmeter (or both), fuses, automatic or non-automatic oil-immersed switches, as in Figs. 1 and 2, or knife switches. The latter switches are only used for circuits up to 600 volts, each pillar being then fitted for two circuits, as in Fig. 3, which shows two unit pillars mounted on 'bus bar chambers. The right-hand pillar is provided with a trifurcating leading-in box for the supply cable, and has two switches. One of these is connected between the 'bus bars and the incoming feeder cable, while the other controls an outgoing circuit. The left-hand box is a distributing box, the two switches controlling outgoing circuits. When isolating switches are required, they are fitted into an intermediate chamber between the 'bus bar and the main switch chamber, from which latter they are separated by an asbestos slate barrier. This arrangement renders the main chamber entirely dead when the isolating switch is open, enabling cleaning and small repairs to be carried out in perfect safety. A very complete interlocking system has been devised, interlocking the main switch with the isolating switch and the isolating switch with the door in such a way that it is impossible to open the door to get at the fuses or main switch until they are cut off from the 'bus bars by means of the isolating switch. Also it is impossible to close the isolating switch and render the pillar alive again until the door has been closed.

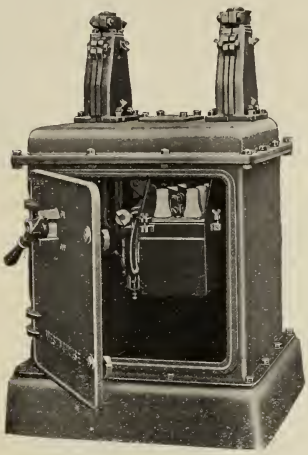

Fig. 2.—Single Control Pillar with Two Cable-Connecting Boxes.

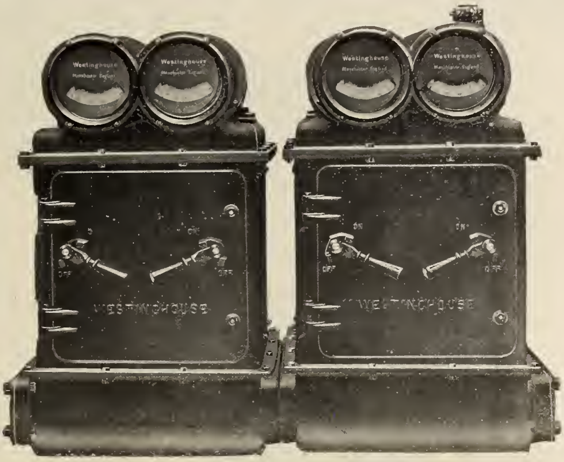

Fig. 3.—Two Unit Pillars Mounted on 'Bus Bar Chambers.

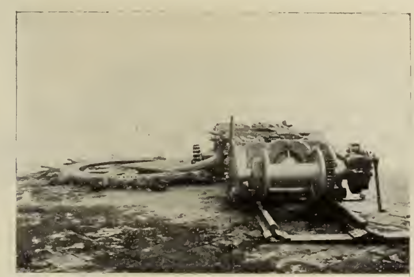

Fig. 4.—Diamond Disc-type Electric Coal Cutter.

The Diamond Coal Cutter Co. have a large stand on which they show their well-known coal cutters and other mining appliances. The firm's standard type of controller for coal-cutter motors is of the barrel type and embodies one or two interesting features. A special arrangement is adopted so that the plug carrying the connecting cable cannot be withdrawn except when the controller is in the "off" position. The starting resistances are enclosed in the same case and consist of former wound asbestos covered coils constructed to withstand a high temperature and arranged for the different sections to be easily replaceable in case of their being burnt out through careless use of the controller. A wooden hand wheel is always fitted so that in event of the spindle becoming accidentally live, the attendant is still able to shut off by means of the controller. We understand that this company was the first to apply a pair of motors with series parallel control to a coal cutter equipment. Several complete coal cutters are shown, some with continuous current and some with three-phase motors. The standard disc type is illustrated in Fig. 4. A chain tpye is also shown which was specially designed for undercutting very soft or friable coal and for other conditions unfavourable to the disc type of machine. It cuts in both directions without having to turn the machine round or remove the chain, and the work is as easily done in one direction as in the other. The cutting tools are readily reversible and simple of construction. Two tools go to each cutter box link, thereby ensuring an even pressure on each side of the link and avoiding the serpentine motion common to change having single cutters and in which the side strain on the pivots is very disastrous The chain is made of toughened cast steel throughout, and is constructed without rivets, so that a link can be easily replaced. The tension of the chain can be adjusted by turning a nut. The

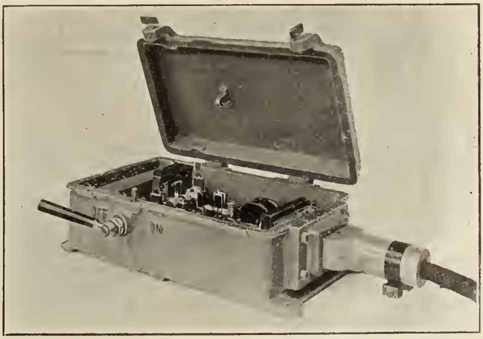

Fig. 5.—"Diamond" Gate-end Switch Box.

standard depth of undercut is 4 ft. 6 in., the width of cut about 4½ in., and the extreme width of the gib under the coal is 18 in. The overall height of the machine holing at floor level is under 20 in. All these types drive through spur gearing.

Another labour-saving apparatus manufactured by the same firm is the Blackett electrically-driven coal conveyor, which is specially intended for use underground for conveying coal from the face. The apparatus is very compact and is well adapted for use in thin seams. A totally enclosed motor of about 10 B.H.P. is used running at 600 revs. per min., driving the chain which passes along the troughs and forms the conveyor itself. The drive is through a spur reduction gear running in oil and a Renolds chain. The motor is specially designed and forms part of the conveyor outfit. Some 30 tons per hour can be dealt with. The height of the conveyor over the troughs is about 10 in. The discharging and the tail ends are a little higher but will easily go under 2 ft. The overall width is 18 in. along the face.

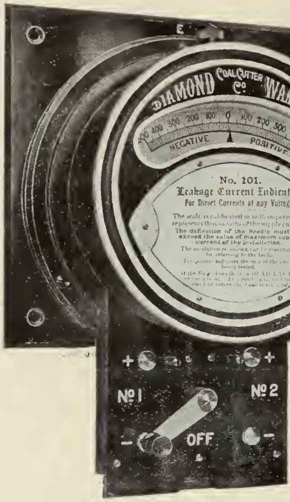
E
DIAMOND COAL CUTTER Co. WAKEFIELD
500 400 300 200 100 0 100 200 300 400 500
NEGATIVE
POSITIVE
No. 101.
Leakage Current Indicator,
For Direct Currents at any Voltage.
The deflection of the Needle must not exceed the value of maximum supply current of the installation.
+
+
No 1
No 2
-
OFF
-

Fig. 6.—Leakage Indicator.

A number of designs of enclosed switch gear for colliery use are shown. Fig. 5 illustrates a gate-end switch box in a gas-tight case. Machined metal to metal joints are used between the lid and the case, which do not require any intermediate packing, and a series of interlocking bolts are provided, so that the switch cannot be closed unless the box is shut, nor can the box be opened unless the switch is in the off position. A further arrangement of locking pins prevents the cable plugs being withdrawn from the sockets except when the switch is off and the case open. The whole apparatus is of particularly solid construction to withstand the rough usage to which it is subjected under mining conditions. A new pattern of electric rotary drill, mounted on a travelling carriage, is also shown, which is fitted with a patented arrangement of split feed nut, which can be instantaneously put in and out of engagement. Another item of electrical interest is the direct reading leakage indicator for continuous current circuits, designed to meet the requirements of the mining regulations, and shown in Fig. 6. The standard size for continuous currents, as illustrated, is suitable for installations not exceeding 500 amps. maximum supply, and is suitable for any voltage. The pointer shows at a glance whether the leakage current is within the prescribed limit of $\frac{1}{1000}$th of the maximum supply current. Two sets of terminals can be provided for testing both positive and negative sides of two separate supply systems, as for instance where the lighting is supplied by a different dynamo to the power. One terminal of the instrument is connected to an earth plate or to a convenient steam or water pipe system, the other terminals respectively to the positive and negative 'bus bars or main terminals of the switchboard. If there is a bad fault on either main the small fuse will blow immediately the key is pressed, and this can be easily replaced. The insulation resistance to earth can be ascertained from the table supplied with the instruments, which is calculated for various voltages. Some portable instruments are also shown with specially protected cases to withstand rough usage.

Electric coal cutters also form a feature of the stand of Messrs. Mavor & Coulson. Fig. 7 shows a specially compact form of the firm's "Pickquick" coal cutter for working thin seams, the overall height is only 16 in. and the weight complete is 28½ cwt. These cutters are of the bar type in which the cutter bar is given a certain amount of reciprocating motion as well as rotating, and is provided with a helical thread which acts as a worm conveyor bringing out the cuttings. The gearing is completely enclosed in the "gear head." A pinion on the motor shaft drives the double bevel wheel, which in turn drives (with a reduction of 2 to 1 in speed) the cutter bar pinion; this pinion is not keyed rigidly to the bar, but is fitted with two feathers projecting into its bore. The feathers engage in long keyways in the bar, which, while being driven, is thus free to reciprocate along its own axis. Ready access to the whole gear is obtained by removing the gear case cover, which is removable endwise, thus affording access for inspection or adjustment without regard to the headroom available. A circular rack in the lower part of the gear case, worked by a pinion, provides for turning the lower part of the gear head with the cutter bar in a horizontal plane for cutting in. The reciprocating motion is obtained from a worm upon the boss of the bar-driving pinion gearing with two small wheels, each of which drives a toggle by means of an eccentric pin. The toggles impart a to-and-fro movement to the thrust block, and with it the cutter bar. The lower portion of the gear case is filled with oil and a stuffing box is provided at the outer end. The motors employed on the continuous-current machines are of the four-pole completely enclosed type with two compound-wound magnet coils. The two end pole pieces which carry the coils are detachable from the sides of the shell, thus exposing the armature for inspection. The armature is built upon a cast-iron sleeve, which can be easily removed from the shaft. A flame tight cast-iron box bolted to the end of the motor shell contains the starting switch and resistance. In the switch-box casting, and accessible through the tool box, is a chamber into which a renewable worm on the end of the armature shaft projects. This worm gives motion to a cross shaft which passes through the side of the box, and operates the haulage gear. The rate of feed is adjustable at will. On the medium and large-size machines a self-coiling arrangement is fitted to lay the steel wire

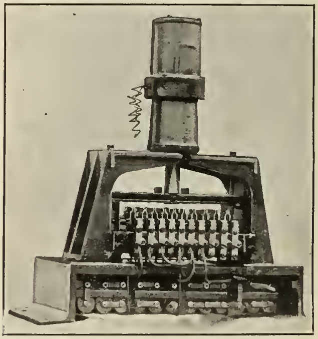
Fig. 8.—Kramos Lift Controller.

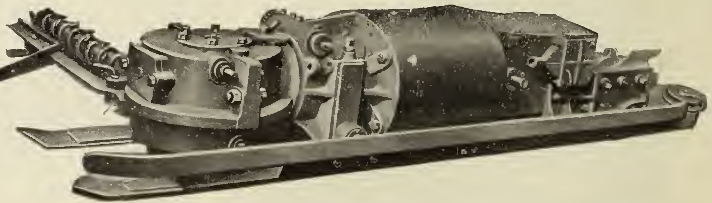
Fig. 7.—Small Size "Pick-quick" Electric Coal Cutter.

rope evenly on the drum. In the case of three-phase machines, a squirrel cage motor is used and an auto-transformer is employed for starting.

The stand of Messrs. Kramos (Ltd.) contains a number of examples of their series of portable self-contained electric drills, ranging from their "midget" drill, weighing 15½ lb. complete, with motor, and drilling up to ⅜ in. holes to larger sizes, to one weighing 60 lb. to take drills up to 1¼ in. These are all provided with fully enclosed motors in aluminium cases and cut-steel gears, and are fitted with a handy type of push-button switch. A neat attachment is provided in the shape of a compact reduction gear so that any of these machines can be used for drilling marble or slate at a slow speed. Some magnetic drilling pillars are shown for use with the larger sizes. Motor and drill presses for flexible shaft drive are also exhibited, the flexible shafts for which are all made in this country. A hand-grinding attachment for use with these flexible shafts is shown which should prove useful for a variety of purposes. The company also make a speciality of electric lifts, and show a working model of their system. A particularly simple form of controller is used (see Fig. 8) which is actuated by a master switch either in the car, or, in case of goods hoist, on one of the floors. The frame carrying the contacts is raised by a solenoid combined with an air dash pot Instead of series starting resistance steps being used, the resistances are placed in parallel and progressively switched into the circuit by the staggered arrangement of contacts, two sets of numbers of parallel resistances being connected in series, one of which forms a fine adjustment, so to speak, for the other. The resistances which are seen underneath the contacts in Fig. 8 are made of a special pulverised resistance material packed into metal cylinders. The reversing is independently actuated by another solenoid. The same arrangement can be adapted to a simple push-button system, in which trip switches on each floor act on the control circuit and determine the position of the main reversing switch.

Messrs. W. F. Jones & Co. show a number of instruments and switches specially designed for mining and other purposes. One of the patterns of enclosed switches for mining work is shown in Fig. 9. The spindle which actuates the switch passes through a stuffing box, R, and is fitted with a crossbar, H¹, to which a knob is attached, and this can only be pushed home when the door of the case is closed and screwed down tight owing to the action of the locking strip U. The switch is then free to be closed, and at the same time the cross bar, H¹, prevents the cable plugs, D¹, at the side being withdrawn from the sockets. Thus, neither can the door be opened nor the cable plug be withdrawn unless the switch is in the off position. The accidental closing of the switch of an unauthorised person is prevented by a small catch which has to be pressed with the other hand at the same time the switch is moved, and when the door is open even it is impossible to reach live parts with the hand. The fuses are attached to a block carried on the door connection being made to the contacts, G G, when the case is closed. A large variety of other switches and fuses are exhibited including a neat switch actuated by a clock movement which switches off after a pre-determined number of minutes. Some electric drills are also shown and some examples of the "Frahm" vibrating tongue speed indicator are also on view on this stand.

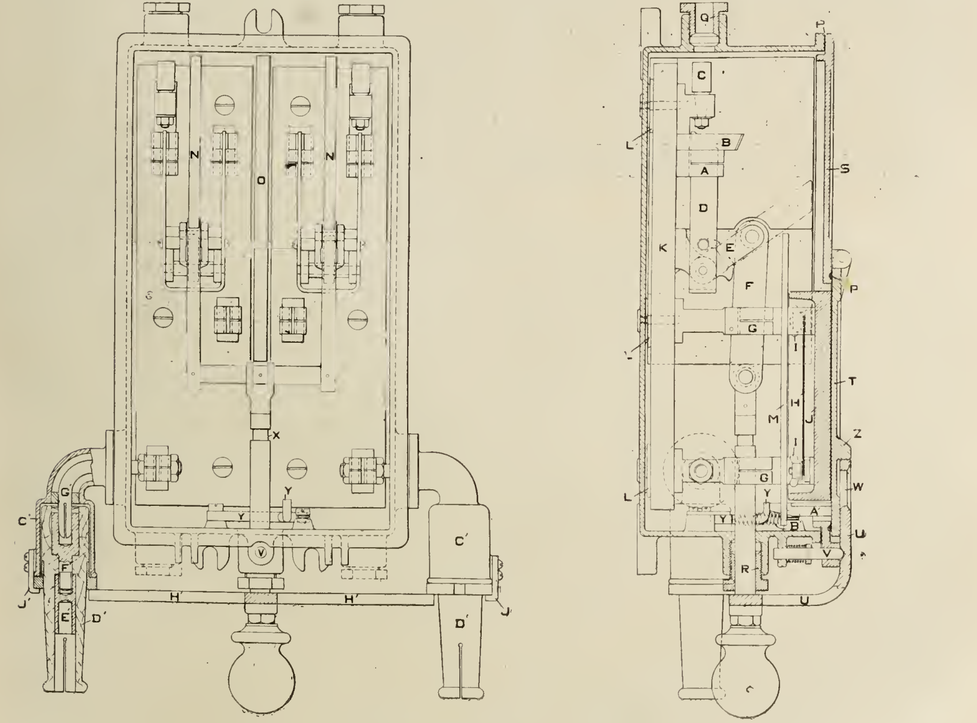

Fig. 9.—Enclosed Switch and Fuses.

The Electric Power Storage Co. have a small stand on which they show some electric signalling hand lamps for railway and other use arranged to show either a white or red light and fitted with osmium lamps.

Messrs. W. H. Allen, Son & Co. have a 450 B.H.P. engine for 400 revs. per min. of the vertical-enclosed three-crank three-cylinder compound type on show, and a similar two-crank engine for 220 B.H.P., together with examples of their three-throw and centrifugal pumps. None of their exhibits are, however, under steam.

The Royal Society.—Among the Papers down for reading yesterday were the following: "The Ionisation produced by Hot Platinum in Different Gases," by O. W. Richardson. Communicated by Prof. J. J. Thomson, F.R.S. "Note on the Production of Secondary Rays by 'α'-rays from Polonium," by W. H. Logeman. Communicated by Prof. J. J. Thomson, F.R.S.

ELEVENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

(*Continued from p. 388.*)

Thursday, June 21st (*concluded*).*

In the afternoon a visit was made to the Bow power house of the Charing Cross, West End & City Electric Supply Co., and in the evening the annual dinner was held.

The toast of "London and other Local Authorities" was proposed by Mr. S. E. Fedden (president-elect), and was responded to by Ald. Bruce (Sunderland) and Councillor Buzzey (Poplar), in the absence of the Mayor of Kingston. Sir Alexander Kennedy proposed the "Health of the Incorporated Municipal Association," which was replied to by the president (Mr. J. E. Edgcome), and the toast of "The Visitors," which was allotted to Mr. C. D. Taite, was replied to by Col. R. E. Crompton and Dr. Glazebrook.

Friday, June 22nd.

The greater part of the morning was taken up with the discussion of two excellent Papers on the output and efficiency of steam plant. The two Papers were discussed together, and we give Mr. Wilkinson's below. Mr. S. J. Watson (Bury), afterwards read a Paper on "The Supply of Power to Tramways from Small Stations," which, with the discussion thereon, we hope to publish next week.

The London County Council power station at Greenwich was visited in the afternoon.

LIVE STEAM HEATED FEED WATER—ITS EFFECT ON THE OUTPUT AND EFFICIENCY OF STEAM BOILERS.

BY G. WILKINSON.

(Chief Electrical Engineer, Harrogate.)

In comparing modern electric generating works with similar works equipped 10 or 15 years ago, one of the most striking features in the former is the increase in output of the generating units in the engine room and their relative decrease in size. It is now common practice to instal three or four times the amount of power in a given size of engine room which was then possible. No such evolution and improvement has taken place in the boiler house, probably in every case the same boilers are at work, doing practically the same duty and at approximately the same efficiency as they gave when first put to work. To supply sufficient steam for the larger generating units now installed in the engine room more boilers have had to be installed; thus the boiler-house equipment becomes longer than the engine room, and complicated and wasteful arrangements of steam pipes ensue which are expensive and undesirable.

Most engineers realise the importance and safety of equipping their works with complete "units" of power, each generating unit being served by its own condensing plant and steam boiler or bank of boilers, and the ideal arrangement is obtained when these boilers and generating units are erected opposite each other immediately on each side of the dividing wall between the boiler and engine rooms. In the modern power houses, where large generating units are installed, one of two things usually happens; either the "complete unit system" is sacrificed, and the boiler-house equipment occupies a greater length of space than the engine-room equipment, long steam-pipe ranges and complicated steam connections being thereby rendered necessary; or the "complete unit system" is adhered to, but, owing to the extra space required by the boiler plant, the generating units in the engine room are placed at such wide centres as to cause waste of floor space. The remedy is to increase the size and steaming capacity of the boilers so as to make the supply of steam per foot run in a single row of boilers equal to the demand per foot run of engine room generators.

If the above-mentioned improvements are to be realised it is necessary to greatly increase the rate of transmission of heat from the hot furnace gases to the water within the boiler, then the size of furnace and rate of combustion can be increased without materially increasing the temperature of the waste gases passing to the chimney, and when called upon to meet sudden heavy loads the duty of the boiler can be further substantially and efficiently increased by using supplementary oil, steam, and air jets on the top or at the back of the ordinary coal fire. Such a fierce and concentrated combustion taking place in a boiler furnace working under ordinary conditions would not only wastefully heat the gases passing to the chimney, but might also overheat and burn the boiler plates or tubes, with the risk of collapse.

The writer is at present experimenting with supplementary oil jets as described, and hopes to obtain some interesting data relating thereto for publication at a future date.

In any steam boiler, the transmission of heat is most rapid through those portions of the heating surface on which evaporation is actually taking place, and if the feed water on admission to the boiler be already raised to the temperature of the steam in the boiler, then those portions of the heating surface which, under ordinary conditions, are occupied in raising the temperature of the admitted feed water towards the temperature of evaporation, will then be occupied in producing actual evaporation, and thus a greater amount of heat per unit of heating surface will be transmitted from the fire to the water side of the heating surface in a given time. The temperature of all heating surfaces, where evaporation is actually taking place, is kept lower than the temperature of those surfaces which are occupied in raising the feed water to the temperature of evaporation; due to this lower temperature the surfaces have greater heat absorption power, and therefore more intense fires can be usefully employed without serious increase of temperatures in the gases passing to the chimney, and in this way the output of any boiler can be greatly increased. Under these altered conditions the limit to the capacity of any boiler becomes less a question of heating surface as at present, and more a question of the capacity of the furnace for consuming fuel.

A common impression prevails that it is dangerous to employ abnormally high temperatures, or to apply heat in too concentrated a form to boiler furnaces owing to the liability of the furnace plates or tubes to become overheated and seriously weakened, rendering the boiler unsafe to work. The researches of Blackynden, Durston, Hirsch, Witz, and Miss E. M. Bryant, B.Sc, amply prove that this idea is entirely without foundation, provided the heating surfaces are kept clean and the internal surfaces free from scale and grease, and these are essential conditions of first importance in any boilers designed for high duty. From his experiments, Hirsch concluded that sound and clean plates in a boiler could not be overheated so long as water was being evaporated from them at rates up to 75 lb. per square foot of surface per hour; and Miss Bryant in her investigations on "The Thermal Condition of Iron, Steel and Copper when acting as Boiler Plates" demonstrated that at 50 lb. per square foot evaporation a ½ in. plate has a temperature of 303° F., and at 70 lb. a temperature of 338° F.

Present practice with modern boilers reveals the astonishing fact that the average evaporation amounts to from 2½ lb. to 7 lb., rarely more, and say exceptionally to 10 lb. or 12 lb. of water per square foot of heating surface per hour. Until this rate is very much increased, boiler house plant cannot be considered as worthy to rank alongside present-day engine-room equipment. A Lancashire boiler, 30 ft. long by 8 ft. 6 in. diameter, with 1,100 sq. ft. of heating surface, is deemed to be doing excellent duty when producing 7,000 lb. of steam per hour. In the published list by the Stirling Boiler Co., the "Rate of evaporation in pounds per hour, with good draught and fuel," is put at 4 lb. of water evaporated per hour per square foot of heating surface, while a note at the bottom of the list says: "The evaporation can be increased 25 per cent. above the figures given." Tests on Babcock and Wilcox boilers appearing in that company's publication entitled "Steam," show the small evaporation of from under 1·5 lb. to 3·06 lb. per square foot of heating surface, the latter with a feed water temperature of 190°F. from the economiser. The contemplation of these figures goes far to explain the abnormal size of boiler houses and the large numbers of boilers installed. The size of the boiler house is especially emphasised in the case of the watertube type of boiler, and to the author it appears desirable to dispense with, say, half the heating surface and secure double the evaporative efficiency on the half left; this would reduce the size of the boiler house, bring the boilers into a single line parallel with the generator room, would substantially reduce upkeep and repairs, while the steam pipes, valves, joints and drainage losses would be brought within reasonable limits.

A maximum evaporation equal to 42·9 lb. and 44·7 lb. per square foot of heating surface per hour was obtained from the firebox end of a locomotive boiler on the Great Northern Railway of France without danger or difficulty; but the evaporation in the fifth section, near the smokebox, varied between 0·72 lb. and 4·76 lb., according to the force of the draught used. In experiments made on a "Niclausse" boiler the rates of evaporation on the tubes near the furnace when burning 60 lb. of fuel per square foot of grate area reached a maximum of between 34 lb. and 35 lb. of water per square foot per hour, but the top, or twelfth row of twelve, evaporated a maximum of only 6 lb. per square foot per hour. There are large numbers of watertube boilers in use in power houses which are giving a maximum average evaporation of less than 4 lb. of water per square foot of heating surface, and it is obvious that they have too much heating surface. Much of the "tail end" is useless for steaming purposes, and it should be cut out, thereby reducing the cost of the boiler and saving valuable space.

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* Mr. J. F. C. Snell's Paper on "Relative Economies of Electrical Supply from Small Local Stations and Power Companies" and the discussion on it (taken on Wednesday, June 20th), will be found on p. 427 of this issue.

It is high time engineers ceased to be satisfied with the boiler equipments offered them by manufacturers at the present time. The author is of opinion that maximum evaporations of from 10 lb. to 20 lb. per square foot of heating surface per hour can be obtained in regular practice with suitably designed boilers and accessories, and given the opportunity, a boiler house equipment can be designed and put down which, with a single row of boilers, would supply steam to any British power house existing to-day with a maximum evaporation of 15 lb. of steam per square foot of heating surface and with a total heat loss not exceeding 20 per cent.

Another important point which does not appear to receive the attention it merits is the large variation in the temperature of the water within steam boilers. From data published in the report on "Red Hot Surface Crown Experiments" by the Manchester Steam Users' Association in 1889, the difference in temperature between the top and bottom of the water in Lancashire and Galloway boilers carrying pressures varying from 50 lb. to 80 lb., after they had been working with others on the steam range for periods varying from half an hour to 1½ hours, was found to be as follows :—

Boilers fed with cold water	(a mean of on 5 boilers)	113°F.
Boilers fed with tepid water	(,, ,, 2 ,,)	106°F.
Boilers fed with hot water from economisers	(,, ,, 3 ,,)	108°F.

As the temperatures of the feed water, strength of draught, intensity of the fires, and the conditions under which the boilers named above were worked are not stated, it would not be fair to draw minute comparisons between the results given, but the figures clearly show that the circulation of water with shell type boilers is sluggish, and if heavy strain on the plates is to be avoided, very hot feed water should be used, and a vigorous and positive circulation between the bottom and top water should be maintained. The difference in temperature between the top and bottom water in the 30 ft. by 8 ft. 6 in. Lancashire boilers in the Harrogate works ranges between 12 deg. and 13 deg., and the difference in temperature is likely to be further reduced. The author has no data as to the variation of temperatures in the water within watertube boilers, but it probably shows a wide range, especially in the number of boilers which are working without economisers or steam feed water heaters. According to some writers the circulation within watertube boilers is so rapid, due to the furnaces being at the bottom of the tall structures, that the hot water from the steaming area is carried over to the cooler downtakes at the back, and thus the difference in temperature between the gases outside the downtake tubes and the steam heated water within is so small that the transmission of heat through the tubes is practically of no value in helping the boiler to produce steam.

Some engineers consider the back banks of tubes in their large boilers as feed-water heaters, but, if they are to be utilised for this purpose, then the steam temperature water from the furnace end of the boiler should not be allowed to circulate through them, as such steam temperature water displaces the cooler water and drives it forward to the front end, thus reducing the temperature towards the front end and reducing the active steam-producing area within boiler.

To use the back end of any boiler for the purpose of heating feed water is to be condemned, as the tubes are often bad conductors of heat, due to the dirt and soot upon them, and better efficiency would be obtained by cutting out the back part of the boiler, letting the gases away at a higher temperature and utilising the waste heat in an economiser which has self-cleaning and efficient heating surfaces, and in which the range of temperature between the gases and the feed water is greater than in the case of the back end of a watertube boiler, where the feed water is immediately raised in temperature by the hot water circulating from the active steaming end of the boiler. Mr. Patchill, in his description of the Charing Cross Company's works at Bow, read before the Institution of Electrical Engineers, said: "The question of economisers was considered, but it was decided that, except at top load, the large heating surface available in the boilers would render the necessity for an economiser doubtful."

This is a view with which the writer cannot agree.

Another improvement which the writer expects to see in watertube boilers is the raising of the furnaces nearer the surface of the water, the hot gases being carried down and through the banks of tubes or flues located below.

For reasons which are embodied in this Paper it will be clear that if steam boilers are to give continuous high duty the whole of the water within them must be maintained at high temperatures, and the nearer the maximum temperature approaches that of the steam the greater will be the output of any boiler.

In order to approach this ideal condition of affairs it is necessary to employ some special method of heating the boiler feed water to steam temperature. One practical method of doing this is found in the well-known Druitt-Halpin thermal storage. In commenting on thermal storage at the discussion of Messrs. Booth and Kershaw's Paper on "Fuel Economy in Steam Power Plants," read before the Institution of Electrical Engineers in 1905, Col. Crompton said :—

In my discussion with Mr. Halpin as to the remarkable increase of boiler output which we undoubtedly obtain from the use of thermal storage, we have not yet been able to say with any certainty how it is that when we add storage reservoirs to a boiler, and draw from them at the time of heavy load, the increase in boiler output is not confined to the 25 per cent. that we would be led to expect by calculation, but we get sometimes an output of at least 150 per cent. for two hours in excess of the maximum output which we obtain from the same boilers if the feed water enters the boiler direct from the economiser at about 250°F. But in addition to the increased output the effect of thermal storage in increasing the boiler economy of a station is very remarkable. One power station that I am connected with, which had previously obtained very good boiler economy, has had this increased nearly 25 per cent. since thermal storage has been added.

The boilers referred to in the above remarks are the Babcock boilers fitted with thermal storage vessels at the Wood Lane works of the Kensington & Notting Hill Electric Lighting Co., the details of which are as follows :—

Each boiler contains 3,654 sq. ft. heating surface, 63 sq. ft. of grate area, and carries a thermal storage vessel holding 21,000 gallons of hot feed which we will assume is at the full temperature of the steam, though it is probably considerably less. The steam pressure is 200 lb. per square inch. The normal duty of each boiler is rated at 12,000 lb. per hour, and this normal output can be raised to 30,000 lb. for one hour when using the hot feed, and this is considered an extraordinary performance.

Examining these figures in detail, however, we find nothing extraordinary has been achieved, and results equal to the emergency output should be obainable without the aid of thermal storage. At normal output the evaporation averages only 3·28 lb. of steam per hour per square foot of heating surface, or 190 lb. of steam per hour per square foot of grate area. Compared with these results the Harrogate boiler gives at normal duty (viz., consuming 24 lb. of fuel per square foot of grate area per hour) an average evaporation of 5·98 lb. of steam per hour square foot of heating surface or 205 lb. of steam per hour per square foot of grate area. Taking now the emergency duty of 30,000 lb. available for one hour only, we find that the hot water in the thermal storage vessel, assuming its temperature to be equal to that of the steam—gives to the boiler in heat units during the hour the equivalent of 6,800 lb. of steam at 200 lb. pressure. This leaves 23,200 lb. of steam for the hour as the work of the boiler, which equals an average evaporation of only 6·34 lb. of steam per square foot of heating surface, or 368 lb. per square foot of grate area per hour, and assuming 6·5 lb. of steam evaporated per pound of coal, the combustion of fuel per hour per square foot of grate area equals 56·7 lb. Again, comparing the Harrogate boiler without steam-heated feed water, we obtain on high duty—after making a deduction due to heat from the economiser—an average evaporation of 10 lb. per square foot of heating surface, or 397 lb. per square foot of grate area, and with a consumption of 63·4 lb. of fuel per square foot of grate area per hour. With steam-heated feed water the Harrogate results would be higher and the already higher figures would thereby be considerably increased.

A disadvantage with the hot-feed system of Mr. Halpin's is that only a certain amount of hot feed is available, and when this supply is exhausted the boilers drop down to their normal steaming power and the process of preparing and storing hot-feed water must commence again. A continuous method of securing steam temperature feed water is to be preferred to a spasmodic one, especially in works occupied in carrying continuous heavy loads.

Since commencing to write this Paper, the author came across a very interesting Paper read before the Belfast Mechanical and Engineering Association in 1902 on "Live Steam Feed Water Heating," by Mr. A. W. Hamilton, in which it is shown that exhaust steam heaters and other feed-water heaters, such as Green's Economisers always save more fuel than can be accounted for by the heat units which they return to the boiler in the feed water, and Mr. Hamilton quotes several carefully-made tests on economisers showing 4, 4·3, 5·7 and 4·6 per cent. saving respectively over and above the actual theoretical saving. In this Paper attention is drawn to the results obtained by the late Sir W. Anderson as far back as 1872 concerning experiments carried out with steam jacketed pans. He found that the quantity of heat passed through the metal per square foot per degree per hour was 260 units when heating water, but that the number of units was 606 after the water began to evaporate, showing a greatly accelerated passage of heat when evaporating; 2½ times as much, indeed, as when only heating. In another experiment, while heating the water to the boiling point, the heat transmitted per square foot per degree per hour was 368 units; but after evaporation began the heat transmitted was 660 units. Here the passage of heat for evaporating water was 1·8 times as much as in heating without evaporation.

The late Sir Frederick Bramwell made similar experiments with a jacketed copper pan with steam successively of 5, 10, 15 and 30 lb. pressure, raising the water in temperature from 58 to 212 deg. and evaporating it. In the first experiment he found that the rate of transmission of heat per square foot per degree per hour was 162 units, while the water was being heated up to 200 deg.; whilst in heating from 200 to 212 deg. the rate advanced to 327 units, and when ebullition commenced the rate increased to 427 units. It is thus proved that the hotter the water in the boiler the greater is the amount of heat which passes through the boiler plate per unit of superficial area, the measure of relative efficiency being the gain in temperature of the water when not steaming and the water evaporated when steaming. The increased heating power when steaming represented a gain of over 160 per cent. over the heat transmission to water at a less temperature than 200 deg. and over 30 per cent. over the heat transmission to water at a temperature between 200 and 212 deg.

The quantity of the draught of steam from a boiler has also an important effect upon the rate of transmission whatever the kind of feed may be, as it is the act of evaporation which produces a more or less rapid rate, and the lowering of the pressure (or maintenance of a pressure) by draught produces the condition of ebullition.

After explaining in a clear and consistent manner the remarkable gain in economy and output due to heating feed water with live steam, Mr. Hamilton sets out his conclusions as follows :—

1. Live-steam heaters do save fuel, and economisers show a greater saving than has been accounted for.

2. Evaporating water absorbs heat more rapidly than water which is being only heated.

3. The rate at which heat passes through a plate depends upon the difference of temperature on the two sides of the plate.

4. Evaporation always cools the surface upon which it takes place.

The live steam feed-water heater advocated by Mr. Hamilton consists of a number of perforated trays inserted in the steam space within the boiler, the feed water is conveyed up the centre stem and drips through the holes from tray to tray until finally it reaches the water level, and during its transit through the steam space it picks up a considerable amount of heat from the steam. This heater, while it is an undoubted improvement on former types of live steam heaters of the Berryman type, suffers from the serious disadvantage of having no provision for deaeration of the feed water, and all the gases occluded are introduced into the boiler, these gases have a detrimental effect on the boiler plates, and experiment has also proved that they prevent in some curious manner the steam from getting freely at the water during its transit; the gases appear to cling round the drops of water and more or less insulate them from the steam. This is proved by the fact that if water is de-aerated it will pick up the heat from the steam more freely than it does if the deaeration cocks are closed, and to get full benefit of the steam heat, effective de-aeration must be first secured. Also Mr. Hamilton's heater does not provide for the removal from the boiler of the sulphates and other salts thrown down during the heating process. The removal of these is of the greatest importance if boilers are to be worked on high duty.

Another and more recent method of increasing the temperature of the feed water to approximately that of the steam is by means of an ingenious and simple feed-water heater made by Messrs Dales & Braithwaite, engineers, of London, and the author's experiments with this apparatus in the Harrogate electricity works appear to confirm the theories propounded in the earlier portion of this Paper.

Before describing the author's experimental work and setting out the results, a short description of Mr. Dales' early experimental work which led to the development of this feed-wrter heater may be interesting.

Mr. Dales set out to find the amount of the difference in the rate of heat transmission to which reference has been made, through surfaces exposed to the absorbing action of water (1) before it reaches the boiling point, and (2) after that point has been passed, looking for a minimum commercial difference rather than for any minute effects of scientific interest In this he provided a good spring balance, on which was placed a small ordinary Bunsen flame gas stove, and over this a suitable water-heating vessel was fixed and equipped with a reliable thermometer. The water vessel was covered to prevent evaporation below boiling point at atmospheric pressure. A definite weight of water (say 4 lb.) was placed in the vessel and the temperature of the water was raised by the gas stove to 100°F. From this temperature the *time* of an increase to 200°F. was carefully noted. This signified the transmission of a definite number of units of heat from the Bunsen flame to the water within a definite time. Then the thermometer, vessel cover, &c., having been removed, the weight shown on the balance dial was carefully noted, and the water after reaching the boiling temperature was allowed to evaporate during the *same period of time* as in the former test. The weight of water lost by evaporation in the time again denoted the units of heat absorbed in that period. Careful adjustment of the gas flames was made so that they should produce uniform boiling all over the bottom of the vessel to which the heat was applied, also precautions were taken to secure uniformity in the supply of heat, by retaining a regular gas pressure. The experiments were repeated many times in each of many different sets of conditions. Mr. Dales found that the rate of heat transmission to the water after ebullition had commenced was 20 per cent. greater per unit of time than the transmission during the time occupied in raising the temperature from 100°F. to 200°F. and that this difference in the rate of transmission under the two conditions of non-evaporative and evaporative heating was the minimum which he could bring about.

It is well known in a general way that almost all the evaporation in a boiler takes place in the region of the fire box and in a comparatively small area, as the hottest part of the heating surface fixes the temperature and consequent pressure of the steam (excepting so far as this is influenced by the draught of steam from the boiler) while the pressure fixes the boiling point. It will thus be evident that the pressure prevents evaporation in all parts of the boiler where the temperature is at all under the boiling point due to the pressure; and so long as the feed temperature is under the boiling temperature, the boiling area will be less than the total heating surface. This restriction of boiling area will exist to a greater or less extent dependent on the difference in temperature of the feed water and the temperature of the steam. If all the water which is in contact with all the heating surface in any boiler could have a temperature which is equal to the boiling temperature, and if such heating surface is exposed to a higher temperature than the boiling temperature, ebullition must take place all over the heating surface, the rate of ebullition being in proportion to the different rates according to the supply of heat on such surfaces, and the maximum efficiency producible, for the supply of heat, will be the result. The extent of the boiling area depends on the temperature of the feed, and to a lesser extent upon the distribution of the heat, assuming a constant draught of steam. Following on this, it is evident that the maximum general rate of transmission of heat through the heating surface can only be attained by full temperature feed, which produces a maximum boiling area, which again has a maximum efficiency.

Several experiments have shown that the rate of transmission of heat through the heating surface of boiling area increases largely as the draught of steam increased, and does not greatly depend upon increased temperature of the furnace, though of course the maintenance of the temperature of the furnace by an increased rate of combustion corresponding to the increased draught on the steam is necessary. Speculations on the nature of the act of evaporation which are put forward by Mr. Dales may not be out of place at this point. Taking the heat required for evaporation from a quantitative point of view, and assuming 100 lb. pressure absolute as a basis of argument, the total heat of the water from the absolute zero at the point of evaporation is 686 units per lb., whilst the instant after the total heat is 1,568 units per lb. Each atom of water which passes to vapour absorbs additional heat to 2·29 times the quantity which it contained whilst in a liquid condition. This absorption takes place with the rapidity of an explosive action, which readily explains the cause of the increased efficiency of boiling surface; and whether the extra heat is absorbed from surrounding superheated particles of water or from the plate of the heating surface, the sudden convection must lower the temperature of either one or the other source of heat. The resistance of the plate to the rate of transmission which either the water or steam is capable of producing is relatively small, and almost a negligible quantity. Following the previous argument, gentle boiling may be defined as a condition of the water where the process of evaporation is taking place at sparse intervals over the heating surface, while more or less violent ebullition is a condition in which the intervals between the vaporised atoms of water are closer, and if this speculation has a sound basis it is evident that the rate of transmission depends on the maintenance of the supply of heat on the one side and the draught of steam on the other rather than upon any considerable increase or decrease in the difference of temperature between the source of heat and the evaporating water. That this is likely to be so is easily demonstrated by boiling water on a gas stove, from which the flame is at all times of about the same temperature. If it is desired to increase the evaporation it is necessary to burn more gas, the temperature of the flame being about the same in both cases. A suitable conclusion to this line of argument may be, that from boiling surface a quantity of steam can be obtained which is approximately proportioned to the quantity of coal consumed, and that this phenomenon is, within limits, practically independent of time. The limit of rate of evaporation evidently depends upon the possibility of maintaining a sufficient supply of heat to produce a condition of evaporation or boiling at the heating surface corresponding to the draught of steam, and it would appear that the provision of any considerable amount of heating surface over and above such as can be supplied by the furnace, with the necessary quantity of heat to produce boiling at the pressure, is largely futile and useless, and that a very plain and simple boiler when supplied with hot feed can reach the maximum of efficiency. What this maximum efficiency is depends, of course, on the temperature of the waste gases of the chimney and the weight of air per pound of coal consumed. Without useless tedium of illustration, perhaps the most authoritative figures may be quoted. An average sample of coal burnt with the theoretical minimum quantity of air produces 18·9 per cent. of CO_2, and as other products are of negligible quantity, this may be taken as the highest standard. The most extreme percentage of CO_2 which has occurred in practice to the knowledge of the writer is 16. This would give an excess of air over the absolute theoretical minimum of $\frac{18\cdot9}{16}=1\cdot18$, and as the theoretical minimum weight of air per pound of coal is about 12 lb., 12 × 1·18 = 14·17 lb. of air per pound of coal. The total weights of the product of combustion per pound of coal burnt would in this case be 15·17 lb., and if the products entered the chimney at 400°F., with a specific heat of 0·2386, a waste would occur of 400 deg.—say, 50 deg. temperature of atmosphere = 350 deg. × 0·2386 = about 84 units per pound of products, which at 15·17 lb. per pound of coal = 1,275 units about per pound. Taking 14,200 units of heat developed per pound of coal, the available heat in this case is about 90 per cent. of the total value of the coal, and deducting 7 per cent. for radiation, the remainder, or 83 per cent., would be the total efficiency of the boiler and economiser (192 pipes Greens). This case, however, is very extraordinary, and was provided with mechanical induced draught, the rate of combustion being about 18 lb. per square foot of grate area. The pressure in the boiler was also low, about 60 lb.

There are few cases in practice where less than 17 lb. of air is used per pound of coal, and this would give 18 lb. of products of combustion, which at, say, 400°F. – 50°F. = 350°F. terminal temperature, would have again 84 units per pound waste heat to the chimney; and at 18 lb. of products would carry off 1,512 units per pound of coal burnt. The available heat, therefore, at an ordinary maximum would be 14,200 – 1,512 per pound of coal, or 89·35 per cent., which, after deducting an allowance of 7 per cent. for radiation (which is perhaps rather low), the maximum efficiency in an unusual case of low air supply, would be 82·35 per cent. It should be observed that no allowance in this reckoning is made for infiltration of air to the flues as regards the 400°F. terminal temperature of the products of combustion, and as this is usually great, the terminal temperature would not be much over 250°F., this being as little as will give any sort of practical chimney draught even where it is induced by mechanical means.

In the case of the boiler of plain Lancashire type at the Harrogate electricity works, with which the tests appended to this Paper were made, a set of comparative trials were made for ascertaining the extra efficiency of very high temperature feed as against the high temperature feed of a three-set economiser of Green's type containing 288 pipes. The temperature of the very high temperature feed was only 10°F. below the steam temperature, and was made by the Dales & Braithwaite live steam feed-water heater shown in Fig. 1. The temperature of the economiser feed supplied to the heater was 265°F.; already very high; and 218°F. above the cold water, which was 47°F. The steam temperature was 358°F., so that the heater had to supply 93°F., to steam temperature, and actually did contribute 83°F.

The general conditions were reproduced as exactly as possible for the comparative test with the economiser only, and the net result was over 7 per cent. in favour of the live steam feed heater. With so little margin for improvement as existed in the efficiency of the boiler and economiser, the above result is remarkable, and as the tables of tests appended show, this live steam-heated feed reached the maximum efficiency attainable under the conditions the terminal temperature at the chimney bottom being lowered by infiltration of air to the flues, and the chimney draught was low, being an average of about 0·475 in. of water.

With greater differences between the economiser feed and the steam temperature, correspondingly greater improvement would naturally follow the use of full temperature feed.

The particulars of these trials, which were made at normal rates of combustion for Lancashire boilers, namely, 22·147 lb. and 24·27 lb. of coal burnt on the square foot of grate area per hour, are stated below.

1. Economiser and live steam heated feed :—

	Per cent.
Calorific value of coal, 14,200 B.T.U. per pound.	
Rate of combustion per ft. sup. grate per hour, 221·47 lb.	
Steam pressure, 150 lb. absolute temperature, 358°F.	
Economiser feed to heater, 265°F.	
Heater feed to boiler, 348°F.	
Efficiency of boiler and economiser from water at 47°F.	76·4
Efficiency of superheater	3·0
Radiation taken at	7·0
22 lb. of air at 50°F. per lb. of coal = 23 lb. of products at 400°F. + 50°F. (atmosphere) = 350°F. above atmosphere	13·6
Total heat of fuel	100 0

2. Economiser heated feed only :—

	Per cent.
Calorific value of fuel, 14,200 B.T.U. per pound.	
Rate of combustion per ft. sup. grate per hour, 24·27 lb.	
Steam pressure, 150 lb. absolute temperature, 358°F.	
Economiser feed, 234°F.	
Efficiency of boiler and economiser from water at 56°F.	69·844
Efficiency of superheater	3·27
Radiation taken at	7·0
22 lb. of air to 1 lb. coal; 23 lb. products at 571°F. terminal temperature	19·886
Total heat of fuel	100·000

In the terminal temperatures given no allowance for infiltration is made; the quantity of gas leaving the boiler is calculated from the CO_2, which was about 10 deg. per cent. The actual terminal temperatures were much lower than shown by the figures. Periodically during the highest rate combustion tests a curious phenomenon was observed. The flues and economisers became full of burning gas at a red heat, which, being generally distributed, gave a periodical increase in the efficiency of the plant. Over 1,200°F. were registered at the economiser after the three runs of the boiler flues had been traversed. This is very remarkable. Concluding this section of the Paper, the author ventures to say that hot gas, more generally distributing the heat than is the case with fires immediately surrounded by water heating surface, would conduce to the efficiency of boilers generally, and with a view to test this important point he is fitting the furnaces of a Lancashire boiler with fire-brick lining and special air inlet provisions for utilising high-rate combustion in this manner. The rate of combustion is limited by the temperature of the furnace, and only fire-brick lining can raise this to the necessary point for the rapid rates of combustion which are required.

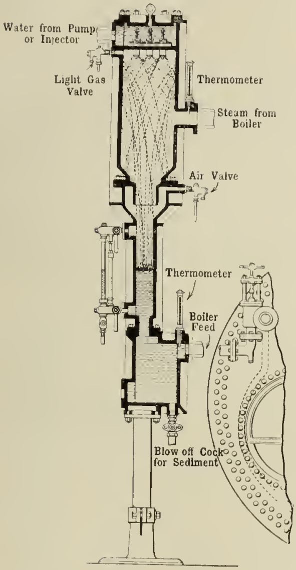

Fig. 1.

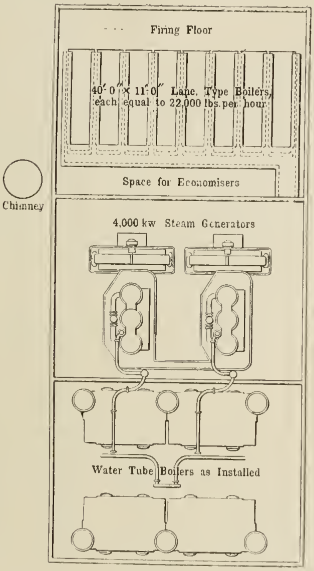
Firing Floor
40'-0" × 11'-0" Lanc. Type Boilers, each equal to 22,000 lbs. per hour
Space for Economisers
Chimney
4,000 kw Steam Generators
Water Tube Boilers as Installed

Fig. 2.

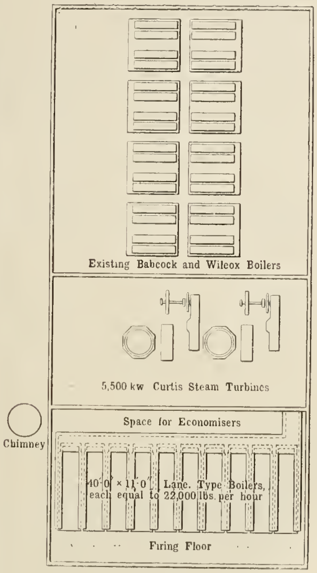
Existing Babcock and Wilcox Boilers
5,500 kw Curtis Steam Turbines
Chimney
Space for Economisers
40'-0" × 11'-0" Lanc. Type Boilers, each equal to 22,000 lbs. per hour
Firing Floor

Fig. 3.

The construction of the feed water heater is shown in Fig. 1, which almost explains itself. The water is fed from pump or injector to spray valves in the upper part of the apparatus, which forms a steam chamber in direct open communication with the boiler steam at full pressure. Steam free of air or gas is maintained by constant slight blowing at the lower or heavy gas or air valve and also at the light gas valve in the upper part of the steam chambers. Air is, of course, about double the weight of steam of any given pressure, and it settles to the lower part of the steam chamber to be eliminated by the air valve, while lighter gases than steam sometimes generated from bad water and often very troublesome in condensers are eliminated from the upper valve. Without this arrangement the air and gases would accumulate, and both spoil the conductivity of the steam for heating and exclude the steam from the vessel by displacement. The water gauges indicate the level of the water in the heater, for comparison with that in the boiler. The heated water overflows by gravity to the boiler from the top of the deposit vessel and the separated incrusting matter is eliminated at the blow off cock at the bottom.

EXPERIMENTAL INVESTIGATIONS.

The boiler on which the experiments were made is as follows:—

30 ft. by 8 ft. 6 in. diameter Lancashire boiler with flues, 3 ft. 5 in. diameter, made with Adamson's rings and heating surface, 1,100 sq. ft., no smoke or water tubes. The grates are 3 ft. 5 in. by 5 ft., 34 ft. sup. area, and the boiler carries a working pressure of 130 lb. per square inch, and is fitted with Whitehead furnaces, slightly forced draughts being produced by steam jets blowing into the metal boxes beneath the fire bars.

The steam feed heater is located between the boiler under test and the next adjoining.

Connections are made so that hot feed water from the economiser or a cold feed may be supplied to the steam heater. The boiler may also be fed through other check-feed valves by hot or cold feed direct, independent of the steam feed heater.

The water supplied to the boiler was measured in two tanks of known capacity, constructed specially for these and other like tests, one tank being filled while the other tank is discharging to the boiler-feed receiver below. By this means was obtained an accurate record of the water used, and the same was checked by a water meter which agreed within 1 per cent. The water was fed to the boiler by a Weir steam pump, and later by a three-throw electrically-driven feed pump, and through a Green's economiser containing 288 tubes in the case of the experiments on hot feed. The temperatures of the water were taken by standardised thermometers, and the flue gases by standardised pyrometers. Many of the latter, however, proved so unreliable and variable that the readings are not given. The coal used was carefully weighed and its calorific value determined by a Thompson's calorimeter. The flue gases were slowly and continuously drawn off into receivers and tested from time to time by D'Orsat apparatus. The furnace gases pass through a flue dipping beneath the boiler-house floor and discharge into a 120 ft., stack 7 ft. diameter, at the back of the works; the suction in the various flues and the chimney bottom was taken by means of Admiralty pattern "U" water gauges.

The analysis of the fuel used in firing the boiler is as follows:—

Tests made on Sample after Drying.

Moisture, 3·42 per cent.; ash, 6·35 per cent.; coke, 65·90 per cent.; volatile matter, 34·10 per cent.; fixed carbon, 59·55 per cent.; calorific value, 14,243 B.T.U.

The tabulated tests were carried out on a regulation type Lancashire boiler with ordinary type accessories, and they indicate the increased duty and efficiency which may be expected by the introduction of steam-heated feed water; less than the average advantage is shown by the figures given, as the boiler bottom was newly cleaned, as also were the economiser pipes, and therefore the bottom water was hotter than is usually the case, due to the ready conduction of heat from the bottom flue. The results would have been better if the feed water had been raised higher so as to approximate more closely to the steam temperature, and in a permanent installation this would be secured.

Fig. 2 shows the 4,000 kw. generating sets at the Bow works of the Charing Cross, West End & City Electric Supply Co. with their boiler house equipment, and on the other side is a single row of 11 ft. by 40 ft. modified Lancashire type boilers which would be capable of steaming these plants. Fig. 3 shows a like comparison between the boiler house equipment at the Fisk-street works of the Commonwealth Company in Chicago. The author's comparisons do not necessarily mean that Lancashire type boilers are alone capable of high duty, or that the watertube boiler is not equally fitted for high duty if subjected to similar modifications and worked under like conditions.

WASTE OF FUEL IN BOILER FURNACES.

When 1 lb. of coal is burnt with, say, 20 lb. of air, a certain temperature is attained in the products of combustion, and this temperature is the same, with the same proportionate weights of coal and air, whatever the quantity of coal may be which is burnt per square foot of grate per unit of time. No increase of temperature from the combustion of the pound of coal can be had without a decrease in the quantity of air which is burned in combination. It follows, therefore, that when the whole heating surface of a boiler has reached its maximum rate of absorption per unit of time for the difference of temperature which exists between the heating surface and the products of combustion there is a certain rate of

Boiler Tests.

Test number	1	2	3	4	5	6
Particulars of test.	Low duty cold water feed	Low duty cold water feed through steam feed heater.	Low duty cold water feed through economiser only.	Medium duty cold water feed through economiser only.	Low duty cold water feed through economiser and steam feed heater.	Medium duty cold water feed through economiser and steam feed heater.
1. Date of test	April 9	April 11	May 1	May 8	April 24	May 11
2. Duration of test	5 hours	4 hours	3 hours	$3\frac{33}{60}$ hours	$4\frac{1}{4}$ hours	$1\frac{55}{60}$ hours
3. Coal consumption in lb.	3,396	3,200	2,400	3,570	3,200	1,700
4. Average coal burnt per hour in lb.	679	800	800	1,004	752	929
5. Average weight of coal per hour per sq. ft. of grate area in lb.	20	23·5	23·53	29·53	22·147	27·3
6. Calorific value of 1 lb. coal in B.T.U.	14,200	14,200	14,200	14,200	14,200	14,200
7. Total water evaporated in lb.	25,710	26,040	20,250	25,600	29,500	14,560
8. Water evaporated per hour in lb.	5,142	6,510	6,750	7,201	5,950	7,956
9. Water evaporated per hour per sq. ft. heating surface in lb.	4·67	5·92	6·13	6·54	6·32	7·23
10. Water evaporated per lb. of coal in lb.	7·57	8·136	8·437	7·17	9·218	8·56
11. Equiv. evaporation from and at 212° F. including superheat in lb.	7·98	8·47	8·76	7·43	9·58	8·87
12. Absolute steam pressure average in lb.	155	153	147	137	150	140
13. Temperature of steam at above pressure in deg. F.	361	360	357	351	358	353
14. Temperature of superheated steam in deg. F.	504	484	439	440	457	474
15. Superheat in deg. F.	139°	124	82	89	93	121
16. Temperature of cold feed water in deg. F.	48°	48·1	49	52	47	52
17. Temperature of water in bottom of boiler in deg. F.	334	344	343	345	341	343
18. Feed temperature from economiser	..	..	237	218	265	213
19. Feed temperature due to the steam feed heater in deg. F.	..	348	..	..	348	333
20. Temperature of feed water entering boiler	48	348	237	218	348	333
21. Temperature of gases leaving boiler flues in deg. F.	809	826	..	420	..	508
22. Temperature of gases leaving economiser for chimney	..	..	256	222	284	217
23. Temperature of Atmosphere in shade	56	62	53	59	49	61
24. Draught under fires due to steam jets	+0·25″	+0·25″	+0·01″	+0·15″	+0·21′	+0·28′
25. Draught inside flues of boiler (terminal)	0·27″	0·23	0·15	0·17″	0·2″	0·3″
26. Draught at base of chimney	0·60″	0·54″	0·38″	0·34″	0·4′	..
27. Average CO_2 by analysis	8%	8·6%	10%	11·4%	10%	10·5%
28. Pounds of air per lb. of fuel by calculation	27·4	25·5	21·9	19·06	21·6	20
29. Combined efficiency of plant	66%	70·8%	72·0%	61·1%	79%	73·87%
30. Percentage efficiency due to boiler and superheater	66%	70·8%	62·3%	53%	64·16%	64·23%
31. Percentage efficiency due to economiser	..	..	9·68%	8·07%	14·14%	9·64%

combustion or heat supply which will maintain such rate of absorption. Any further increase in the rate of combustion, using the same quantity of air per pound or unit of weight of combustible, simply increases the quantity of gas which passes through the flues without increasing the rate of evaporation.

This line of reasoning may be said to be inapplicable to boiler practice on the ground that the position of such a set of conditions is never reached. Experimental data, however, shows that it does apply, relatively, all along the line, the very fact that, as the rate of combustion per unit of grate area per unit of time increases, the weight of water evaporated per pound of coal consumed decreases, being sufficient proof. In the course of the experiments which have been made in this connection at the Harrogate works, the following results were observed:—

At a rate of combustion of 35 lb. per square foot per hour the water evaporated was 8·08 lb. per pound of coal. 35 × 8·08 = 282·8, which is the pounds of water evaporated per square foot of grate area per hour.

At 43·75 lb. per square foot of grate area per hour, the water evaporated was 6·425 lb. of coal, and 43·75 lb. × 6·425 is 281·0 lb. of water per square foot of grate per hour.

Again, at 47·7 lb. per square foot of grate per hour, the water evaporated was 5·91 lb. per pound of coal, and 47·7 × 5·91 comes to 281·3.

As all these results were from consecutive experiments and with the same draught of steam, and were obtained by simply burning the coal at the different rates, it is evident that the maximum absorption for the steam draught had been reached, and that the same quantity of steam was evaporated for the 35 lb. of coal per square foot per hour as for the 47·7 lb.

The absorption of the boiler for the steam draught was evidently 282 lb. per square foot of grate area, equal to 9,588 lb. per hour, or about 160 lb. per minute.

More experimental data on these lines for other steam draughts would be useful; but it is sufficiently evident that every steam draught has its corresponding rate of absorption for any evaporating system whatever, and that the rate of combustion which corresponds with such rate of absorption should be carefully ascertained and tabulated, so that the boiler-house staff may know what quantity of coal to fire for any given work required, and so avoid waste by burning more fuel than can have any useful effect.

As an outcome of the Harrogate tests and the observations which led to the above conclusions, an instrument has been devised which will approximately show the draught of steam from the boiler and the corresponding quantity of fuel which, according to the calibration of the boiler steaming capacity, should be burnt in the furnace. These indications cannot fail to be of great assistance to the boiler-house staff in preventing the waste which is constantly going on from over-combustion. It is not known to the author that there is at present any instrument in use which shows at sight both the draught of steam and the quantity of coal which ought to maintain it.

The foregone figures were obtained by actually weighing the coal and the water, and are no mere deductions made to fit a theory, but rather were results which made a theory.

Following on this, it becomes evident that a first necessity of boiler efficiency is the adoption of a system of feed, which will ensure the maximum rate of absorption, and this must be certainly the hottest of the hot feed. In the Harrogate installation the temperature of the feed is from 10° F. to 12° F. of that of the steam in the boiler. No practicable surface contact heating system can reach this point, nor can any surface contact system maintain any grade of efficiency permanently. Direct steam contact with the feed water to be heated becomes therefore a necessary feature for either the attainment or maintenance of a very close temperature in the feed water.

General Conclusions.

1. Boiler house plant can with advantage be reduced in size, and the duty increased with a saving in capital, working expenses and upkeep, and this without sacrifice of efficiency.
2. In high duty boiler plant the heating of feed water to the steam temperature (or to a temperature closely approximating thereto), and the actual generation of steam should be treated as separate and distinct operations each demanding its own special plant.
3. The terminal temperature of the flue gases leaving the steam generators will be higher, the residue down to the chimney temperature being taken up by the feed water and possibly air heating plant, provided with scrapers to remove the soot and flue dirt from the heating surfaces.
4. Intense heat applied to a restricted area curtails the area of ebullition within the boiler. High duty demands a more extended distribution of the furnace heat than is generally obtained at present.
5. For high duty with efficiency, clean boilers, good water and steam temperature feed water are essential conditions.
6. Boiler house plant designed for low duty (say, from 3 lb. to 5 lb. of water per square foot of heating surface) cannot be fitted for efficient high duty without considerable modification such as the enlarging and rearrangement of the furnaces, the cutting out of the "tail end" of the heating surface, and the provision of plant for taking up the heat from the gases emitted from the boiler flues and transferring same to the feed water and air heaters.

(*To be concluded.*)

THE BACKSTROM-SMITH STEAM TURBINE.

One of the first examples of this new type of turbine has been recently set to work in a station of the Milwaukee Electric Railway Co. where it is coupled to a 400 kw. alternator. The set is described in a recent issue of the *Street Railway Journal.* The turbine is of the multicellular inward flow type, and works under constant stage pressures with varying quantities of steam to suit varying loads. It is provided with means for meeting the requirements of changing loads without throttling, making it nearly as economical for light loads as for the heaviest. This object is accomplished by using flexible steel bands, which are secured to the periphery of the nozzle sections and to spools or rollers mounted on a collar or ring, which has a limited rotary travel around the housing in which each turbine wheel revolves. A movement of this collar winds or unwinds the steel tape on each of the spools, uncovering or covering the series of nozzles or ports, which admit steam to the active buckets of the turbine wheels. This winding or unwinding of the steel tape is automatic, the device being so arranged that the flow of steam is always in proportion to the load, steam entering the different stages at a pre-determined and constant pressure but in varying quantities, which depend upon the number of nozzles covered or uncovered by the steel tapes. This automatic regulation is accomplished by means of a shaft running the full length of the turbine in the bottom of the housings. At proper intervals on this shaft are keyed pinions which engage corresponding teeth, cut in the ring or collar on which the several tape rollers are mounted, these rollers engaging with short racks secured to the nozzle ring or housing. The minutest motion of the shaft results in winding or unwinding the tape on the rollers, thus closing or opening more or less of the nozzles. The motions of the shaft operating this ingenious cut-off mechanism are controlled by a governor which controls a flow of oil under constant pressure, and by means of a pressure cylinder and a rack and pinion, rotates the shaft in one or the other direction. The governor is dependent upon the proper action of the lubricating mechanism, as any accident to the latter results in an automatic stopping of the turbine which insures the machine against self-destruction. In addition to this governor, with its two important functions, a safety device is provided in the shape of a safety governor controlling a butterfly valve, which closes automatically when the turbine speed reaches 5 per cent. above the normal, but is otherwise inoperative.

The 400 kw. size has 10 wheels or runners. The bucket face of each successive wheel being wider. All the runners have an equal number of buckets of a uniform cross-section. This feature applies also to the nozzles.

It is held that superheated steam is not as essential to the economical operation of this turbine as in others. In the first place, it is claimed that there is a minimum of condensation, because of the constant pressure and temperature maintained at all loads in all the stages of the turbine. The next contention is that all the water contained in the steam is separated from it and that this drained into the succeeding stage by automatic means, is at once in part, if not wholly, re-evaporated, thus becoming useful energy. Again, by using high steam velocities, the surplus velocity appears in the form of superheat—which greatly reduces internal condensation and skin friction.

A turbine of this type, built and installed for use in connection with a condenser, is arranged so that it may be quickly converted into an economical non-condensing type, should the condensing apparatus get out of order or become inoperative. This is done by providing an auxiliary exhaust at a point favourable for exhaust to atmosphere. This early exhaust relieves the turbine from a certain amount of back pressure which would arise from forcing a large volume of already fully expanded steam through a number of useless and idle turbine wheels, causing a considerably reduced efficiency and other unfavourable effects.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.

"Electric Power Transmission." By Louis Bell. 4th Edition. (London: Archibald Constable & Co.) 16s. net.

"Electricity in Homes and Workshops." By Sydney F. Walker. Fourth edition. (London: Whittaker & Co.) 5s. net.

"Electric Wiring, Diagrams and Switchboards." By Newton Harrison. (London: Crosby Lockwood & Son.) 5s. net.

"Atlas of the World's Commerce." By J. G. Bartholomew. Part 5. Price 6d. net. (London: Geo. Newnes, Ltd.; New York: F. Warne & Co.)

"Electric Wiring." By W. C. Clinton. 4th edition. (London: John Murray.) 2s.

"Proceedings of the Royal Society." Series A. Vol. LXXVII. No. A520. Mathematical and Physical Sciences. (London: Harrison & Sons.) 2s.

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THE GREENWICH OBSERVATORY.

IT was a most unfortunate chance that placed the site of the new power station of the London County Council upon the meridian of Greenwich, and a matter of some surprise that the authorities of Greenwich Observatory were not earlier able to foretell and guard against the disturbances of which they now complain. The matter was again brought into prominence last week, by Lord ELLENBOROUGH in the House of Lords, whose remarks are reported in another column together with the short debate that followed. It is strange that in all the clauses in the various Bills which led up to the establishment of the London County Council Electric Tramway system, no adequate provisions were included for the protection of the Royal Observatory. One protective clause was referred to by Lord TWEEDMOUTH under the name of the Observatory clause, but, as we shall see, the protection it affords is by no means complete. The clause in question is not a part of the 1902 London County Council Tramways and Improvements Act, as was stated in the House of Lords, but forms sec. 4, sub-sec. 7 of a previous Act, the London County Tramways (Electrical Power) Act of 1900. It is worthy of note that at the stage which the development of the tramway scheme had then reached, Greenwich had not been settled upon as the site for the power house. It was the 1902 Act which contained the provisions for the acquirement of the site on the famous meridian; but strange to say, although the most elaborate precautions were then taken in this later Act to safeguard the interests of the War Department, the neighbouring railways and local property owners, no word is contained as to the interference with the working of the Observatory. On the other hand, the 1900 Act, which gave the Council power to equip electrically tramways in Greenwich, but, as we have said already, did not provide for the erection of a gene-

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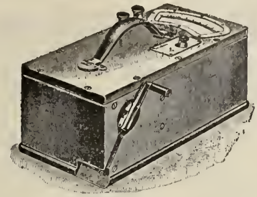

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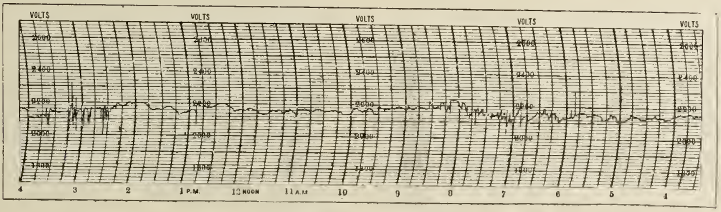

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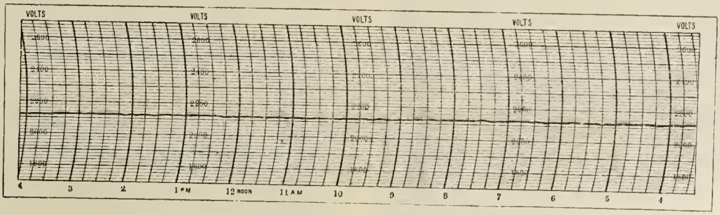

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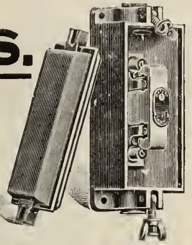
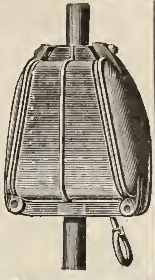

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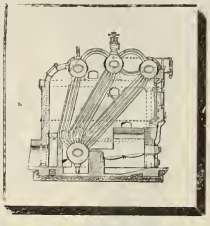

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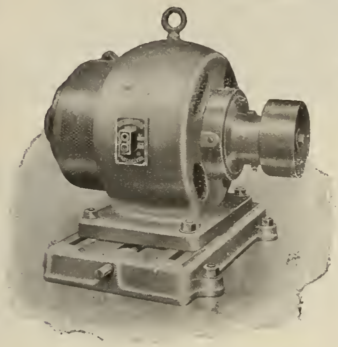

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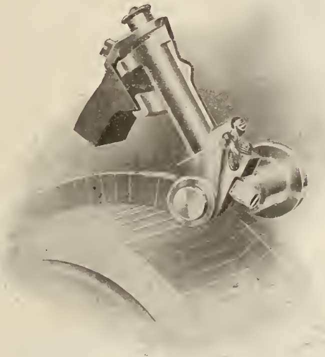

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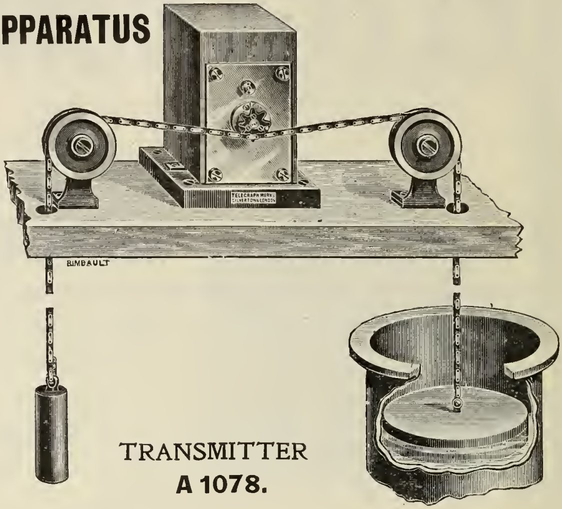

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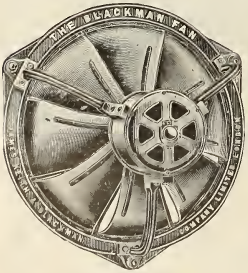
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rating station in that locality, contains the following sub-section :—

> §4 (vii.) When any department of Her Majesty's Government represents to the Board of Trade that the use of electrical power under this Act injuriously affects, or is likely to injuriously affect, any instruments or apparatus whether electrical or not used in any observatory or laboratory belonging to or under the control of that department the Board of Trade after such inspection or inquiry as they may think proper may by their regulations require the Council to use such reasonable and proper precautions, including insulated returns as the Board of Trade may deem necessary for the prevention of such injurious affection. For the purposes of this sub-section any inspector of the Board of Trade may, during his inspection of the Council's works and apparatus, be accompanied by any person or persons appointed in that behalf by the Government Department concerned, and the Council shall give all due facilities for the inspection. Provided, always, that in the case of any observatory or laboratory established after the passing of this Act or of any instrument or apparatus hereafter used in any existing observatory or laboratory which may be of greater delicacy than those used therein at the passing of this Act, the Board of Trade shall consider to what extent, if any, it is expedient, in the interests of the public, that the powers of this sub-section should be exercised, regard being had to the site of the observatory or laboratory, or the purposes of the instruments or apparatus as the case may be.

It is, perhaps, open to question whether this clause may be held to cover disturbances incidental to the *generation* of electric power under the Act as well as its *use*. Again, it is evident that the particular disturbance on account of which the clause was framed, was that due to leakage of the return current from the rails, and that neither vibration nor effects caused by the position of the chimneys were considered, as the station was then to be in Camberwell.

Whatever may be the views held regarding the correct manner of dealing with the problem, there is no doubt that a disturbance has actually been produced, although possibly not so great as some would have us believe, and that if the station is completed on its present lines, the magnitude of the perturbation will be much increased. It is useless to weigh up the relative importance of the work of the two organisations and say that the one or the other must cease its operations. It is absurd also to talk lightly of the removal of the Observatory or the partial discontinuance of the observations of world-wide importance which have been carried on there for so long, and equally irrational is the demand for the abandonment of a generating station upon which such an immense amount of public money has already been spent. We said, when the matter was first brought before the public, that it must be approached in a spirit of compromise, and we desire to emphasise this ; it cannot be fought out to the death. The mistake, as Lord Goschen pointed out, is not due to one, but to many, and several must unavoidably suffer for it. The first thing to be done is to investigate thoroughly the extent of the evil, and we are pleased to see so suitable an expert proposed for the task as Prof. Ewing, whose experience in the handling not only of instruments but also of Committees renders him eminently the right man for the purpose.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books).

◆

Water Softening and Treatment. By William H. Booth. (London : A. Constable & Co.) 7s. 6d. net.

This is a very practical book, and will be of considerable use as a text book for all engineers, and particularly for power-station engineers. The book is written from a practical point of view throughout, and by one who has evidently dealt with the subject matter in person. The first chapters deal with the various sources of water and their relation to strata, and the chemical compositions and impurities usually found in such waters. The simple chemical relations of the salts responsible for incrustation and their equations, and the chemical action of the reagents commonly used are then dealt with, together with a practical treatise on the effect of scale, grease and organic matter on the raising of steam.

A useful chapter is that on water analysis from a steam user's point of view, together with a practical description of the usual simple tests. The following chapters then deal very thoroughly with the various kinds of apparatus generally used in water softening and detartarising. These are amply and well illustrated, together with tables which will be of much use for reference.

The author then gives a treatise on filters, including the construction of filter beds as might reasonably arise in practical work. Boiler compounds are dealt with, but one is sorry to learn that "by far the most usual method of treating boiler feed for prevention of scale . . . is to add to the feed water tank certain compounds." Even in railway work, nowadays, the tendency is to soften the water where necessary at the local reservoirs and not in the locomotive boilers. The next section then deals with oil separation, and the various methods employed, both chemical and mechanical, and is very thoroughly illustrated. An appendix to this section is given, being an abstract from the report on incrustation in boilers by Dr. Angus Smith, followed by other appendices giving useful data required in practice.

The author then goes on to deal with condensers and their auxiliaries, and after treating the physical problems connected with them proceeds to a very full description of the various forms of condenser, including the most modern and up-to-date kinds, such as Parsons supplementary condenser arrangement which appears to be so necessary with turbine work. Every leading type of air-pump is given, together with practical hints as to the lay-out of condensing systems. The author is barely correct in his reference to the Newcastle-on-Tyne Manors Power Station, where a turbine is direct coupled to the shaft of a motor pump and the resultant work on the pump is very small.

Feed heating is very thoroughly dealt with, both through the agency of economisers and steam heaters ; and an important and interesting chapter is devoted to the practical application of stage heating in the generation of steam. A section is then given on water cooling, which is particularly full of practical information. The book concludes with a description of the usual types of feed pumps and injectors, and with useful tables and definitions.

Altogether the book is distinctly one to be included among the text books for students, and the reference books of practical engineers. John F. C. Snell.

Die Vorgänge in Ein- und Mehrphasengeneratoren. By J. Rezelman (Stuttgart : F. Enke.)

The first half of this treatise is devoted to an examination of the occurrences at short-circuit. The part played by the higher harmonics is shown to be by no means negligible. Recent events have demonstrated that some of the engineers entrusted with the designing of large alternators have been utterly oblivious of the very existence of complicated phenomena at short-circuit (which is more or less the condition when two machines are badly synchronised), and it was high time that an engineer of the author's evident capacity should give serious attention to the formulation of a theory bearing on the conditions involved. It is not creditable to the electrical engineering profession that important machines should be built and put in service only to be wrecked at the first mischance, owing to their having been constructed without the slightest regard for phenomena which have for a long time been common knowledge to all well-informed designers of dynamo-electric machinery.

The latter sections of the treatise deal with the subject of the inherent regulation of alternators. A method for the predetermination of the inherent regulation curve is expounded, and is shown to successfully emerge from the ordeal of comparisons with test results. Thus still another is added to the already long list of attempts to predetermine the characteristics of alternators. This newest attempt is, however, more on the lines recognised as sound when considered in the light of recent investigations. Progress was for a long time retarded by the frequent use of high-sounding but meaningless expressions, such as the "synchronous impedance" of alternators, and, in general, the attempt to gloss over our ignorance by a display of imposing formulæ, has accompanied the early stages of the study of each new type of dynamo-electric machinery.

The nature of the subjects handled in the earlier sections of the present treatise is precisely such as to justify adopting a mathematical treatment, but the author intersperses this with clear statements at each stage and with carefully-prepared diagrams. The author's plan appears to have been to discard mathematical treatment for plain prose to as great an extent as was permitted by the nature of his task.

HIGH-SPEED AND HIGH-VOLTAGE CONTINUOUS-CURRENT DYNAMOS.

BY H. M. HOBART.

In view of the rapid progress in the development of the steam turbine, the practicability of designing continuous-current dynamos for high speeds becomes a question of considerable importance. While it is well known that a number of fairly successful continuous-current dynamos are now in service, it is coming to be recognised that the difficulties attending the design and construction of such machinery are sufficiently great to demand being treated with greater respect than was originally accorded them.

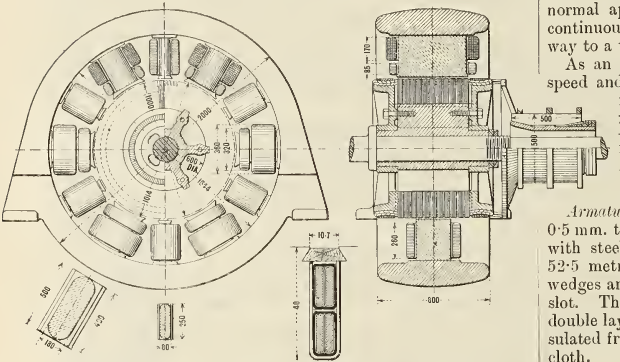

FIG. 1.—GENERAL ARRANGEMENT OF HIGH SPEED CONTINUOUS CURRENT GENERATOR.
1,000 kw. 6 poles. 1,000 volts. 1,000 revs. per min.
Dimensions in millimetres.

In the first place it may be said that the lowest speed which the steam turbine designer is likely to agree to adopt, will be much higher than would be desirable for the continuous-current dynamo driven from the turbine. This has been pointed out again and again by a few designers including the present writer, but for the time being the assertion of large numbers of other designers that there would be no trouble in obtaining excellent results at any speed preferred by the steam turbine designers, led to the building of a good many continuous-current dynamos for very high speed. While this has resulted in a long series of disappointing results, it has served the useful purpose of stimulating the development of ways and means for obtaining better commutation at high speeds. Chief amongst these means stands the use of commutating poles, which, as has been pointed out by Dr. Breslauer* in a very clear and interesting article on the subject, are due to Menges, Swinburne, Fischer-Hinnen and others. Dr. Breslauer reminded the reader that Menges' patent was granted in 1884, and that Fischer-Hinnen's descriptions date from 1891.

The writer's practice is to proportion the commutating pole to overcome the reactance voltage, and without reference to overcoming armature interference; hence the commuting pole is as short in the direction of the shaft as is permitted by this plan of procedure. Aside from the question of overcoming the reactance voltage, there is also the difficulty of avoiding undue heating of the commutator without employing excessive length. The diameter of the commutator must, in the first place, be so small as to avoid immoderately high peripheral speeds. As is well known, the lower the peripheral speed the better is the performance of carbon brushes under otherwise equal conditions. But with carbon brushes it is desirable also to restrict the current density at the brush surface to a low value. Hence the smaller the diameter for a given amount of current to be collected, the longer must be the commutator. Graphite brushes, copper brushes, or some new development, may ultimately improve matters in these respects, but in the meantime the smaller the current to be collected, the more satisfactory may be the design. Realising the importance of studying these questions, the writer has recently worked out a large number of high-speed continuous-current dynamo designs for various outputs and voltages, ranging up to 4,000 kw. and 4,000 volts. Of course, in such work, a number of questions arise which require very careful study, and it must be admitted that at this stage it is impracticable to speak with full confidence as to the results to be looked for. But in a general way, the difficulties decrease with increasing voltage, and a 4,000 kw. 2,000 volt 500 revs. per min. continuous-current design gives every indication of being a sound proposition. This may be of interest, since it has generally been considered that single machines of so large capacity at normal load were only satisfactory for alternating-current generators. But when associated with pressures of 2,000 to 5,000 volts, the utility of large continuous-current sets becomes apparent. When designed for high pressures at the commutator, the abnormal appearance which has come to be associated with a continuous-current dynamo connected to a steam turbine, gives way to a well-proportioned design.

As an instance of a design for moderately high voltage, speed and output, it may be of interest to describe a study made by the writer for a 1,000 kw. 1,000 volt 1,000 revs. per min. continuous-current dynamo. It is not put forward as by any means an ideal design, but more as a rough draft for the purpose of concentrating ideas and for effecting comparisons.

An outline sketch of the machine is shown in Fig. 1.

Armature.—The armature core is built from laminations 0·5 mm. thick, mounted on a well-ventilated cast-iron spider, with steel end brackets. The external peripheral speed is 52·5 metres per second, which is not excessive. Hardwood wedges are adopted to secure the armature conductors in the slot. The armature end connections are kept in place by a double layer of steel binding wire. The binding wires are insulated from the armature winding by a layer of mica-lined cloth.

Commutator.—The commutator is built up on a cast-iron sleeve, which permits of access of air through the interior. The segments are secured against centrifugal forces by three steel rings shrunk on over mica bands. The peripheral speed is 26 metres per second, which is moderately low for this class of machine.

Brushes and Brush Gear.—Carbon brushes are employed. These must be carried in a form of holder suitable for preventing excessive vibration at high peripheral speeds.

Magnet Frame.—The yoke is of cast iron and is split just below the middle pole on either side. The magnet cores are of cast steel of elongated cross-section with rounded ends.

Commutating Poles.—These are of cast steel and are placed equidistantly between the main poles. The winding consists of 23 turns of edge-wound copper strip. A diverter rheostat is used in parallel with this winding, which is adjusted to give good commutation at all loads.

Designing Data for 1,000 kw. 1,000 volt 1,000 r.p.m. Continuous-current Generator.

Number of poles	6
Kw. output at rated load	1,000
Speed in revs. per min.	1,000
Frequency in cycles per sec.	50
Terminal voltage	1,000
Amps. output at full-rated load	1,000

---

* *Elektrotechnische Zeitschrift*, July 13, 1905, p. 610.

General Dimensions.

Armature.

	Cms.
External diam. of laminations	100
Diam. at bottom of slots	92
Internal diam. of laminations	60
Gross length of core between flanges	50
No. of ventilating ducts	8
Width of each duct	1·0
% insulation on core plates	10
Effective length of core	36
No. of slots	162
Depth of slot	4·0
Width of slot as stamped	1·07
Width of slot assembled	1·04
Av. width of tooth	0·8

Magnet Core.

	Cms.
Length of pole face parallel to shaft	50
Mean length of pole arc	29
Width of magnet core parallel to shaft	49
Width of magnet core at right angles to shaft	18
Thickness of pole shoe at centre of arc	2·0
Radial length of magnet core	27
Radial depth of air gap	0·7

Yoke.

	Cms.
External diam.	200
Internal diam.	164
Thickness of yoke	17·5
Axial width	80

Reversing Pole Core.

	Cms.
Length of pole face parallel to shaft	25
Length of pole arc	10
Radial depth of air gap	0·8
Width of magnet core parallel to shaft	25
Width of magnet core at right angles to shaft	8·0
Cross section of core..sq. cms.	184

Electrical Data.

No. of face conductors	648
No. of slots	162
No. of conductors per slot	4
Style of winding..circ. single	6
No. of circuits through armature	6
Total amps. from com'utator.	1,000
Amps. per circuit	167
Mean length of one turn..cms	230
Turns in series between brushes	54
Total length of conducting paths between brushes ..cms.	12,400
Height of bare conductor	1·48
Width of bare conductor	0·28
Cross section of one conductor ..sq.cm.	0·392
Cross section of all parallel conductors	2·34
Resistance of armature windings from + to − brushes at 60°C. ..ohm	0·0106

Commutator Calculations.

Commutator diam. ....cms.	50
No. of segments	324
Thickness of segment + insulation at periphery..cms.	0·485
Total length of commutator ....cms.	50
No. of sets of brushes	6
No. of brushes per set	14
Width of brush ....cms.	2·0
Length of arc of contact.. ,,	2·0
Contact surface per brush ,,	4·0
Amps. per sq. cm. of brush contact surface	6·0
Peripheral speed of commutator	26
Reactance voltage	20·0

Magnetic Data.

Terminal voltage at rated output	1,000
Total induced voltage at rated output	1,020
Flux entering armature per pole at rated full load ....megalines	9·5
Leakage factor for main magnetic circuits	1·35
Flux generated per pole at rated full load ....megalines	12·4

Ampere-turns required for Full-load Voltage, but at No Load.

	Density in lines per sq. cm.	Total ampere-turns per pole.
Armature core	8,250	70
Armature teeth	20,700	1,720
Air gap	7,200	4,030
Magnet core	15,200	1,400
Magnet yoke	4,550	1,000
Total amp.-turns for full-load voltage, but at no load		8,224
Amp.-turns provided by shunt winding		8,000
Amp.-turns provided by series winding		4,800

Magnetising Winding Calculations.

Shunt Spool.

Axial length of winding..cms.	17
Depth of winding ,,	8
Gauge No. of conductor.B.W.G.	17
Amp. in the winding	2·25
Current density in amp. per sq. cm.	132
Watts lost per spool	314
Weight of copper per shunt spool ....kgs.	81

Series Spool.

Dimens. of conductor cms.	6 × 0·47
No. in parallel	2
Total cross-section....sq. cms.	5·65
No. of turns per spool	6½
Current in winding	740
Current density in amp. per sq. cm.	130
Watts lost per spool	180
Weight of copper per spool .kgs.	47

Reversing Pole Winding.

Length of winding ......cms.	26
Depth ,, ... ,,	6
Dimens. of conductor cms.	6 × 0·45
No. in parallel	2
Total cross-section....sq. cms.	5·4
Turns per spool	23
Watts lost per spool	340
Current density in amp. per sq. cm.	116
Kgs. of copper per spool	91

Armature Losses.

Copper Loss.

Total amp. from commutator	1,000
Resistance of winding from + to − at 60°C. temp. rise	0·0106
Watts lost in armature winding	10,600
Weight of armature copper kgs.	260

Iron Loss.

Tot. weight of laminations kgs.	1,200
Flux density in core, kilo-lines per sq. c.m.	8·25
Periodicity in cycles per sec.	50
Total core loss........watts	14,000
Friction & windage losses watts	4,000

Heating.

Armature watts lost per sq. dcm.	91
Commutator watts lost ,,	69·0
Shunt spool watts lost ,,	10·7
Series spool watts lost ,,	15·0
Reversing pole spool watts lost.........per sq. dcm.	15·0

Total Losses.

Total constant losses	22,840
Total variable losses	17,810
Total	40,650

Commercial efficiency at full load ....96 per cent.

Weights of Effective Materials.

	kgs.
Armature copper	260
Commutator copper	470
Shunt spool copper	488
Series spool copper	282
Reversing pole spool copper	550
Armature laminations	1,200
Magnet cores, cast steel	2,140
Reversing pole cores, cast steel	260
Yoke, cast iron	12,000
Total weight of effective material	17,650

Costs.

	Shillings.
Total cost of copper	4,100
Total cost of effective iron	3,320
Total cost of effective material	7,420
Total cost of effective material per kilowatt	7·41

NATIONAL PHYSICAL LABORATORY.

The new electrical laboratory was opened by Mr. R. B. Haldane, K.C., M.P., the Secretary of State for War, on Tuesday, in the presence of a very large company. Lord Rayleigh was in the chair, and on the platform which had been erected in the new electrical laboratory where the opening ceremony took place were Dr. R. T. Glazebrook, F.R.S. (Director of the National Physical Laboratory), Mr. J. Gavey, C.B. (Engineer-in-Chief to the Post Office), Lord Kelvin, Sir William White, K.C.B., F.R.S., Sir J. Wolfe Barry, K.C.B., F.R.S., Sir A. Rücker, F.R.S., Mr. R. Kaye Gray, M. E. Hospitalier, Sir William Huggins, Sir John Brunner, Bart., M.P., Lord Blythswood, Lord Brassey, Lord Rosse, Prof. Semenza, M. Gerard, M. Paul Janet, Sir Owen Roberts, Sir Philip Magnus, Dr. J. A. Larmor and Sir A. Geikie. A large portion of the audience was composed of the members of foreign electro-technical societies now visiting Great Britain as the guests of the Institution of Electrical Engineers. In addition to the above the following were present: Sir Joseph Swan, F.R.S., Prof. J. Perry, F.R.S., Prof. S. P. Thompson, F.R.S., Col. R. E. B. Crompton, Mr. W. M. Mordey, Mr. G. C. Lloyd (secretary of the Institution of Electrical Engineers), Mr. E. Worthington (secretary of the Institution of Mechanical Engineers), Mr. J. E. Edgcome (President of the Incorporated Municipal Electrical Association), Prof. J. A. Fleming, F.R.S., Mr. G. F. C. Searle, F.R.S., Mr. W. H. Maw, Mr. Bertram Blount, Mr. W. Duddell, Mr. A. A. Campbell Swinton, Mr. C. E. Strohmeyer, Mr. Robert Hammond and several other well-known engineers and men of science.

Lord RAYLEIGH, in opening the proceedings, said that their gathering that day marked another stage in the evolution of the National Physical Laboratory. It was nine years since Sir Michael Hicks Beach's Treasury Committee was constituted to go into the question of what should be done in the direction of a national physical laboratory. The report of that Committee was favourable, and from that time until the present, steps had been taken—some people thought them rather small—but steady progress had been made. They could now congratulate themselves upon the completion of the electrical laboratory, which it was hoped would play an important part in the development of science and electro-technics in this country. He thought they had been fortunate in many respects. They had an executive committee and a general board upon which many men of great experience, and with many claims upon their time, had helped willingly and had worked in the most harmonious manner towards the furtherance of the object for which the National Physical Laboratory had been founded. They had also been fortunate in their director, Dr. Glazebrook, and there was every reason for congratulation upon the skill with which the undertaking had been conducted.

Dr. R. T. GLAZEBROOK, F.R.S., the director of the National Physical Laboratory, in expressing a few words of thanks to those who have contributed towards the development of the laboratory, said that the need for extension was brought to the notice of the Royal Society by the executive committee in 1904, and received the cordial support of the council, who laid the matter before the Chancellor of the Exchequer. In this task a prominent place was taken by Sir Wm. Huggins, who, during his term of office exerted himself on every opportunity in the interests of the laboratory, and was a member of a deputation to Mr. Balfour, the First Lord of the Treasury, and the Chancellor of the Exchequer, to urge its claims. As a result Mr. Austen Chamberlain asked Parliament for a grant of £5,000, which was voted last session. This sum, supplemented by an anonymous gift of £2,000, had been used for the erection of the building in which they were that day. This was rendered possible by the generosity of Messrs. Mott and Hay, who had given their services as architects, and of Messrs. Mowlem, who, recognising the national character of the work, undertook to erect it at cost price. For the equipment they were indebted to many friends. Messrs. Siemens Bros. led the way with a gift of an alternate current outfit. The India Rubber, Gutta-percha & Telegraph Works Co., of Silvertown (Mr. R. K. Gray), and

Messrs. Callender had given all the cable necessary for power, lighting and experimental work. Messrs. Cromptons were supplying the switchboards, Messrs. Mather & Platt some machines, Messrs. Boltons the copper, and the General Electric Co. (Mr. Hirst) the fittings on terms of the most generous character. The heavy current battery was being obtained from Messrs. Pritchett & Gold and a switchboard for controlling it from Messrs. Reyrolles, and to both firms they were indebted for very liberal treatment. Thanks were due to the British Westinghouse Co. and the British Thomson-Houston Co. for offers which they had made with regard to certain special machines, and though at present funds had not allowed of the acceptance of these offers, he was confident that the acceptance will not be long delayed. And they had been emboldened by the kindness of Mr. Haldane and many of the guests that day to go further. About a year ago Sir Joseph Lawrence, Sir John Brunner and Mr. Bigwood organised a meeting in the House of Commons. Mr. Haldane, as President of the British Science Guild, took the chair, and a petition to the Chancellor of the Exchequer resulted in a grant for this year of £10,000. This sum was being expended in the erection of buildings for metrology, metallurgical chemistry and engineering, but it would only cover the cost of the bricks and mortar. For the equipment of the metallurgical laboratory the Goldsmiths' Co. had made a most welcome grant of £1,000. To complete the three, a sum of at least £5,000 more needed. Generous friends would follow the example of those whose names had been mentioned and of others to whose munificence they had been indebted but who wished to remain unknown. In conclusion, Dr. Glazebrook expressed his thanks to the members of his staff who had helped in designing and fitting up the building, especially to Mr. Paterson, Mr. Melsom and Mr. Rayner, who would, he felt confident, have in the future opportunities for research and investigation which it would be hard to equal elsewhere.

Mr. R. B. HALDANE, K.C., M.P., said that his great love for the National Physical Laboratory had induced him to be present in spite of great pressure of other duties. But it was not merely as an individual that he was there. The Government was keenly interested in the development of science and their regard for the National Physical Laboratory had not been merely of a platonic character; the donation of the Chancellor of the Exchequer on the scale of double what was anticipated, was an earnest of what the Government meant, and he thought that Dr. Glazebrook had correctly defined the proprieties of the situation when he made an intimation of gratitude in the sense, somewhat, of favours to come. The future would not disclose its secrets, and who could influence a Chancellor of the Exchequer? Some of the audience came from foreign lands, and they might have been struck with this fact—viz., that however well Governments in this country did in the end, in the beginning they were always unwilling. On the Continent, science came at the beginning of a period of great industrial development. The history of Germany at the time when she was recovering from the invasion of Napoleon, took a form that was very unfamiliar to us in this country. Prussia began her emancipation by founding a university and Prussia won, and in the end Germany became the victor by the sheer might of thought, and by the wonderful organisation which the might of thought enabled her to create as the foundation for her future power. With us it had never been so. We had always marched to the effort, after material prosperity, and when prosperity had been attained we had strained after science. He did not think that this had been an altogether arbitrary result. It was rather the outcome of the Anglo-Saxon temperament. There was an aversion in this land to anything that was abstract; the desire to rest on individul effort in the first instance, to do as much as possible through individual effort, and finally to turn to science and to the aid of the organisation for the completion rather than the foundation of the edifice. This led to great waste, and it was not altogether a good plan. But it did mean this: that individual effort was always very much to the fore in a country like this, and individual effort was a valuable thing, even with a national institution like the National Physical Laboratory. Nevertheless, he thought all of them—and he spoke for the Government as well—were proud of the National Physical Laboratory as an asset, and the new building was a further addition to the national asset. They were pleased to welcome those who had come from a distance. There were present representatives of that International Congress, in which his friend, Colonel Crompton, had taken such a lively interest, and there were those who were present as the guests of the Institution of Electrical Engineers, and also there was that large body of distinguished Englishmen interested in science on its theoretical and applied side who had come to witness the triumph of this institution and to rejoice over it. This brotherhood of science which brought men of different races and different temperaments together was a good sign. Those of them who knew that brilliant study of the life of Erasmus which was written by the late Mr. Froude, made a picture more noble than any ever drawn before of the life of a scholar as it used to be in mediæval times. The scholar, like the poor, might have no luxurious mode of locomotion, but there was one passport which gave him everything, and which saw him through his troubles however great, and that was the bond of learning. In those days Latin was the bond between men of all nationalities. That bond, now almost entirely vanished, had been succeeded by another which was used more and more every year—viz., the bond of science; this had brought about a great intellectual common ground which brought men together united in the effort of accomplishing a common task, and so we were getting back in a more modern and beneficial fashion to the great bond of learning which drew people together in the middle ages. The functions of the State were becoming more and more recognised and yet more and more people in different parts of the world were coming to feel that it was not merely the State, but the great individualities of which they were proud, individualities which formed a common heritage. It was not merely Frenchmen who were proud of Laplace and Lavoisier; it was not merely Germans who rejoiced in the names of Weber, Helmholtz and Gauss; and it was not merely Englishmen who spoke with pride of Newton and of Darwin. These, among others, were names that belonged to the world at large. Once they made their necessity felt by their works they remained for all time. Dealing with the apparent want of sympathy of Governments with scientific attainments, Mr. Haldane said we should not lose heart at the want of science and method in our system of Government; at the want of interest in and recognition of the more scientific claims of our time. We must take these things as the echo of the voice of the people and of the constituencies. If the cause of science was to be advanced we must turn to the people and to the constituencies, and he could not help but thinking that if on the platform our prominent orators would talk a little more of what would be saved to the country by taking thought, and a little less of what cannot be brought about even by not taking thought, the world would be a good deal further on to-day. He was pleased to be there to-day, because he felt that in the National Physical Laboratory there was a sign and a portent of the times, evidence that we were advancing in these matters. A few years ago and such an institution would have been an impossibility. The National Physical Laboratory was certainly not early Victorian, whatever else it was, and he thought they might look at it as a sign that we were coming into line with the rest of the world and recognising that it was to science that we must look for the means of maintaining ourselves in the vast competition of the world. He had the greatest pleasure in declaring the building open.

On the motion of Sir JOHN WOLFE BARRY, K.C.B., F.R.S., seconded by Sir JOHN BRUNNER, a hearty vote of thanks was accorded to Mr. Haldane for being present; and on the motion of Mr. J. GAVEY, C.B., a vote of thanks was also accorded to Lord Rayleigh for presiding.

The whole of the buildings of the laboratory were afterwards inspected.

The new building, which is to contain the electrical laboratory, has just been completed by Messrs. Mowlem from the designs of Messrs. Mott & Hay. It is planned for electrotechnical experiments, including in these photometric work. The apparatus connected with the fundamental electrical standards of current, E.M.F. and resistance will remain in Bushey House along with the standards of capacity and inductance. The main portion of the new laboratory consists of a top lighted shed 120 ft. by 50 ft., divided into two bays each 25 ft. wide. The southern of these two bays is divided transversely, thus forming two rooms, each 60 ft. by 25 ft. One of these two rooms has a glass ceiling, and the lights above are glazed with a double thickness of glass; the space between the ceiling and the roof will be heated, and it is hoped thus to maintain the temperature fairly uniform. Artificial ventilation is provided. The entering air passes over steam pipes, by which its temperature can be regulated. The room is intended for resistance measurements. The other half of the same bay is designed for heavy test work. Two bed-plates are fixed in the floor, and arrangements are made for a travelling crane traversing the length of the room. The long bay to the north of the building is for most of the ordinary test work. At the extreme west end is the main switchboard, receiving power from the dynamo room and also from the mains of the supply company, and distributing it to the machines in the building and also to the batteries.

Adjacent to this will be the machines placed on a concrete platform isolated from the rest of the building. The rest of the bay is assigned to experimental work, the western portion being reserved for alternating-current experiments, and the eastern portion for direct current. The batteries are on the top floor of an annexe to the east of the main block, above the rooms reserved for photometry; thus the direct-current work requiring heavy currents will go on in the extreme eastern portion of the main bay.

The photometric department, to the east of the main block, occupies a space 100 ft. by 20 ft., and is arranged mainly on two floors; at the south end of the block, however, there is a space extending from the ground to the roof, designed for large apparatus or for experiments requiring a range of height. Convenient galleries enable access to be obtained to apparatus at various levels. Of the two other rooms on the ground floor, one is arranged for life tests on lamps, the other for general experimental work; the photometer rooms proper are on the first floor, that to the north being for standard work and that to the south for ordinary tests and experiments. Tracks are laid in the floor, along which the photometers can be moved; one of these is the full length of the building, and gives a range of about 80 ft. for work with high candle-power lamps. Between the two photometer rooms is an office, arranged to overlook the main testing bay, and a small workshop. Above these two rooms comes the battery room. Chases in the floors and walls allow leads to be carried from this to the distributing boards situated partly on the first floor of the photometry room, partly at the east end of the main test room.

To the south of the resistance room and heavy test room is a second annexe on the ground floor, containing an office, workshop, store room, packing and receiving room; the building was planned so as to surround the resistance room entirely and thus assist in maintaining its temperature uniform.

The work of removing the apparatus from the present electrical laboratories and the photometer room will soon be commenced.

The most interesting of the recent additions to the laboratory is the absolute standard ampere balance which has been constructed from the designs of the late Prof. Viriamu Jones and Prof. W. E. Ayrton, as developed by Mr. Mather. Tests are still being carried out on this, but it will serve ultimately as the absolute standard for current. The fixed coils are wound on two marble cylinders. Each coil is a single layer of bare wire laid in a groove on the cylinder. Thus the geometrical dimensions of the coils can be measured to a very high degree of accuracy. The movable coils suspended from the arms of a balance are wound in the same manner. The balance, which has recently been set up by Mr. F. E. Smith, has been used some 50 times to determine the E.M.F. of a standard cadmium cell. No one observation differs from the mean by more than some few parts in 100,000. A Lorenz apparatus for the absolute determination of resistance has been promised to the laboratory.

Continuous current for experimental work is supplied to the electrotechnical department from two main batteries. One of these consists of 56 600 ampere-hour cells, supplying current at 110 volts over the building for experimental work and machine driving where constant speed is required; the battery can also be used for lighting, should this prove necessary, though the lighting circuits are ordinarily connected to the main lighting battery in the power house.

The second battery is for heavy current work and for experimental work generally. It consists of 60 540 ampere-hour cells arranged in 20 groups of three cells each. Each cell will give 240 amperes for an hour; thus, when the cells are all parallel, nearly 5,000 amperes at 6 volts are available. For a shorter time a still larger current can be obtained. A suitable board enables the groups to be arranged in various manners as required, and there are arrangements for charging the groups singly or in series. In addition to these a battery of 150 hour cells gives a steady supply for testing and for photometric work up to 300 volts—it is hoped shortly to increase this to 600 or 1,000 volts; while a fourth battery of 500 small cells gives a pressure of 1,000 volts for insulation resistance and similar work.

A plug circuit running round the building, connected to the main 'bus bars in the dynamo room, gives a supply at 100 volts for lights for experimental purposes, small motors, &c.

The machines are placed on the platform at the west end of the main bay, and include a 5 kw. motor-generator set for experimental purposes. The motor runs at 100 volts from the main 'bus bars or the machine battery; the generator gives single or three-phase alternating current, and the frequency can be varied within wide limits. Among the other machines will be a motor-generator set for the supply of alternating current for transformer and high-tension work, and a third set for life tests on electric lamps; this will be run off the outside supply, and will give direct current at 100 and 200 volts, or, by means of slip-rings, alternating current at 100 volts; the voltage is to be controlled by a Tyrrell regulator. Leads are taken either along the wall or in special chases in the floor to the various distributing boards; to reduce the disturbing effect on the instruments the long leads are of concentric cable.

The alternating-current board, placed near the testing station, carries the resistances, &c., required to regulate the alternator; the continuous-current testing stations are fitted with measuring instruments, which can readily be compared with the standards; a set of Kelvin balances can be used both for continuous and alternating-current work, while various sensitive electrostatic voltmeters are available for the latter.

Mr. Paterson is generally in charge of the building, and is assisted in the alternating current and photometric work by Mr. Rayner. In the resistance room, which is under Mr. Melsom's care, for delicate work, a pattern of astatic Broca galvanometer, designed by Dr. Harker, is mainly used, and the following apparatus will be permanently installed—the standard resistance measurements are carried out in the electrical standards department:—(1) A Wheatstone's bridge for ordinary resistance work; (2) potentiometers for measuring current-carrying resistances under working conditions; (3) a Thomson double bridge; (4) apparatus for measuring small resistances by the differential galvanometer method; (5) apparatus for measuring large resistances, including a constant temperature tank for cables, &c., and a standard 10 megohm resistance; (6) apparatus for conductivity measurements; (7) a constant temperature enclosure for resistances under test and ovens for high-temperature work.

In the main testing bay, the testing stations will be fitted for the rapid calibration and testing of electrical-measuring instruments, ammeters, voltmeters, wattmeters, &c., both direct and alternating.

The photometric department is designed chiefly for electric light photometry, but an ample supply of gas has been laid on from the Hampton Court Gas Co.'s mains.

The standard room will contain a photometer of the Reichsanstalt pattern with a Lummer-Brodhun head and electric appliances for the regulation and measurement of the volts.

An inspection of the laboratories was made by the visitors before returning to town, and Dr. Glazebrook and his assistants were indefatigable in their efforts to show and explain everything to all who were interested.

RELATIVE ECONOMIES OF ELECTRICAL SUPPLY FROM SMALL LOCAL STATIONS, AND FROM POWER COMPANIES.

BY JOHN F. C. SNELL.

(Chief Electrical Engineer, Sunderland.)

The advent and development of power companies has altered materially the position of the supply of electricity. The Local Government Board has wisely refused to grant loans to small district councils in certain cases, suggesting rather that terms should be arranged with neighbouring power companies. Thus it is desirable to investigate fairly the position of small boroughs and urban districts with respect to a supply of electricity.

This question is wholly one of economy; that there are some districts already supplied by gas, and in which there is no scope for electricity, may be granted; it is usual, however, to find that in many cases the gas supplied by a local company is charged at a very high price, often exceeding 5s. per 1,000 cubic ft. In such cases competition is desirable in the public interest. It must be admitted also that there are many classes of people who prefer electricity to gas as an illuminant, and also for the occasional power supply required in such districts. In these days, if public opinion demands a commodity, it will obtain it, either through the representative council, or failing that, through private enterprise.

There is, therefore, this problem: at what cost can a small district instal and work its own plant on the one hand; and on the other, on what terms can a power company supply energy to such a district? The relation between these two alternatives will vary in different localities, of course, the cost of coal being one of the principal factors. A generalisation is, therefore, open to criticism, and will not be without inaccuracies, but a broad investigation will give results approximately true for all districts, and will probably prove of value to those interested in such problems. The author proposes to deal with this by taking an example of a small borough, first calculating the cost of installation of, and production from, local plant; then stating broadly the cost at which a power company could reliably and safely supply from a distance, the local district council supplying the requisite transforming sub-station and low tension distributors. This Paper, therefore, deals first with the cost of generation only, since the distribution is common to both sources of supply.

For example, the author knows a small borough of 3,400 inhabitants, situated on a broad and navigable river, and where land for the local generating station could be procured at a low cost beside the river, and with every facility for sea-borne coal, and for circulating water for condensing. Sea-borne Welsh coal is about 12s. 6d. per ton delivered. The rateable value of the borough is £10,000 in round figures; the area, 170 acres, and there are five miles of roadway and streets. A gas company now provides the supply for lighting at a cost of 4s. 3d. per 1,000 cubic ft., and 3s. 6d. for cooking and heating. This company has an annual output in cubit ft. of gas of 5,000,000. There are 750 houses within the borough. The corporation now pays the company £300 annually for street lighting. If the author shows that electricity can be commercially sold in such a district, then *a fortiori*, it can be better provided in an inland district where the same facilities for cheap coal, &c., are not available.

What scope would there be for electricity? Suppose the Corporation to consider taking this matter up. There is the street lighting; 125 street lamps, each consuming 60 watts (say each column having two "tantalum" lamps) would compare most favourably with the present lighting. With a cheap method of wiring—referred to later on—the local shops, residences, churches and other public buildings would represent an equivalent of 7,500 - 32 watt lamps installed. Then there are a few tradesmen who would require a small supply of power for stable machinery, hoists, printing, saws, laundry work and small machines for butchers, bakers and grocers. Such is the general list of small users of power.

The annual output would be somewhat of this nature:—

STREET LIGHTING.

125 lamps × 60 watts × 4,380 hours per annum....	32,850 units

PRIVATE LIGHTING.

7,500 lamps × 13 units per annum each	97,500 ,,
Small users of power as given above, say........	100,000 ,,
Total	230,350 units sold

representing 70 units per inhabitant.

Such an installation would probably have a load factor (units sold) of 16 per cent.; the maximum demand on the plant would, therefore, be 165 kw.; or, allowing for distribution losses, the station would have a maximum demand at the switchboard of practically 200 kw., and would require to generate some 270,000 units. The plant installed, therefore (with a reasonable battery) would be, say, two 125 kw. steam sets, and including land and buildings, boilers, piping, steam dynamos, battery, switchboards, &c., would cost about £7,000. If suction producer gas plant were installed in place of steam sets the cost would be practically the same figure.

The cost of production would be about 1·25d. per unit generated without capital charges or 1·86d. per unit generated, including capital charges, or 2·2d. per unit sold, but without any charges for mains, distribution, meters or services.

Now, consider a power company situate within, say, 7 miles of this borough. Would it pay the power company to supply, and the borough to take, electricity from this source? Firstly, the borough must provide a sub-station with the necessary converting plant and battery, if the supply is to be direct current. On the same output as above this sub-station would require the following plant, and would cost as follows:—

Land and buildings, two 125 kw. motor generators, battery and booster, switchboards, &c.:—£4,150, or £16·6 per kilowatt.

thus saving about £3,000 in capital outlay.

The annual capital charges on this would be £270.

The local charges at the sub-station would, therefore, be somewhat as follows:—

Wages at sub-station	£260
Capital charges	270
	£530, or 0·55d. per unit generated.

Thus leaving 1·86d.—0·55d. or 1·31d. per unit generated at the sub-station for the power company to compete on equal terms. The average efficiency of conversion by small machines may be taken at 75 per cent.; therefore, the power company could receive 0·98d. for unconverted high-tension energy.

Suppose the transmission line from the power company's station to this borough to be required wholly for that supply and no other. The cost of such overhead line would be about £2,900, allowing for a practical line with about 5 per cent. loss at full load. The company would, therefore, have to bear the following additional charges for distribution:—

Interest and renewals on line, say	£290
Wayleaves for 91 poles	91
	£381, or 0·3d. per unit.

Thus the remaining cost to the power company at their station switchboard would be 0·68d. per unit supplied to line. Owing to the local battery and the desire to there reduce wages at sub-station the load factor on the power station would be easily 25 per cent. or more. It would, therefore, pay the power company in this case. Indeed, most companies should be able to afford to supply at, say, £4 per kilowatt, and 0·33d. for untransformed energy at the sub-station terminals. Therefore, the price offered to the local borough would probably be (allowing for effect of battery):—

150 kilowatts at £4	£600
310,000 units at 0·33d.	426
	£1,026, or 0·8d. per unit supplied,

as against 0·98d. mentioned above, showing a saving to the local borough of £232 annually, or 20 per cent.

In such a case (and, indeed, in probably most cases when the local demand is under 500 kw.) it will be better to obtain the supply from the power company.

The local distribution can be well carried out by overhead wires. In small and compact boroughs, which are an exception, the mains can be laid underground, and will probably pay to be so laid. In sparser districts the mains must be run overhead, and poles can be dispensed with to a very great extent, and wayleaves obtained to attach small brackets and insulators to house fronts, thus minimising initial cost. This system has been in operation in the little village of Mevagissey, in Cornwall, for several years, with really excellent results and a surprising freedom from trouble. The author's opinion is that to deal with such districts a low pressure of 100 volts or thereabout should be adopted, a few cables laid underground as feeders to one or two important points, and existing houses wired with flexible leads if necessary run through insulated eyebolts, thus making electrical supply practically cheap. The prejudice against fire risks, &c., usually following this type of wiring really exists mainly in the imagination, and is not borne out in practice.

The author calculates the cost of distribution in this example to to be as follows (the sub-station being centrally situated):—

Two underground feeders laid solid. 5 miles of overhead conductors, partly erected on poles, partly on house brackets erected. Public lighting 125 lamps (one half being new, and one half taken as existing gas standards or brackets), £2,475, say £2,500.

The total cost, then, of production and distribution would be as follows:—

310,000 units high-tension energy supplied at a maximum demand of 150 kw.	£1,026
Wages at sub-station	260
Management, general expenses, rating &c., say	815
Capital charges on sub-station and distributing system	445
	£2,546 or 2·65d per unit sold.

The revenue account of such a business would be somewhat as follows:—

Private lighting—97,500 units at 4d.............	£1,625	0	0
Small power users—100,000 units at 2d.........	833	0	0
Street lighting—125 lamps at £2. 5s. each	281	5	0
	£2,739	5	0

leaving a net balance of £193, or a gross profit to the borough of £448 + £193 = £638, representing practically 10 per cent. on the capital outlay of £6,650.

The average lighting consumer would pay about £5 a year for his lighting; the street lighting would be less than the present cost of gas; and the public would benefit by owning their own plant, from better conditions in their houses and from having the energy available for small motors when gas engines would be entirely out of the question.

After all such a condition of things already exists abroad where tiny motors are used wholesale for all sorts and conditions of service. Hundreds of such towns exist to-day in our country. Electricity is now no longer only at the service of the larger towns and more compact areas; and the author looks forward to the not remote day when every such borough will have its electrical supply with all its concomitant advantages.

Can smaller districts than this example be so supplied? The author is sure they can, by the aid of the power companies' overhead transmission and overhead distribution.

The gist of this whole argument and example is, therefore:

(*a*) Small districts must take the supply from an outside source when available, at reasonable rates, rather than instal local generating plant.

(*b*) Facilities must be given to overhead transmission from power station—which no doubt the power companies will take care to obtain.

(*c*) Facilities are imperatively necessary for overhead local distribution, as the only means for economical supply. Underground distribution would almost invariably put electricity "out of court" in competition with local gas supply.

(*d*) The fire insurance companies must be induced to show encouragement to householders to enable surface wiring as described above to be adopted at the low pressure named.

The removal of the prejudice against such systems would increase and multiply the use of electrical energy, and make its adoption by small districts practicable and commercially possible. The author has not dealt with a supply by alternating current; three-phase transmission is almost universally in operation, and the advantages of a local battery as standby and a means of improving load factor are so apparent, coupled to the sweet simplicity of a low pressure two-wire local overhead transmission, that this latter system will be found hard to beat. It is hoped this short Paper will arouse the representatives of smaller districts to the economical possibilities of electrical supply.

DISCUSSION.

Mr. A. B. MOUNTAIN (Huddersfield) said that in small towns there was not such a large revenue as Mr. Snell had estimated in the Paper. The conditions of living in a small place were far more economical, and the use of electricity would be less; further, there was a factor that Mr. Snell had overlooked when mentioning Switzerland—viz., that there was no competition there from gas. Mr. Snell had estimated that there would be 70 units per inhabitant, but in Sunderland itself the corresponding figure was only 21, deducting the tramway load, which could not possibly be obtained in a small town. Mr. Snell had taken 13 units per lamp per annum. Looking forward about 10 years this figure might be right, but for the first three or four years there would not be more than 8 or 9 units per lamp. Mr. Snell's revenue would then be decreased from £2,700 to £800, and this figure was borne out by actual experience of small towns. Although this strengthened the case for the power company, it could be met by putting in very much cheaper plant. Steam plant in such cases was not desirable, but gas could be used, as it would not be necessary to run all day. An evening supply would meet many cases. If he were taking his supply from a power company, he would never for a moment think of converting to continuous current, and his estimate of a sub-station for such a small place was £500, as against the £7,000 estimated by Mr. Snell.

Mr. LEONARD ANDREWS had ascertained that there were something like 1,300 townships or villages with populations over 3,000 that had no means of getting electrical energy. He endorsed what Mr. Mountain had said about Mr. Snell's estimated capital cost being too high. Mr. Snell had taken a town within a radius of 6 or 7 miles of a power station and had shown that with certain figures a saving of 20 per cent. could be effected by taking energy from a company. But if that distance of 7 miles were increased to 10 miles, the whole of the 20 per cent. profit would disappear, and he thought there would be a large number of places that would be near the 10 miles limit. Again, Mr. Snell, with regard to gas generation, merely stated that the capital cost was about the same as for a steam plant, and said nothing about the running costs. As a matter of fact gas plants could be put down for even less capital cost than steam plant, and the figures of running expenses would be very much less than the 1·25d. given by Mr. Snell for steam. Probably members would recollect the Scottish trials of gas producers made just before Christmas, and these showed that power generated by gas in 30 H.P. to 40 H.P. engines cost $\frac{1}{20}$d. per horse-power, so that it should be possible to get down to $\frac{1}{10}$d. per unit, and this would beat anything that could be done with steam plant. Gas engines also had the advantage in all-day running with stand-by losses as compared with a steam engine, because when a gas or oil engine was shut down it stopped entirely, and there were no steam-pipe losses. Again, there were no automatic stokers and auxiliary plant, whilst the labour would be less, one man being able to look after a producer and gas engine, although repairs were higher. Improvements were being made, however, in gas engines very rapidly, and very soon he thought repairs would be less, probably, than with steam engines. Repairs on producers were extremely low, he believed.

Mr. J. N. SHOOLBRED recommended the establishment of a public board of representative interests, such as the Mersey Docks and Harbour Board, and in this way the various interests would be brought into harmony and reconciled, and the distributor would be better able to deal with such an authority as the wholesale suppliers than with a company or municipality.

Mr. H. MAXWELL (Partick) said that the whole revenue of the gas works of a Scotch town that he was acquainted with of 16,000 inhabitants was less than that estimated by Mr. Snell for the electricity works. He considered that the revenue estimated from power was absolutely impossible. Like Mr. Mountain, he could see no reason why alternating current should be converted to continuous current. His estimate of the cost of a sub-station in a small town was £800, including a voltage regulator, which would enable them to do without the sub-station attendant. In fact, the whole undertaking could be run by a small boy and a resident engineer. The only reason for converting from alternating to continuous current was the idiocy of the power companies in supplying 25 periodicity current. It was only by this means that supply in bulk to small towns could be made profitable, because the additional capital charges for the converting machinery and the additional labour charges in running that machinery made the prices quite prohibitive.

Mr. R. M. CARR (Leek), who is in charge of a small gas-driven plant, said he could not agree with Mr. Snell in his estimate of the units sold in a town with a population of 3,000. His town had a population of 16,000, and in the first year, just completed, he sold 58,390 units. He paid for his gas at the rate of 1s. $4\frac{1}{2}$d. per 1,000 feet. Town gas was used at present, but it was expected soon to use producer gas, and all his engines were made suitable for that purpose. The cost per unit sold for gas was 0·75d. and the total cost was 3·2d. per unit. excluding capital charges. The average price received was 3·91d. per unit, so that there was a very small gross profit. Actually, however, there was a deficit of £536, which his committee was satisfied with, and he did not think it was bad for the first financial year.

Mr. C. C. ATCHISON (Rochdale) thought that Mr. Snell's intention in suggesting a sub-station with all the necessary converting machinery and battery was really to obtain the benefit in the load factor due to the battery. Otherwise he was strongly with Mr. Mountain and others that there was no reason for converting at all. He believed that Mr. Snell had mentioned the sweet simplicity of the two-wire system. There were a large number of stations in the country running at the present time with that sweet simplicity with three-wire supply, and they seemed to keep going very well. Personally, he would like to see a two-wire supply, but it was cheaper to run a three-wire supply. In connection with small districts lying outside manufacturing areas there might be some point in converting, for probably the larger borough was looking forward to the time when it would either absorb the outlying area or be running tramways through it. He agreed with Mr. Andrews as to gas or oil engines, but with regard to Mr. Andrews' point as to what happened if the distance from the power station were 10 miles instead of seven, the Lancashire Electric Power Co. had covered itself by taking power to erect generating stations anywhere. Overhead feeders would frequently enable a supply to be given to outlying districts where it was not possible to give a supply through underground cables owing to the cost. The saving in wiring houses with "flexible" was discounted by the fact that it was necessary to run casing or tubes up to the switch points, but even then he preferred lead-covered cables to "flexible."

Mr. A. F. BERRY thought that there were cases in which the sub-stations had cost about $\frac{1}{20}$th the figure given by Mr. Snell, when it was not proposed to convert from alternating to continuous. Mr. Snell's £260 in his sub-station for wages, and £270 by way of capital charges, representing together 0·55d. per unit generated, would be reduced to about £150 if the current were not converted, and the efficiency would be increased from 75 to 95 per cent. if he left the current unconverted. For cooking purposes and so on, it was not possible to charge more than 1d. per unit. He had carried out some tests, as a prospective user of electricity for heating purposes, and he found that electricity at 1d. was equivalent to gas at 3s. per thousand. He would like to hear the experience of power company engineers on this point.

Mr. H. BOOT (Tunbridge Wells) said his experience did not accord with that of other engineers as to the lesser expense of gas engines. From tenders which he had in his office it was shown that a gas plant would be 10 per cent. more expensive than steam for a small undertaking, and an oil plant would be 20 per cent. more. The main point in making a village undertaking pay was to keep the capital expenditure down, and one element in this was to put down very much cheaper buildings. The price of gas in the district must also be taken into consideration. He did not agree with Mr. Snell as to the price of a 250 kw. station. £7,000, including land, buildings and mains was far too low. He had had some experience with oil and gas engines for village plants and Mr. Andrews' figures for running costs were never realised in practice. The lowest figures that he had got with accumulators were 0·74d.

Mr. G. WILKINSON (Harrogate) said that his vote would be decidedly with the erection of a local station. He had had a 40 H.P. internal combustion engine at work for five years generating 7 B.H.P. per hour for $\frac{1}{7}$d. The whole question of the success or non-success in the supply of electricity in small villages and rural districts depended upon the use of overhead wires, not only as feeders, but more especially as distributors. Tadcaster was the first town to receive the approval of the Board of Trade for overhead distribution. It was on the two-wire system, and the live wire occupied the top of the post—(with three-wire distribution the two live wires would occupy the extreme ends of a short arm)—and the earthed return consisted of two wires put upon a cross arm, immediately below the live wire. Looping pieces were connected across the earthed wires, so that in any event if one of the potential wires should drop down it was immediately short-circuited on one of the bridging pieces, In this way the system was made dead safe. So far none of the wires had fallen.

Mr. J. F. C. SNELL, who will complete his reply in the *Proceedings*, said that Mr. Mountain had accused him of taking too big a number of units per inhabitant, and mentioned that Sunderland has only 21 units. As a matter of fact, it was 28, but Mr. Mountain forgot that Brighton sold 70, and that after all we are only in the early days of our development, and that within the next few years 70 units per inhabitant would be reached in a great many places. Mr. Mountain also stated that the revenue should be reduced from £2,700 to £800. He would agree to this, if the revenue was only for the first few years. There was a great revenue in small towns which Mr. Mountain had entirely left out—viz., the supply of electricity to small power purposes, trivial power purposes, in fact, sewing machines, grocers' machinery, stabling machinery, &c. In a small village on the Continent it would be found that all these small apparatus were driven electrically, and the same would happen here. Therefore he must add a very considerable figure per inhabitant to the number of units. In fact, he was quite sure that if they discussed this matter 10 years hence it would be found that his estimate was not far wrong. He did not at all agree with Mr. Mountain that an evening supply would suffice in many places; certainly not as a general proposition. For industrial purposes there must be a 24-hours' supply. On the question of conversion he pointed out that for the case taken in the Paper he had only taken a single overhead transmission line from the power station for a distance of seven miles. High-tension alternating current was quite reliable in these days, still with overhead transmission they laid themselves open to being shut down through an accident at the power station, and it would be safer and better to use a local battery and also to get the advantage of the better load factor. Mr. Andrews had pointed out that by increasing the distance the 20 per cent. advantage referred to would disappear. He had dealt with that very fully last year at the Institution of Civil Engineers, and he quite agreed. Mr. Carr's figures were very useful, although in excess of his own estimate, and it rather proved that his own estimate was a reasonable one. He agreed that if alternating current were used and static transformers, the capital expenditure would be reduced and the running costs would be less, therefore if he could show that in this particular example it would pay, so much the more would it pay if alternating current were used.

A THEATRE DIMMER INSTALLATION.

The Capetown Theatre is about to have one of the most complete installations of dimmers that has yet been made. It provides for four colours and employs resistances of the "Wirt" type. The theatre is wired for 48 circuits, varying from 10 to 20 lights each, and the arrangement of the dimmer board enables either each circuit to be controlled independently or any desired number of the controlling handles to be interlocked on a driving shaft, so that a number of circuits can be raised or lowered by a single operation, in the same or contrary direction, by a quick or a slow motion. The dimmers are mounted on stands and driven by steel cords arranged so as to leave the operating board entirely dead, even in the event of any part of the dimmer frame being alive. The dimmers are of the jointless mica insulated Wirt construction, the resistance in each case being a single tapered ribbon, of which the folds are insulated with mica and the coils, placed between mica sheets, are gripped and held in position by steel plates secured by a steel band spun over the edge. In this way faults caused by the cracking of the enamel or the action of absorbed moisture on the resistance ribbon are wholly avoided, and the dimmers are capable of withstanding very heavy overloads and sudden heating and cooling without injury. The operating gear is mounted on a polished slate board, all holes being bushed with ebonite, and the slow motion is obtained by a worm on a vertical shaft, which can be thrown into gear by means of gun-metal clutches with one or more of the horizontal shafts carrying the operating levers. The operating board and group of rheostats is shown in Fig. 1, which is from a photograph sent us by Messrs. J. Defries & Sons (Ltd.), the makers of the apparatus, who are, we understand, sole licensees for the manufacture of Wirt dimmers and rheostats for Europe and the British colonies (except Canada).

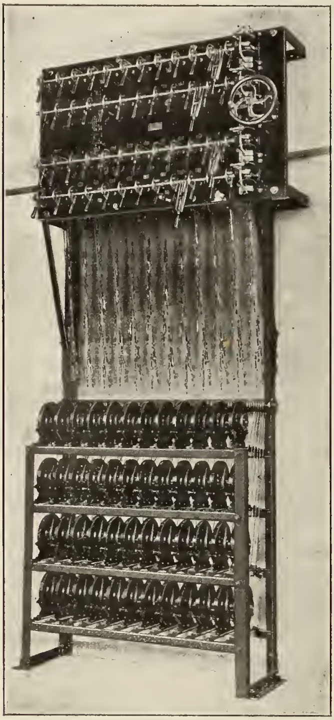

Fig. 1.—Theatre Dimmer and Control Board.

CORRESPONDENCE.

"THE ORIGIN OF LIFE."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: My attention has been called to your remarks concerning radiobes, apropos of the recent investigations of Mr. Rudge with barium salts, as well as to the letter of Mr. Butler Burke in your issue of this week. For years past I have been well aware that there are many modified crystalline bodies whose appearance is such as to make it almost impossible to distinguish them, by mere inspection, from actual living cells.

Recently some remarkable specimens of this kind were sent to me by another worker as bodies presenting many of the characteristics of cells, together with the positive statement that they multiplied by fission. The appearances shown by groups of these bodies seemed to indicate that it was so. I satisfied, myself, however, by photographing the same groups at different intervals that no division took place, and that the deceptive appearances were due to crystals growing close to one another, and so producing a modification in shape suggestive of fission. These bodies, so like cells at first, ultimately became resolved into aggregates of minute cystals—much as the radiobes do.

I notice that Mr. Burke says M. Dubois "has had no difficulty in observing the effects of sub-division" of his eobes. But watching "the effects of sub-division," or the supposed effects, is very different from watching the actual division. And I should like to ask Mr. Burke again, whether he has ever actually followed the process of division in one of his radiobes, and, if so, how long the process took? Or is it that he, too, like M. Dubois, has had no difficulty, merely "in observing the effects of sub-division." The point is interesting, though not all-important; for even if he has watched the process all through he would have done nothing more, as I have pointed out in my book "The Nature and Origin of Living Matter" (p. 61), than was done very many years ago by Robin, the great French microscopist, who observed processes of fission and budding occurring in dead matter simulating living cells and filaments.

The fact that radiobes are soluble in water is of itself damnatory of their claim to be regarded as living things. They have, in my opinion, absolutely nothing to do with the origin of life; so that I am disposed to agree with you in your verdict "that the radiobe is—in more senses than one—dead."—Yours, &c., H. Charlton Bastian, M.D., F.R.S.

London, June 18.

CAPACITY CURRENTS AND LEAKAGE INDICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your report of my supplementary remarks on my Paper at the Institute of Mining Engineers you have rather missed the point of the whole question. As I understand the matter, the case in which a large capacity discharge current arises from the third harmonics of a three-phase system is when the third harmonics of each of the three phases are in phase with each other, and this arises principally because the periodicity of the third harmonic is three times that of the first harmonic. The third harmonics of the three phases are in phase with each other, when their time elements are equally displaced from that of their first harmonics.—Yours, &c.,

Bath, June 23. Sydney F. Walker.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of June 22nd you give an abstract of the discussion on Mr. S. F. Walker's interesting Paper on capacity as affecting three-phase leakage indicators. I was unfortunately prevented from attending the meeting, so may I be allowed to add a word or two through the medium of your valuable columns.

Mr. Walker very rightly draws attention to the disturbing effect of capacity currents in the case of leakage indicators for three-phase plants. As a matter of fact, however, I think that the disturbance is of much less importance than would at first sight appear. What is actually demanded of a leakage indicator is that it shall indicate immediately, and in an unmistakable manner, the occurence of a fault on any one of the three mains. This function of the instrument will not be appreciably affected by capacity currents. Experience, moreover, shows that by glancing down the tabulated readings taken on the three mains, the occurrence of even a slight earth can be almost invariably traced.

The arrangement suggested by Mr. A. F. Harris of connecting a milliammeter and battery between the system and earth is described in Raphael's "Localisation of Faults," p. 51, and has been in use, chiefly as a temporary expedient, for some seven or eight years, being first suggested, I believe, by Messrs. Siemens & Halske as a means of testing alternating-current house installations during working. It has not, I fancy, been very largely used, on account chiefly of the fact that a separate source of direct current (either a generator or battery) has to be employed, and from the point of view of a colliery installation this is a serious disadvantage.

I am much interested in Mr. Pope's suggested arrangement for an earthed system, as it is practically identical with that which has been supplied by my firm for some 18 months now, with this difference, that they provide a 100 ampere short-circuiting switch, which, on the occurrence of an earth, cuts out the instrument and sets a warning bell ringing.

It would seem that with Mr. Pope's arrangement the bell would be instantly burnt out in the case of a serious fault, and the earth circuit thereby opened. Moreover, unless the ammeter switch were left continuously on the 1,000 : 1 shunt the ammeter would be almost inevitably damaged, while, on the other hand, when so shunted the instrument would be so unsensitive that almost nothing short of a dead earth would be noticeable. Both these objections are overcome by the use of the short-circuiting switch.—Yours, &c.,

Westminster, June 23. KENELM EDGCUMBE.

LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The recent thunderstorms have produced the usual crop of reports of buildings damaged by lightning, yet those responsible for tall structures appear less inclined than ever to adopt the means of protection that science has devised. On all sides one hears it said that lightning conductors are apparently useless, and even that they are a source of added danger. It seems evident that the report of the Lightning Research Committee, and the supplement written by Mr. Killingworth Hedges under the title of "Modern Lightning Conductors," have confused the mind of the lay reader, leading him to suppose that if a duly appointed committee can give no more definite information on the matter, then science is hopelessly at fault, and it is useless for him to think of means of safety.

A perusal of the report and the supplement referred to leads me to think that they cast doubt on the effectiveness of methods of protection hitherto adopted without showing any reason for the doubt. This committee, after starting with a fanfare of trumpets and a sort of promise to put the world right, evidently found that the methods generally adopted were not so hopelessly at fault as they at first supposed, and, in fact, insinuated, as evidenced by the formation of the committee to investigate.

The attention of the Lightning Research Committee has been mainly directed to compiling a list of buildings that, although fitted with conductors, had been damaged. That information adds nothing to the science of protection. The question arises: Were the buildings that were damaged protected in accordance with the rules of the 1882 Conference report, or were the accidents owing to neglect to keep those conductors in good condition ?—Yours, &c., W. DALBY.

Birmingham, June 23.

ELECTRIC POWER SUPPLY IN LONDON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 8th there appeared an article entitled "Electric Power Supply in London," the whole purport of which was to prove that, owing to the high prices charged in the London area for current, the manufacturers were steadily leaving it for more favoured districts. To quote your own words: "It is notorious that London, the greatest clearing house and port in the world, is threatened with a total loss of its position as a great manufacturing centre. . . . Some of these things affect the lighter industries also, and the matter is a serious one, not only for Londoners, but for all Englishmen."

The foregoing remarks you may have meant to apply only to London proper—*i.e.*, within what is known as the London County Council's sphere of influence; therefore I should have no special right to address you on the matter. But, as you go further, as follows: "To retain some of these industries within the *neighbourhood* (the italics are mine) of the metropolis, one of the first things that is wanted is cheap electric power." Now, Sir, to what extent you had West Ham in mind when writing the above words I cannot say, but my apology for taking up your space is that West Ham is the most important manufacturing district in the neighbourhood of London.

In the first place, electricity for power purposes, either on a large or small scale, is not to be purchased cheaper in any district in the United Kingdom than in West Ham; furthermore, owing to the effective system of waterways which connect the northern and southern districts of the borough together with the fact that some of the largest docks on the river are situated within its borders—a great advantage to those manufacturing for export—the cost of carriage is reduced to a minimum, and finally, being within such a comparatively short distance by road from the City, West Ham possesses what is known commercially as good wheel cartage to London, all of which advantages the manufacturers in West Ham are able to appreciate as against the disadvantages of the admittedly high local rates. In short, their extra expenses on rates are more than balanced by the big savings they can now make by availing themselves of a cheap source of power and of the exceptional transport facilities this borough affords them.

It is well known that many new factories have been (and are being) built in West Ham during the last two or three years, and others have been extended, which trend of affairs is being very considerably strengthened by the low rates which the Corporation are now charging for electricity.

One word with regard to the rates. It is only fair to point out that 31 per cent. of the total rates are on account of education, which is self explanatory to those who understand the conditions of the large majority of inhabitants in the borough, and this expenditure has resulted in the grant from the Government of nearly a 1s. rate. This, although not applied until the next half-year, has already had a marked effect upon business generally in the borough, and indirectly upon its electricity department.

Trusting that this letter will be of service in clearing up any misconceptions which may have existed in the minds of manufacturers on the look-out for factory sites having the advantages and facilities above mentioned.—Yours, &c.,

West Ham Corporation Electricity C. ROCKLEY.
Supply Department, June 25.

A Form of Repulsion-induction Motor.—A Paper by Mr. Maurice Milch, read at the Milwaukee convention of the American Institute of Electrical Engineers, describes fully a new type of motor in which starting characteristics similar to those of a repulsion motor are inherently combined with the near synchronous load characteristics of an induction motor. If two armatures, representing respectively an armature of the Gramme type of a four-pole repulsion motor and a Gramme armature of a two-pole commutator induction motor be coupled together, at the same time connecting the primary members of both motors in series, a combination is obtained that, due to its repulsion motor element, possesses a good starting torque, and, due to its induction motor element, some of the load characteristics of such a motor near synchronous speed; for, when starting, the induction element will merely represent an impedance in series with the repulsion motor, without adding any torque to the combination. With increasing speed, however, the impedance of the induction-motor element rapidly increases, and consequently it will drain the line voltage of the combination into its own circuits, thereby impressing upon the combination its own characteristics more and more as synchronism is approached. The induction-motor element does not possess any torque at synchronous speed. At this speed, however, the repulsion motor carries the magnetising current of the commutator induction motor connected in series with it, and, due to its consequent torque, drives the induction motor above synchronism up to a speed where the positive torque of the repulsion motor and the negative (generator) torque of the commutator induction motor balance each other. This speed then will be the limiting speed of the combination, and it will act as a motor below this speed and as a generator above it. Instead of producing this effect by two separate structures, both elements may be blended into one. For this purpose the same armature is used, as the armatures are identical in both elements, and both primary windings are wound into the same slots above each other.

PARLIAMENTARY INTELLIGENCE.

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GREENWICH OBSERVATORY AND THE LONDON COUNTY COUNCIL POWER STATION.

In the House of Lords on Thursday, June 21, the subject of the interference of the Greenwich power station with the observations at Greenwich Observatory was introduced by Lord Ellenborough, who, in speaking of the work of the Royal Observatory, within half a-mile of which the L.C.C. had built their power station, pointed out that the presumed position of every ship at sea, out of sight of land, was based upon a comparison of the results of observations taken by her officers with other observations taken years previously by astronomers at the Royal Observatory, and also that the positions of all places shown on British and American maps and charts, and also on most foreign maps and charts, were dependent upon observations taken at Greenwich. A conference of delegates from the principal countries in the world, held at Washington in October, 1884, had decided in favour of adopting the meridian passing through the centre of the transit instrument at the Observatory at Greenwich as the initial meridian for longitude, and, in consequence of this, nearly all nations of importance now used Greenwich time as a standard or universal time. If a single ship was lost in consequence of confusion being introduced into longitudes, its value might well be treble that of these new electrical works. During the last 230 years many millions of astronomical and other observations had been made, the value of which largely depended upon the fixity of the Royal Observatory as a reference point. The County Council power station, with its tall chimneys, was almost due north of the Observatory and the engines which they were using caused some of the astronomical instruments to vibrate in such a manner as to destroy all possibility of accurate observation. He asked the Government whether they would apply to Parliament for power to prevent the Royal Observatory from being shaken or smoked out, either at present or at any future time. He suggested that the difficulty might have been obviated by the use of turbines or triple-expansion horizontal engines. But the geography of the whole world must not be interfered with because the County Council preferred to use vertical engines. From the County Council's reply to the Astronomer Royal, in which they said they were "unable to acknowledge any liability in regard to the effect on the Observatory of the working of the station," it was clear that they did not realise the mischief they were doing.

Lord **TWEEDMOUTH** said that as to the origin of this generating station, in 1901 the L.C.C. resolved on it, and in 1902 a bill was passed through Parliament. In this bill was inserted a clause known as the Observatory clause, which gave to the Board of Trade the power, if any use of electrical power was likely to affect injuriously the instruments used in the observatory, to require reasonable and proper precautions to be taken. He thought that rather an exaggerated account had been given of what had taken place. He admitted that there was apprehension of it, when the generating station was developed to its fullest power. Its engines, when completed, would work up to 52,000 H.P. The Astronomer Royal told him that no serious damage had yet arisen in the working of the principal meridian instruments, but that what had been affected was a portable transit instrument, which must necessarily be used for determining longitude. At present he believed that the station was never worked up to more than 3,000 H.P. A trial had been made of two engines, but the experiments were neither complete nor satisfactory. What he proposed to do was to ask Prof. Ewing, Director of Naval Education, who lived at Greenwich, a distinguished engineer intimately acquainted with scientific instruments, to represent the Admiralty in the observations to be taken. He proposed also to ask the County Council to appoint a representative of their own for observation in order to have an independent report as to the exact amount of disturbance that might arise.

Viscount **GOSCHEN** asked whether the County Council were going to continue the gigantic work on which they were engaged. Was there no possibility of arriving at an arrangement whereby, at all events pending the inquiry, they should not continue to spend large sums of money upon these works? A gigantic mistake had been made—a mistake by the Admiralty, by the Astronomer Royal, by the County Council and by Parliament.

The Earl of **CRAWFORD** discussed the refraction effects of the hot gases issuing from the chimneys, and did not think that lowering their height would have any great effect. With reference to the question of tremor, he said that the shaking was so small that the ordinary person might treat it with contempt, yet the movement was very large when taken in connection with the delicate observations which had to be carried out at Greenwich. In connection with the meridian, careful observations of the moon required to be made. For many many years the Royal Observatory had specialised on the moon, mainly owing to the grand labours of Sir George Airey, the late Astronomer Royal, so that the position of the moon at a given time hence might be fairly accurately predicted. Disputes as to boundaries between countries were mainly settled by astronomical observation as to the position of the moon; and, as the moon was being constantly watched at Greenwich Observatory, applications were frequently received from foreign countries as to the error of the moon at such an hour on such a day. That also showed how extremely important it was that the observations at Greenwich should be reliable.

Lord **KELVIN** said that it was most undesirable that the site of the Royal Observatory should be changed. On the other hand, there was a serious responsibility on account of the amount of ratepayers' money which had been spent by the L.C.C. If there was any solution by which the electric works at Greenwich could go on without seriously threatening or unduly interfering with the work of the Observatory the whole public would be glad. Even at present, he thought, they might look forward to possible changes in the arrangement of the works by which the operations might not seriously disturb or practically cripple the astronomical observations at Greenwich. He suggested that the disturbance caused at the Observatory by the vibration from the electric works might be to some extent avoided by the substitution of steam turbines for reciprocating engines.

Earl **CAWDOR** thought that the first step to be taken, if it was possible to do so, was to stop any further expenditure by the L.C.C. that might be found to be useless, or worse than useless. It appeared certain that any further development of the powerful engines that were being used must increase the evils.

Lord **TWEEDMOUTH** thought the House would agree that before doing anything they were bound to discover whether by any rearrangement of the machinery the threatened damage could be averted. He undertook that every effort should be made to make the inquiry a thorough one.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL REJECTED.

At the meeting of the Committee on Thursday last week Mr. **LLEWELLYN-SMITH**, C.B., gave the views of the Board of Trade. In effect these were that the scheme of the London County Council Bill is not sufficiently comprehensive. He refused to express any opinion on the relative merits of municipal control versus a company in the matter of electric supply, but in discussing the clauses of the bill stated that, in the opinion of the Board of Trade, there should be a time limit inserted within which the powers of the bill should be exercised; that the supply should be made compulsory upon the L.C.C., and not permissive; and that the clause relating to revision of the prices of authorised distributors should be modified. Generally speaking, the Board of Trade take the view expressed so many times by both parties in this controversy—viz., that London is woefully backward in the matter of electric supply, and that, although existing suppliers had a certain claim for consideration, yet this should not stand in the way of the establishment of a really comprehensive scheme. On this point Mr. Smith said that it was imperative that any such scheme must include the industrial area over the borders of the County of London.

Decision.

The Committee met specially yesterday for the decision to be made public.

The **CHAIRMAN** said: With regard to the bill which the Committee have been considering for the past few weeks—the London County Council Electric Supply Bill—we have given full consideration to all the evidence and statements that have been laid before us, and after doing so we have come to the conclusion that in our opinion we must report to the House that the preamble of the bill is not proven.

In making that statement I have also to say that with regard to the instruction from the House of Commons, we have given full consideration to a report, which is now in the hands of the printers, and will be presented to the House this afternoon. According to the rules of the House I cannot state the purport of that report, but it is a full report so far as the Committee is concerned, with regard to the supply of electrical energy in bulk in London and the adjoining districts. Copies of this report will be available in a very short time.

With regard to our conclusion on the preamble of the London County Council Bill, and also with regard to the report, I am in a position to. say that the whole of the nine members of the Committee are unanimous

In conclusion, the Chairman thanked the various counsel and witnesses engaged in connection with the bill for the way in which the evidence had been placed before the Committee.

Sir **RALPH LITTLER**, K.C., and Mr. **FREEMAN**, K.C., replied for the bar.

THE ROYAL COLLEGE OF SCIENCE.

In the House of Commons on Tuesday,

Sir **WILLIAM COLLINS** asked what action the Board of Education proposed to take with regard to the report of the Departmental Committee on the Royal College of Science.

Mr. T. **LOUGH** replied that the Board of Education had now in preparation a scheme for the establishment of a new institution corresponding as closely as possible to the recommendations of the Committee referred to. The Board of Education was agreed with the Committee that the relation of London to the new university should be that of a school to the university. The Board had also under consideration the suggestion of the Committee that, without delaying the commencement of the new institution's work, a Royal Commission should be appointed to consider whether changes could advisably be made in the character and constitution of the university, which might make it desirable and possible to amalgamate the two institutions. They had also had before them the resolution of the Senate of the University, deprecating the appointment of such a Royal Commission within so short a period after the reorganisation of the University, and expressing the desire that opportunity should be offered for conference between the Board and the Senate as to any changes of the kind suggested. In the course of the conference, which took place on March 9, between the Board of Education and a deputation from the University Senate upon these matters, the suggestions thrown out by the University deputation seemed to be contingent, practically, upon the incorporation of the new institution within the University. As this would necessitate a prolonged delay in the starting of the institution, which the Committee specially recommended should be avoided, the Board had found it impracticable to proceed on these lines, but were hastening as much as possible the preparation of a draft charter on the lines of the report of the Committee.

Sir PHILIP MAGNUS asked whether the Senate of the University of London would have an opportunity of considering the new scheme before it was adopted by the Board of Education.

Mr. LOUGH asked for notice of the question.

THE HIGHGATE TRAMWAY ACCIDENT.

Several questions were asked in the House of Commons on Wednesday regarding the fatal tramcar accident at Highgate on Saturday.

Mr. MEYER and Mr. HENDERSON both suggested that an inquiry should be held into the whole question of brakes on tramcars. They also asked with what brakes the car at Highgate was fitted, and also those at Huddersfield and Swindon which recently got out of control.

Mr. LLOYD-GEORGE said that in the latter two instances the Board of Trade were holding inquiries, and until these reports were received it would be unwise to make any statement on the question of brakes. He was informed that the car at Highgate was fitted with brakes in accordance with the Board of Trade regulations.

In answer to further questions, Mr. LLOYD-GEORGE said that he would call the attention of the technical advisers to the Board of Trade to the suggestion that magnetic track brakes become inoperative when the wheels skidded, and also to the question of stopping places on steep gradients.

ROYAL ASSENT.

Royal Assent was given to the following Acts of Parliament, among others, last week:—Electric Lighting Orders Confirmation (No. 1) Act 1906; Electric Lighting Orders Confirmation (No. 2) Act 1906; The Mersey Railway Act 1906; Preston, Chorley & Horwich Tramway Act 1906; South Lancashire Tramways Act 1906.

MISCELLANEOUS.

The Folkestone & District Electricity Supply Bill was read a second time in the House of Commons on Wednesday.

In the House of Lords on Monday last week, the Shropshire, Worcestershire & Staffordshire Electric Power Bill was read a third time and passed. In the House of Commons on the same day, the Hackney Electricity Bill was read a third time.

On Tuesday last week in the House of Lords, the following Bills were read a second time:—North East London Railway, Baker-street and Waterloo Railway, Lancashire Electric Power, St. Pancras Electricity, Metropolitan District Railway, North West London Railway, and Hackney Electricity. In the House of Commons the West Yorkshire Tramways Bill was read a second time.

In the House of Lords on Friday, the L.C.C. (General Powers) and the L.C.C. (Tramways) Bills were read a second time, and the Folkestone, Sandgate & Hythe Tramways (No. 2) Bill was read a third time.

The Nottinghamshire and Derbyshire Tramways Bill was passed by the Unopposed Committee of the House of Commons last week.

The Hackney Electricity Bill has now been passed by the Unopposed Committee of the House of Commons. Originally the bill contained powers for a mutual supply of electricity in bulk between the Hackney Borough Council and the Shoreditch Council, in addition to certain other powers, such as hiring out fittings, motors, &c. In order to prevent the bill being "hung up" with the other electric power bills, all bulk supply powers have been withdrawn.

LEGAL INTELLIGENCE.

Chitty v. British Westinghouse Electric & Mfg. Co. (Ltd)

On Friday, Mr. J. B. Matthews applied to have the costs of the plaintiff's application for attachment made part of the plaintiff's costs of the action, but Mr. Justice Bigham declined to make any order as to those costs. Counsel then asked that plaintiff should have his costs of the action on the higher scale, but this also was refused. Mr. Matthews further asked his lordship to express an opinion for the guidance of the taxing master that it was reasonable for the plaintiff to have retained three counsel.

Mr. Justice BIGHAM said it was not necessary for him to express an opinion on the matter. Defendants had four counsel and if he were asked whether plaintiff was extravagant in retaining three counsel he should say "No."

F. A. Glover & Co. (Ltd.) v. Delta Metal Co. (Ltd.)

In the High Court (London) on Saturday Mr. POLLOCK, one of the official referees, delivered his reserved judgment in this case. He said the action was brought by plaintiffs to recover £682. 10s. 1d. in respect of balance due for work done, materials supplied and labour in connection with a contract for the installation of electric light. The contract was dated March 7, 1905, and there were additions and extras. The defence set up was that there was no proper certificate as provided by the contract that no alterations were to be done unless they were ordered in writing, and that the work had not been completed in accordance with the contract. Defendants counterclaimed in respect of damages sustained by them by reason of the work not having been completed in accordance with the contract. The case was one of considerable importance and some difficulty. On behalf of the plaintiffs the point was raised that by reason of defendants having paid into Court a sum of £250 with their appearance they were precluded from setting up the want of a certificate as an answer to the claim. As to that contention he did not agree. Defendants did not in any way seek to deny the contract, but they said under the contract the plaintiffs must have a certificate from the engineer and they had not got one. That was a defence which it was perfectly competent for defendants to raise in the action although they paid £250 into Court. Both parties had given up their claim in respect of penalties. Plaintiffs urged that defendants were bound by the decision of the engineer (Mr. Jenkinson), that he had passed the work and that therefore defendants were bound. In his opinion that could not mean that the engineer had any power to make an absolutely different contract from that which he had undertaken to carry out on behalf of his employer. There must be some limit to the interpretation to be put upon the question of decisions. The engineer could not put upon any clause in the contract or specification an interpretation which was absolutely inconsistent with the plain meaning of the words used in the contract and specification. Where there was any ambiguity and difficulty in construing the matter, no doubt the engineer might properly say what was the meaning of the clause. There was a clause in the contract that no alterations or variations might be made without the consent in writing of the engineer. That strongly showed that the engineer had no power under the clause of decisions to make a new contract. The engineer had power to make certain alterations and variations, but they must be in writing. Whether under that he could make alterations carrying out an entirely different contract it was not for the referee to decide here. His impression was that the engineer could not. Supposing he could, then he must do it in writing, and so far as the alterations complained of were concerned, there was no writing. The engineer on Dec. 11 gave the certificate relied upon by plaintiffs certifying that plaintiffs had, to the best of his knowledge, completed their work in connection with the contract of March 7, 1905, and are now entitled to payment to invoiced accounts, less £450 already paid on account. This certificate was given subject entirely to the conditions of contract above referred to, and did not relieve plaintiffs of any liability whatever under the contract, and any defects or omissions which might come to his (Mr. Jenkinson's) knowledge must be remedied forthwith. The referee said he regarded the certificate as a provisional one and not a final and conclusive certificate within the meaning of the contract. But assuming that the certificate did comply with the terms of the contract as regarded payment, did the plaintiffs complete the work in accordance with the contract? The main objection raised by the defendants to the work done had reference to the use of braided wire. It was perfectly clear that the expressions used in the specification as to mains and cables could not be satisfied by the use of the braided wire which was put in by plaintiffs, and that both Mr. Jenkinson and the contractors must have known this. He came to the conclusion that the braided wire was not in accordance with the contract. Then as to the work in general he was of opinion that the contract had been departed from in important particulars, and had been departed from with the knowledge of Mr. Jenkinson and of the contractors. There was a further provision that the installation should comply with the rules of the Institution of Electrical Engineers. Upon the evidence the referee was of opinion that it did not comply with those rules. They did not comply with rule 24. The dynamos provided, he was further of opinion, did not comply with the contract. He held that the certificate was not binding because it was given in respect of work which was not carried out in accordance with the contract. There had been an endeavour to satisfy the contract by work which was entirely different to that which was provided for in the contract. There was no authority in the engineer under the contract to so vary it as to compel the defendants to accept what was admittedly very inferior and less costly work than that which was provided for. He disallowed all the extra work claimed by plaintiffs. There had been paid on account £450 before action, leaving a balance of £485. Defendants had paid £250 into Court, and plaintiffs were entitled to that as against the contract. There was thus left a balance of £235, and he thought defendants were entitled to that sum on their counterclaim. Defendants must pay plaintiffs' costs up to the time of their payment of £250 into Court, and the costs after that date together with the costs of the defendants' counterclaim must be paid by the plaintiffs.

Moore v. City of London Electric Lighting Co. (Ltd.)

In the Lord Mayor's Court (London) last week, the Recorder (Sir Forrest Fulton, K.C.) and a jury heard an action brought by F. J. Moore against defendant company for damages for injuries sustained while installing the electric light. It was stated that plaintiff received severe burns through the arcing of a loop of live wire which he was in the act of moving and which, he said, was not properly cased and was loosely connected.

For the defence it was contended that plaintiff must have used considerable force to displace the cable, and that he was the author of his own misfortune.

The jury gave judgment for defendants.

Tramcar Collision.

At Salford Court of Record on Wednesday, Dr. Robert Mitchell sued Bury Corporation for £32. 16s. as compensation for damages sustained in a collision between his brougham and one of defendants' electric tramcars in April last year. The case had been previously heard and a verdict given for plaintiff, and this was a re-hearing which had been directed as the result of defendants' appeal. The question of the liability of defendants to pay £250 compensation to the widow of plaintiff's coachman, who died from the effects of the accident, was involved in the case.

Dr. MITCHELL said that at the time the brougham was struck by the car the former had partially crossed the tramlines at a junction of two streets, and he did not hear the gong until the car was only two car-lengths away.

Mr. S. E. BASTOW, electrical engineer, expressed the opinion that if the car driver had used the emergency brake the collision would have been averted.

It was stated that the car driver had no thumb on his right hand, and Mr. J. Hall, chairman of Bury Tramways committee, admitted that a motorman minus a thumb was not as competent as a man with both thumbs.

Mr. SUTTON (for defendants) submitted that the tramcar driver had not been guilty of negligence and that had plaintiff's coachman been on the right side of the road there would have been no accident.

THOS. HAMER, the tramcar driver, said he was travelling at about 5 miles an hour at the time of the accident. He rang the gong and had his hand brake partially on.

Mr. W. CLOUGH, manager of the tramways, said that, under the circumstances, Hamer was right in using the hand brake.

Various questions were submitted to the jury, who replied that the motorman was not a competent man to employ, that he gave sufficient warning of his approach by using his gong, that he ought to have used the magnetic brake, that he was going at a proper speed at the time of the accident, that there was contributory negligence on the part of plaintiff's coachman which caused the accident, and that the tramcar driver, notwithstanding such negligence, could have avoided the accident. They found defendants' driver guilty of negligence, and that the act of negligence which caused the accident was not using the magnetic brake, and also omitting to use sand.

Judgment was given for plaintiff for the amount claimed and costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An advertisement on another page notifies that three shift engineers, three switchboard attendants, and one supervisor of mains are required for a large central electricity station in the South of England. The scale of pay and other particulars will be found in the advertisement.

A draughtsman is required immediately, used to general engineering and electrical work, &c. Applications to Mr. John Christie, engineer and manager, Corporation electricity works, Brighton. See an advertisement.

Heston and Isleworth Council require an electrical engineer. Salary £300, rising to £400, per annum. Applications to the clerk (Mr. H. J. Baker), Council House, Hounslow, by 10 a.m. July 2.

A junior demonstrator is required in the physical laboratories of Birmingham Municipal Technical School. Salary £80 per annum. Particulars from the secretary, Mr. Geo. Mellor, Suffolk-street, Birmingham. Applications by July 4.

Portsmouth Corporation require an inspector and canvasser for their electricity supply department. Salary £104 and commission. Applications to the Engineer and Manager by June 27.

Scunthorpe (Yorks.) Council require a working electrician conversant with steam engines and three-phase generators. Forms from Mr. A. M. Cobban, Home-street, Scunthorpe. Applications by July 5.

An assistant, to teach electrical engineering and practical mathematics, is required at Darlington Technical College. Salary, £120 per annum. Applications to Mr. A. C. Coffin, Education Offices, Darlington.

The Bombay, Baroda & Central India Railway Co. require an assistant telegraph superintendent. Salary R.350 per month, rising to R.500. Applications to Mr. W. V. Constable, Gloucester House, Bishopsgate-street Without, London, E.C., by July 11.

An assistant master to teach electrical engineering, mathematics, &c., is required at Aston Manor Technical School. Commencing salary £150. Applications by July 7.

An assistant lecturer in physics is wanted at Hartley University College, Southampton. Salary £150, rising to £200. Applications to Principal by July 12.

A junior demonstrator is required in the Physical Laboratory of Birmingham Technical School. Salary £80 Applications by July 4.

Mr. E. T. Williams, chief electrical engineer, and Mr. H. A. Nott, deputy electrical engineer to Gibraltar Sanitary Commissioners, have resigned their positions to take up appointments under the Admiralty, and Mr. A. S. L. Barnes, assistant electrical engineer, has been promoted to the position of electrical engineer at Gibraltar.

Mr. E. S. A. Smith has resigned his appointment as canvasser to the electrical undertaking of Battersea. A successor is to be appointed for six months with a technical knowledge of electricity, and to be styled "Commercial Assistant, Electricity Department," at a salary of £2 a week, and commission at the rate of 10s. for every 100 8 c.p. lamps connected as a result of his efforts. Mr. W. F. Duncan, temporary shift engineer to Battersea electrical undertaking, has resigned. A successor is to be appointed permanently at a salary of £104 per annum.

Walthamstow Council have appointed Mr. Mills, of Manchester, works foreman at the electricity works at £2. 15s. per week; Mr. Notley as mains inspector at £3 a week; and Mr. W. H. Taylor, of Forest Gate, as draughtsman and station superintendent at £130 per annum

Mr. E. Grime, of Ealing Corporation electricity works, has been appointed charge engineer at Southwark (London) Penrose-street generating station at £2. 5s. a week, rising to £2. 15s. There were 152 applications.

The following changes have taken place in the staff of West Ham electricity department:—

Mr. Perry, boiler house superintendent, has resigned. The vacancy is not to be filled, but Mr. S. M. Hopewell, late in charge of Manchester Corporation motor department, has been appointed to take charge of the motor hiring and power supply development department.

Mr. Kemble, shift engineer, has resigned and has been succeeded by Mr. Midwinter, late shift engineer in the employ of the County of London Co., at a salary of 50s. per week.

Mr. Forster, draughtsman and spare charge engineer, has resigned. The vacancy is not to be filled.

The salary of Mr. Masters, assistant station superintendent, is to be increased from £150 to £175 a year and he is to be given the title of resident engineer. Mr. Masters undertakes to remain for two years in the Council's service and to take up residence in rooms provided at the generating station.

The chief assistant to the electrical engineer having resigned, Mr. J. Smith, chief assistant accountant of Barking Council, has been appointed chief clerk, at a commencing salary of £190, rising to the authorised maximum of £200 in 12 months.

EDUCATIONAL NOTICES.

University College, Nottingham.—The Council offer a scholarship for scientific research, tenable for one year, of the value of £50, with free admission to the college, open to graduates of British universities. Forms from the Registrar. Applications by Sept. 1. See an advertisement

Victoria University, Manchester.—The Council of Victoria University, Manchester, is about to appoint to a Vulcan Fellowship in Mechanical and Electrical Engineering, open to University graduates only and value £120. Conditions of the appointment can be obtained from the Registrar. Some additional particulars will be found in an advertisement.

Argentina.—The "Review of the River Plate" states that Chacabuco Municipality have received a proposal for the construction of an electric tramway.

The City of La Plata & Ensenada Tramway Co. ask permission to convert their line to electric traction.

Chivilcoy electricity supply undertaking was inaugurated on 24th ult. The works were equipped by Buxton & Cassini, and Trant & Soldani are the concessionaires.

Australasia.—The "Australian Mining Standard" states that the inauguration of the Kerang (Victoria) electric lighting plant took place last month. The plant, which was erected under the superintendence of Mr. P. Boll, comprises two Ransomes, Sims & Jefferies 65 H.P. high-speed vertical engines, two Helios 40 kw. 220 volt c.c. dynamos, and a switchboard by Voigt & Haeffner, Frankfort. 250 poles and 35 miles of wire have been used in the distributing network and eight 1,200 c.p. arc lamps, supplied by Siemens Bros. & Co., and 24 16 c.p. incandescents are to be used, at the outset, for public lighting.

Launceston (Tasmania) Corporation contemplate the construction of electric tramways, estimated to cost between £50,000 and £70,000, and information is being obtained from local authorities owning tramways in Australia and New Zealand to aid the Corporation in preparing more precise estimates of capital and working expenses.

Our Australian correspondent says that Broken Hill (N.S.W.) Electric Light committee recommend the erection of 75 arc lamps for street lighting and the borrowing of £6,000 (repayable in 10 years) for the purchase of additional plant, &c.

The Governor (Lord Northcote) is to be asked to formally inaugurate the service of Marconi wireless telegraphy between Queenscliffe (Victoria) and Devonport (Tasmania). The terms of the licence have been arranged so as to safeguard the interests of the Post and Telegraph department. The issuing of the licence does not bind the Commonwealth to the Marconi system or prejudicially affect any other company that may apply for a license, and the installation is not to be used for transmitting commercial messages in competition with the State Telegraphs.

Ayr.—The Council have adopted a recommendation by the Lighting sub-committee that the electricity department be at liberty to sell electric lamps at a profit of 25 per cent. on cost, unless private traders in the town agree to sell lamps at a profit not exceeding that figure.

This action was taken, it was announced, in consequence of a letter from Reid & Co. complaining that the Corporation were selling lamps in competition with the town traders. Provost Allen said cheap and defective lamps had been sold in the town consuming more current than the best makes of lamp, and, in a short time, giving a poor light.

Assessment of Electricity and Tramway Undertakings.—The assessment of Cardiff Corporation electricity works has been reduced from £6,500 to £4,000 and that of the tramways from £20,000 to £15,000.

Bargoed (near Cardiff).—Mr. Herbert Lewis (Herbert Lewis & Fletcher) explained to Golligaer & Rhigos District Council the proposals of the Rhymney Valley District Supply Co. for supplying electricity in the district. The Council decided to support the company's application for an order.

Bequests.—The late Mr. F. W. Webb, chief mechanical engineer of the L. & N. W. Railway, bequeathed £5,000 to the Benevolent Fund of the Institution of Civil Engineers, and £2,000 each to the Victoria University, Manchester, and University College, Liverpool, and, after providing for other legacies, the residue of Mr. Webb's estate is to be devoted to founding an orphanage for children of deceased L. & N. W. employés.

Bridgend.—The Council have agreed to pay to the South Wales Electrical Power Distribution Co. ¾d. extra per unit for current for four months if other consumers agree to the same arrangement. The company ask for this increase to save them working at a loss, and they undertake to recoup the Council in the event of their bill in Parliament being passed.

Brighouse.—At their meeting on Wednesday the Council decided to put in an additional engine and dynamo to meet the increasing demand for current.

Brighton.—The Lighting committee have decided to reject all the tenders for coal, which were recently withdrawn from consideration, and have authorised the engineer to order 1,000 tons of Nixon's steam navigation coal at 23s. 9d. per ton, pending the call for tenders for 6 or 12 months' supply.

The committee have received a letter from Councillor Sone inquiring why the committee have not reported to the Council as to the sum of £4,500 for scrapped meters, as promised by the town clerk at the recent local inquiry. The committee replied that they had had before them a report from the borough accountant which dealt with the question, and which was approved by the Council on Feb. 1 last, and the committee did not propose to take any further action in the matter.

On Thursday last week, on the motion of Ald. Carden, the accounts of the Tramway department were adopted.

Caoutchouc.—Mr. Acting-Vice-Consul T. Trood has prepared an interesting report on the trade of Samoa (Western Pacific), and this has just been issued. Rubber cultivation and export form the principal items of trade of the Samoa group, and instructive particulars of the extension of this culture are given in Mr. Trood's report.

Chicago.—In a lengthy description of the trade of the consular district of Chicago Mr. Consul Finn states that the Great Northern Power Co., which has been actively engaged during the past year in the construction of a large electric power plant at Duluth, will be ready to distribute power by July 1. The complete scheme is for an 80,000 H.P. station. The plant now being installed represents 30,000 H.P., and orders are already booked for 20,000 H.P. of this power. The establishment of electricity works has attracted industry, and several large new works are being established in Duluth in consequence, and a number of works now driven by steam intend changing over to electricity.

Church Lighting.—On the 17th inst., at Gorleston Parish Church, the gas was turned off for the last time and electricity switched on for the first time to the general satisfaction of the congregation. Messrs. Mann, Egerton & Co., Norwich, were contractors for the fitting and wiring.

Devizes.—The Council have received an offer from London to promote a company to work the Council's electric lighting order. The Council, however, stipulated that the basis of the ultimate repurchase of the undertaking by them would be its value as a going concern, and the negotiations have been dropped.

Direct Labour and the L.G.B.—At an inquiry at Wallasey last week, Major C. E. Norton, R.E., the L.G. Board inspector, said, in reference to the Council's proposal to borrow £700 for street widening to be carried out by the Council's workmen, that the Board had decided not to sanction any payments for work done in this way, as it meant charging to capital what should be charged to revenue. The Council's surveyor said the work would, therefore, be done by contract.

Dundee.—The revenue of the electricity department for the year to March last was £31,392, including balance from previous year (surplus of £2,147 over estimated revenue), and the expenses were £20,876 (surplus £1,631). The output of current was 3,439,231 units (against 3,067,624), or an increase of 371,607 units. The coal bill was £798 less. Generating costs were £8,479.

It is proposed to reduce the price of current to private consumers for lighting by ½d. per unit, and for current for tramways to 1¼d. per unit. During the past four years £19,606 has been paid off by sinking fund and depreciation of plant, besides the cost of relaying mains, &c., to the extent of £9,520. The Gas commissioners have decided that the price of current otherwise than by agreement or for motive power, shall be for any quantity up to 20 units per quarter 5s. 10d., 3½d. per unit for all additional current up to 10,000 units, and 3d. above 10,000 units, subject to 5 per cent. discount for payment within 28 days; that public lamps be charged £15 per lamp per annum for all night lighting, and £7. 10d. for part of night; and that the charges for motive power and heating vary from a maximum of 2½d. per unit, in proportion to consumers' demands in kilowatts and in units consumed, these power and heating rates to apply only to current taken through a separate meter, and the minimum charge to be 5s. 10d. per quarter.

The Electricity committee on Tuesday considered a proposal made by the city electrical engineer (Mr. H. Richardson) for putting down a h.t. turbo-alternator at the present station, constructing two permanent sub-stations and laying h.t. cables at a cost of about £13,000. Mr. Richardson says these additions could be ready for supplying current by about mid-winter, and could be ultimately utilised in connection with the more extensive scheme which it is proposed to carry out. He is to submit more detailed estimates.

Electric Coal Cranes.—H. Wilson & Co., Liverpool, have recently erected two electric cranes at Queen's Quay, Belfast, for the Harbour Commissioners. The lifting, revolving, derricking and travelling are performed by separate motors, the lifting motor being of 70 H.P. and the travelling and derricking motors of 10 H.P. and 9 H.P. respectively. The motors are series wound for 440 volts and the controllers are of the tramway type, with magnetic blow-out windings. Each crane is capable of lifting 4 tons and the grab used has a capacity of 35 cwt. Mr. W. Redfern Kelly, engineer-in-chief to the Commissioners, superintended the construction work. Current is taken from Belfast Corporation mains.

Electric Transporter Bridge.—In connection with the projected extension of the tramways from County Gates, Bournemouth, to Canford Cliffs and the Sandbanks, a transporter bridge is to be erected over Poole Harbour.

This will be a stiffened suspension bridge, the girders of which will be traversed by an electrically-operated truck from which will be suspended a car with its floor at road level, conveying passengers, &c., across the harbour. Similar bridges are working on the Continent and elsewhere, two being constructed over the Mersey and the Usk, and two are authorised at Southport and Portsmouth.

Electric Ventilation.—The James Keith & Blackman Co. are carrying out (under the supervision of Mr. Albion T. Snell) the first portion of a scheme for ventilating the Manchester Royal Exchange, which has a floor area of about 40,000 sq. ft. Five 54 in. diameter electric fans are being fitted, calculated to renew from 5,000,000 to 6,000,000 cubic ft. of air per hour, and to change the air of the whole cubic space in the exchange once in every 10 minutes.

Electrical Industrial Progress in Italy.—The utilisation of water power for the generation of electricity for lighting and industrial purposes in Italy is rapidly increasing, and large works of this character are in course of erection in various parts of the country. Among the most important concessions recently granted by the Italian Government is one to the Société des Forces Hydrauliques du Haut Po for the erection of works at a cost of £68,320 for the utilisation of power from the River Varaita for the purposes of electricity to the districts of Saluzzo and Pinerolo.

The Italian State Railways Administration are considering alternative schemes for the electrification of the Giovi Railway.

Electrical Literature.—The "World's Work and Play" for July contains several articles dealing with electricity supply, &c. Mr. McKinnon Wood, M.P., contributes an article entitled "Why the L.C.C. should Electrify London."

Electricity in a Japanese Shipyard.—Kelso & Co., Glasgow, have received an order to construct an experimental tank for a shipbuilding firm in Japan (the Mitsu Bishi Co., of Nagasaki). The tank will have a waterway about 445 ft. in length, a width of about 20 ft., and a depth varying to a maximum of 10 ft., with various offices and other rooms. The machinery connected with the tank will be worked electrically, and Kelso & Co. will supply the dynamos and all other apparatus. The only existing tank in connection with which electric power is at present used is said to be that at John Brown & Co.'s yard at Clydebank.

Electricity in Tin Mining.—At the meeting of the Cornish Consolidated Tin Mines (Ltd.) last week, Mr. F. Allen said the company had a small investment in the Duchy Development Synd. formed to establish electric power plant in Cornwall to supply power to the mines. The first plant was to be established at Hayle.

Electricity Supply in France.—The new law regulating the establishment and working of electricity supply undertakings in France is set out in the French "Journal Officiel" of June 17.

Fiume (Austria-Hungary).—The municipal authorities of this city have under consideration a scheme for the erection of electricity works for the supply of energy for lighting and power. The scheme embraces a water power station of about 10,000 H.P. capacity, to cost between £40,000 and £50,000, the work to be executed within the next two years.

Flame Arcs.—Edinburgh Council are experimenting with flame arc lamps for street lighting. For the purpose of comparison one half of Princes-street is being lighted by ordinary and the other half by flame arcs. Several firms sent samples of lamps for the experiments.

Greenock.—The salary of the electrical engineer (Mr. J. A. Robertson) has been increased from £350 to £450.

Hamilton (N.B.).—Capital expenditure on the electricity undertaking at May 15 was £53,156, of which £46,684 had been paid to Edmundson's Electricity Corpn., who are running the works. Further borrowing will be necessary to meet the demand for current.

It was proposed to obtain powers to borrow up to £20,000, but Mr. Cassels moved that the recommendation be referred back. The Provost said that Messrs. Edmundson had a much better knowledge of the subject than the Council, and expected to recoup themselves later on for their loss in the earlier years. The apparent loss on the past year (£1,418) really represented a sinking fund that was being paid by the company. The matter was, however, ultimately referred back.

Hammersmith (London).—The Council are about to apply for sanction to a loan of £19,343 for machinery, mains, service lines, boiler house foundations, wiring, pumps, feed-water heater, forced draught apparatus, &c.

Hampstead (London).—There is a net profit of £13,159 on the past year's working of the electricity department, of whch £7,000 is being placed to reserve and £2,060 applied to relief of rates.

Hawaii.—A very complete service of electricity supply is established at Honolulu, and lengthy additions are being made to the tramway service in that city.

Inquests.—At Islington (London) Coroner's Court on Tuesday Dr. Danford Thomas opened an inquiry into the deaths of John D. Mansfield, Henry S. Hall and Edgar V. Cordell, who were victims of the Highgate tramway disaster.

Ernest H. Cone, driver of the runaway car, said he had been driving 22 days on the Highgate-Whetstone- road, and he had previously been a month at the school at Hendon, but had had no previous experience. On the day in question he took the car from the yard, and it seemed in good order. He drove to the Archway terminus, and on going back to Whetstone had the signal to stop at Highgate police station. He put the brake on and found the wheels skidded. He applied the hand brake, but had considerable difficulty in stopping the car. He thought something was wrong at the time, but the car afterwards went well to Whetstone, where he arrived three minutes late. On the return journey there was further trouble with the brakes, and he then told the conductor to call an inspector, if he saw one, as something had gone wrong with the brakes. No inspector was seen on the journey. At the next stopping place (the "Winchester") several passengers alighted, leaving over 20 in the car. The car re-started all right, but would not stop at the Archway point, which is at the top of an incline. He released the hand brake, but the wheels still skidded. Then he put on the magnetic brakes, but they would not act. He reversed the motion of the car, but it still went on, and he was unable to get the wheels unlocked. The car meanwhile had gained great speed. About 100 yds. down the incline towards the "Archway Tavern" terminus they collided with a hearse, smashing it to pieces and sweeping it off the track. The car still gained speed and was then going at 20 miles an hour sliding on the rails. Finding that he could do nothing more, and believing that his life was in danger, he swung himself off the car. He was dragged along the line for about 10 yards and then let go. He had his certificate from the school and also his licence from Scotland Yard. He had been down this same hill a hundred times and had never had any trouble before. There were two brakes on the car, a hand brake and a magnetic brake. The latter was used on emergency, but would not act unless the wheels were revolving. Putting the hand brake on too hard made the wheels skid, but that was not the cause of the skidding in this instance. Some cars would not "pick up" at all, no matter how hard the brakes were applied. He was sure he had switched off the current when going down the hill, and the only power he had applied was when he attempted to reverse the current. The hand brake acted on four of the eight wheels of the car. The magnetic brake acted on both lines and wheels. The skidding of the wheels had made a flat on the wheels. At the end of the journey to Whetstone there was an official of the company (the Metropolitan Electric Tramways, Ltd., lessees of the line) to whom he might have complained, but he was late and he had forgotten the incident of the brake having failed to act. He made the next journey without complaint, but half way on the journey he was pulled up again by a skid. He jumped off about 200 yards from the terminus, about 230 yards from the point at which the wheels first started skidding. Skidding was of daily occurrence, and was so common that he had only reported it once. The wet and greasy state of the road greatly contributed to this skidding trouble.

Mr. A. H. Pott, chief engineer of the Metropolitan Electric Tramways (Ltd.), said it was true that while the wheels were skidding the brakes were useless. In his view, however, it was a sign of a bad driver, if the wheels skidded. He thought the accident was due to an error of judgment on the part of the driver, who should not have used the hand brake. The magnetic track brake was quite sufficient, except in case of absolutely bad manipulation of the apparatus.

The Coroner: Do you think, Mr. Pott, that the present brakes and apparatus are sufficient to enable a driver to negotiate this hill?—Yes, in my opinion there is nothing better. The Board of Trade were satisfied. And we had no complaint against the driver. This car had just been renovated and inspected by the police, and the day of the accident (June 23) was the first day on which it had been put into use again. The wheels of the car were made of chilled iron.

After some further evidence, the inquiry was adjourned to July 10.

Mr. A. L. Forrester, coroner for North Wilts., proceeded on Wednesday with the inquiry into the circumstances attending the deaths of E. H. Croad, H. Dyke, R. J. Durnford and C. C. Phippen, who died from the effects of an accident on the Swindon Corporation electric tramways on 1st inst. Lieut-Col. Von Donop (Board of Trade inspector) was present.

The borough surveyor (Mr. H. J. Hamp) produced plans and a statement showing gradients.

Evidence was given that the car was overcrowded, and H. E. Walker, engineer's assistant, of Cardiff, said he was a passenger on the car, and was standing inside. When approaching one of the down grades the driver practically brought his car to a standstill. It was stationary for a moment, and then started forward with a jerk. It was at that point that a flash occurred from the controlling apparatus, and witness saw the driver jump, but he did not lose control of the car. On the bend witness observed a second flash, and the driver appeared to lose control, the speed of the car increasing rapidly. The next thing witness remembered was the car turning over. There were 15 or 16 people standing up inside the car.

T. H. Pearce, another passenger, said in descending the hill the driver released his hold of both brake handles and took off his coat. Whilst engaged in this latter operation the car gained speed, and shortly after seemed to go like lightning.

G. E. Willoughby: of Lyneham, another passenger, corroborated as to the driver releasing his levers, unbuttoning his great coat, folding it up, and placing it in a recess. He was certain the car was moving all the time the driver was taking off his coat.

The inquiry was again adjourned.

Islington (London).—The London County Council have notified the Borough Council that they cannot depart from their invariable practice of paving the tramway track with granite setts, except in the vicinity of hospitals and places of worship, where wood or other noiseless material is used.

The Works committee recommended that the Board of Trade be informed that the Islington Council raises no objection to the conversion of the tramway route along the Upper-street to the conduit system, subject to the Council's right to have the question of the paving material referred to arbitration, and asking that the L.C.C. be informed that the Borough Council require the line to be paved with wood or other noiseless material. The recommendations were carried.

Italy.—In an interesting report upon the trade of Lombardy for 1905 Mr. Consul Towsey states that several large factories have of late been established in this district for the electrolytic production of caustic soda and hypochlorites, and that the progress which electrochemistry is making in Italy is a feature of the industrial development of that country. Mr. Towsey's report gives some instructive particulars regarding the exhibition now being held at Milan.

Leyton.—The revenue of the Council's electricity undertaking for the year ended March was £20,280, an increase of £1,100 over the previous year. Gross profit was £10,296, and after meeting capital charges the net profit is £1,104.

The Council have purchased the portion of the North Metropolitan Tramways within their area, and the system is to be converted to electric traction.

Light Railways.—Major Pringle (for the Board of Trade) has approved the Burton and Ashby light railway, which he recently inspected, and has over-ruled the objection of Swadlincote Council to the construction of a double track along certain narrow roads. Mr. A. P. Trotter is about to inspect the overhead equipment.

The Board of Trade have confirmed the Stretford and West Manchester (New Lines, &c.) Light Railways Orders, 1906.

London County Council.—At Tuesday's meeting the Finance committee submitted a report on the subject of the payment of income tax in respect of profits on the tramways, and particularly in regard to the amount to be allowed for depreciation for renewals on the reconstructed electric lines.

The committee recommended that an appeal to the High Court be lodged against the decision of the Commissioners.—Carried.

Islington Council's Electricity Undertaking.—A lengthy report was submitted by the same committee with regard to the application of Islington Council for a loan of £17,156 for extensions of street arc lighting. The cost of the lighting by electricity will be about £1,500 more than by gas. With considerable hesitation the committee recommended the granting of the loan. It was further recommended that Islington Council be asked what action it proposes to take of establishing a reserve fund.—After some discussion the recommendation was agreed to.

Cables.—It was resolved to extend the contract with the Western Electric Co. to include the provision, at a cost not exceeding £2,450, of additional high-tension cable required for the Deptford and Greenwich generating stations.

Steelwork Contract.—With regard to the contract of J. Westwood & Co. for the steelwork for the first portion of the Greenwich power station, the Council had decided to retain £500 for delay. The contractors had, however, refused to consent to any deduction and had made a counterclaim for £925. Under these circumstances it was resolved that steps be taken to recover £2,500, which is the total sum the Council claim as liquidated damages for delay.

Highgate Hill Light Railways Order.—It was agreed to oppose the application of the Highgate Hill Tramways Co. to the Light Railway Commissioners to allow them to electrify their line up Highgate-hill.

Education.—The Education committee reported that the Governors of Battersea Polytechnic propose to advertise for a head of the department of electrical engineering (in place of Mr. A. G. Cooke, appointed principal of Paddington Technical Institute) at a salary of £300, rising to £350, and to appoint the present lecturer in physics as head of the physics department at a similar salary.

The Establishment committee recommended that an advertisement be issued for a principal assistant in the engineer's department (in the place of the late Mr. T. P. Gunyon, principal assistant in charge of highways, electric lighting, &c., section of the department) at £500 a year.

London County Council Tramways.—Finsbury Council has resolved to petition the L.C.C. to institute a direct service between King's Cross and Finsbury-pavement, as formerly.

Louth.—The Council have been asked by the Board of Trade to show cause why their electric lighting order (1902) should not be revoked.

Manchester.—At a meeting on Tuesday Manchester Tramways committee received the annual report on the tramways, which shows that the capital expenditure is £1,675,811, compared with £1,587,930 at the end of the previous financial year.

Traffic revenue was £661,806 (against £628,529), and total revenue £663,706. Working expenses were £433,560, leaving gross profit £230,146 (against £220,358). Capital charges absorbed £111,925, leaving a disposable balance (including bank interest £1,951) of £232,097 (against £120,950). £70,082 is to be placed to renewals and depreciation, £46,000 contributed to relief of rates, and £4,090 appropriated for street improvements. 14,655,908 car-miles were run (against 14,123,124), and the number of passengers carried was 133,923,932 (against 126,900,875). Traffic revenue per car-mile was 10·84d. (against 10·68d.), and the average car-miles per car per day were 95 (against 96·7). The average working expenses per car-mile were 7·10d. (against 6·99d.) The slight increase in cost was due to the use of covered cars. The average fare per passenger was 1·19d. (the same as in the previous year).

Mr. J. M. M'Elroy, the general manager of the tramways, is preparing a special report on the working of the tramways parcel department, but the accounts show that the total operating expenses amounted last year to £17,366, and that the income was £11,996.

Marylebone (London).—The Council are applying for a loan of £136,000 for electricity supply, to cover all requirements up to 1912. The amount is partly made up of expenses incurred in carrying out the change of voltage of supply and in meeting ratepayer's opposition thereto.

Milan Exhibition.—The following are some of the exhibitors in the British Division of this Exhibition, which was opened by the King of Italy on April 28:—

Section 1.—Armorduct Mfg. Co. show steel conducts, bare and insulated wires, &c.; Berry, Skinner & Co., fool-proof ironclad switches and fuses and switch-fuse plugs; British Electric Transformer Co., Berry transformers; Cambridge Scientific Instrument Co., magnetographs, pyrometers, electrometer, micro-electroscope, thermo-electric key, galvanometers, oscillograph, coils, commutators, &c.; Clayton & Shuttleworth, engines, &c.; F. Darton & Co., luminous compasses, &c.; Elliott Bros., galvanometers, fault-localising bridge, Wheatstone bridge, voltmeters, ammeters and wattmeters; Hele-Shaw Patent Clutch Co., Prof. Hele-Shaw's clutch for automobiles; Lundberg & Sons, electric lighting accessories; Magnesia Coverings (Ltd.), boiler and pipe-covering material; Marconi's Wireless Telegraph Co., wireless telegraph apparatus; Merryweather & Sons, fire boat, &c.; Nalder Bros. & Thompson, direct-current instruments, recording instruments, insulation testing set, circuit breakers, automatic switches, and d.c. and a.c. indicating wattmeters; National Electrical Manufacturers' Association, collective display of goods made by electrical firms belonging to the Association; Simplex Conduits (Ltd.), conduits, fittings and accessories, couplings, bends and tees, junction boxes, switch, ceiling rose and cut-out fittings, watertight bracket, &c.

Section 2.—Babcock & Wilcox, boilers, superheaters, stokers, fuel economisers, feed water heaters, electric cranes, &c.; Chadburn's (Ship) Telegraph Co., telegraph apparatus for docking orders and for steering, a double-dial engine telegraph transmitter and a wheel-handle transmitter; the Hon. C. A. Parsons, drawings, photographs, &c., illustrating inventions which are the subject of Mr. Parsons' Italian patents; Stirling Boiler Co., Stirling boiler of 830 sq. ft. heating surface and capable of developing 280 H.P., working model and drawings and photographs of Stirling boiler installations; Vickers, Sons & Maxim, guns, projectiles, ship models, &c.

Section 5.—Alfred Herbert, Ltd., Standard No. 4 hexagon turret lathe; John M. Sumner & Co., electric and belt-driven fans, manufactured by the Blackman Export Co.

Section 6.—Institution of Civil Engineers, commemorative panel, emblematic of the institution's past work and dedicated to the engineers of Italy; Institution of Mechanical Engineers, 71 volumes of "Proceedings," portraits, photographs, historic rails and accessories.

Section 7.—Ruston, Proctor & Co., portable steam engines, &c.

Section 9.—Doulton & Co., railway carriage and other sanitary fittings.

Special pavilions annexed to British Section or where British products are exhibited.—Alfred Graham & Co., telephones for nautical purposes, &c.; Sir W. G. Armstrong, Whitworth & Co., electrically-driven lathe, drilling, milling, slotting and other machines, &c.; Greenwood & Batley, dynamos and motors, fire alarms, &c.

Municipal Profit-Sharing.—Stafford Council has approved the payment of £458 to the employés of the gas department and £55 to the staff and workmen of the electric lighting department (equal to 7½ per cent. and 6½ per cent. respectively on their wages) in accordance with the profit-sharing scheme adopted by the Corporation.

Municipal Telephony.—It was reported at the meeting of *Cardiff* Chamber of Commerce last week that the Post Office were refusing to quote inclusive rates to new subscribers on the ground that the charge hitherto made for unlimited service was inadequate. It was decided to send a letter to the Secretary of the G.P.O., and also to local members of Parliament asking them to support a protest against the change.

Hull Telephone committee decided on Monday to recommend the adoption of (1) a two-party line rate for private houses at £4, and (2) an exclusive line rate at £5 up to 1,000 calls.

Plymouth.—The Tramways committee witnessed on Monday tests of the new track brake, devised by Mr. C. R. Everson, (manager) and Mr. W. H. Sleep (mechanical engineer).

It is stated that it was found that the new brake brought the cars to a standstill in a shorter time and distance than the older pattern in use at present, and moreover required fewer turns of the hand-wheel. The committee will recommend the Council to equip with the new pattern brake 10 of the cars at present in use and also the demi-cars now being built.

Paraguay.—Mr. C. Gosling, British Chargé d'Affaires at Asuncion, reports that electric traction is shortly to be introduced on the animal-drawn tramways in this city, which are owned by a British company. Suitable means of transport are, it is said, greatly lacking in Paraguay, and it is thought probable that the Central Railway will shortly be considerably extended. It is also announced that two concessions for railways have recently been applied for, and that a British company in the Chacco district are laying down a narrow gauge line on their property.

Paris-Rome Telephone.—The new telephonic communication between Paris, Lyons and Rome will be opened to the public on July 1. The public will at the commencement be able only to make use of above communication from the cabins at Paris, Gutenberg, Lyons Central and Rome Central offices, but this will eventually be extended to all general offices in the above towns and to telephone subscribers, should conversation prove satisfactory. The charges for seven minutes' conversation during the day time will be 4fr. between Paris and Rome and 3fr. 5c. between Lyons and Rome. The night charges are, respectively, 2fr. 40c. and 2fr. 10c.

Postal Arrangements.—The rates of postage for inland parcels exceeding 4 lb. in weight will be reduced on Monday next.

The poundage charges on money orders payable abroad and on postal orders for inland circulation will undergo some reduction and rearragement from Monday next.

It is pointed out that at the Postal Union Congress which has just concluded its sittings in Rome the unit of weight for international letters was raised from 15 to 20 grammes. It was, moreover, decided that in countries such as the United Kingdom, where the decimal-metric system of weights and measures is not in force, 1 oz. avoirdupois should be the equivalent of 20 grammes. These decisions of the Rome Congress (which are of considerable interest to traders) take effect from Oct. 1, 1907.

Presentation.—Mr. J. F. Roberts, British Consul-General at Barcelona, Mr. H. V. Browne, the Direct Spanish Telegraph Co.'s superintendent at Barcelona, and Mr. Kendall Park, delegate of British residents at Madrid, recently waited upon the new Queen of Spain, and presented to Her Majesty an address expressing the congratulations and good wishes of the British residents in Spain, and a sum of money to be devoted to works of charity. The deputation, which was very cordially received, was introduced by the British Ambassador, Sir Maurice de Bunsen.

Private Fire Brigades Competition.—At the annual competition between the private fire brigades in the County of London at the Guildhall, London, on Saturday, the Robertson Electric Lamps' team won the silver challenge shield easily, making the highest number of marks in both wet and dry drills Eighteen teams competed. The shield is presented by the City of London Corporation and is of the value of about £150. The Robertson team of seven men each received a silver medal.

Provisional Order Extension.—Newton (Lancs.) Council have obtained the extension of their electric lighting order for a further 12 months.

Provisional Order Revocation.—The Clevedon, Portishead and Long Ashton Order, 1904, has also been revoked.

Provisional Order Transfer.—The Board of Trade have approved the transfer of Chichester Corporation's electric lighting order to the Chichester Electric Light & Power Co.

Queenborough.—The Council have assented to the use of overhead electric light and power cables.

Rhyl.—In consequence of comments as to the loss on the Council's electricity department, the engineer, Mr. E. E. Wright, has presented a report on the generating costs of other electricity undertakings having outputs of 200,000 units or less per annum as is the case at Rhyl.

The report showed that at Barnstaple the cost was the same as at Rhyl (2·89d.), 9 were lower (the lowest being Nuneaton, 1·45d.), and 9 higher (Kendal highest, 4·67d.). Mr. Wright points out that Rhyl is handicapped by having provided separate traction plant for the abortive Rhyl & Prestatyn Light Railway.

Safety Appliances Exhibition.—Yesterday's "Daily Chronicle" (London) contains a discription of a permanent exhibition of appliances devised for the protection of workpeople from accidents which has been established at Charlottenburg, Berlin, by the German Imperial Government on the suggestion of Dr. Reichel, of the Imperial Insurance Office.

About 115 large and 600 small machines are shown, and the machinery in motion is driven by four large and 11 smaller electric motors. The portions of machinery which are attached specially for protective purposes are painted red, so as to call the attention of the uninitiated to the purposes for which they are used. The exhibits include safety attachments for cranes, lifts, lathes and metal working machines, miners' lamps that can only be opened by magnets, special clothing for engineers and electrical workers, &c.

Saffron Walden.—Mr. M. Parker has submitted a scheme for working the Council's electric lighting order, which the Council have decided not to entertain unless the expenses of obtaining the order are paid and future expenses guaranteed.

Sheffield.—At last week's Council meeting, Ald. Styring, in introducing the accounts of the electricity department (abstracted in our issue of 15th inst.), said the Electric Lighting committee had contributed £18,781 out of income towards paying off capital, whereas the Water department, with a three times larger capital, had contributed only £12,443 for sinking fund, and the markets, with more than half the capital of the electric light undertaking, only £3,508.

The electricity department (continued the alderman) had now motors connected of an aggregate of 4,806 H.P. That side of the undertaking had been almost entirely developed during the last two or three years. He did not think the Council treated the electric light undertaking at all fairly, as the only contribution the Council made towards supporting electric lighting for street illumination was in respect of the lamps around the Town Hall. They were paying £12,000 a year for gas, and if they realised their duty to the electric department they would transfer a large part of that sum to enable the committee to reduce the price of current, and so be in a position to compete on more even terms with gas.

Councillor HENDERSON congratulated the committee on the reduction in working cost. At Neepsend two years ago the cost was 0·67d. per unit, while this year it was only 0·30d. If it had been possible to produce all the current they had generated at the Neepsend figures the expenditure would have been £6,400, instead of £10,400. This should make them consider whether they were wise in continuing the Sheaf-street works.

The committee's report was adopted.

The Council also adopted the minutes and accounts of the Tramway committee. Out of the tramway profits for the year £9,000 is to be devoted to relief of rates, £1,000 is contributed to the University. £2,000 for providing music in parks and £169 for winter concerts.

South Africa.—Vryheid (Natal) Council are raising a loan for electric or other public lighting.

South Shields.—The Corporation's electric tramways between Frederick-street and Slake-terrace were officially inspected by Col. von Donop and were opened for traffic on Saturday.

The capital expenditure on the electricity undertaking increased during the past year from £151,838 to £163,047. Revenue was £17,331 (against £18,132 in the previous year) and working expenses were £7,210 (against £11,196). Interest required £4,770 and sinking fund £4,493, leaving £857 net profit (against £2,066), the diminished profit being due to reductions in charges for current equal to £1,700 of receipts. There are 1,144 private consumers, 618 being on the maximum demand system, 480 on the flat rate and 2, 18, and 26 respectively on theatre, heating, and power rates. The average prices received were 3·47d. from private consumers and 1·3d. for street lighting. 1,696,142 units were generated (against 1,573,480), 522,874 supplied to public lamps (against 506,166) and 916,047 to private consumers (against 879,227). The engineer, Mr. J. H. Cawthra, calls attention to the low works costs (0·61d.) in the last two years, this low percentage having been reached without a traction load.

Southend-on-Sea.—The Corporation tramways have shown a profit of £25 on the past year's working.

Mr. A. C. Johnson, assistant electrical engineer, has resigned.

Spain.—Mr. Haggard, the British Consul for the Malaga district of Spain (comprising Malaga, Almeria, Granada, Jaen and Murcia), has recently furnished an interesting report upon the trade of that district for 1905, and refers to the electricity works which have been established at Chorro, where the waterfall of the river Guadalhorce at the Chorro, a distance of 32 miles, has been utilised for the generation of electric energy and its transmission to Malaga and other places in the district for industrial purposes. Both the English and German electric lighting companies which supply current in the district utilise current so generated, as also does the tramway company. The financial part of the enterprise has been taken in hand by a Belgian company, the Sociedad Hispano-Belga, which has a capital of 3,000,000 fr. and is formed to work railways and tramways in Spain and to exploit and develop electrical enterprises generally. A large number of new electric railways and tramways are in course of construction or in contemplation, originating within the Malaga district. Work was commenced during the past year with the electrification of the local system of tramways which is being considerably extended in various directions. The new lines will, most of them, be in operation during the current year.

At Carthagena the local tramways are being converted from animal into electric traction, and a concession has been granted for the laying down and working of an electric tramway from Carthagena to La Union.

At Granada the tramways are being extended and the track is being laid for a line leading to the Alhambra. There is also a project on foot for establishing a tramway to the foot of the Sierra Nevada.

The project for establishing a wireless telegraphy service between Melilla and Almeria, which has been approved by the Spanish Government, has not yet been put into operation.

Stepney (London).—At the last meeting of the Council Councillor L. Davis moved—

"That, consequent upon the assurances of the chairman of the Electricity committee, given at the last meeting of the Council in moving the adoption of the accounts of the electricity undertaking, that the undertaking is now financially sound and thoroughly efficient, it be referred to the Electric Lighting committee to consider and report whether the engagement of the consulting electrical engineer can now be advantageously terminated." Mr. Davis went on to say, in effect, that the undertaking was thriving under Mr. Tapper's care, and he (Mr. Davis) did not think they ought to be paying £800 a year for other professional services. This was not a new question, but the position now was somewhat different from what it was before, inasmuch as the agreement with Mr. Wright terminated in February last.

Ald. CHIDGLEY said he did not regard the motion as a businesslike proposal. When they had a profitable undertaking it did not seem businesslike to get rid of those who had made it profitable. Even referring such a question to committee did not tend to confirm a man in his position and make him put his heart into his work.

Councillor GORDON said that only a few days previously a statement was brought forward in the House of Lords in which Mr. Wright showed what they had done at Stepney, and that statement would have the utmost influence in deciding the minds of the Commissioners in the action to be adopted. If a new joint monopoly in electricity supply was created in London they would require the utmost expert advice to enable them to keep their heads above water.

Councillor O'CONNOR said the undertaking was made successful "at the expense of the ratepayers." The appointment of Mr. Wright was for five years, and that five years had expired. It was time the committee sought to carry on the undertaking on more economical lines.

Ald. POTTER said there were strong reasons against the motion. He claimed that Mr. Wright was unquestionably one of the first consulting engineers in relation to electric lighting undertakings in this country. Where they had such a large undertaking, involving a quarter of a million, and which would involve a further sum of a quarter of a million at least, they wanted to see they had the best advice. They would either have to have a man at a fixed sum or pay a fee for each piece of advice. If in a year or two's time, when matters electrical were somewhat settled, then it might be considered, but certainly not in a time of crisis like this.

The motion was ultimately carried by 21 votes to 16, the mayor and one other councillor not voting.

Superannuation.—Reference was made in our last issue (p. 360) to the British Electrical Superannuation Fund, and we would especially call attention to the issue by the Trustees of a quantity of informing literature relating to the Fund, and enabling the reader to obtain a complete grasp of the chief points of special interest in regard to this completely organised and well-managed Institution. It is the desire of those who have carried out all the heavy preliminary work necessarily attendant upon the organisation of such a scheme to put the merits of the Fund clearly before those companies and firms which, by the terms of the Trust Deed and the rules and regulations, may become associated with this scheme for providing superannuation allowances for officials and employés in electrical undertakings of all kinds. We can speak with knowledge of the care and attention which have been given to the preparation of the rules and regulations which govern the Fund. A report and a supplementary report upon the valuation of its liabilities at June 30, 1905, and a set of notes and recommendations prepared by Messrs. T. G. Acland and J. Bacon, the former a Vice-President and the latter a Fellow of the Institute of Actuaries, will be perused with interest, especially in view of the fact that the recommendations have been adopted, and the British Electrical Superannuation Fund placed upon that sound financial basis which is the chief essential of success in regard to a scheme of this character. Copies of the publications referred to and the report of the managing trustees and a statement of accounts for the year to Dec. 31, 1905, can be obtained by parties interested from the Secretary, Mr. Thomas Bower, Donington House, Norfolk-street, London, W.C.

Turbine Cruiser for Germany.—It is stated that the Allgemeine Elektrizitäts-Gesellschaft are about to supply turbines for a new German cruiser. In the vessels of the German navy already equipped for turbine propulsion Parsons turbines are used.

Walsall —It was reported at the Chamber of Commerce meeting on Monday that the Shropshire, Worcestershire & Staffordshire Electric Power Co. had offered, if the consent of the Corporation could be obtained, to supply electric current to manufacturers in Walsall at from ¼d. to ½d. per unit, compared with the 1¼d. now charged by the Corporation.

Walthamstow.—The special committee appointed to consider the district auditor's report upon the annual accounts of the Council have issued their report. The committee report that they have informed the auditor that the whole question of the electric lighting accounts is under the consideration of the Council.

The question of installing additional plant at the generating station is under consideration.

West Ham.—In a report just issued the electrical engineer (Mr. A. H. Seabrook) states that, in addition to the 1,500 H.P. in motors connected to the Corporation mains on March 31 500 H.P. has been ordered by new and old consumers. The estimated annual consumption of the additional motors is 1,250,000 units per annum.

Workhouse Lighting.—St. Pancras workhouse is to be lighted electrically at an initial cost of about £500.

Dinner.—On Saturday last the annual outing and dinner of the staff of Stepney electricity department took place.

The party travelled by train to Clacton-on-Sea and partook of dinner at the Brunswick Hotel. Mr. W. Young presided, with Mr. A. J. Somerville in the vice-chair. The chairman expressed his pleasure at again meeting the staff under such circumstances, and regretted that the exigencies of business prevented all the staff from attending. A vote of thanks was accorded to the hon. treasurer and secretary (Mr. E. E. Dorking) and the Outing committee.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Hackney Borough Council require tenders for section A, arc lamp pillars; B, erection of arc lamp pillars and switch pillars; C, arc lamps and accessories, and D, switch pillars. Conditions, specificatiods, &c., can be inspected at the offices of Mr. Robert Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, S.W., and can be obtained from that address after Monday next. Tenders to the town clerk, Mr. W. A. Williams, Town Hall, Hackney, by 4 p.m. July 26. An advertisement gives further particulars.

Dublin Corporation Lighting committee invite tenders for supply of sub-station switchboards and accessories and transformer pillars. Specifications, &c., from the city electrical engineer, Fleet street, Dublin, and tenders (addressed "Chairman of Lighting committee, 3, Cork-hill, Dublin") are to be in by July 9. An advertisement gives further particulars.

London County Council invite tenders for about 33 miles of high-tension three core lead covered cable, telephone cables, &c.; and about 25 miles of low-tension lead-covered cables, telephone cables, &c. Specifications, &c., from the County Hall, Spring-gardens, S.W. Tenders to the clerk (Mr. G. L. Gomme) by 10 a.m. July 10.

London County Council also require tenders by 10 a.m. July 3 for supply of tramcar fittings, motors and fittings and insulating materials.

Portsmouth Town Council invite tenders for water softening plant, water storage tank, steam feed and exhaust piping, and sundry ironwork. Tenders to the town clerk (Mr. Alexander Hellard) by noon June 27th.

Twickenham District Council require tenders by noon, July 11, for electric lighting and the supply of electrical machinery, &c. Specifications, &c., from Mr. W. Fairley, 59, Victoria-street, London, S.W., or Mr. T. W. Pearce, Town Hall, Twickenham.

Middlesex County Council want tenders by noon July 11 for construction of permanent way of about 3 miles of electric tramway in Green Lanes, bridge work, road widenings, &c. Schedules from County Engineer, Middlesex Guildhall, S.W.

The Board of Public Works, *Dublin*, want tenders by 10 a.m. July 9 for certain electric works at the Royal Irish Academy House, Dawson-street, the Science & Art Buildings, and Leinster House, Kildare-street. Forms of tender, &c., from the secretary.

Stockport Tramways committee want tenders by noon July 3 for the erection of car-shed extension and river-retaining wall at Mersey-square.

Birmingham Corporation wants tenders by noon July 9 for reconstruction of portion of a tramway depot. Form of tender, &c., from Mr. A. Rowse, King's-court, Colmore-row, Birmingham.

Bolton Electricity Committee want tenders by noon, July 12, for condensing apparatus. Specification, &c., from the borough engineer.

Oldham Education committee want tenders by July 4 for the electric lighting and ventilation of the new Clarksfield school. Specification, &c., from Mr. J. Rennie, Education Offices.

Leeds Electricity committee require tenders by July 16 for 150 tons of coal-tar pitch. Forms of tender from Whitehall-road, Leeds.

Umtata (Cape Colony) Municipality require tenders by Aug. 1 for electric or acetylene gas lighting.

TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board have accepted tenders from the following firms for supply of electrical accessories for the twelve months to June 29, 1907:—

Pryke & Palmer, General Electric Co., Ltd, Sterling Telephone & Electric Co., W. T. Henley's Telegraph Works Co., Edison & Swan Co., Baxter & Caunter, Amalgamated Dry Batteries, H. G. Mayer & Co., Siemens Bros. & Co., London Electric Wire Co., Davies Kent & Stewart, British Insulated & Helsby Cables, Johnson & Phillips, E. Goossens, Pope & Co., Sunbeam Lamp Co., Indiarubber Co., G. Straus & Co., London Electrical Fittings Co., Moorwood, Sons & Co, Callender's Co.

Erith's grateless underfeed stokers, manufactured by Erith's Engineering Co., have recently been fitted to Lancashire boilers at Woolwich Arsenal (repeat order); at Crewe for L. & N.W. Railway Co. (repeat); at Port Sunlight for Lever Bros. (repeat); and at Bolsover Colliery, Chesterfield (repeat); to Nesdrum boilers at Middlesbrough for Cargo Fleet Iron Co. (20 stokers); to Babcock boilers for Durham Collieries Power Supply Co. (15 stokers) and for Islington Borough Council; and to Economic boilers for Southend Corporation.

Poplar Borough Council recently invited amended tenders for coal-conveying plant at the electricity works, including foundations, &c., and the following amended tenders have been received:—Babcock & Wilcox (recommended for acceptance) £2,158, Edgar Allen & Co. £1,655, Ed. Bennis & Co. £1,320, New Conveyor Co. £2,150. 10s., Gibbons Bros. £1,875.

Southwark (London) Council have received the following tenders for the electric motors to work the patent clero machines at the Manor-place depot:—

Electric Construction Co. (*accepted*) £235. 10s., Cutting Bros. £249. 12s., Chain Belt Eng. Co. £269. 0s. 6d., Bruce Peebles & Co. £315, Mather & Platt £264. 9s., General Electric Co. £280, British Westinghouse Co. £376, Lancashire Dynamo Co. £277. 15s., Siemens Bros. & Co. £362. 12s.

The Paterson Engineering Co. have received orders to supply Bexhill electricity works with a condensation water purifier and grease eliminator, with quartz sand filter, and Gravesend electricity department with a cold process water softener, with quartz sand filter, of 1,500 gallons hourly capacity.

West Ham Corporation have accepted a tender of Mackeys' Electric Lamp Co. for incandescent lamps, and an order has been given to Cory & Co. for a further supply of 5,000 tons of coal at 9s. 5d. per ton.

The Northern Electrical & Ventilating Co., Liverpool, have secured the contract for wiring the new Liverpool Cotton Exchange for electric lighting and for the ventilation of the building by electric fans.

Battersea Borough Council have accepted the tender of Evered & Co. for electrical fittings for their museum, recreation room and gymnasium in Plough-road.

Birkenhead Corporation have accepted the tenders of the Electric Construction Co. for balancer, boosters and switchboard extension, and Jas. Spencer & Co. for overhead travelling crane.

Cardiff Asylums committee have accepted the tender of Arnold & Sons for the electric lighting of the Asylum attendants' cottages at £158. J. B. Saunders & Co. tendered at £242. 12s. 2d.

Hammersmith (London) Council have accepted the tender of A. B. Bosher & Co. at £76. 10s. 9d. for 12 months' supply of files to the electricity works.

Croydon Corporation have accepted the tenders of the British Westinghouse Co. for 10 tramcars at £521. 10s. each and the British Thomson-Houston Co. for a track watering cart at £619. 10s.

Bury Electricity committee have accepted the tender of Boby Bros. & Chapman for best Portland hard steam coal at 18s. per ton for the electricity works.

The British Thomson-Houston Co. have received the order for a switchboard panel and switch gear for Southend Corporation at £126.

Bury (Lancs) Corporation have accepted the tender of Mountain & Gibson for a track-watering and cleaning car.

Australian Post Office Contracts.—Announcement is made in the "Commonwealth Gazette" that specifications or forms of tender for supplies required by the Postmaster-General's Department at any time will be sent without further application to those firms who indicate to the Secretary of the Department, 51, Spring-street, Melbourne, their desire to receive them.

BUSINESS NOTICES.

Mr. J. L. Cateaux is, we are informed, leaving the British Thomson-Houston Co., Rugby, and expects to take up other work at an early date.

Mr. John A. Rudd informs us that as from June 30, he will cease to represent the British Insulated & Helsby Cables (Ltd.) in Scotland. He is removing to 68, Gordon-street, Glasgow, where he will continue to carry on the other branches of his business as hitherto. Mr. Rudd informs us that he has represented first the Telegraph Mfg. Co. and afterwards its successors, the British Insulated & Helsby Cables, since 1892.

The title of the firm of E M. Evans, 18A and 18B, Fountain-street, Manchester, has been altered to "E. M. Evans & Son," in consequence of Mr. Joseph H. Evans, who has been identified with the management for a number of years, having joined the firm as acting partner.

Mr. A. Morrison, 100, Central-chambers, 12, Waterloo-street, Glasgow, has been appointed representative for Scotland of the I.T.E. Electric Co.

The agency which the British Electrical Trade Supply & Bitumen Co. have formerly had with Rumney & Rumney for the sale of refined Trinidad bitumen and insulating box compounds terminates on June 30, and the company asks that all orders should be sent to them direct.

We are asked by the Brush Electrical Engineering Co. to state that Messrs. Hunter & Swan, of 1, James street, Bute Docks, Cardiff, have been appointed representatives in South Wales for the manufactures of the Brush Co.

Messrs. J. Burns (Ltd.) notify that they are removing from 76, Little Britain to 189, Central-street, London, E.C.

Personal.—Mr. W. H. Patchell, vice-president Inst.E.E., M.Inst.C.E., M.I.Mech.E., and A.M.Inst.E.E., who has been engineer-in-chief to the Charing Cross, West End & City Electricity Co. (Ltd.) for the last 13 years, has completed a seven years' contract with that company in connection with their City of London extensions. Mr. Patchell now proposes to establish himself in Westminster as a consulting engineer. He will devote a good deal of his attention to the application of electricity to mines. It will be remembered that Mr. Patchell served on the Home Office Electricity in Mines Committee which inquired into and reported on this subject. Mr. Patchell's Westminster address will be notified shortly. Meantime, his address will continue to be 60, St. Martin's-lane, London, W.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

An application for the discharge of Alex. Gavan Inrig, electrical engineer, 16, Bruce-grove, Tottenham, and lately of Woking, will be heard on July 19 at the Town Hall, Guildford.

Mr. Walter Osmond, 20, Gardnor-mansions, Church-row, Hampstead, London, N.W., has been appointed trustee in the bankruptcy of Theodore F. L. Rene, electrical engineer, 9, Plum Tree-court, Farringdon-street, E.C., and lately of 6, Snow-hill, E.C., London.

Claims against the Automatic Light Controlling Co. (Ltd.) are to be sent to Mr. John Gunning, 100, Holdenhurst-road, Bournemouth, by Aug. 1.

A meeting will be held on July 30 at 22, Booth-street, Manchester, to receive an account of the winding up of Heaton & Smith (Ltd.)

Plant Wanted.—Mr. J. C. Simpson, 48, George-street, Hull, requires a c c. dynamo of 25 kw. to 50 kw, 100 volts, preferably combined with steam engine suitable for 80 lb. working pressure. See an advertisement.

Plant, &c., for Sale.—Messrs. Watson, Laidlaw & Co., 98, Dundas-street, Glasgow, advertise for sale a shunt-wound Mavor & Coulson dynamo, giving 75 amperes at 110 volts.

Messrs. Wm. Denny & Bros, Dumbarton, N.B., invite tenders for the purchase of the whole or part of the electric lighting plant at the Kirkton-hill electric lighting station, comprising two Paterson & Cooper dynamos and two Hornsby-Akroyd oil engines, main switchboard, battery of 60 D.P. cells, &c. See also an advertisement.

A quantity of electric light wire and cables, 300 megohm grade and English make, is advertised for sale in another column.

Mr. A. Underwood, 3, Queen street, London, E.C., has for sale two Lancashire boilers by Tetlow Bros, two compound vertical engines by Browett Lindley coupled to Siemens dynamos, also two Willans & Robinson compound vertical engines coupled to dynamos. See an advertisement.

Sale by Auction—Messrs. S. Walker & Son will sell at the Mart, Lothbury, London, E.C., on Thursday, July 19, at two o'clock, in one lot, some valuable freehold factory property at South Norwood. Particulars can be obtained of Messrs. G. Newman & Co., 15, Station-road, Croydon: of Mr. E. A. Burnie, 1, Lombard-court, London, E.C.; or of the auctioneers, 22, Moorgate-street, London, E.C.

Factory Premises, &c., for Sale and to Let.—Messrs. Fuller, Horsey, Sons & Cassell have a large number of eligible factories, warehouses, &c., for sale and to let detailed in their register.

A factory or motor garage in the west end of London is advertised to be let in another column.

Messrs. B. R. Vickers & Sons, Gascoigne street, Leeds, advertise for sale (or for letting) conveniently situated works on navigable river and near three goods stations, with good water supply, cheap coal, &c.

Tantalum Lamps.—Messrs. Drake & Gorham in an advertisement call special attention to their ability to supply Tantalum lamps at the largely reduced prices recently announced.

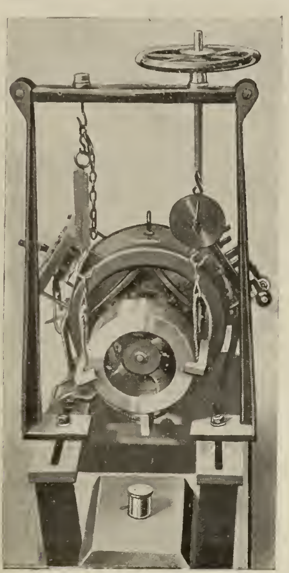
"Kelly's Directory of the Building Trades," 1906.—This directory (the 10th edition of which is ready, price 30s.) comprises every trade and profession in any way connected with architecture and building in Great Britain and the principal towns in Ireland, the Channel Islands and the Isle of Man. A copious index of names of places is provided, and this refers the reader to the pages on which the names of firms or individuals are classified under their trade headings, the towns or villages being at the same time alphabetically arranged in counties. Another section contains the names of the same persons alphabetically arranged under their trades only. The book contains nearly 3,000 pages and should prove serviceable to those who wish to circularise or make business calls upon the firms listed. The book is got up in Messrs. Kelly's usual good style.

German Electrical Directory.—We have received from Messrs. Schulze & Co., 3, Czermaksgarten, Leipzig, a copy of the 6th edition (for 1906-7) of Vol. I. of their well-known "Adressbuch der Elektrizitats-Branche und der damit verwandten Geschäftszweige von Europa." Part I. of the directory contains a very complete and accurate list of electrical engineers (manufacturing, contracting and consulting) and of firms and companies connected (directly and indirectly) with the electrical industry in Germany. In Part II. the names are placed in alphabetical order under the towns of the various provinces of the German Empire, while Part. III. is a classified trades section. The concluding portion of the book gives particulars of the electricity supply works and tramways in Germany; also some useful information regarding the Government post and telegraph departments, public testing laboratories and stations, technical high schools and educational establishments, engineering societies, &c. The new edition of the book has been thoroughly revised and brought up to date, and should prove useful to those having trade relations with Germany.

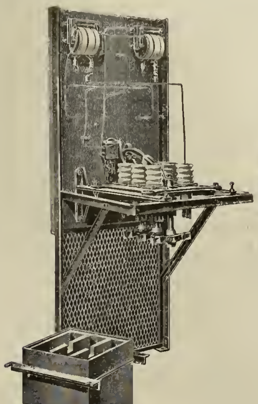
Lundberg Specialities.—In an advertisement on another page of this issue an attractive method of advertising the well-known Lundberg specialities has been adopted.

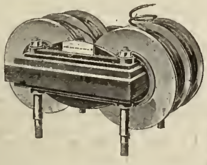
Union Arc Lamps.—The Union Electric Co. write us that they have often found that trouble has been given to the users of arc lamps owing to the installing firms being either unwilling or unable to give simple instructions for their maintenance. The Union Co. have, therefore, issued a hanging card, upon which are legibly printed instructions for the proper use of arc lamps in general and of "Excello" arc lamps in particular. Copies of this card can be obtained from the company either by consumers or by the trade.

Testing Brakes.—Messrs. Johnson & Phillips have ready an illustrated description of the Collins testing brake, specially designed for taking the brake-horse-power of engines and motors. A view of the Collins brake is shown in the accompanying illustration. It is claimed for this brake that only one attendant is required to operate it, at the same time taking the speed of the machine under test. The brake consists of a strip of suitable form and material, usually ropes, embracing the pulley on the machine under test, the tension on the rope being determined by a spring balance attached to each end of the brake strap, and the tension of each spring being so adapted that it may be read by an index and graduated scale. The pressure on the pulley of the machine under test is adjusted by means of a screw operated by a handwheel at the side of the brake strap which is subjected to the greater tension, so that the tension may be adjusted quickly. The frame is of such design that it may be adapted to motors of various sizes and suitable for bolting on to the frame or foundation of the motor. The brakes are arranged for testing motors up to about 20 H.P., and for larger sizes are slightly modified. Messrs. Johnson & Phillips are the sole manufacturers of this brake, which they claim will be found a much more simple apparatus for taking brake tests than any at present on the market.


The Collins Testing Brake.

Catalogues, &c.—The General Electric Co. are issuing a pamphlet giving particulars of their make of three-phase high-tension oil switches. This is a new line of manufacture for this company, and the pamphlet gives very full particulars of the general arrangements of the switches and the method of construction adopted. The accompanying illustration gives a good view of a complete switchboard fitted with these high-tension switches. The smaller illustration shows the potential transformers used as an accessory with three-phase high-tension oil switches and instruments.


G.E.C. High-tension Oil Switches.
(Complete switchboard.)


Potential Transformer, used with G.E.C. High-tension Oil Switches.

Marples, Leach & Co., London, have issued a new list of self-starting motors which have just been put on the market for single-phase alternating current. It is claimed for these motors that they are capable of starting under full load, and that no complicated or delicate starting devices are employed, the only device necessary to start or stop the motor being an ordinary d.p. single-throw knife switch.

Messrs. Arnold Goodwin & Son, of Southwark, London, have a number of new lists ready relating to "Beatall" engineering specialities, including piston rings, lifting blocks, suspension liftways, hydraulic operating valves, &c.

The A.E.G. Foreign Department, 125, Charing Cross-road, London, W.C., forward some of the company's latest publications dealing respectively with (1) switches and fuses, (2) continuous, single-phase and three-phase current electricity meters, and (3) rubber-insulated wires and cables (type QV). The lists are fully illustrated and give a large quantity of information relating to the different items of the company's manufactures to which they refer.

Mechanical Chain Grate Stokers.—A booklet treating fully of the performances of Babcock-Wilcox patent mechanical chain grate stokers for burning bituminous coal smokelessly has been issued by Messrs. Babcock & Wilcox, 30, Farringdon-street, London, E.C. The booklet contains a number of new illustrations of the stoker as installed in connection with Babcock-Wilcox boilers in some of the largest boiler houses in the world. An interesting feature of the pamphlet takes the form of a number of letters from the chief engineers of electricity works, &c., who have had Babcock-Wilcox boilers, stokers, superheaters, &c., under their charge. The earlier illustrations in the booklet are views of the company's large works at Renfrew (Scotland), Bayonne, N.J. (U.S.A.), Paris (France) and Oberhausen (Germany), and a fine elevation of the machines in the largest steam installation in the United Kingdom—*i e.*, the famous works of the Underground Electric Railways Co. of London, at Lot's-road, Chelsea, where 64 Babcock-Wilcox boilers (provision being made for the ultimate installation of 80 boilers), all fitted with superheaters and chain-grate stokers, have been put in. A general view of the boiler room at Lot's road is also given and makes an impressive picture. A number of tests of the Babcock-Wilcox apparatus and much general information will be found in the booklet, which possesses great interest for steam users, to whom the subject of smoke prevention, coal consumption economy, and general upkeep of steam plant are subjects demanding constant attention. Not the least important point of interest in the booklet is the proof given that the record for the lowest coal costs amongst electricity generating stations in this country is held by those stations where Babcock-Wilcox stokers are working—*i.e.*, the works of the Borough of Hackney (London) and the Carville power station of the Newcastle Electric Supply Co. in the provinces.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from June 20 to June 26, with the ports of destination :—

Aden—£12. *Africa*—Alexandria, £16 ; Beira, £7 ; Cape Town, £153 ; Delagoa Bay, £289 ; Durban, £989 (including £250 telegraph material); East London, £17 ; Port Elizabetb, £223. *Argentina*—Buenos Aires, £2,010 (including £346 telegraph material). *Australasia*—Auckland, £10; Brisbane, £117 ; Christchurch, £227 ; Melbourne, £2,029 (including £1,300 telegraph material) ; Sydney, £707 (including £175 telegraph material); Wellington, £27. *Brazil*—Pernambuco, £97 (telegraph material) ; Rio Janeiro, £24 ; Santos, £120. *Chili*—Valparaiso, £59. *China*—Shanghai, £10; Tientsin, £94. *Cochin China*—Saigon, £250. *France*—Le Treport, £80. *Gibraltar*, £250. *Holland*—Amsterdam, £125 ; (including £15 telegraph material) ; Rotterdam, £45. *Hong Kong*, £104. *India*—Bombay, £3,458 ; Calcutta, £977 (including £32 telegraph material) ; Karachi, £16 ; Madras, £311. *Italy*—Genoa, £50 ; Leghorn, £81. *Japan*—Nagasaki, £315 ; Tokio, £76 ; Yokohama, £293. *Madagascar*—Tamatave, £53 (telegraph material). *Malta*, £205. *Mauritius*, £26 (telegraph material). *Port Swettenham*, £115 (including £77 telegraph material), *Portugal*—Lisbon, £10. *Reunion*, £81 (telegraph material). *Russia*—Kurch, £265 ; Odessa, £26 (telegraph material) ; St. Petersburg, £155 (telegraph material). *Siam*—Bangkok, £60. *Spain*—Grenada, £7. *Straits Settlements*—Penang, £598 (including £104 telegraph material) ; Singapore, £1,817 (including £1,745 telegraph material). *Sweden*—Gothenburg, £95 ; Stockholm, £75 (telegraph material). *Uruguay*—Monte Video, £922 (including £68 telegraph material). *U.S.A.*—New Plymouth, £89 ; New York, £108 (telegraph material). *West Indies*—Trinidad, £17. Total £18,472, against £31,415 in the corresponding week last year (June 21 to 27).

GREENWOOD & BATLEY (LTD.)—After providing for debenture interest and expenses of management, and making provision for doubtful accounts, the profit for the year ended March was £20,713. 9s. 10d., added to £6,026. 2s. from 1905. The directors have written off £5,000 for depreciation, and recommend dividends for the year of 7 per cent. on the cumulative preference and 5 per cent. on the paid-up ordinary share capital (absorbing £15,615. 13s. 3d.), leaving £6,123. 18s. 7d. to be carried forward.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE. – *The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 14, 1906.

11,203 Holden. Automatic electric safety fuse replacer.
11,217 Ranken. Trolley electric lamp-carrying apparatus.
11,238 Raworth. (Clayton, Sweden.) Induction motors.
11,251 Hildburgh. Machinery for the magnification of small variations of current.
11,253 Hales. Preventing unauthorised removal of electric lamps.
11,268 Moul. Carbons of flame arc lamps.*
11,279 Bourdos, Rothschild & Sutcliffe. Filaments of incandescent lamps.
11,297 B.T.-H. Co. (G.E. Co., U.S.) Electrical transformers.
11,298 Fynn. Generators, converters and alternate-current motors.
11,300 Bergmann-Elektricitäts-Werke A.G. Rotary field magnets for single and polyphase generators. (Date applied for, May 20, 1905.)*†
11,301 Bergmann-Elektricitäts-Werke A.G. Rotors for dynamos and electromotors. (Date applied for, May 20, 1905.)*†
11,303 Becker. Electric signalling apparatus.*

May 15, 1906.

11,323 Carr & Wilkinson. Compound rails for tramways.
11,333 Peace. Lubricating tramway trolley wheels and the like.
11,335 Eckstein & Heap. Switches.
11,347 Reid & Webb. Controlling the trolley pulleys of electric tramcars.
11,367 Case. Telescopic floor standards for electric lamps.
11,405 Belliss & Morcom & Jude. Turbines for expansible fluids.*

May 16, 1906.

11,409 B.T.-H. Co. (G.E. Co., U.S.) Tungsten compound lamp filaments.
11,430 Lundberg & Lundberg. Detachable wall connections for electric lighting and heating.*
11,458 Cooper. Controlling systems for electric motors. (Date applied for, May 22, 1905.)*†
11,462 Zani. Power transmission.*
11,469 Ruzicka. Arc lamps.*
11,490 Kelson. Rotary motors.
11,493 Keen. Automatic mechanical combination electric switch.
11,497 B.T.-H. Co. (G.E. Co., U.S.) Block signal systems.
11,498 Trunkhahn. Obtaining electrolytic metallic deposits.*
15,860A/05 B.T.-H. Co. (G.E. Co., U.S.) Equalising conductors of dynamo-electric machines. (Date applied for, Aug. 2, 1905.)

May 17, 1906.

11,506 Scallion & Bellis. Preventing the trolley fork from turning in the event of the wheel leaving the wire, and keeping the wheel in line with the wire.
11,532 Field. Electromagnets.
11,577 Iliff. Relays for automatically completing an incoming junction call after insertion of junction peg at a common battery telephone exchange.

May 18, 1906.

11,587 Panton. Retaining axles and motor shafts of self-propelled railway and tramway vehicles in their respective positions.
11,594 Moul. Arc lamps.
11,606 Wakelam & Lander. Rail joints of light railway and tramway tracks.
11,639 Bloxam. (Lux, Austria.) Metallic filaments for electric lamps.
11,648 Stewart. Mounting or supporting motors on electric vehicles.*
11,652 Buhot. Batteries. (Date applied for, May 23, 1905.)*†
11,657 & 11,658 B.T.-H Co. (G.E. Co., U.S.) Electric-heating devices.
11,659 B.T.-H. Co. (G.E. Co., U.S.) Automatic controlling devices for electric circuits.
11,667 Oprendek & Pollak. Switches.
11,668 Lake. (Soc. An. Electromotion, France.) Electrically-propelled vehicles.*
11,675 Brindley. Effecting fusion of materials by electricity.*
11,676 Berry & Harrison. Connecting conductors of electric circuits.

May 19, 1906.

11,690 Record & Bevis. Electrical automatic controlling devices.

May 21, 1906.

11,772 Moore & Hirst. Saftey cutout for electric motors.*
11,783 Hall. Mechanical appliance for electric organ blowing.
11,794 Dossetter. Switches.
11,802 McGeoch & Co. & Reynolds. Incandescent lamp-holder switches.
11,803 Siemens-Schuckertwerke G.m.b.H. Overhead conductors of electric railways. (Date applied for, June 29, 1905.)*†
11,810 Lee. Metallic filaments for incandescent lamps.
11,812 Biggs. Brush or collector for dynamos and motors.
11,839 Arno. Trolleys for electric motor cars.*
11,853 Johnson. (Felten & Guilleaume Lahmeyerwerke A.G., Germany.) Compensating load variations in electrical installations.*
11,858 Warwick Machinery Co. (G.E. Co., U.S.) Governing mechanism for turbines.
11,863 and 11,864 Cowper-Coles. Electrolytic production of sheets, tubes, wire, &c.
11,867 Cowper-Coles. Manufacture of metallic wire or strip.

May 22, 1906.

11,885 Fugill. Electro-mechanically playing pianos.
11,896 Calvert. Electric light switch finder.
11,897 Kelland. Terminals for electrical purposes.
11,907 Mayes. Safety devices for electric motor starting switches.
11,936 and 11,937 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
11,939 Soulier. Mechanical rectifiers for alternating current. (Date applied for, Sept. 2, 1905.)*†
11,944 Just, Hanamann & Vereinigte Electricitäts A.G. Incandescing bodies for electric lamps.
11,950 Hess. Insulating material.
11,956 and 11,957 Ritchie. Telautographs.*
11 958 Bowley. Flexible metallic tubing.*
11,959 Siemens Bros & Co. (Siemens-Schuckertwerke G.m.b.H., Germany.) Safety apparatus for preventing excessive voltages.*
11,961 Brockie. Electric arc magazine lamps.*
11,974 Hadfield. Manufacture of magnetic material.

May 23, 1906.

11,995 Vidal. Brush-holders for electro-motors.*
11,998 Whitehead & Marino. An improved composition of agglutinant for consolidating electric accumulator active material.
11,999 Whitehead & Marino. Improvements in the construction of electric accumulators.
12,001 Dugdill. Fittings for electric lamps
12,010 Record & Bevis. Cost indicator for electricity meters.
12,024 and 12,025 Electrical Improvements (Ltd.) & Hacking. Electrically lighting gas lamps.
12,041 Siemens Bros. & Co. (Siemens-Schuckertwerke G.m.b.H., Germany.) Accelerating the excitation of dynamo-electric machines.*
12,061 Crowley & Wolf. Storage battery.
12,067 Siemens Bros. & Co. (Siemens & Halske A.G., Germany.) Operating railway signals in connection with points.*
12,087 Levantin. Steam turbines.*
12,090 Cooper. Holder for pastilles for measuring X-rays.

May 24, 1906.

12,095 Craggs & Preston. Brush-holders for dynamos and electric motors.
12,107 Eckstein, Heap & Mellis. Oil-break switches.
12,111 Harris & Lewis. Cooling and ventilating bracket for use with electric or other lamps for tramcars and the like.*
12,120 Mitchell. Point-shifters for tramway and other lines.
12,135 Schübbe. Electromagnetic playing device for musical instruments. (Date applied for, May 25, 1905.)*†
12,136 Hill. A front door lock acting as an electric lock.
12,153 Kuzel. Electrically connecting the filaments of glow lamps with their supply wires. (Date applied for, Aug. 4, 1905.)*†
12,166 Cook. Turbine.

May 25, 1906.

12,183 Gardner. System of wireless telegraphy.
12,189 Bennis. Furnaces for steam generators and other purposes.
12,196 Chambers. Facilitating the climbing of telegraph and other poles.
12,205 Möllenbruck & Dielmann. Carbon electrodes.
12,215 Sonnenschein. Supplying current to alternating-current traction motors.
12,221 Melhuish. Appliance for cleaning contacts of electrical apparatus.
12,233 Sprowson, Hall & Burn. Electric elevators.
12,257 Davy. Arc lamps.

May 26, 1906.

12,280 Hall. Protecting electric flexible wires from breakage.
12,286 Somerville. Flexible suspension of electric lamps.
12,290 Johnson. Turbines.
12,292 Holmes, Holmes, Holmes, Holmes, Ralph & Page. Control of electric motors.*
12,295 Chadburn's (Ship) Telegraph Co. & Grant. Ships' mechanical telegraphic apparatus.
12,304 Young & Boothroyd, Electromotors.
12,305 Streuber. Electric igniters for explosive engines.*
12,325 Justice. (Deutsche Gasglühlicht A.G., Auer Ges., Germany.) Glow lamps.*
12,329 Röchling & Rodenhauser. Electric furnaces.*
12,333 Berry. Electrical production of heat for cooking and other purposes.
12,339 Levantin. Steam turbines.
12,340 Zani. Electromagnetic power transmission.

SPECIFICATIONS PUBLISHED.

1905 SPECIFICATIONS.

6,456 Sunderland & Pillinger. Incandescent lamps.
10,830 Arnold & La Cour. Starting and regulating the speed of compensated single-phase motors. (Date applied for, May 24, 1904.)
10,893 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control.
11,654 Schanschieff. Accumulator plates.
13,107 Parsons & Flint. Dynamo-electric machinery.
13,379 B.T.-H. Co. (G.E. Co., U.S.) Dynamo electric machines.
13,918 Brooks & Read. Electrical junction boxes, switch boxes, &c.
14,938 Brokie. Railway carriage lighting.
15,002 James. Electrically-controlled variable-speed gear for electromotors.
17,896 Electric Ignition Co. & Hall. Electrical ignition systems.
18,233 Roberts & Roberts. Fuel economisers for heating feed water.
19,028 Bennis. Chain and other furnace grates drawn out from brick settings.
19,853 Caton. Secondary batteries for propulsion.
20,275 Cooper. Turbines.
20,548 Kitsée. Transmission of intelligence by the aid of electric energy.
23,083 Lawrence. Point mechanism for tramways and the like.

1906 Specifications.

767 Richter. Turbines. (Date applied for, April 20, 1905.)
235 Lienekampf. Electric photographic copying apparatus. (Date applied for, Oct. 23, 1905.)
368 Whyte. Switches.
376 Siemens Bros. & Co. (Siemens Schuckertwerke G.m.b.H.) Influencing an electric circuit in dependance upon the load of a continuous-current motor in another circuit.
918 Lambert. Variable electric resistance devices.
1,077 Otis Elevator Co. (Otis Elevator Co.) Elevators or hoists.
2,669 Hannan. Spring drive for electric vehicles and other machines.
2,928 Davies. Alternate or change-over tumbler switch.
3,224 Ljungman, Berglund, & Hjorth. Combined telephone receivers and microphones.
3,732 Otis Elevator Co. Stopping devices for elevators or lifts.
4,190 Thorogood. Switches for electric bells and buzzers.
4,579 Ozonair (Ltd.) & Joseph. Ozonising atmospheric air.
4.711 Pevear Control of switches. (Date applied for, Feb. 27, 1905.)
4,710 Potter. Circuit-breakers for electric vehicles. (Date applied for, Feb. 27, 1905.)
4,795 Soc. Anon. Westinghouse & Brun. Direct-current electric motors. (Date applied for, March 1, 1905.)
5,003 Otis Elevator Co. Controlling devices for electric motors of elevators.
5,883 Rockwell. Trolleys for electricity. (Date applied for, 11/4/1905.)
6,557 Thomas. Vapour electric apparatus for rectifying electric currents. (Date applied for, March, 30, 1905.)

COMPANIES' MEETINGS AND REPORTS.

BRITISH AUTOMATIC TELEPHONE SYND. (LTD.)—A private meeting of this syndicate was held on Tuesday under the presidency of Mr. R. C. Richards. The following note was subsequently issued to the Press: Mr. Richards said they had got an installation which was going to do away with the telephone girl. There would be no intermediary between the subscribers, the communication being absolutely automatic, with the result that there would be no waste of temper and no possibility of a mistake. The system, he said, appeared to be absolutely perfect. He himself had seen it in operation in Paris, and it seemed to him that the Central office might be abandoned for a month without any inconvenience arising to anyone. An important element (he continued) was that there was absolute secrecy, as no one could overhear any message, while another important point was that no call was ineffective. If the line was engaged the call was stored up, and was effective automatically when the line was clear.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The directors' report for the year ended March 31 states that the total amount for appropriation (including £14,996. 8s. 7d. from last year) is £246,734. 2s. 10d. (after reserving £77,172. 8s. 10d., one half the profits on Bombay undertaking, and after making a provision of £35,000). The following amounts in respect of debenture interest and preference dividend have already been paid or provided for:—Interest on 5 per cent. perpetual debenture stock (£72,448. 1s. 3d.), and on 4½ per cent. second debenture stock for year ended March 31 (£20,297. 3s. 5d.), and dividend on 6 per cent. preference shares for the year (£96,862. 4s.), leaving £57,126. 14s. 2d., which the directors propose should be applied in payment of a dividend of 3 per cent. on the ordinary shares for the year (£39,990. 6s.), the balance (£17,136. 8s. 2d.) being carried forward. The total subscribed share and debenture capital at March 31, 1906, was £4,949,969, of which £1,333,010 is ordinary, £1,614,370 6 per cent. cumulative preference, £1,473,653 5 per cent. perpetual debenture, and £528,936 4½ per cent. second debenture capital. The amount now standing to credit of reserve is £575,136. 16s. 2d. The aggregate par value of the company's investments is £4,837,526, standing in the books at £4,544,071. The majority of these investments, representing £3,105,846, are revenue earning, and have in the past year yielded £143,652, an average of 4⅝ per cent. The aggregate cost of the investments on which no return was earned during the year is £1,438,225, but the directors believe that the larger proportion of these will in due course yield the average return, and with regard to the remainder the directors are making every effort to improve them. Most of the items for management and general expenses show reduction upon those of the preceding year, and the total is £54,467, against £61,436 for 1904-5. A comparative table accompanying the report shows that 278,404,026 passengers were carried (compared with 242,640,521 in the previous year), or 631,645 per route-mile (against 561,680); the traffic receipts were £1,431,654 (against £1,264,061), or £3,248 per route-mile (against £2,926). The route-mileage is 441 (against 432). Attention is called to the fact that a number of the associated companies in which the British Electric Traction Co. is interested are still in course of construction or in the initial stages of working, while others, from temporary causes, have not maintained the dividends for the preceding year. The investments, as a whole, are of a progressive character, notwithstanding that the local rates and other burdens imposed upon tramway companies in this country are heavy, while the fares which it is permissible to charge are unduly low; and it is stated that although the dividend is reduced the general trading results show an advance.

The number of members subscribing to the British Electrical Superannuation Fund has increased to 203, and the contributing companies to 47. The total invested funds on Dec. 31, 1905, stood at £14,468. 16s. The first quinquennial valuation has been made, and certain amendments to the rules to meet points raised by the actuaries have been approved by the contributories. The British Electrical Friendly Society had a membership on Sept. 30 last of 2,142, against 1,950 at the end of the preceding financial year. The British Electrical Provident Fund, which was established early in 1905, has met with encouraging support. The total number of depositors during the year was 383, and the amount deposited £2,068. 12s. 6d., and £642. 19s. 6d. was withdrawn during the year.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The report of the directors for the year ended May 31, shows a gross profit on the year of £15,924. 11s. 3d. After deducting all general charges and the interim preference and ordinary dividends already paid, and providing for the proportion of the final dividend accrued on the preference shares to May 31, there is a net balance of £6,861. 12s. Of this the directors propose to carry to contingencies fund £5,861. 12s., leaving £1,000 to be distributed as a balance dividend of 1s. per share on the ordinary shares for the year. The trustees for the ordinary shares reserve fund propose to distribute 1s. per share out of dividends received on trust investments, making a total present distribution of 2s. per share (or 3s. for the year) on each ordinary share. The trustees for the founders' shares reserve fund will distribute £10 per share out of dividends received on trust investments.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—The directors report to December states that owing to various causes it was impossible to commence supply of current at date anticipated in previous report. The buildings are nearly completed, the plant is in course of erection, the mains and track are partly laid and the contractors expect to finish their work by Nov. 30.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ended June 30, 1906. The following statement, dated June 13, shows the condition of the company at the close of the quarter ended March 31, 1906:—

Surplus Jan. 1, 1906, as per last quarterly report ...		$16,738,355 61
Net revenues, quarter ended March 31, 1906		1,469,158 62
		$18,207,514 23
From which deducting for—		
Dividend of 1¼ per cent. paid April 16	$1,217,022 50	
Interest on bonded debt	331,300 00	
		1,548,322 50
Left a surplus March 31, 1906, of		$16,659,191 73
The net revenues of the quarter ending June 30, based upon nearly completed returns for April, partial returns for May, and estimating the business for June, will be about		1,750,000 00
From which appropriating for—		$18,409,191 73
Interest on bonds		331,300 00
		$18,077,891 73
It requires for a dividend of 1¼ per cent. on capital stock issued		1,217,022 50
Deducting which leaves a surplus, after paying dividend, of..		$16,860,869 23

In view of the preceding statements, the committee recommend that a dividend of 1¼ per cent. on the capital stock of the company be declared

J. G. WHITE & CO. (LTD.)—The report of the directors to Feb. 28 states that the result of the year's trading is a profit of £33,610. 7s. 6d., which is in advance of any previous year's result. The contracts referred to in the previous report were practically completed during the year under review, with the exception of the works at Montevideo and Buenos Aires, which are still in progress, and in respect of which profit has only been taken into the accounts for work actually completed and paid for at date of balance sheet. The directors report a considerable development of the company's business, particularly in the foreign field, and there is very little doubt but that the average of profit will be maintained for the current year. Contracts have been secured and work is in progress for the London County Council (reconstruction of Battersea and Kingsland sections of Council's tramways); the London United Tramways (reconstruction of Wimbledon section of company's lines, &c.); North Melbourne Electric Tramways & Lighting Co. (complete construction of tramways in North Melbourne, including power house and cars); Works Construction Co. (reconstruction of tramways in Para, including power house and cars); Bombay Electric Supply & Tramways Co. (reconstruction of permanent way, &c.); Lacroze Electric Tramways & Buenos Aires Central Railway Co. (Buenos Aires); and United Electric Tramways of Montevideo (reconstruction of tramways, including power house and cars); and various other contracts and engineering work, both at home and abroad, the total contract value of work in hand exceeding £2,000,000. The company is interested in various negotiations which it is expected will result in further profitable contracts being obtained.

The company is operating the tramway system of Dartford District Council with success. The company has taken advantage of favourable opportunities of assisting in the development of financial enterprises having relation to its own line of business, and the results have proved entirely satisfactory during the year. Considerable attention will be given to this branch business in future. The valuation of investments has been made on a conservative basis. After bringing forward the balance from last year (£12,679. 3s.) and deducting interim dividend paid on preferred shares (£3,136. 1s. 10d.) is £43,153. 8s. 8d., and the directors recommend a dividend (tax free) at the rate of 6 per cent. on the cumulative preferred shares for the half-year to Feb. 28 (£4,380. 7s. 10d.), a dividend (tax free) at the rate of 6 per cent. per annum on the ordinary shares for the year to Feb. 28 (£3,000) with a bonus of 1 per cent. on the full amount of the preferred and ordinary share capital (£2,000). The percentage to directors and to staff absorbs a further £2,415. 11s. 10d. £15,000 has been placed to reserve and the balance (£16,357. 9s.) has been carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

ADAMSON, RAMSBOTTOM & CO. (LTD) (89,135.)—Reg. June 15, capital £5,000 in £1 shares to carry on business of manufacturers of and dealers in electric, hand and other cranes, electric and general engineers, makers of tools and railway, hydraulic, electric, pneumatic and other plant, &c. First directors: E. Adamson and H. Ramsbottom (manager directors), and A. Adamson.

BEAUMONT & STILL TRAIN-LIGHTING CO. (LTD.) (89,190.)—Reg. June 20, with capital £18,000 in £1 shares, to acquire from M. W. W. Mackie, E. J. Glyn, A. R. M. Lockwood, F. J. Beaumont and W. M. Still certain inventions relating to improvements in dynamos and the lighting of railway carriages and other vehicles by dynamos on such a system that the variable speed of the train or coach drives a dynamo at a varying speed, but that such dynamo is self-regulating or driven at a fixed rate of speed by mechanical governing, to adopt agreement with said vendors, and to carry on business of electricians, electrical and general engineers, suppliers of electricity, manufacturers of dynamos and other electrical apparatus, &c. First directors, E. J. Glyn, W. G. Richards, M. W. W. Mackie, F. J. Beaumont and W. M. Still.

BROWN, BOVERI & CO. (LTD.) (89,167.)—Reg. June 18, with capital of £50,000 in £5 shares (1,500 A and 8,500 B), to carry on the business of electrical and general engineers, suppliers of electricity for light, heat and power, ironfounders, copper smelters and workers, &c., and to adopt agreements with A. G. Brown, Boveri et Cie., with A. C. Eborall, and with Witting, Eborall & Co. (Ltd.) Subscribers, C. E. L. Brown, W. Boveri, C. Baumann, S. W. Brown, E. Brown, A. C. Eborall, and C. E. Holland. No initial public issue. First directors, C. E. L. Brown, W. Boveri, C. Baumann and A. C. Eborall.

COATBRIDGE & AIRDRIE ELECTRIC SUPPLY CO. (LTD.) (89,178.)–Reg. June 19, capital £30,000 in £10 shares, to acquire the business carried on at Moorgate-court, London, E.C., Coatbridge and Airdrie, N.B., as the "Scottish House-to-House Electricity Co. (Ltd.)," and to carry on business of electrical engineers, electricians, producers and suppliers of electricity for light, heat, sound and power, manufacturers of electrical apparatus, &c. The subscribers are A. Ayres, M.Inst.C.E., F. E. Savory, H. B. Renwick, F. C. McQuown, G. Tweedie, J. G. Shortis and J. J. Lightfoot. First directors, A. Ayres, F. E. Savory and P. Murray. Reg. office, Moorgate-court, E.C.

JAPANESE KELVIN & JAMES WHITE MFG. CO. (LTD.)—Reg. (in Edinburgh) June 13, capital £10,000 in £1 shares, to carry on business of manufacturers of and dealers in optical, nautical, mathematical and philosophical instruments, &c.

LA PLATA SYND. (LTD.) (89,182.)—Reg. June 19, capital £30,000 in £1 shares, to adopt agreement with B. Newgass, to construct or acquire tramways and light railways in the Argentine Republic, and to carry on business of tramway, railway and omnibus proprietors, suppliers of electricity, &c.

SWANAGE ELECTRICITY SUPPLY CO. (LTD.) (89,186.)—Reg. June 19, capital £10,000 in £10 shares, to carry on the business of electrical engineers, electricians, contractors, suppliers of electricity, manufacturers of electrical apparatus, &c. The subscribers are A. H. Sanderson, H. B. Renwick, F. C. McQuown, G. Tweedie, J. G. Sbortis, J. Hazard and J. J. Lightfoot. Reg. office, Moorgate-court, London, E.C.

STATUTORY RETURNS.

ACCUMULATOR SYND. (LTD.)—Return to Dec. 31, 1905 (filed April 7, 1906), gives capital as £30,000 in £1 shares, all of which have been taken up. £5,000 has been received and £25,000 is considered as paid. Mortgages and charges, £375.

AUTOMATIC ELECTRIC CO. (LTD.)—Return to April 4 gives capital as £1,000 in 900 ordinary and 100 preference shares of £1 each, of which 606 ordinary and 100 preference have been taken up. £1 per share has been called up on 106 ordinary and 100 preference, and £205 has been received, leaving £1 in arrears. 500 ordinary shares are considered as fully paid. Mortgages and charges, £30.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)—In return to April 6 capital is £100,000 in 20,000 shares of £5 each, of which 14,000 have been taken up. £70,000 has been received. Mortgages and charges, £70,000,

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—Return to March 22 gives capital as £300,000 in 40,000 ordinary and 20,000 preference shares of £5 each, of which 29,828 ordinary and 10,172 preference have been taken up. £5 per share has been called up on 28,828 ordinary and 10,172 preference and £195,000 has been received. £5,000 is considered as paid on 1,000 ordinary. Mortgages and charges, nil.

CYCLE ELECTRIC LAMP (LTD.)—In return to May 1, 1906 (filed April 4, 1906) capital is £30,000 in £10 shares, all of which have been taken up. £10 per share has been called up on 275 and £2,350 has been received, leaving £400 in arrears. £27,250 is considered as paid on 2,725. Mortgages and charges, nil.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—Return to April 13 gives capital as £100,000 in £5 shares, all taken up and fully paid. Mortgages and charges, £90,000.

GENERAL ELECTRIC TRAMWAYS CO. (LTD.)—Return to April 18 gives capital as £50,000 in £1 shares, of which 18,500 have been taken up. £1 per share has been called up and £18,500 received. Mortgages and charges, £15,000.

HARTLEPOOL ELECTRIC TRAMWAYS CO. (LTD.)—Return to April 12 gives capital as £100,000 in 10,000 shares of £10 each, all taken up and paid for in full. Mortgages and charges, £50,000.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—In the return to May 8, the capital is given as £450,000 in 18,000 shares of £25 each, of which 17,000 have been taken up. £25 per share has been called up and £425,000 has been received. Mortgages and charges, nil.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—Return to April 23 gives capital as £100,000 in 5,000 preference and 5,000 ordinary shares of £10 each, of which £3,000 preference and 4,700 ordinary have been taken up. £10 per share has been called up and £77,000 received. Mortgages and charges, £27,500.

LOUGHBOROUGH & DISTRICT ELECTRIC TRACTION SYND. (LTD.)—Return to May 23 gives capital as £1,000 in 100 shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges, nil.

LYMINGTON ELECTRIC LIGHT CO. (LTD.)—Return to May 2 gives capital as £30,000 in 4,600 ordinary and 1,400 preference shares of £5 each, of which 1,710 ordinary and 1,284 preference have been taken up. £5 per share has been called up on 1,710 ordinary and 700 preference and £4 per share on 584 preference, and £14,636 received, leaving £145 in arrears. Mortgages and charges: £10,000.

NORTH METROPOLITAN ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—Return to June 12 gives capital as £50,000 in 5,000 shares of £10 each, of which 2,507 have been taken up. £10 per share has been called up and £25,070 received. Mortgages and charges, nil.

PERTH ELECTRIC TRAMWAYS (LTD.)—Return to April 4 gives capital as £200,000 in 100,000 ordinary and 100,000 preference shares of £1 each, all of which have been taken up and paid for in full. Mortgages and charges, £233,832.

WYCOMBE BOROUGH ELECTRIC LIGHT & POWER CO. (LTD.)—Return to April 25 gives capital as £50,000 in 10,000 shares of £5 each, of which 8,000 have been taken up. £5 per share has been called up, and £40,000 has been received. Mortgages and charges, £32,100.

MORTGAGES AND CHARGES.

KRAMOS (LTD.)—Issue May 25 of £200 6 per cent. debentures, part of series created Feb. 22, 1905, to secure £4,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder, W. H. Gowing. No trustees. Previously issued of same series, £1,900.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.) (London).—Issue on June 18 of £8,000 7 per cent. debentures, part of series created Nov. 20, 1905, to secure £25,000 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £8,000.

CITY NOTES.

MEMORANDA (June 28).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $30\frac{5}{16}$d. per oz. Consols $87\frac{15}{16}$—$88\frac{1}{16}$ for money, $87\frac{15}{16}$—$88\frac{1}{16}$ for account; $2\frac{1}{2}$ per cent. annuities $86\frac{3}{4}$—87. Consols Pay Day, July 4; Stocks and Shares Continuation Day, July 10; Ticket Day, July 11; Pay Day, July 12; Mining Share Carry-over Day, July 9.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—This company's transfer books and register of members will be closed from June 30 to July 14 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share (tax free), payable July 14. The share register will be closed from 6th to 13th prox. inclusive.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—A quarterly interim dividend of 2s per share has been declared.

PROVINCIAL TRAMWAYS CO. (LTD.)—The directors have declared an ordinary dividend of 3s. per share for the year to Sept. 30 next.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have granted a quotation to £300,000 sterling 5 per cent. 1st mortgage debenture stock of the *Buenos Ayres Lacroze Tramways Co.* The committee have been asked to appoint special settling days in and grant quotations to London certificates for 11,000 $100 fully paid shares of the *Canadian General Electric Co. (Ltd.)*, and $2,500,000 $500 first mortgage sinking fund 5 per cent. gold bonds of the *Electrical Development Co. of Ontario (Ltd.)*, and also to grant quotations to 36,000 $100 fully paid shares of the *Canadian General Electric Co. (Ltd.)*, and £270,000 £100 first mortgage 4 per cent. prior lien gold bonds of the *Montreal Water & Power Co.* (renewed application).

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors have resolved to recommend payment of a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Airdrie	June 15	289	+ 27	24	5,735	+ 544
Anglo-Argentine	,, 24	13,766	+ 1,363	25	373,025	+ 89,868
Ashton-under-Lyne Corp.	,, 16	168	- 18	12	4,176	+ 477
Ayr Corporation	,, 23	362	- 16	6	1,754	- 125
Baker St. & Waterloo Ry.	,, 23	1,368	...	15	21,694	...
Barnsley	,, 15	155	- 70	24	3,842	+ 23
Barrow	,, 15	502	- 65	24	5,602	+ 384
Bath Electric Trams, Ltd	,, 20	831	+ 110	25	18,399	+ 2,730
Birkenhead Corporation	,, 24	1,060	- 79	...	...	...
Birmingham Corporation	,, 23	581	+ 264	11	7,011	+ 2,675
*Birmingham & Mid.	,, 16	1,415	- 1,456	24	33 811	- 10,370
Blackburn Corporation	,, 21	1,040	+ 148	¶12	13,212	+ 748
Blackpool Corporation	,, 21	1,0 8	- 198	11	11,743	+ 712
Blackpool and Fleetwood	,, 23	747	- 166	25	9,909	+ 811
Blackp'l,St.Anne's&Lytham	,, 21	461	- 274	§33	8,744	+ 1,136
Bolton Corporation	,, 25	2,186	- 90	12	26,241	+ 1,631
Bournemouth Corporation.	,, 20	1,558	+ 120	†12	19,079	+ 5,283
Bradford Corporation	,, 23	4,714	+ 362	12	56,146	+ 2,767
Brighton Corporation	,, 24	1,053	+ 8	12	11,691	- 429
Bristol Trams & Carriage	,, 22	5,088	- 223	19	93,378	+ 8,930
Buenos Ayres & Belgrano	,, 24	3,431	+ 135	¶16	89,273	+ 5,900
Buenos Ayres Elec. Trms.	May 26	1,438	+ 323	21	29,578	+ 6,017
Burnley Corporation	June 23	1,173	+ 91	12	14,736	+ 463
Burton Corporation	,, 24	308	- 15	§12	3,649	- 272
Bury Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 23	R43,312	- R1,316	25	R1,086,161	+ R101,664
Camborne-Redruth	,, 16	212	+ 77	...	...	...
Cardiff Corporation	,, 16	2,105	- 106	11	22,685	- 292
Carlisle Tramways Co.	,, 23	197	- 21	...	...	...
Cavehill	,, 15	139	+ 55	24	1,746	+ 500
Central London Railway	,, 23	5,959	- 442	25	167,335	- 6,035
Chatham & Dist. Lt. Rys.	,, 21	672	- 16	†21	15,387	+ 16
*City of Birm'gh'm Tram Co	,, 15	5,245	- 2,137	24	123,906	- 7,849
City & South London Rly.	,, 24	2,365	+ 96	25	69,795	+ 180
Colchester Corporation	,, 21	223	+ 19	47	8,821	- 1,306
Cork Electric Trams Co.	,, 21	624	- 83	25	11,138	- 248
Croydon Corporation	,, 22	1,582	- 107	8	5,898	+ 664
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 15	456	- 103	24	10,316	- 411
Dover Corporation	,, 23	292	+ 62	12	2,943	+ 392
Dublin & Lucan Railway	,, 22	135	- 4	‡25	2,658	- 153
Dublin United	,, 22	5,479	- 57	‡25	119,643	+ 922
Dudley—Stourbridge	,, 15	788	- 903	24	19,638	- 99
Dundee Corporation	,, 20	1,101	+ 235	§5	5,560	+ 1,107
East Ham Council	,, 23	977	+ 79	12	11,412	+ 1,231
Exeter Corporation	,, 22	295	- 10	12	3,422	- 377
Gateshead & Dist. Trams	,, 15	961	- 112	24	22,207	+ 1,077
Glasgow Corporation	,, 23	17,187	+ 1,066	4	60,863	+ 5,063
Glossop	,, 23	126	+ 9	25	3,216	+ 312
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 15	262	- 103	24	5,254	+ 238
Gt. Northern & City Rly.	,, 23	1,097	+ 180	25	44,725	+ 2,529
Greenock & Port Glasgow	,, 15	847	+ 76	24	14,986	+ 862
Halifax Corporation	,, 20	1,670	+ 215	12	20,003	+ 1,249
Hartlepool Tramways	,, 15	500	- 116	24	6,518	+ 501
Hastings Elec. Trams Co.	,, 21	765	...	25	13,131	...
Huddersfield	,, 23	1,530	+ 176	12	18,539	+ 2,032
Hull Corporation	,, 23	2,275	+ 136	12	26,814	+ 579
Ilford Dist. Coun.	,, 24	519	+ 6	12	6,155	+ 211
Ilkeston Dist. Council	,, 20	1.6	+ 7	12	1,537	+ 24
Ipswich Corporation	,, 23	496	+ 82	12	5,164	- 41
Isle of Thanet Co.	,, 23	849	+ 50	37	12,913	- 825
Keighley Corporation	,, 21	163	+ 19	50	7,247	...
Kidderminster & District	,, 15	113	- 157	24	2,544	- 27
Kilmarnock Corporation	,, 23	158	- 1	6	879	- 42
Kirkcaldy Corporation	,, 20	221	+ 7	...	...	...
Lanarkshire Trams Co.	,, 21	377	+ 206	†25	21,328	+ 4,204
Leamington	,, 15	187	+ 98	24	3,684	+ 2,019
Leeds Corporation	,, 23	6,200	+ 264	12	76,008	+ 4,487
Leicester Corporation	,, 23	2,338	+ 57	25	53,639	+ 4,366
Leith Corporation	,, 16	525	+ 279	‡5	2,452	+ 1,528
Liverpool Overhead Rly.	,, 24	1,509	- 93	25	35,461	- 2,559
Liverpool Corporation	,, 16	10,932	- 1,357	21	251,998	+ 5,701
*London County Council	,, 16	25,962	+ 8,755	11	292,410	+ 132,741
London United	,, 22	7,256	+ 698	†25	144,316	+ 8,466
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 21	111	- 18	12	1,108	- 168
Manchester Corporation	,, 23	13,815	+ 794	12	163,168	+ 9,508
Mersey Railway	,, 23	1,612	+ 20	25	43,363	+ 2,832
Merthyr	,, 15	203	- 53	24	4,568	+ 26
Metropolitan Dist. Railway	,, 24	8,038	+ 848	25	200,869	+ 14,228
*Metropolitan Elec. Trams	,, 15	8,729	- 535	24	76,577	+ 23,826
Middleton	,, 16	625	+ 61	24	7,891	+ 469
Nelson Corporation	,, 23	164	+ 8	13	1,833	+ 180
Newcastle-on-Tyne Corp.	,, 23	8,942	+ 222	12	47,279	+ 2,093
Newport (Mon.)	,, 23	609	+ 36	12	7,598	+ 357
Northampton Corporation.	,, 22	440	- 7	12	5,278	+ 23
Oldham, Ashton & Hyde	,, 15	7.8	- 2	24	15,161	+ 554
Oldham Corporation	,, 24	1,818	+ 90	13	25,205	+ 1,569
Perth (N.B.) Corporation	,, 20	149	...	‡5	797	...
Perth (W. A.) Elec Trams	,, 22	1,383	+ 186	‡25	37,536	+ 2,150
Peterborough	,, 15	125	- 147	24	2,705	- 250
Pontypridd District Coun.	,, 24	161	+ 4	12	2,118	- 23
Portsmouth Corporation	,, 23	2,098	- 42	12	28,585	+ 181
Potteries	,, 15	1,698	- 299	21	42,041	+ 2,302
Preston Corporation	,, 13	716	- 267	...	...	...
	,, 20	724	+ 126			
Reading Corporation	,, 21	671	- 15	...	...	...
Rochdale Corporation	,, 18	1,017	+ 182	12	12,858	+ 4,838
Rotherham Corporation	,, 21	469	+ 68	12	5,878	+ 581
Rothesay	,, 15	350	+ 136	24	2,699	+ 167
Salford Corporation	,, 25	4,584	+ 29	12	55,714	+ 1,083
Sheerness	,, 13	64	- 31	24	1,257	- 230
Sheffield Corporation	,, 21	5,403	+ 431	13	68,444	+ 4,830
Southampton Corporation.	,, 20	978	- 10	†12	11,067	+ 84
Southend Corporation	,, 20	409	- 18	12	4,241	+ 166
Southport Tramways	,, 15	450	- 163	24	6,824	+ 166

(a) These comparisons are with the corresponding period last year. † Minus 8 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 5 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	June 15	758	- 391	24	19,200	+ 2,628
Stalyb'dge,Hyde,&c.,Jt.Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	...	...
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	,, 20	321	...	25	9,192	...
Swansea Trams	,, 15	890	- 232	24	18,643	+ 4,426
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 15	45	- 27	24	1,028	- 68
Tynemouth and District	,, 15	324	- 221	24	4,960	- 108
Tyneside Trams Co.	,, 20	394	+ 17	25	9,924	+ 516
Wallasey District Council	,, 23	849	+ 30	12	9,618	+ 850
Walsall Corporation	,, 23	505	+ 85	22	12,675	+ 942
Warrington Corporation	,, 21	360	+ 24	12	4,402	+ 449
West Ham Corporation	,, 21	2,801	+ 654	12	27,421	+ 8,994
Weston-super-Mare	,, 13	226	- 83	24	1,713	+ 69
Wolverhampton Corpn.	,, 20	791	...	...	...	...
* Wolverhampton District	,, 15	879	- 375	24	9,719	+ 798
* Worcester	,, 15	304	- 190	24	6,193	- 570
Wrexham	,, 15	109	+ 26	24	2,329	- 27
Yorkshire W.R. Trams	,, 24	850	- 10	25	19,583	...
Yorkshire Woollen District	,, 15	901	- 107	21	20,751	+ 6,180

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., June 27.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to June 27. Highest.	Business, Week to June 27. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-ArgentineOrd.Shs.	$6\frac{1}{16}$–$7\frac{3}{16}$	5 12 6	Ap, Oct	7⅛	7
5	2/9	Do. 5½% Cum. Pref.	5⅞–6⅛	4 10 0	—	$6\frac{1}{16}$	..
St.	6%	Do. Permanent 6% Deb. Stock	140 —143	4 3 9	—	141⅝	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	104 —106	4 14 3	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—4½	5 11 0	—	$4\frac{3}{32}$	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	98 —101	4 9 0	—	99	98¼
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115 —118	5 1 6	—	117	..
St.	5%	Do. Pref. Ord. Stk	107 —110	4 11 0	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	107⅞	107½
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103 —106	4 4 0	—	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	$2\frac{15}{16}$—$3\frac{3}{16}$	4 18 0	—	..	..
5	6/0	Do. 6 per Cent. "A" Cm. Pref.	5⅝—5⅞	5 2 6	—	..	..
5	6/0	Do. "B"	5 —5½	5 7 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	106 —108	4 12 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	103 —106	4 4 8	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	102 —104	4 16 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	103 —107	5 3 0	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	103 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8½- 9	4 9 0	—	8⅝	..
5	2/6	Do. Nos. 105,001 to 137,610	8⅛—8⅝	4 12 9	..	[illegible]	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	105 —108	4 3 8	—	..	..
[illegible]	0/6	Cape Electric Tram Shares	½- ¾	6 13 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Corp. Bds.	97 —99%	5 1 0	..	..	..
St.	..	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91 —93	..	..	93	92¾
St.	..	Do. 6% "B" Ditto	90 - 95	..	..	$1\frac{1}{32}$	..
1	1/0	†Lisbon Elec. Trams Ord.	⅞—$1\frac{1}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	102 – 105	4 15 0	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	107 —109	4 11 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	144 – 147	..	..	..	..
..	5%	Do, 5% 1st Mt. $500 Dbs,	97%—99%	5 1 0	..	98½	97½
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	..	..
5	5/3	Calcutta Elec (1-50,000)	8⅛ 8⅝	4 18 0	—	$8\frac{7}{16}$	8½
10	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	50 —52	4 16 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	94 —96	5 4 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½- 3	..	..	..	—
St.	5%	Do. 5% Debs.	87 —91	5 10 0	—	..	..
St.	26/2	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	113 – 116	5 8 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	⅞ –1	6 0 0	—	..	..
1	1/6	Rand Electric	$1\frac{1}{16}$—$1\frac{3}{16}$	—	—	—	...
1	..	River Plate Electricity Co. Ord.	$1\frac{7}{16}$—$1\frac{9}{16}$	..	..	..	..
1	1/2¾	Do. 6% Non. Cum. Pref	⅞- 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	101 —103	4 17 0	..	..	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	101 —103	4 17 0	..	101¾	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., June 27.	Rate % Yielded £ s. d.	Dividend Due	Business, Week to June 27. Highest	Business, Week to June 27. Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	11–12	5 16 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅜–10⅝	4 5 3	..	10¾	..
10	6/0	Do. 6% Cum. Second Pref.	11–12	5 0 0	..	.	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	106–108	4 8 3	..	.	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	3½–3⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101–104	4 7 6	–	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8–9	5 11 6	–	..	..
5	3/6	Do. 7 per Cent. Pref.	5¾–6¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100–103	3 17 9	–	101½	101
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4–5	5 0 0	Feb, Aug	4½	..
5	2/3	Do. 4½ per Cent. Pref.	4½–4¾	4 14 9	Feb, Aug	4⅝	..
St.	4%	† Do. 4% Deb. Stock (red.)	99–102	3 18 8	–	–	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3⅞–4⅜	5 2 6	–	..	..
5	2/3	Do. Do. (1908)	3⅞–4⅜	5 2 6	–	..	..
5	3/9	Chelsea Electric Supply Ord.	5½–5¾	5 6 0	March	5 9/16	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	108–110	4 2 0	Jn, Dec	..	.
10	7/6	City of London Electric Lighting Ord.	10½–11¼	5 0 6	Feb, Aug	11	10⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4 12 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123–126	3 19 4	Jn, Dec	–	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	100–103	4 10 0	..	101½	100¾
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	3–3 1/32	4 0 0	April, Oct	–	..
5	5%	Do. Do. 5% non cum. pref.	5¼–5⅝	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8–9	5 11 0	–	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12¼	4 18 0	Mar, Sept	12	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	109–112	4 0 4	..	109¾	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101–104	4 6 6	..	102	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅜	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101–104	4 6 6	–	–	..
5	5/0	Hove Electric Lighting Ord.	7¾–8¼	5 0 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98–101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	10–11	4 11 0	–	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98–101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101–103	3 17 6	–	..	..
3	2/4½	London Electric Supply Ord.	2–2½	4 0 0	–	..	..
5	3/0	Do. 6 per Cent. Pref.	5–5½	5 7 0	–	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	97–100	4 0 0	Mr, Jn, S, D	–	..
5	10%	Metropolitan Electric Sup. Ord.	8–9	5 11 0	April, Oct	..	–
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	Jan. July	5 9/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	110–114	3 19 0	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95–97	3 12 8	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	100–103%	4 7 4	–	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12–12½	5 11 1	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103–104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾–7⅞	5 2 6	Feb, Aug	..	–
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞–6	4 1 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100–101	3 19 7	Jan, July	..	–
1	3%	Northern Counties Elec. Sup.	1 3/32–1⅛	2 13 3	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	101–102	4 8 9	Jan, July	–	–
10	9/0	Notting Hill Electric Ord.	13½–14½	6 4 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97–99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅝–6⅞	4 17 0	March	6 11/16	..
St.	4%	Do. 4% Deb. Stock	99–101	3 19 0	–	..	.
5	7/6	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	11⅜	11 1/16
5	3/6	Do. 7 per Cent. Pref.	7–8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	96–98	3 12 0	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2¼–2¾	8 4 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76–80	5 0 0	–	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 8 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	–	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1 3/16–1 5/16	5 0 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105–106	4 5 0	–	..	.
5	2/6	Urban Electric Supply Ord.	3–3½	6 8 6	–	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100–102	4 8 0	..	101½	..
5	6/6	Westminster Elec. Sup. Ord.	10¾–11¼	5 15 6	Mar, Sept	10⅝	10 9/16
5	2/6	Do. 5 per Cent. Cum. Pref.	5 5/16–5 9/16	4 10 0	..	5½	5 5/16
5	..	Do. Issued at 7/6 premium all paid	5 5/16–5 9/16	..	..	5 5/32	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	92–94	4 5 0	..	94	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	15/16	..
1	0/6	Do. 5% Cum. Pref.	31/32–1 3/32	4 11 6	..	1 1/32	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101–104	4 6 6	–	102½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	100–102	4 8 0	..	100¾	..
10	8½%	Bristol Tramways and Carriage Ord.	15½–15¾	5 8 0	Feb, Aug	–	–
10	4%	† Do. Cum. Pref. (fully paid)	10–10½	3 18 0	..	..	–
St.	4%	† Do. 4 per Cent. Debs.	101–103	3 17 6	Feb, Aug	..	.
10	6/0	British Electric Traction Ord.	6⅛–6⅜	4 14 0	–	6½	5
10	6/0	Do. 6 per Cent. Cum. Pref.	9⅜–9⅝	6 4 0	Feb, Aug	9 7/16	9¼
St.	5%	Do. 5 per Cent. Perpetual Debs	112–115	4 7	..	114½	110
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92–95	4 14 9	..	..	..
St.	4%	Central London Ordinary Stock	85–87	4 12 0	June, Dec	86½	85
St.	4%	Do. 4 per Cent. Pref. Stock	99–101	3 19 0	..	100	..
St.	4%	Do. Deferred Stock	74–77	5 4 0	..	77	75
100	4%	† Do. 4 per Cent. Debs.	110–112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	91–93	4 6 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞–5⅛	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100–103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	40–42	4 9 0	Feb, Aug	41	40⅛
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120–123	4 1 4	Feb, Aug	–	..
St.	5%	Do. (1896)	114–117	4 5 3	..	.	..
St.	5%	Do. (1901)	114–117	4 5 3	..	115	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104–107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14½–15½	3 17 8	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¾–4¼	9 8 0	..	4 1/16	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	101–103	4 7 6	..	101½	..
10	9%	‡ Imperial Tramways Ord	15–16	5 12 0	Mar, Sept	..	..
10	6%	†‡ Do. 6 per Cent. Pref.	11¾–12¼	4 18 0	Mar, Sept	–	..
St.	4½%	†‡ Do. 4½ per Cent. Debs.	102½–104½	4 6 0	Jan, July	–	–
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2–2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	80–85	4 14 0	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16–8 3/16	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99–102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8½–9½	5 5 0	–	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	96–99	4 1 0	–	..	..
St.	..	Mersey Con. Ord. Stock	4–6	–	–	4	..
St.	..	Do. 3 per Cent. Perp. Pref.	8–11	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	–	15/16	..
St.	4½%	Do. 4½% Deb. Stock	102–104	4 0 6	–	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7–8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7⅜–8⅜	5 14 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100–103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	93–96	5 4 0	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	94–95	5 4 0	..	94⅝	94⅛
St.	3½%	Waterloo and City Ord.	100–103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3–3½	..	..	–	..
St.	4½%	Do. 4½% 1st Debs.	95–97	4 13 0	..	95	..

Shre.	Last Dividend	Name.	Price Wed., June 27.	Rate % Yielded £ s. d.	Dividend Due.	Business, Week to June 27. Highest	Business, Week to June 27. Lowest
		ELECTRIC MANUFACTURING, &c.					
	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	–	⅛	..
1	2/4½	Babcock & Wilcox Ord	3¾–4	4 14 0	..	3 15/16	3 13/16
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	–
1	4/0	British Insulated & Helsby Cables Ord.	6½–7	5 14 0	July, Feb	.	..
1	3/0	Do. 6 per Cent. Pref.	5¾–6¼	16 0	Jan, July	6 1/32	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	104–107	4 4 0	..	–	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96–98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1½–1¾	..	..	1 9/16	1 1/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	80–85	4 14 0	..	80	..
	1/0	Brush Electrical Engineering	⅝–⅞	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	..	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97–99	4 11 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	84–86	5 4 6	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	11	10⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6	4 3 4	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	109–111	4 1 0	Nov, May	..	..
1	1¾d.	Castner-Kellner Alkali Co.	1 3/16–1 5/16	4 11 0	..	1 3/32	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97–102	4 8 0	–	..	..
1	9¾d.	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	–	..	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅞–2⅛	3 7 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	96%–99%	5 1 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1¾–1⅞	5 8 0	Sept	1 9/16	..
5	8/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	104–107	4 5 0	..	..	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	–	Feb, Aug	–	..
5	2/6	Do. (£5 paid)	2½–3	–	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86–88	4 11 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90–95	5 5 0	–	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾–4¼	3 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4½–5	6 0 0	..	–	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103–106	4 5 0	–	104	..
2	1/7½	Electric Construction Co.	⅝–⅞	11 4 0	July	..	..
2	2/9½	Do. 7 per Cent. Cum. Pref	2–2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	88–91	4 8 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9⅛–9⅝	5 8 6	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93–97	4 2 6	–	..	..
5	10/0	Fenley's Telegraph Works Ord.	12–13	5 15 0	Feb, Aug	..	–
5	9/9	Do. 4½ per Cent. Pref.	5¼–5½	4 1 6	Feb, Aug	..	–
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107–109	4 2 6	..	107½	..
St.	22/6	Do. Do. Scrip (all paid)	107–109	4 2 6	..	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	17–18	2 17 2	Feb, Aug	17¾	17
100	..	Do. 4% Debs. Red.	99½–101½	..	..	100¼	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	.
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	31/32	15/16
1	7½d.	Do. 6% Cum. Pref.	⅞–1	6 0 0	..	31/32	..
St.	4½%	Do. 4½% Perp. Deb. Stock	97–100	4 10 0	..	..	..
12	24/0	Telegraph Construction & Maint'n'ce.	32–34	5 6 0	Mar, July	34	33
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	102–104	3 17 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16–2 9/16	5 15 0	..	2 15/32	2 13/32
1	6d.	Do. 5% Non-Cum. Preference	1 1/16–1 3/16	4 4 0	..	1 5/32	..
St.	5%	Do. 5% Non-Cum. Preferred	111–117	4 5 4	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103–105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	104–106	4 5 0	..	105¾	..
5	–	Willans and Robinson Ord.	1¼–1¾	–	Apr, Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	5¾–6¼	–	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	78–83	4 16 6	May Nov	78¾	..
		TELEGRAPHS.					
100	4%	* African Direct Tel. 4% Mrt. Deb. (red.)	99–102	3 18 0	Jan, July	..	..
10	–	Amazon Telegraph	8–8½	–	Jn, Dec	..	..
100	5%	Do. 5% Debs. (red.)	83–88	..	..	..	..
St.	15/0	Anglo-American	66–68	4 15 6	F, My, Ag, N	..	..
St.	10/0	Do. Preferred	113–114	5 8 0	F, My, Ag, N	114	113
St.	10/0	Do. Deferred	25–26¼	..	F, My Ag, N	26 5/16	26
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	98–100	4 0 0	Jn Ap, Jy, O	99½	[illegible]
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	8⅞	–
10	10/0	Do. Preference 10 per Cent.	17–18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent. Deb.	100%–103%	4 7 3	Jan, July	..	..
20	4/0	Direct United States Cable	15½–16	4 13 9	Ja, Ap, Jy, O	15 11/16	15⅝
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	101–103	4 7 6	Jn, Dec	..	..
St.	[illegible]	Eastern Ordinary	142–145	4 16 9	Ja, Ap, Jy, O	144½	143
St.	17/6	Do. 3½ per Cent. Pref. Stock	90–92	3 16 0	Ja, Ap, Jy, O	91½	90⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107–109	3 13 4	May, Nov	108¼	..
10	6/6	Eastern Extension	14–14½	4 16 0	Ja, Ap, Jy, O	14⅜	14 1/16
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 4	Feb, Aug	107¼	107
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	100–102	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	38/0	G. N. (of Copenhagen) with coupon 67	39–41	5 17 0	Jan, July	39⅞	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	101–103	4 7 3	June, Dec	..	..
25	52/6	Indo-European	57–59	5 10 0	May, Nov	58	..
100	5%	Mackay Companies Common	75 3/16–75 11/16	5 6 0	Jan, July	–	..
100	4%	Do. Preference	74 13/16–75 3/16	5 6 6	Ja, Ap, Jy, O	..	..
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	101–104	3 17 0	June, Dec	..	..
10	4/0	† West African Telegraph Shares	9½–10	5 0 0	..	..	..
2½	–	West Coast of America	¾–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	101–104	3 17 0	Jan, July	..	..
10	–	West India and Panama	1 7/16–1 9/16	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6–7	3 11 4	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–[illegible]	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	101–104	4 10 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14⅝	14 5/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	101–103	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	104–107	3 14 9	..	..	..
		TELEPHONES					
–	..	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	96–98	..	..	97¼	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101–103	4 17 0	..	..	..
6	8/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August	..	..
1	0/4	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	–	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110–112	5 7 0	–	111½	110
St.	5%	Do. Def. Stock	107–109	4 11 0	–	109	107½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12–14	4 5 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10–12	5 0 0	Feb, Aug	..	–
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98–100	3 11 0	June, Dec	99¼	99
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	104–106	3 15 6	–	105⅜	105
1	0/9	Oriental	1 1/16–1 3/16	4 8 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1⅜	4 7 0	–	..	..
St.	24/7½	Do. 4% Red. Deb. Stock	99–101	3 19 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	103–106	4 4 9	..	..	..
5	8/0	United River Plate	7–7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅜–5⅝	4 0 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	110–113	4 8 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	4¾–5¼	5 14 0	–	..	..
10	6/0	Globe Telegraph and Trust	10⅞–11⅛	4 0 0	Ja Ap Jy O	11⅛	10⅞
10	8/0	Do. 6 per Cent. Pref	14⅜–14⅞	4 0 6	Ja, Ap, Jy, O	14⅜	[illegible]
10	6%	Submarine Cables Trust (Cert.)	127–130	4 12 3	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but not for redemption, † Ex Dividend, ‡ The London Stock Exchange Committee have declined to quote (these

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NOTES.

THE rejection of the London County Council Electric Supply Bill has given rise to a flood of comments in the daily press; and since the question of a cheap power supply for London is, in many quarters, no longer one of the general good but of party politics, the views that are taken vary with the professed political opinions of each particular organ. Thus, the Labour Party, while regretting the fate of the Bill, considers the general result as a "triumph for municipalisation"—a triumph which would have been complete if the Bill had only been stronger instead of such a mild character as to consider the protection of existing interests. In the *Daily News*, the power supply of London is regarded as the people's gold mine which is being rescued none too soon from the hands of Mr. GARCKE and Mr. MERZ. Mr. GARCKE is apparently regarded as one of those evil disposed persons who get hold of gold mines of this kind in a surreptitious sort of way and subsequently sell them to the rightful owners—the ratepayers—at a fictitious price, thereby levying a kind of blackmail. As for Mr. MERZ, he handles prospective millions with the ease of a Colossus, but our contemporary prefers the "humdrum finance" of the London County Council, though presumably not that of its Finance Committee.

SOME people may think that the scheme of the London County Council is quite comprehensive enough, but this is not the opinion of Mr. DOIG, who, we understand, gave evidence before the Select Committee as "a member of the public." We are not aware that the public were otherwise represented, so that it would probably be more correct to style Mr. DOIG as "*the* member of the public." Fortunately the requirements of the public have been preserved in a letter by Mr. DOIG to the *Tribune*, from which we learn that if only electric energy were produced at the pit-head by a Government department for the supply of the metropolis, and eventually of the entire United Kingdom, a huge sum of money would be brought into the Treasury, and might be applied to the extinction of all direct taxation and rating and to the amelioration of the conditions of the poor. Engineers will be interested to hear that if distributors were supplied in bulk at 0·75d. per unit, the Government department would make a profit of 0·65d. per unit, and since the metropolis alone in future days of enlightenment will require about 15,330,000,000 units per annum, the yearly revenue to the Government Exchequer would be over £40,000,000. Later on, the supply to the whole United Kingdom would yield a grand total of £280,000,000 per annum for the benefit of the people. Doubtless such a source of wealth should not be lost to the country in favour of a short-sighted policy of local extravagance in the metropolis, but surely Mr. DOIG is unjust in charging the distributors so high a price.

◆

OUR contemporary, the *Labour Leader*, has an article of rejoicing on "how the Labour Party saved the people's rights" in wrecking the Bill promoted by the Mersey Railway Co. This Bill was to enable the company to run motor omnibuses between their stations and hotels. But since the Birkenhead tramways are now owned by the Corporation, it was felt that this might be the thin end of the wedge of competition, and that such a "bare-faced attempt" to smash the municipal tram service could not be allowed. Although we quite admit that monopolies are very necessary under certain conditions, it will assuredly be a bad day when municipal enterprise puts a stop to competition. A case of this kind was recently mentioned by Mr. W. L. MADGEN, at a meeting of the Automobile Club. It appears that the town of Macclesfield many years ago acquired the gas works, and consequently for the past 10 years the Council have prevented the introduction of electrical energy for light and power.

Our Institution guests are having a busy time in the provinces and are completing a successful programme. They have, generally, been fortunate in the weather—a large factor on these occasions—and the organisation has been excellent. Our members have received so much kindness on trips of this kind in foreign parts that we are glad some return of hospitality has at length been made. The thanks of all of us who have taken part in these foreign visits is due to the committee who have organised the present programme. Few realise the enormous amount of work entailed by a visit of this kind if it is to be anything like a success, or the ready way in which many of the busiest members of the Council have given their time to the entertainment of our guests.

From an adjourned report of the Highways Committee of the London County Council it appears that, although at the end of 1903 the work of the Greenwich generating station was well advanced and the first two chimneys were almost completed, no objection was raised by the Observatory authorities until nearly two years later. It is stated that up to the present there has been no serious interference with the observations—a point which we hope will be confirmed by the Astronomer Royal. Meanwhile the building of the two new chimneys has been stopped, and the Admiralty have been informed that the Council is desirous of co-operating in ascertaining how any interference with the scientific observations at the Observatory can be obviated.

Increased interest has arisen in the subject of directive wireless telegraphy through the recent work of MARCONI, BRAUN and others. On another page we reproduce a Paper by Dr. J. A. FLEMING, which will be read with interest by those who wish to follow up the theory of the subject. In this Paper Dr. FLEMING gives a mathematical explanation of the fact that a bent oscillator radiates more in the direction opposite to that in which the free ends point than it does in the other direction.

As we go to press we learn that the Glasgow Corporation have decided, by 45 votes to 13, to transfer their telephone undertaking to the Post Office for the sum of £305 000.

Obituary.—We regret to record that one of the victims of the sad railway disaster at Salisbury, on Sunday last, was Mr. Louis Cassier, of Bridgeport, Connecticut, who was well known on both sides of the Atlantic in connection with *Cassier's Magazine* and other journals.

Wireless Telegraph Notes.—It is announced that a wireless telegraph station is to be erected at Tobermory, in Argyllshire, to communicate in the first instance with Lochboisdale and the Uist and Barra district, and eventually with the outer Hebrides. The total height of the proposed mast is 330 ft. above sea level.

Engineering Standards Committee.—Report No. 15 of the Engineering Standards Committee, which has just been issued, contains British standard specifications for structural steel for bridges and general building construction, with an appendix of forms of British standard tensile test pieces.

The Council of the Institution of Mechanical Engineers have appointed their president, Mr. Edward P. Martin, as one of the representatives of that Institution upon the main committee of the Engineering Standards Committee in place of Mr. E. Windsor Richards, past president of the Institution of Mechanical Engineers, who has retired.

Steam Turbines.—We are asked to point out, in connection with the remark in Mr. Baynes' Paper on "Steam Turbines" to the effect that the makers of the Rateau and Zoelly turbines are still building their turbines in two sections, although they contemplate constructing them in future in one section, that the Oerlikon turbine, which was originally built on Rateau principles, has for some time been monocylindrical. The makers claim a high degree of economy as compared with machines in two sections. A description of one of these turbines will be found in another column.

The Society of Arts.—The Annual Conversazione of the Society of Arts was held on Tuesday evening in the gardens of the Royal Botanical Society, Regent's Park. A large number of members and their friends were present and were received by Sir Owen Roberts and other members of the Council at the entrance to the conservatory. The gardens were picturesquely illuminated and full advantage was taken of the fine weather which enabled the two performances of Pastoral Plays, by Mr. Patrick Kirwan's Idyllic Players, to be held in the open air. A concert was also given in the Club House and the bands of the Royal Artillery and H.M. Scots Guards performed selections of music.

Telephone Notes.—An underground telephone line, fitted with self-induction coils placed at intervals along the line after the manner originally proposed by Pupin and said to be the first commercial example of the kind, was put into service last Saturday between New York and Stamford. It is stated by the *New York Herald* that Prof. Pupin's patents have been acquired for $500,000 by the American Telegraph & Telephone Co.

A Reuter's telegram states that the Paris–Rome telephone trunk line was formally opened on July 1st by the Ministers of Posts and Telegraphs of France and Italy, who exchanged congratulatory messages.

British Association Meeting at York.—The following Papers are included in the provisional programme of Papers, &c., to be read before the Engineering section of the British Association at the forthcoming meeting at York, commencing August 1st:—

Presidential Address by J. A. Ewing, D.Sc., F.R.S., President of the Section; "Modern Armour and its Attack," by Major W. E. Edwards, R.A.: "The Deformation and Fracture of Iron and Steel," by W. Rosenhain; "Segregation in Steel Ingots, and its Effect in Modifying the Mechanical Properties of Steel," by J. E. Stead; "Structural Changes in Nickel Wire at High Temperatures," by H. C. H. Carpenter; "Standardisation in British Engineering Practice," by Sir John Wolfe Barry, K.C.B., F.R.S.; "Recent Advances in our Knowledge of Radiation Phenomena, and their Bearing on the Optical Measurement of Temperature," by J. B. Henderson; "The Removal of Dust and Smoke from Chimney Gases," by S. H. Davies and F. G. Fryer; "Glow Lamps Up-to-Date, and the Grading of Voltages," by Sir W. H. Preece, K.C.B., F.R.S.; "The Advent of Single-phase Electric Traction on Railways," by C. F. Jenkin; "Some Recent Developments of the Steam Turbine," by G. Gerald Stoney; "Some Recent Experimental Results with Internal Combustion Engines," by Prof. W. E. Dalby; "A General Supply of Gas for Heat, Light and Power Purposes," by A. J. Martin; "Experiments Illustrating the Balancing of Engines," by Prof. W. E. Dalby; "An Indicator for High-speed Engines," by Prof. B. Hopkinson; "A New Form of Transmission Dynamometer," by Prof. B. Hopkinson and L. G. P. Thring; "The New Engineering Laboratories, Edinburgh University, and their Equipment," by Prof. T. Hudson Beare; "Waterproof Roads as a Solution of the Dust Problem," by Douglas Mackenzie; "The Central Technical College Lecture Table Testing Machine," by Prof. Ashcroft; "The Teaching of Mechanics by Experiment (with illustrations)," by C. E. Ashford.

The Self-Synchronising of Alternators.—A Paper on the above subject by Prof. Morgan Brooks and Mr. A. K. Akers was amongst those read at the recent Milwaukee Convention of the American Institute of Electrical engineers. The Paper, which is briefly abstracted in the *Engineering News*, described the results of the experiments intended to show how, in paralleling alternators, the machines may be caused to draw each other into synchronism and proper phase relation, without exchanging injuriously heavy circulating currents, even when thrown into parallel at a considerable phase difference. The desired effect is secured, they find, if an air-core inductance of suitable value is contained in the parallel connection. By choosing an inductance of such value that the momentary current interchange under the worst conditions does not exceed half the full-load current of one machine, enough synchronising force remains to bring the machines into step quite positively.

The method may be applied to rotary converters, but when these are started on the continuous-current side an additional inductance should be placed in the continuous-current leads, in order to prevent possible tendency to race due to field weakening in synchronising. The authors also predict that their method may be used to great advantage in synchronising frequency-changing motor-generator sets, which require to be synchronised on two circuits simultaneously. In this case it is recommended that the extra inductance be chosen of such size as to leave a synchronising force insufficient to force the machines into step unless both circuits are simultaneously in synchronism.

Birthday Honours.—The following are among the honours announced on the occasion of the celebration of the King's Birthday :—

New Peer : The Right Hon. W. J. Pirrie.

The Right Hon. W. J. Pirrie, who is chairman of the well-known engineering and shipbuilding firm of Harland & Wolff, Belfast, is also a director of the Eastern Telegraph Co.

New Privy Councillors : Sir J. T. Brunner, Bart., M.P. ; Sir James Kitson, Bart, M.P. ; Sir Francis Mowatt, G.C.B.

Sir John Brunner is on the General Board of the National Physical Laboratory and, as announced in another part of this issue, has just made a munificent donation to the funds of that institution. His firm, Messrs. Brunner, Mond & Co., promoted the South Staffordshire Mond Gas scheme.

Sir James Kitson was Chairman of the Select Committee of the House of Commons which considered the original proposals for the formation of electric power companies, and many of the clauses inserted in those bills are now regarded as standard clauses. Sir James was also Chairman of the House of Commons Committee which dealt with the bill of the Administrative County of London & District Electric Power Bill last year.

Sir Francis Mowatt acted as Chairman, until December, 1904, of the Departmental Committee which was appointed in April, 1904, to inquire into the present working of the Royal College of Science and School of Mines, the report of which was published early this year, the later chairman being Mr. R. B. Haldane, K.C., M.P., now Secretary for War.

New Baronets : Mr. Felix Schuster and Mr. Edgar Speyer.

The name of Mr. Felix Schuster is of interest to our readers in that he was a member of the Royal Commission on London Traffic. Mr. Edgar Speyer, of course, is a member of the firm of Messrs. Speyer Bros., who, in collaboration with the late Mr. C. T. Yerkes, brought about the conversion of the District Railway from steam to electric traction, and the completion of the Baker Street & Waterloo Railway.

New Knight : Mr. J. Williams Benn, M.P.

Mr. Benn was Chairman of the Highways committee of the London County Council at the time when the reconstruction of the London tramway system was first taken in hand, and has since been Chairman of the London County Council,

In addition to the above, Mr. John Ardron, one of the assistant secretaries to the Post Office, has had the honour of C.B. conferred upon him.

The International Electro-technical Commission.—It will be remembered that towards the close of the International Electrical Congress at St. Louis in 1904, a resolution was unanimously adopted by the Chamber of Government Delegates that steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and ratings of electrical apparatus and machinery. In November last, the Institution of Electrical Engineers appointed an executive committee, under the chairmanship of Mr. Alexander Siemens and including Sir William H. Preece, K.C.B., Col. R. E. Crompton, C.B., Mr. John Gavey, C.B., Dr. R. T. Glazebrook, Mr. R. K. Gray, Mr. Charles P. Sparks and Mr. C. H. Wordingham. A set of draft rules was prepared and circulated to the countries who had signified their intention to send delegates. The preliminary meeting of the commission was held at the Hotel Cecil on Tuesday, June 26th, with Mr. Alexander Siemens in the chair, the following being the delegates representing the various authorities :—

America (Institute of Electrical Engineers), Dr. F. B. Crocker, Dr. A. E. Kennelly and Mr. C. O. Mailloux ; Austria (Elektrotechnischer Verein in Vienna), Prof. Karl Pichelmeyer and Dr. E. Rosenberg ; Belgium (Société Belge d'Electriciens), Mr. Léon Gérard ; Canada Dr. R. B. Owens and Mr. L. A. Herdt ; France (Société Internationale des Electriciens), Prof. Paul Janet, Mr. Paul Boucherot, Mr. C. David ; Germany (Verband Deutscher Elektrotechniker), Dr. E. Budde and Mr. G. Dettmar ; Holland (Koninklyk Instituut van Ingenieurs), Prof. E. Feldmann and Mr. W. Smit ; Hungary (Minister of Commerce), Mr. Joseph Vater and Mr. D. Harsanyi ; Italy (Elettrotecnica Italiana), Prof. L. Lombardi and Mr. Guido Semenza ; Spain (Spanish Government), Prof. Juan Alonso y Millan and Prof. Blas Cabrera Felipe ; Japan (Denkigakukwai, Electrical Society of Japan), Dr. Ichisake Fujioka ; Switzerland (Association Suisse des Electriciens), Prof. J. L. Farny and Mr. K. P. Täuber.

The draft rules by which the organisation and work of the commission is to be regulated were considered and some amendments were introduced. At the adjourned meeting on Wednesday, June 27th, the rules were finally adopted, subject to ratification by the authorities by whom the delegates were appointed. Care has been taken to prevent the Electrotechnical Commission being in any way hampered by Government control ; the work is to be directed by the council of the Commission and the local committees directly under the several technical societies. Lord Kelvin was unanimously elected the first president of the commission and Col. Crompton, who has kindly supplied us with this information, was appointed as the first honorary secretary. It is intended that the work of the commission shall proceed by correspondence, and that the efforts of the Commission will be addressed in the first instance to the standardisation of nomenclature, so that the electro-technical terms used shall be common to all countries, and it is hoped then that a similar standardisation of physical formulæ, which are equally common to all countries, may be reached.

Royal Commission on London Traffic.—The publication of Volume IV., "Appendices to the Report," containing 1,250 pages and 102 plates, brings to a close the long and complicated inquiry of the Royal Commission on London Traffic. Though numbered four, it is, in fact, the last to be issued of the eight volumes forming the report of the Commission. Some 14 appendices are included, each appendix representing a separate investigation into, and report upon, some important question connected with London traffic. Appendix A contains a most complete history of traction matters in America, special reports having been prepared upon New York, Boston and Philadelphia. In fact, anything that is worth knowing concerning American locomotion from all points of view is to be found in this appendix. The conclusions of the Commissioners upon their visit to the United States are interesting. Whilst having great admiration for the tramway system in New York, which the Commissioners think is far ahead of London, in other respects New York is regarded as rather behind London in its general provision for locomotion. At the same time, it is pointed out that the general tendency in New York in recent years is towards a comprehensive and general scheme for the provision of means of rapid transit, in marked contrast to the manner in which London is being treated. In regard to elevated railways, the Commissioners were informed that, although these are cheap to construct, easy to operate and provide convenient and rapid transit, yet very strong objection to them is widely entertained on the ground of their noise, their interference with light, and the obstruction to traffic in narrow streets caused by the supports, as well as on æsthetic grounds. After studying this type of locomotion in other cities as well, the Commissioners report that, in their opinion, they are clearly unsuited for London streets. Sir George Trout Bartley, K.C.B., M.P., a member of the Commission, paid a special visit to several European cities, and contributes a report setting forth the main facts as regards the Parliamentary powers, financial arrangements, &c., which obtain there. In a further special report, Mr. Stephen Sellon deals with the tramway systems in the principal cities and towns in the United Kingdom (excluding London). He sets out exhaustively the effect of tramways on the value of property, omnibus and cab traffic, cost of street maintenance and the housing problem. In a section on the economics of tramway operation, Mr. Sellon points to the tramways in the Birmingham district as an example of the evil effects caused by the want of a central control over tramway interests in a large industrial centre. Owing to the large number of local authorities and companies having powers in this district there are serious gaps in the tramway network due to the fact that no agreement for uniform administration has been come to between the local authorities and the companies. The volume, in addition, contains a report on the law of France relating to tramways, and also information on many of the other aspects of locomotion in London which do not legitimately fall within our purview.

SERIES PARALLEL ARMATURE WINDINGS WITH EQUIPOTENTIAL CONNECTIONS.

BY PROF. E. ARNOLD.

(*Concluded from page 324*).

4. *Conditions for Z/a and K/a Equal to a Whole Number in Series Parallel Windings.*—We will now examine in what cases the condition that Z/a = whole number can be satisfied.

If we put in the formula

$$y_k = \frac{K \pm a}{p},$$

the value $\frac{u_n}{2}Z$ for K and the value g = a whole number for Z/a —*i.e.*, $Z = ag$, we get

$$y_k = \frac{K \pm a}{p} = \frac{\frac{u_n}{2}Z + a}{p} = \frac{a}{p}\left(\frac{u_n}{2}g \pm 1\right).$$

If we reduce the fraction a/p so that $a/p = t/r$, in which t and r have no common factor, or, we can put

$$y_k = \frac{t}{r}\left(\frac{u_n}{2}g \pm 1\right). \quad . \quad . \quad . \quad . \quad . \quad (7)$$

From this equation we can determine for what proportions of a, p and u_n, the pitch y_k can be made a whole number.

If we consider only the values 2, 4, 6 and 8 for u_n we get, if Z/a is to be a whole number, the following conditions for the winding: (1) If r is divisible by 2 and not by 3, u_n must be equal to 2 or 6. (2) If r is divisible by 3 and not by 2, u_n must be equal to 2, 4 or 8. (3) If r is divisible by 2 and 3, u_n must be equal to 2. (4) If r is not divisible by either 2 or 3, u_n must be equal to 2, 4, 6 or 8.

From these conditions the following table is compiled which shows the proportions for which Z/a can be made a whole number :—

$p = 1$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 2$	$u_n = 2$,	—	6,	—	$a = 1, 3$
	$u_n = 2$,	4,	6,	8	$a = 2, 4$
$p = 3$	$u_n = 2$,	4,	—	8	$a = 1, 2, 4, 5$
	$u_n = 2$,	4,	6,	8	$a = 3, 6$
$p = 4$	$u_n = 2$,	—	6,	—	$a = 1, 2, 3, 5, 6, 7$
	$u_n = 2$,	4,	6,	8	$a = 4, 8$
$p = 5$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 6$	$u_n = 2$,	—	—	—	$a = 1, 5, 7, 11$
	$u_n = 2$,	4,	—	8	$a = 2, 4, 8, 10$
	$u_n = 2$,	—	6,	—	$a = 3, 9$
	$u_n = 2$,	4,	6,	8	$a = 6, 12$
$p = 7$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 8$	$u_n = 2$,	—	6,	—	$a = 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15$
	$u_n = 2$,	4,	6,	8	$a = 8, 16$
$p = 9$	$u_n = 2$,	4,	—	8	$a = 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17$
	$u_n = 2$,	4,	6,	8	$a = 9, 18$
$p = 10$	$u_n = 2$,	—	6,	—	$a = 1, 3, 5, 7, 9, 11, 13, 15, 17, 19$
	$u_n = 2$,	4,	6,	8	$a = 2, 4, 6, 8, 10, 12, 14, 16, 18, 20$
$p = 11$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 12$	$u_n = 2$,	—	—	—	$a = 1, 2, 5, 7, 10, 11, 13, 14, 17, 19, 22, 23$
	$u_n = 2$,	—	6,	—	$a = 3, 6, 9, 15, 18, 21$
	$u_n = 2$,	4,	—	8	$a = 4, 8, 16, 20$
	$u_n = 2$,	4,	6,	8	$a = 12, 24$
$p = 13$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 14$	$u_n = 2$,	—	6,	—	$a = 1. 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27$
	$u_n = 2$,	4,	6,	8	$a = 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28$
$p = 15$	$u_n = 2$,	4,	—	8	$a = 1. 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, 17, 19, 20, 22, 23, 25, 26, 28, 29$
	$u_n = 2$,	4,	6,	8	$a = 3, 6, 9, 12, 15, 18, 21, 24, 27. 30$
$p = 16$	$u_n = 2$,	—	6,	—	$a = 1, 2, 3, 4, 5. 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31$
	$u_n = 2$,	4,	6,	8	$a = 16, 32$
$p = 17$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 18$	$u_n = 2$,	—	—	—	$a = 1, 3, 5, 7, 11, 13, 15, 17, 19, 21, 23, 25, 29, 31, 33, 35$
	$u_n = 2$,	4,	—	8	$a = 2, 4, 6, 8, 10, 12, 14, 16, 20, 22, 24, 26, 28, 30, 32, 34$
	$u_n = 2$,	—	6,	—	$a = 9, 27$
	$u_n = 2$,	4,	6,	8	$a = 18, 36$
$p = 19$	$u_n = 2$,	4,	6,	8	for all values of a
$p = 20$	$u_n = 2$,	—	6,	—	$a = 1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26, 27, 29, 30, 31, 33, 34, 35, 37, 38, 39$
	$u_n = 2$,	4,	6,	8	$a = 4, 8, 12, 16, 20, 28, 32, 36, 40$

From the equation

$$y_k \frac{K \pm a}{p} = \frac{a}{p}\left(\frac{K}{a} \pm 1\right),$$

it is seen that the condition K/a = a whole number can be always fulfilled for a regularly distributed winding; for slotted armatures in which every slot is to have the same number of conductors, we obtain the further condition that K divided by $u_n/2$ must be = a whole number.

A closer examination* shows that the condition K/a equal to a whole number when the number of conductors in each slot is the same can be fulfilled, if (1) a is divisible by $u_n/2$, or (2) the proportions in the table, for Z/a equal to a whole number, hold.

5. *The Methods whereby K and a and also Z and a may be made Divisible by adding Dead Bars and increasing the number of Slots.*—We have seen above that it is not always possible to fulfil the condition that K/a may be a whole number and to have at the same time $\frac{K}{u_n/2}$ also equal to a whole number. In these cases the chief condition of symmetry—*i.e.*, that K/a be equal to a whole number—is to be fulfilled. By increasing the number of slots and adding dead bars the condition that Z/a be a whole number can always be fulfilled. If we add $2a$ dead bars then Z/a is always equal to a whole number. The examination of different windings has shown that the errors which exist in windings for which p/a is not a whole number are not diminished by increasing the number of slots to a value which is divisible by a.

On the other hand windings with p/a = to a whole number and for which the condition that Z/a be a whole number cannot be fulfilled without increasing the number of slots, are by means of this increase made completely symmetrical.

In the case of series parallel windings in which p/a = a whole number, therefore, we will only fulfil the condition that Z/a be a whole number (and K/a = a whole number) by increasing the number of slots. With series parallel windings in which p/a is not a whole number we only make K/a = a whole number.

6. *Summary of the Conditions of Symmetry for Slotted Armatures with Series-Parallel Windings.*—The chief condition that K/a = whole number must always be fulfilled. In windings with p/a equal to a whole number the condition that Z/a = whole number must always be fulfilled. If a/p is equal to a whole number it is sufficient that Z/p be a whole number. Only windings, in which a/p or p/a is equal to a whole number and for which these conditions are fulfilled will be completely symmetrical. For the other windings less importance is to be attached to the fulfilling of the condition Z/a equals a whole number. But when possible proportions should always be chosen for which Z/a becomes a whole number without auxiliary means (see table). As soon as an error appears in the potential pitch we must examine whether the error exceeds a certain allowable limit.

7. *Calculation of Pitch Error.*—By placing the coil sides in slots their position is different to what it would be with regularly distributed winding. For the latter winding, in which the conductors are all at the same distance from one another, the error is easily expressed by a formula. With a slotted armature the position of the bars relatively to one another is so different that in order to determine the error it is simplest to draw out the position of the conductor in the slot, and the position of the corresponding conductor in a regularly distributed winding. The error is then calculated for the distributed winding, and the amount found by which the position of the conductor differs when the winding is in slots and when it is regularly distributed; from these two errors the resulting error can be found.

We will next determine by how much the position of a coil side differs when the winding is in slots and when regularly distributed. In Fig. 3 two slots are shown, and the connections of the upper conductors to the commutator segments is represented diagrammatically. The distance between two

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* In the second edition of my book "Die Gleichstrommaschine," which is now in the press, the proof will be found.

neighbouring conductors in a slot is denoted by r_s or if measured in commutator segments by r_c. We can now write

$t_1 : r_s = u_n/2$ commutator segments : r_c commutator segments

or $$r_c = \frac{r_s u_n}{2t_1} \text{ commutator segments.}$$

If we consider the winding as regularly distributed along the circumference of the armature, then the distance between two neighbouring conductors is equal to 1 commutator segment. If we further suppose that the coil sides 1 and 7 retain the same position on the armature which they would have with a regularly distributed winding, and the other coil sides displaced out of the position they would have with a regularly distributed winding, then the coil sides 3 and 9 will be displaced by an amount $\left(1 - \frac{r_s u_n}{2t_1}\right)$, and the coil sides 5 and 11 by an amount $2\left(1 - \frac{r_s u_n}{2t_1}\right)$. In series parallel windings with p/a and Z/a equal to a whole number, or with a/p and Z/p equal to a whole number, no errors occur, therefore $a_x = 0$.

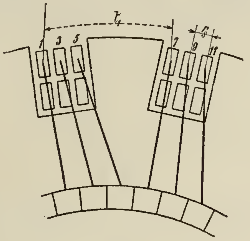

Fig. 3.

With all other series-parallel windings errors always occur. The calculation of these errors is best illustrated by means of examples.

Consider first an example where $a < p$ and Z/a a whole number.

The calculation of a machine has given as the most favourable proportions $p = 6$, $a = 4$, $u_n = 4$ when K is about 404. From the above table it is seen that for the proportions $p = 6$, $a = 4$ and $u_n = 4$ the condition Z/a = a whole number can be satisfied. We choose then $K = 400$ and $Z = 200$. The commutator pitch is therefore $y_k = \frac{400 - 4}{6} = 66$.

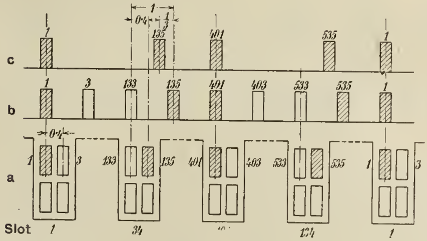

Fig. 4.

Since y_k and K have 2 as the greatest common factor the winding will be doubly re-entrant. For the calculation of the E.P. pitch we use the formula $y_p = xy_k \pm 1$, and for the calculation of the pitch error the formula $a_x = \pm\left(1 - x\frac{a}{p}\right)$.

Since the number of connections of a system is equal to 4 then, $x_1 + x_2 + x_3 + x_4 = p = 6$, and we get

$x_1 = 1$	$y_{p1} = 1 \cdot 66 + 1 = 67$	$a_{x1} = 1 - 1\frac{4}{6} = \frac{1}{3}$
$x_2 = 2$	$y_{p2} = 2 \cdot 66 + 1 = 133$	$a_{x2} = 1 - 2\frac{4}{6} = -\frac{1}{3}$
$x_3 = 1$	$y_{p3} = 1 \cdot 66 + 1 = 67$	$a_{x3} = 1 - 1\frac{4}{6} = \frac{1}{3}$
$x_4 = 2$	$y_{p4} = 2 \cdot 66 + 1 = 133$	$a_{x4} = 1 - 2\frac{4}{6} = -\frac{1}{3}$

Commutator segment 1 is to be connected with segment 1 + 67 = 68 ; 68 + 133 = 201 ; 201 + 67 = 268. The segments 1, 68, 201 and 268 are connected respectively to the coil sides, 1, 135, 401, 535. In Fig. 4*a* the coil sides are shown in their positions in the slot.

In Fig. 4*b* the position of the coil sides are shown, when the conductors are regularly distributed on the armature circumference. Now $K/p = 400/6 = 66\frac{2}{3}$ and $2K/p = 133\frac{1}{3}$. The pitches y_{p1} and y_{p3} are thus too great by one-third of a commutator segment, whilst the pitches y_{p2} and y_{p4} are too small by one-third of a commutator segment. In Fig. 4*c* the coil sides are shown in a position for which their potentials are equal, and for which, therefore, no error arises.

As shown above, the distance between two conductors in the slot is equal to $r_s u_n/2t_1$ commutator segments, and we can, therefore, determine the displacement of each coil side from the position of equality of potential.

If we assume $r_s u_n/2t_1 = 0 \cdot 4$, the errors for the coil sides 135 and 535 are equal.

$$a_n = 1 - \tfrac{1}{3} - 0 \cdot 4 = 0 \cdot 27 \text{ commutator segment,}$$

or $$a_{x^\circ} = a\frac{360}{K}a_n = 4 \times \frac{360}{400} \times 0 \cdot 27 = 0 \cdot 97 \text{ deg.}$$

As we will see later, the amount of this error is quite allowable. If we connect the segments 2, 69, 202 and 269 to a system, then the coil sides connected to these segments are respectively 3, 137, 403, 537. For this case are shown in Fig. 5*a* the position of the coil sides in the slot, in Fig. 5*b* the position of the coil sides when the winding is regularly distributed, and in Fig. 5*c* the position of the coil sides for equality of potential. The error for the coil sides 137 and 537 is here

$$a_n = 1 + \tfrac{1}{3} - 0 \cdot 4 = 0 \cdot 93.$$

or $$a_n^\circ = a\frac{360}{K}a_n = 4 \times \frac{360}{400} \times 0 \cdot 93 = 3 \cdot 35 \text{ deg.}$$

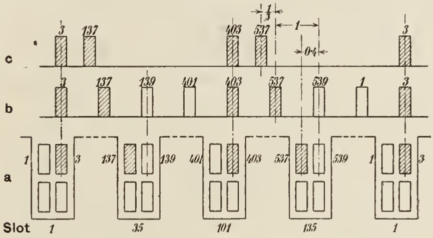

Fig. 5.

This error reaches the allowable limit. It is seen that the smallest error is only 0·97 deg. if we start from the left-hand top coil side of the slot and begin with the smaller pitch. It is to be noticed further that a and p have the greatest common factor 2, and since Z is divisible by 2, two points of a system will have exactly the same potential. In Figs. 4 and 5, the coil sides 1 and 401, 3 and 403 have respectively the same potential.

Consider now a case where a/p = a whole number, and Z/p = a whole number. We will take $a = 6$, $p = 3$, $K = 48$, $n_n = 4$, $Z = 24$. The commutator pitch is then

$$y_k = \frac{K \pm a}{p} = \frac{48 - 6}{3} = 14.$$

Since K and y_k have the greatest common factor 2 the winding is doubly re-entrant. Now

$$x_1 + x_2 + x_3 + x_3 + x_4 + x_5 + x_6 = 3$$
$$x_1 = x_3 = x_5 = 1$$
$$x_2 = x_4 = x_6 = 0$$
$$y_{p1} = y_{p3} = y_{p5} = 1 \cdot 14 + 1 \times \tfrac{6}{3} = 16$$
$$y_{p2} = y_{p4} = y_{p6} = 0.$$

The segments which are connected by a system of equipotential connections, for example 1 – 17 – 33 and respectively the conductors 1, $1 + 2y_p = 33$, $33 + 2y_p = 65$, belong to the same winding. The bars lie at a distance of eight slots from one another and have a perfectly symmetrical position in the field and therefore $a_n = 0$. The pitches y_{p2}, y_{p4} and y_{p6} can be made if we connect the conductors which lie in the same slot.

The pitch $y_p = 0$ causes an error $\alpha_n = r_s u_n / 2t_1$ between the two conductors which lie together in a slot. For $r_s u_n / 2t_1 = 0{\cdot}4$ is $\alpha_n^\circ = p\frac{360}{K}\alpha_n = 3 \times \frac{360}{48} \times 0{\cdot}4 = 9$ deg.

This error is much too large, so that in this case it is not allowable to connect neighbouring conductors.

As a last example we will choose the following winding data $p = 4$, $a = 2$, $u_n = 4$. It is seen from the table that for this winding the condition $Z/a =$ a whole number cannot be fulfilled without auxiliary means. We will, however, satisfy the condition for this winding by adding $2a = 4$ dead bars. We choose $s = 68$ and $K = 34$. The total number of coil sides inclusive of dead coil sides will then be $= 2{\cdot}34 + 4 = 72$ and the number of slots $= 72/4 = 18$. Then $Z/a = 18/2$ is = a whole number. The position of the dead conductors is so chosen that they are symmetrically distributed around the armature circumference. All similarly situated coil sides of both groups lie in the same field as shown in Fig. 6. The winding has thus been made completely symmetrical through increasing the number of slots

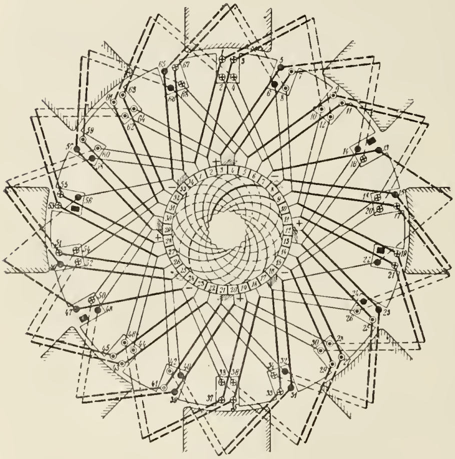

Fig. 6.

8. *Comparison of the Values of α_n° in Machines actually Built.*—In the following table the error α_n° is shown for different machines constructed with series-parallel windings. Remarks are added as to the behaviour of the machine. The machines 14 and 15 with pitch errors of 4·4 and 5·1 deg. respectively showed the presence of large internal currents on running which did not, however, cause undue heating, and the commutation was good. The last machine had to be rebuilt as it became too hot on account of the internal currents. The error for this machine was 7·1 deg. In the columns p/a and Z/a the symbols *wh . n* and *n . wh . n* are used to indicate whether p/a and Z/a respectively are whole numbers or not whole numbers.

Table *of Pitch-error α_n and α_n° in Machines built with Series-Parallel Windings.*

No.	p	a	K	Z	u_n	$\frac{p}{a}$	$\frac{Z}{a}$	$\frac{r_s u_n}{2t_1}$	$\alpha_{n\,max}$	$\alpha_n^\circ{}_{max}$
1	6	3	609	203	6	*wh. n.*	*n. wh. n.*	0·4	1·2	2·13
2	6	2	490	245	4	„	„	0·35	0·65	0·95
3	6	3	651	217	6	„	„	0·4	1·2	2·0
4	5	2	303	303	2	*n. wh. n.*	„	. .	0·2	0·48
5	5	3	412	412	2	„	„	. .	0·4	1·05
6	3	2	236	118	4	„	*wh. n.*	0·5	0·83	2·55
*7	3	3	285	95	6	*wh. n.*	*n. wh. n.*	0·3	1·4	5·3
8	4	2	366	183	4	„	„	0·3	0·7	1·38
9	6	3	795	265	6	„	„	0·3	1·4	1·9
10	4	2	238	119	4	„	„	0·55	0·45	1·35
†11	4	2	422	141	6	„	„	0·5	0·0	1·7
12	4	2	342	171	4	„	„	0·4	1·6	1·26
†13	6	2	776	259	6	„	„	0·5	1·0	0·95
†14	2	2	164	55	6	„	„	0·5	1·0	4·4
†15	2	2	140	47	6	„	„	0·5	1·0	5·1
‡16	3	3	213	71	6	„	„	0·3	1·4	7·1

* Sensitive. † In two slots one dead bar. ‡ Had to be rebuilt.

9. *The Number of Equipotential Connections.*—It is not necessary that all segments should be joined to equipotential connections, although in view of the equalising of the short circuit current the greatest possible number of connections is desirable. In most cases it is sufficient to connect only 1/3, 1/4, 1/5, 1/10 or still less of the segments.

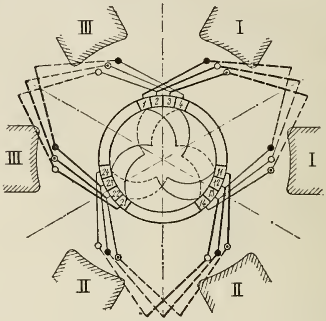

Fig. 7A.

In series parallel windings p coils are passed over each time a complete way round of the armature is made, the sides of which are so distributed under all the poles in drum windings that one coil side lies under each pole, so that a segments on the commutator circumference are passed over.

There is, therefore, the same E.M.F. induced in every p coils even when the strengths of the poles are different. If we arrange therefore by means of the equipotential connections every p coils in opposition in that we connect only every ath segment to equipotential connections, no internal armature currents can arise from the inequality of the pole strengths, and at the same time the beneficial effect of the E.P.C. on the commutation remains.

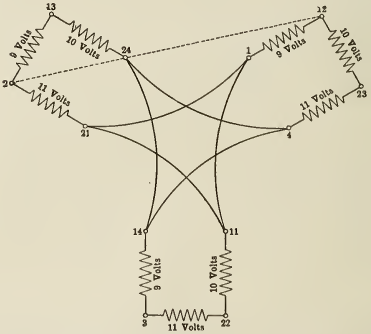

Fig. 7B.

In Fig. 7A part of the wave winding is shown for $p = 3$, $a = 3$, $y_k = 11$, $K = 3 \times 11 - 3 = 30$ and $y_{p1} = y_{p2} = y_{p3} = 1 \times 11 - 1 = 10$. Starting from segment 1 we arrive after one round at segment $1 + a = 4$ and after a second round to segment $4 + a = 7$. In the loop $1 - 12 - 23 - 4 - 24 - 13 - 2 - 21 - 1$ formed by the E.P.C. p coils are arranged against p coils and their E.M.F.s balance one another even with poles of unequal strength.

In this lies an important superiority of series parallel windings as compared with lap windings, and this holds also when $a=p$—*i.e.*, when it is possible to use a lap winding. If all the segments (1 – 11, 2 – 12) has been joined to equipotential connections and not only every ath segment (1 – 11, 4 – 14) the coils for example 1 – 12 (9 volts) and 21 – 2 (11 volts) would have been arranged in series and given rise to internal currents. With lap windings a compensation of this kind is impossible. In view, however, of the balancing of the armature, it is desirable, in turbo-generators, for example, to compensate for the magnetic pull due to the unequal pole strengths. In this case the number of connections is to be such that the difference of the field strengths will be neutralised by the internal currents.

SELF-INDUCTION EFFECTS IN STEEL RAILS.

BY ERNEST WILSON.

In a previous Paper on the above subject[*] it was shown to what extent the resistance opposed to an alternate current by a 70 lb. bull-headed steel rail is increased at ordinary frequencies over the value it would have with direct currents. The self-induction effects then studied have since received further attention.[†] A simple calculation shows that the *equivalent* depth of penetration at ordinary frequencies is only of the order 0·2 cm., so that the amperes per centimetre of perimeter is a fair criterion as to the relative merits of different sections. It was suggested that a bridge rail would offer a less resistance to alternate currents of given frequency and magnitude on account of its greater perimeter. The following table has been compiled from the sections published by the British Standards Committee, except in the case of bridge rails, the sections for which have been kindly furnished by Messrs. Dorman, Long & Co. It will be seen that the flat-bottomed and bridge rails are superior to the bull-headed rail for a given weight per yard. It is interesting to note how greatly superior are the channel and tramway rail sections. The figures are mean values taken after plotting the curves :—

Weight in lb. per yard.	Perimeter in centimetres.				
	Bull-headed railway rails.	Flat-bottomed railway rails.	Bridge rails.	Tramway girder section.	Channel.
60	40	48·5	49·0	72·0	73·5
70	42	52·5	51·0	76·0	78·0
80	44	56·0	53·0	79·5	82·5
90	46	60·0	55·0	83·0	87·0
100	48	63·5	57·5	87·0	92·0
110	50	67·0	59·5	91·0	96·0

THE ELECTROLYTIC DEPOSITION OF ZINC USING ROTATING ELECTRODES.[‡]

BY T. SLATER PRICE AND G. H. B. JUDGE.

Under ordinary conditions zinc cannot be quantitatively deposited from a pure solution of zinc sulphate, or from one containing a small proportion of free sulphuric acid. An examination of the literature shows that although various methods have been worked out using rotating electrodes and solutions of zinc sulphate to which some foreign electrolyte, such as oxalic acid, sodium acetate, &c., has been added, only two investigators have endeavoured to deposit zinc from the pure solution of the sulphate. Denso (*Zeitschrift für Elektrochemie*, 1903, 9, 463), using a very imperfect method of stirring the electrolyte, was unable to obtain good results, although he could satisfactorily deposit cadmium from slightly acid solutions of the sulphate. Kollock and Smith (*Journal* Amer. Chem. Soc., 1905, 27, 1,255) obtained quantitative results, even in the presence of free sulphuric acid, using a mercury cathode and rotating anode; we shall have occasion to refer to this later.

We have investigated the deposition of zinc from solutions of zinc sulphate, making use of a rotating cathode, and the present communication gives a summary of the results so far obtained.

The platinum electrodes used were similar to those described in F. Mollwo Perkin's "Practical Methods of Electro-chemistry," p. 81; the sand blasted gauze cathode was 22 mm. in diameter, and 40 mm. long; the double ring of wire with baffle plates, forming the anode, was 40 mm. in diameter. For rotating the cathode use has been made of the front hub of a bicycle. This was suggested to one of us by Mr. H. L. Heathcote, B.Sc., the chief chemist at Rudge-Whitworth (Ltd.), and we have found that it works extremely well, and, moreover, has the advantage of being cheap. One end of the spindle is drilled to receive the cathode, which is fastened in position by means of a screw; or the spindle may be fitted with a small chuck for holding the cathode. The other end of the spindle is fitted with a grooved pulley. In order to make connection with the source of current two spokes are soldered across the hub, the one being bent and connected with the negative leading wire. The ball bearings are lubricated with a mixture of graphite and oil. The whole arrangement is practically frictionless, and can be driven by means of a small motor which works with 4–6 volts, and only costs 8s. 6d. The drop in potential across the bearings varies from ½ to 1 volt.

In working with rotating cathodes we have not found it convenient to use a beaker to hold the solution. After the electrolysis is finished it is not satisfactory to stop the cathode rotating in order to syphon off the electrolyte and at the same time run in distilled water till all the solution has been displaced. It often happens that a trace of metal is re-dissolved from the cathode. If the beaker is to be so wide that the syphon tube can be put down between it and the anode, the cathode being kept rotating, the volume of the solution becomes inconveniently large. An ordinary tap funnel answers admirably in place of the beaker. The one we have used has a capacity of about 100 cubic cm., and the anode ring just fits into it. The suction caused by the rotating cathode continually draws up the liquid from the neck of the funnel just above the tap, so that the circulation of the electrolyte is complete. We have tested this by putting a little chloroform into the neck, and then water above it; on rotating the cathode all the chloroform was rapidly drawn up and mixed with the water.

In all our experiments the volume of the solution was 50 cubic cm. to 60 cubic cm., and during the electrolysis the mouth of the funnel was covered by means of a split cover glass; towards the end of the experiment the cover glass and the sides of the funnel were washed down with distilled water, and the current passed for a short time longer in order to make sure that deposition was complete. The cover glass was then removed and the washing of the cathode commenced at the same time as the tap of the funnel was turned in order to let the solution run out. The washing was continued until the current had fallen to zero, the cathode continuously rotating meanwhile. The electrode was then washed with absolute alcohol, and dried at steam heat. In all cases the cathode was silvered before deposition of the zinc upon it.

The first experiments were made without taking any precautions to keep the electrolyte cool. The solution of zinc sulphate does not conduct very well, and it was found that if the voltage used was high enough to give a current of 2 amperes at the commencement of the experiment, the deposit was very liable to be spongy. The method finally adopted was as follows: At the commencement of the experiment the current used was 0·25 ampere, the voltage necessary being 4; after five minutes the current was raised to 0·5 ampere, the necessary voltage being 5–5·5; after five more minutes the current was made equal to 1 ampere, and the voltage was 6–6·5. If the apparatus was then left to itself the current gradually increased to 2 amperes (in about 10 minutes), owing to the increase in conductivity, due partly to the liberation of sulphuric acid as the zinc is deposited, and partly to the heating effect of the current. The current was then kept at 2 amperes for 20 minutes (voltage finally 4·5–5·5), the cover glass and sides of the funnel being washed down about five minutes before the end of the experiment. The current could have been raised to 2 amperes in a shorter time than given above, but our object was not to cut down the time of deposition to a minimum, but rather to get a quantitative result.

The weight of zinc in each case was 0·2275 gramme and the weights of zinc deposited were 0·2257, 0·2251, 0·2258, 0·2249 gramme respectively. The deposit was very fine in appearance, of a light grey colour and quite firm and adherent. In each case the solution was tested with ammonium sulphide and no zinc could be detected. The results, although agreeing among themselves, were, however, uniformly low. It was afterwards found that the test with ammonium sulphide was not delicate enough, and that potassium ferro-cyanide in hydrochloric acid solution must be used in its place. During the experiment the solution became quite warm, and it was possible that the low result was due to the increased solvent action of the free sulphuric acid on the deposited zinc (this statement is simpler than discussing the alteration with the temperature of the deposition potential of the zinc and hydrogen ions respectively). This was tested by increasing the current during the latter part of the experiment, the solution thereby being heated to a still higher temperature. With 4 amperes the weights of zinc deposited were 0·2230 and 0·2220 gramme respectively; with 5 amperes

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[*] See *The Electrician*, February 23, 1906.

[†] See Roy. Soc. *Proc.*, June, 1906.

[‡] Paper read before the Faraday Society on Tuesday, June 12th.

0·2209 gramme. The low result was evidently due to the heating effect of the current.

In the next experiments the electrolyte was kept cool by means of a jacket containing ice. The tap of the funnel could easily be turned by means of a glass rod, which hooked into a loop put on to one end of the tap.

The results obtained were very satisfactory. The weight of zinc taken in each case was 0·2274 gramme. The weights found were 0·2274, 0·2266, 0·2271, 0·2260, 0·2274, 0·2268, 0·2273, 0·2273, 0·2272, 0·2269 gramme respectively. The temperature of the solution did not rise above 14°C.; the number of revolutions per minute of the cathode varied from 300 to 500, and in each case the deposit was very good. At the end of the experiment the normality of the solution with respect to sulphuric acid would be somewhere about N/20; it cannot be accurately given, owing to the dilution on washing down.

It was even found possible to add a certain amount of sulphuric acid to the solution of zinc sulphate used, as shown by the following table. The normality of the solution with respect to sulphuric acid is that before the electrolysis was started. After washing down it would be diminished by about one-third, neglecting the acidity due to the sulphuric acid formed from the zinc sulphate.

The first four experiments gave good results; in the last two the concentration of the acid was too great.

Weight of zinc taken.	Normality of acid.	Weight of zinc found.	Error.
Gramme.		Gramme.	Gramme.
0·2275	*n*/15	0·2261	−0·0014
0·2275	*n*/15	0·2275	±0·0000
0·2275	*n*/7·5	0·2267	−0·0008
0·2275	*n*/6	0·2271	−0·0004
0·2275	*n*/4	0·2255	−0·0020
0·2275	*n*/3	0·2193	−0·0082

Instead of cooling with ice, cooling by means of a continuous flow of water through the outer vessel was tried, with the following results: Weight of zinc taken was 0·2274 gramme. The weights found were 0·2270, 0·2271, 0·2265 and 0·2261 gramme respectively. The temperature in any of the four experiments did not rise above 17°C.

The following table gives a series of results obtained when various salts were added to the solution of zinc sulphate. In each case the experiment was started with a low current, which was then gradually increased to 2 amperes; t_1 is the time in minutes taken to increase the current from 0·5 to 2 amperes, and t_2 the time the current was kept at 2 amperes. The solution was not cooled, and the weight of zinc taken in each case was 0·2274 gramme.

Grammes of—		C.C. of 2N H_2SO_4	t_2	t_1	Volts	Weight of Zn. found.	Error.	Temp. of solution rose to
Na_2SO_4	Sal Acetate.							
1	..	..	10	19	3·5-6·8	0·2269	−0·0005	..
2	..	..	6	17	3·0-5·8	0·2274	±0·0000	27°
3	..	..	4	16	3·5-5·3	0·2277	+0·0003	..
..	1	..	11	19	4·5-8·0	0·2266	−0·0008	..
..	2	..	5	16	4·0-6·8	0·2276	+0·0002	..
2	1	..	7	13	3·5-5·8	0·2276	+0·0002	28°
3	..	5	5	17	3·5-4·0	0·2262	−0·0012	..
3	..	5	6	20	3·5-4·3	0·2259	−0·0015	..
3	..	5	6	11	3·8-4·5	0·2213	−0·0061	..
3	..	10	..	25	3·5-4·0	0·2187	−0·0087	..
..	3	5	5	19	4·0-6·0	0·2278	+0·0004	..
2	1	2	4	18	4·3-5·5	0·2262	−0·0012	31°
2	1	5	5	16	4·5-5·0	0·2235	−0·0039	..
2	1	5	4	20	4·3-5·0	0·2206	−0·0068	..
1	2	5	8	17	5·0-6·0	0·2250	−0·0024	..
2	2	5	6	18	3·8-5·5	0·2245	−0·0029	..
*2	..	..	..	..	..	0·2252	−0·0022	42°
*2	1	..	..	..	..	0·2278	+0·0004	45°

* In these two cases the current was allowed to rise to 3 amperes.

The deposits were all that could be desired in every case where sodium sulphate was present, but where sodium acetate alone was added the deposit was liable to be spongy, and even if it was adherent it was of a bad colour. The table shows that good results are obtained in the presence of 2–3 grammes of sodium sulphate, with or without sodium acetate, but that it is not advisable to have any free sulphuric acid present to start with. Exner (*Journal* Amer. Chem. Soc. 1904, 25, 896), Ingham (*Journal* Amer. Chem. Soc., 1904, 26, 1269) and Fischer and Boddaert (*Zeitschrift für Elektrochemische*, 1904, 10, 945) use sodium acetate (1–3 grammes) and acetic acid (0·2 cubic cm. of 30 per cent. acid) and rotating anode; in the present case it is preferable to replace some or all of the sodium acetate by sodium sulphate, and the addition of acetic acid is unnecessary. Even with currents of 3 amperes, when the temperature rises to 45°C., good results are obtained in the presence of 2 grammes of sodium sulphate plus 1 gramme of sodium acetate.

Further experiments on the deposition of zinc, using the above apparatus, are being carried out in this laboratory, the results of which we hope to communicate later to the society.

Kollock and Smith's method (*Journal* Amer. Chem. Soc., 1905, 17, 1,255) for the determination of zinc, using a mercury cathode and a rotating anode, is a very good one, but we think that a slight modification of the apparatus makes it more convenient. According to the original Paper the mercury and the zinc amalgam are both dried and weighed in the glass tube which is used for the deposition. In our experiments the mercury was weighed in a porcelain crucible, put into the electrolysis tube, and at the end of the experiment the amalgam was run off into the crucible through the tap; it is even possible to obtain the amalgam dry in this manner, although it is not advisable to neglect washing it with alcohol and ether. It is not absolutely necessary to syphon off the electrolyte and replace it by distilled water before running off the amalgam, although this latter procedure would tend to greater accuracy, obviating any carelessness in tapping off the amalgam. The figures given in the following table were obtained in this way—*i.e.*, without syphoning off the electrolyte. They show, moreover, that it is necessary not to exceed a certain amount of free sulphuric acid, although Kollock and Smith do not mention this in their Paper in the case of zinc. In each case the volume of the solution used was 10 cubic cm., and the current employed 5 amperes, requiring a voltage of 7.

Zinc present. Gramme.	Conc. H_2SO_4 added. 40 drops=3 cc.	Time (in mins.)	Zinc found.	Error.
0·2234	7	20	0·2008	−0·0226
0·2234	7	10	0·2173	−0·0061
0·2234	7	5	0·2200	−0·0034
0·2234	6	10	0·2202	−0·0032
0·2234	6	8	0·2202	−0·0032
0·2316	4	8	0·2279	−0.0037
0·2316	3	8	0·2288	−0·0028
0·2316	2	8	0·2317	+0·0001
0·3316	2	8	0·2318	+0·0001
0·2316	2	8	0·2304	−0·0012
0·2316	2	5	0·2246	−0·0070
0·3353	2	10	0·3351	−0·0002
0·3353	2	10	0 3347	−0·0006
0·2316	..	5	0·2288	−0·0028

Thus accurate results were obtained when not more than two drops (40 drops=3 cubic cm.) of concentrated sulphuric acid were used in the presence of 0·2316–0·3353 gramme of zinc, the time of deposition being 8 to 10 minutes.

A 1,500 KW. TURBO-GENERATOR.

The Oerlikon Company has just completed a 1,500 kw. three-phase turbo-alternator for the Saturn Company's mines at Woikowice, near Sosnowice, which show some points of difference from the smaller turbo sets constructed by this company.

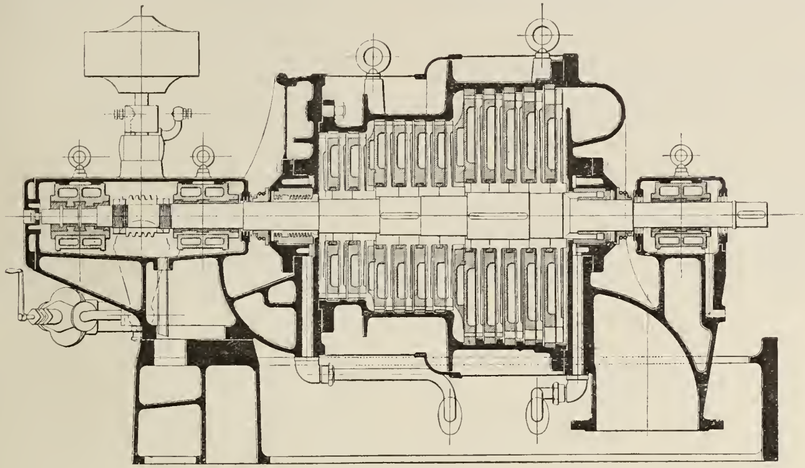
The turbine has an effective output of 2,300 B.H.P. and is designed to work with steam superheated to 250°C. at a pressure of about 140 lb. per square inch. It is directly coupled to a four-pole alternator capable of an output of 1,500 kw. at 2,000 volts, 50 cycles at 1,500 revs. per min. Three distinct groups of vanes are contained in the turbine, but these high, intermediate and low-pressure groups are all placed in one case as shown in the section in the Figure.

The partitions between each wheel chamber are composed of fixed discs made in two parts which carry the guide blades. By this means the waste space can be made very small. The shaft, which is very firmly supported, is of greatest diameter inside the case, as seen in the section, so that the vane discs can be slipped off some from one end of the shaft and some from the other. The vane discs themselves are of steel, machined all over. To these the vanes are fixed without riveting and an outside ring holds them firmly in place. Every vane wheel is balanced separately and tested at 1½ times the speed it is run before the rotor is built up.

For purposes of overloads a valve is provided by means of which live steam can be introduced between the high pressure and intermediate groups of vanes. As the pressure of the steam is the same on both sides of the discs a relatively greater clearance is allowable both between the vanes and guide and between the rotor and casing than is usually the case. Also thrust discs are not required, as no axial thrust is produced.

Lubrication of the bearings is accomplished by an oil pump driven by a worm gear off the shaft, a hand pump being provided to flood the bearings when starting, and all the bearings are water-cooled.

A centrifugal governor is driven by gearing from the pump shaft which controls the steam supply through a valve opened and closed by the pressure of the steam. If the speed rises by 10 or 15 per cent. the governor entirely closes the stop valve. This emergency stop can also be operated by hand. A further arrangement enables the governor to automatically reopen the steam valve again when the speed has dropped to its normal value. The failure of the oil pump can also cause the emergency stop to come into action and cut off the steam supply from the turbine. A special patented flexible coupling is provided between the turbine and the generator, which allows a certain amount of freedom for end play.



Section of Turbine.

The alternator is of the revolving field type. The rotor core plates are slotted all round the periphery with relatively large slots in which the former wound field coils are embedded and held in place by metallic keys. In the centre of each there are a few slots without winding. These are left empty and not filled with magnetic material in order to improve the distribution of field under the poles and improve the voltage regulation of the machine. This arrangement has been adopted in the Oerlikon Company's machines since the year 1901. The system of forced ventilation follows the lines usual in the majority of Continental turbo-alternators. The main object in view is to proportion the cooling effect of the current of air through the various parts of the machine, with due regard to the liability of each part to develop heat. Two fans are provided, one at each end of the rotor, and the air is driven by these through ventilating channels in the various parts of the machine. In contradistinction to the usual practice on the Continent, the stator is divided into two parts about a horizontal plane. The alternator bearings are spherically seated and water cooled, and are provided with oil by the same oil pump that supplies the turbine bearings.

A NOTE ON THE THEORY OF DIRECTIVE ANTENNÆ OR UNSYMMETRICAL HERTZIAN OSCILLATORS.*

BY J. A. FLEMING, M.A., D.SC., F.R.S.

The employment in wireless telegraphy of antennæ or radiating wires which have part of their length vertical and part horizontal and possess the power of radiating unequally in various horizontal directions draws attention to the particular qualities of bent electric oscillators when used as radiators or transmitters.† The object of the following note is to show that the properties of such radiators can be deduced from accepted principles, and that experimental results so far obtained are in general accordance with theory.

The nature of the field of electric and magnetic force round a short straight electric oscillator or doublet has been expressed analytically and delineated graphically in well-known memoirs by Hertz,‡ Pearson and Lee§ and others, and that around a not very short rod or linear oscillator has been ivestigated by M. Abraham‖ and depicted by F. Hack.¶ In these cases we have perfect symmetry of radiation round the axis of the oscillator. This equality is, however, destroyed by bending the oscillator, and it then radiates unequally in different directions taken in the equatorial or symmetrical plane of the oscillator through its centre; being somewhat greater or stronger on the convex side of the oscillator.

The analytical treatment of the subject presents, however, enormous difficulties unless we limit consideration to the case in which the current in the oscillator is assumed to have the same value at all points at the same time, and also that the dimensions of the oscillator are small compared with the distance from it of the points at which the field is considered.

One form of bent oscillator of the above kind may be considered to be made up by the superposition of three Hertzian electric doublets placed at right angles to each other, the poles being so arranged that at the two corners poles of opposite sign are superimposed, the oscillations in all being synchronous and similarly directed (see Fig. 1). Hence, to obtain the field of the bent oscillator, we need merely to calculate those of the components and add them together.

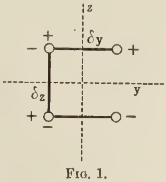


Fig. 1.

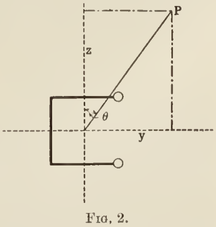


Fig. 2.

Let a single electric oscillator or doublet be placed with centre at the origin and axis coinciding with the z axis. Let oscillations exist in it of period $2\pi/n$, and radiation be emitted of wave-length $2\pi/m$. Suppose the length of the oscillator to be denoted by δz, the electric charge at either pole at any instant by q, the uniform current in the axis by i, whilst Q and I are the maximum values of q and i which vary so that $q=Q \sin nt$ and $i=I \cos nt$. Also let $\phi=Q\delta z$ be the maximum electric moment of the oscillator. We have, therefore, $I=Qn$ or $\phi n=I\delta z$, and $n/m=v$ the velocity of propagation of the radiation through space. The scalar potential V at any point P whose distance from the origin is r is given by

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* Paper read before the Royal Society, March 22nd.

† See G. Marconi, LL.D., D.Sc., "On Methods whereby the Radiation of Electric Waves may be mainly confined to certain Directions, and whereby the Receptivity of a Receiver may be restricted to Electric Waves emanating from certain directions," Roy. Soc. *Proc.*, Vol. LXXVII., p. 413, 1906, and *The Electrician*, May 4, p. 100.

‡ H. Hertz, *Wied. Ann.*, Vol. XXXVI., p. 1, 1889, or "Electric Waves," English translation, p. 137.

§ Pearson and Lee, *Phil. Trans.*, A., Vol. CLXLIII., p. 159, 1900.

‖ M. Abraham, *Ann. der Physik.*, Vol, LXVI., p. 435, 1898.

¶ F. Hack, *Ann. der Physik.*, Vol. XIV., p. 539, 1904.

$$V=-\frac{\phi}{k}\frac{d}{dz}\left(\frac{\sin(mr-nt)}{r}\right), \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where k is the dielectric constant of the medium, and $r^2=x+y^2+z^2$.

Also, if F, G, and H are the components of vector potential at P, we have in this case $F=G=0$, and

$$H=-I\delta z\frac{\cos(mr-nt)}{r}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If we employ the symbol Π to stand for $\sin(mr-nt)/r$, we can write the above expressions (1) and (2) in the form

$$V=-\frac{\phi}{k}\frac{d\Pi}{dz} \qquad H=\phi\frac{d\Pi}{dt} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

If we suppose this doublet to be moved parallel to itself in the negative direction so that its centre is displaced by a distance $-\frac{1}{2}\delta y$, the scalar and vector potentials at P become

$$V=\left(-\frac{\phi}{k}\frac{d\Pi}{dz}\right)+\frac{1}{2}\frac{d}{dy}\left(\frac{\phi}{k}\frac{d\Pi}{dz}\right)\delta y. \quad . \quad . \quad . \quad . \quad (4)$$

$$H=\phi\frac{d\Pi}{dt}-\frac{1}{2}\frac{d}{dy}\left(\phi\frac{d\Pi}{dt}\right)\delta y. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Consider, then, two other similar doublets of length δy, and maximum moment ϕ', placed with poles pointing in opposite directions and axes parallel to the axis of y, the doublets having centres at distances $+\frac{1}{2}\delta z$ and $-\frac{1}{2}\delta z$ from the origin and poles arranged as in Fig. 1. The scalar and vector potentials at the point P of these last two doublets constituting together a double-doublet are obviously given by—

$$V=-\frac{\phi'}{k}\frac{d^2\Pi}{dz\,dy}\delta z. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$G=\phi'\frac{d^2\Pi}{dz\,dt}\delta z. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Hence, if three such short, straight oscillators, having equal currents and charges, are placed round the origin so as to create a doubly-bent oscillator, the scalar and vector potentials of this oscillator at a point P (see Fig. 2), the distance of which from the origin is large compared with the linear dimensions of the oscillator are given by—

$$V=-\frac{\phi}{k}\frac{d\Pi}{dz}+\frac{1}{2}\frac{\phi}{k}\frac{d^2\Pi}{dy\,dz}\delta y-\frac{\phi'}{k}\frac{d^2\Pi}{dz\,dy}\delta z. \quad . \quad . \quad . \quad (8)$$

$$\left.\begin{aligned}&F=0\\&G'=\phi'\frac{d^2\Pi}{dz\,dt}\delta z\\&H=\phi\frac{d\Pi}{dt}-\frac{1}{2}\phi\frac{d^2\Pi}{dy\,dt}\delta y\end{aligned}\right\}, \quad . \quad . \quad . \quad . \quad . \quad (9)$$

where $\phi'\delta z=\phi\delta y$.

The electric and magnetic forces at the point P, of which the axial components are P, Q, R, and a, b, c, can be obtained from equations (8) and (9) at once by the aid of the relations—

$$\left.\begin{aligned}P&=-\frac{dF}{dt}-\frac{dV}{dx} & a&=\frac{dH}{dy}-\frac{dG}{dz}\\Q&=-\frac{dG}{dt}-\frac{dV}{dy} & b&=\frac{dF}{dz}-\frac{dH}{dx}\\R&=-\frac{dH}{dt}-\frac{dV}{dz} & c&=\frac{dG}{dx}-\frac{dF}{dy}\end{aligned}\right\} \quad . \quad . \quad . \quad (10)$$

It is obvious that if the electric circuit is completed by placing a pair of double doublets of moments ϕ and ϕ' at right angles to each other with poles directed in like sense all round the origin, the free charges cancel each other pair and pair, and we are left with a closed electric circuit of area $\delta y\,.\,\delta z$, traversed by a maximum current I. This quadruple doublet creates potentials such that

$$\left.\begin{aligned}V&=0 & F&=0\\G&=\phi'\frac{d^2\Pi}{dz\,dt}\delta z & H&=\phi\frac{d^2\Pi}{dy\,dt}\delta y\end{aligned}\right\}, \quad . \quad . \quad . \quad (11)$$

where $\phi'\delta z=\phi\delta y$.

Such a completely closed circuit or *magnetic doublet* creates, therefore, periodic electric and magnetic forces in its field when current oscillations are set up in the circuit.*

For the present purposes we require only the electric and magnetic forces perpendicular to the radius vector r, taken at its extremity, when that radius is taken in the plane xy, which is normal to the plane yz in which the oscillator is situated. Hence we need only calculate the value of R, a and b for the case in question.

If we write M for $I\,\delta y\,\delta z$ and call this the magnetic moment of the bent oscillator, so that $\phi\delta y=\phi'\delta z=M/n$, we have the following equations for the potentials and forces in the field at points not very near the oscillator:—

$$V=-\frac{\phi}{k}\frac{d\Pi}{dz}+\frac{\phi}{2k}\frac{d^2\Pi}{dy\,dz}\delta y-\frac{\phi'}{k}\frac{d^2\Pi}{dz\,dy}\delta z=-\frac{\phi}{k}\frac{d\Pi}{dz}-\frac{M}{2kn}\frac{d\Pi}{dy\,dz}$$

$$G=\phi'\frac{d^2\Pi}{dz\,dt}\delta z=\frac{M}{n}\frac{d^2\Pi}{dy\,dt}$$

$$H=\phi\frac{d\Pi}{dt}-\frac{\phi}{2}\frac{d^2\Pi}{dy\,dt^2}\delta y=\phi\frac{d\Pi}{dt}-\frac{M}{2n}\frac{d^2\Pi}{dy\,dt}$$

$$R=-\phi\frac{d^2\Pi}{dt^2}+\frac{M}{2n}\frac{d^3\Pi}{dy\,dt^2}+\frac{\phi}{k}\frac{d^2\Pi}{dz^2}+\frac{M}{2kn}\frac{d^3\Pi}{dy\,dz^2} \quad . \quad . \quad . \quad . \quad (12)$$

$$a=\phi\frac{d^2\Pi}{dy\,dt}-\frac{M}{2n}\frac{d^3\Pi}{dy^2\,dt}-\frac{M}{n}\frac{d^3\Pi}{dz^2\,dt}$$

$$b=-\phi\frac{d^2\Pi}{dx\,dt}+\frac{M}{2n}\frac{d^3\Pi}{dx\,dy\,dt}.$$

Performing the necessary differentiations on the function $\Pi=\sin(mr-nt)/r$ and collecting terms in $\sin(mr-nt)$ and $\cos(mr-nt)$, which for shortness will be written $\sin X$ and $\cos X$, also putting v for n/m or $(\mu k)^{-\frac{1}{2}}$, where μ and k are the permeability and dielectric constant of the medium we have the following expressions for R, a and b.

$$\begin{aligned}R=&\left\{\phi(m^2r^2-1)-\phi(m^2r^2-3)\left(\frac{z}{r}\right)^2+\frac{M}{2v}\frac{3}{mr}\left(\frac{y}{r}\right)\right.\\&\qquad\left.+\frac{M}{2v}\frac{(8m^2r^2-15)}{mr}\left(\frac{y}{r}\right)\left(\frac{z}{r}\right)^2\right\}\frac{\sin X}{kr^3}\\&+\left\{\phi mr-\phi 3mr\left(\frac{z}{r}\right)^2-\frac{M}{2v}(m^2r^2+3)\left(\frac{y}{r}\right)\right.\\&\qquad\left.+\frac{M}{2v}(m^2r^2+18)\left(\frac{y}{r}\right)\left(\frac{z}{r}\right)^2\right\}\frac{\cos X}{kr^3}. \quad . \quad (13)\end{aligned}$$

$$\begin{aligned}a=&\left\{\phi vm^2r^2\left(\frac{y}{r}\right)+\frac{M}{2}3mr\left(\frac{y}{r}\right)^2-\frac{M}{2}3mr+3Mmr\left(\frac{z}{r}\right)^2\right\}\frac{\sin X}{r^3}\\&+\left\{\phi vmr\left(\frac{y}{r}\right)-\frac{M}{2}(m^2r^2-3)\left(\frac{y}{r}\right)^2-\frac{3M}{2}\right.\\&\qquad\left.-M(m^2r^2-3)\left(\frac{z}{r}\right)^2\right\}\frac{\cos X}{r^3}. \quad . \quad . \quad . \quad (14)\end{aligned}$$

$$\begin{aligned}b=&-\left\{\phi vm^2r^2\left(\frac{x}{r}\right)+\frac{M}{2}3mr\left(\frac{x}{r}\right)\left(\frac{y}{r}\right)\right\}\frac{\sin X}{r^3}\\&-\left\{\phi vmr\left(\frac{x}{r}\right)-\frac{M}{2}(m^2r^2-3)\left(\frac{x}{r}\right)\left(\frac{y}{r}\right)\right\}\frac{\cos X}{r^3}. \quad . \quad . \quad . \quad . \quad (15)\end{aligned}$$

Suppose we limit attention to the value of the electric force e and the magnetic force d at right angles to the extremity of the radius vector r, the former being parallel to the z-axis and the latter being drawn in the plane of xy. The magnetic force d in this direction is equal to $ay/r-bx/r$. Hence we obtain its value by multiplication of the values of a and b by y/r and x/r and subtraction. Then putting $z=0$ in the above equations and writing $\cos\theta$ for y/r we have,

$$\begin{aligned}e=&\left\{\phi(m^2r^2-1)+\frac{M}{2v}\frac{3}{mr}\cos\theta\right\}\frac{\sin X}{kr^3}\\&\qquad+\left\{\phi mr-\frac{M}{2v}(m^2r^2+3)\cos\theta\right\}\frac{\cos X}{kr^3}. \quad . \quad . \quad . \quad (16)\end{aligned}$$

$$d=\left\{\phi vm^2r^2\right\}\frac{\sin X}{r^3}+\left\{\phi vmr-\frac{M}{2}m^2r^2\cos\theta\right\}\frac{\cos X}{r^3}. \quad . \quad . \quad . \quad (17)$$

If we denote the amplitudes of e and d by E and H, we have finally

$$\begin{aligned}E=\frac{1}{kr^3}\Bigg[&\left\{\phi(m^2r^2-1)+\frac{3}{2}\frac{M}{v}\frac{\cos\theta}{mr}\right\}^2\\&+\left\{\phi mr-\frac{M}{2v}(m^2r^2+3)\cos\theta\right\}^2\Bigg]^{\frac{1}{2}}. \quad . \quad . \quad (18)\end{aligned}$$

$$H=\frac{1}{r^3}\left[(\phi vm^2r^2)^2+\left(\phi vmr-\frac{M}{2}m^2r^2\cos\theta\right)^2\right]^{\frac{1}{2}}, \quad . \quad . \quad . \quad (19)$$

where E is the amplitude of the electric force perpendicular to the radius vector and to the equatorial plane, and H is the amplitude of the magnetic force perpendicular to the radius vector and in the equatorial plane.

Hence, since m^2r^2 is always much greater than $1/mr$ it is clear that when θ is 180 deg. the values of E and H are both greater than when $\theta=0$ deg.

If we put $M=0$ in the above equations they reduce to the values given by Hertz for the electric and magnetic forces of the short, straight oscillator or doublet taken in the equatorial plane, the electric force being parallel to the axis and magnetic force at right angles. When mr is large compared with unity we have $k\mathrm{E}^2=\mu\mathrm{H}^2$, showing that the energies of the magnetic and electric components of the wave then become equal. Also there is a minimum value of H and E corresponding to a value of θ, such that

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* In the discussion on Mr. Marconi's Paper (*loc. cit.*), read at the Royal Society on March 22, 1906, Prof. J. Larmor, Sec. R.S., pointed out that the bent antenna employed by Mr. Marconi was equivalent in effect at distant points to the combination of a magnetic doublet or bi-pole magnetic oscillator of the kind investigated, in advance of Hertz's discovery of electric radiation, by Prof. G. F. Fitzgerald (see "The Scientific Writings of the late Professor G. F. Fitzgerald," edited by Prof. J. Larmor, p. 128), and a straight Hertzian doublet or bi-pole electric oscillator. It is obvious that if a straight electric oscillator is placed in contiguity to one side of a closed rectangular circuit or magnetic oscillator, the currents being of the same value and directed in an opposite sense in the open and adjacent side of the closed circuit, the resultant electro-magnetic effect must be that of a doubly bent oscillator of the type considered in the text. The equations (8), (9), (4), (5) and (11) are consistent with this mode of viewing the facts.

$$\cos\theta=\frac{2\phi v}{\mathrm{M}}\frac{1}{mr}, \quad \text{or} \quad \cos\theta=\frac{2\phi v}{\mathrm{M}}\frac{mr}{m^2r^2+3}. \quad (20)$$

The above expressions are numerically small when r is large compared with the wave-length of the radiation. Hence a minimum value of the forces at the extremity of the radius vector is found, corresponding to some azimuthal angle θ rather less than 90 deg. reckoned from the direction in which the free ends of the bent oscillator point.

A reference to the records of observations made by Mr. Marconi* on the radiation from a bent antenna shows that the above deductions from theory agree with his observed facts. Hence we conclude that whereas a straight vertical oscillator earthed at the lower end radiates equally in all horizontal directions or azimuths, the result of bending the antenna over to one side, so that a portion of it is horizontal, is to cause it to radiate less vigorously in the direction in which the free end points than in the opposite direction, and to create a minimum radiation in two other directions equally inclined to the direction of maximum radiation.

The degree of this fore-and-aft inequality in the plane of the oscillator will depend upon the ratio of the magnitude of the quantities $\frac{1}{2}\mathrm{M}mr$ and ϕv, or upon the ratio of δy to $2/m^2r$, that is upon the ratio of

$$\frac{\delta y}{\frac{1}{2}\delta z+\delta y} \quad \text{to} \quad \frac{4}{m^2rl}, \quad \textit{i.e.}, \text{ to} \quad \frac{\lambda^2}{\pi^2rl},$$

where $2l$ is the total length of the bent oscillator. The greatest inequality between the fore and aft radiation in the plane of the oscillator will exist when π^2 times the ratio of the sum of the lengths of the two horizontal parts of the oscillator to its total length is as nearly as possible equal to the product of the ratios of λ^2/l^2 and l/r. The ratio λ/l is fixed by the geometrical form of the oscillator, hence the inequality in radiative power in the fore and aft directions for a given oscillator essentially depends upon the ratio of wave-length to the distance of the point at which observations are made, and at large distances will only be sensible when long wave-lengths are employed. This result also agrees with the observations of Mr. Marconi, who says :—†

> "I have observed that, in order that the effects should be well marked, it is necessary that the length of the horizontal conductors should be great in proportion to their height above the ground, and that the wave-lengths employed should be considerable, a condition which makes it difficult to carry out such experiments within the walls of a laboratory.
>
> I have found the results to be well marked for wave-lengths of 150 metres and over, but have not been able to obtain as well-defined results when employing much shorter waves, the effects following some law which I have not yet had time to investigate."

The above theoretical examination of this operation of a bent oscillator shows clearly that its unsymmetrical radiation in the equatorial plane depends not upon absolute wave-length, but upon the ratio of wave-length to the distance of the receiving point and upon the proportion between the length of the vertical and of the horizontal portions of the oscillator.

The theory is thus supported by the observed facts. If necessary, it would be possible from the equations given above to delineate the lines of electric force in the field of the bent oscillator for various epochs. Thus, if R and Q are the components of the electric force in the plane yz, the differential equation to the lines of electric force in that plane is $\mathrm{R}dy-\mathrm{Q}dz=0$. The substitution of the values of R and Q and integration of this equation would furnish the equation to the lines of electric force in the yz plane from which they might be delineated, but its complexity does not make the task of actually delineating the lines of force for the bent oscillator an inviting one.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Tuesday afternoon (the 2nd inst.), His Grace the Duke of Northumberland, K.G., F.R.S., president, in the chair. The Hon. Arthur Stanley, M.V.O., M.P., Dr. T. B. Hyslop and Dr. J. G. McKendrick were elected members. The special thanks of the members were returned to the Rt. Hon. Lord Sanderson, G.C.B., K.C.M.G., for his donation of five guineas to the fund for the Promotion of Experimental Research at Low Temperatures.

EFFICIENCY OF STEAM PLANT.*

BY WALTER A. VIGNOLES.

(Chief Electrical Engineer, Grimsby.)

PRELIMINARY.

A year or two ago the author's attention was called to the amount of coal used in electricity works per unit generated, and to the statement made in certain quarters that, to do an equivalent amount of work, engineers on board ship used considerably less coal than electrical engineers in their central stations. This led to the investigation of the quantity of coal and water used in the electricity works at Grimsby, in order to test the accuracy of this statement. Last year the author wrote a Paper, which was published in *The Electrician*, in which the coal consumption in electricity works was compared with the published results of the steam trials of warships. In this Paper a table was given comparing the result of the trials of a battleship and of a cruiser with a test run at the Grimsby electricity works. For purposes of comparison, the marine engines were considered as driving dynamos, the over-all efficiency being taken at 85 per cent., and the coal per kilowatt-hour was worked out on that basis. The two ships taken were the best and worst in the steam trials made during 1904. The evaporation at Grimsby was, in all probability, as good as in the case of the cruiser, as the latter was no doubt using Welsh coal, while the coal used at Grimsby is fine slack, costing 5s. 6d. per ton delivered; but both the ships used considerably less steam per kilowatt-hour than the electricity works. The author has endeavoured to analyse in the following Paper the coal and steam consumption, with a view to showing where the losses are incurred and how they can best be avoided or reduced. In this connection the author thinks that one of the great disadvantages on board ship—want of space—is a blessing in disguise. Space is so valuable that the boilers are placed close to the engines, the length of steam pipes is reduced to a minimum and everything possible is done to avoid complications which would take up room; in this way a great many losses are avoided.

BOILER-HOUSE ECONOMY.

This subject has been discussed at several recent conventions, and the author cannot throw any new light upon it; but it may be convenient to summarise the points to be kept in view, as it is part of the more general subject that he is attempting to deal with. Sufficient air must be supplied to the fire to ensure all the carbon in the coal being properly burned, and to prevent any CO being left in the products of combustion. On the other hand, the amount of air supplied must not be too great, otherwise the temperature of the gases is reduced unnecessarily, and there is a considerable loss owing to heat being carried away by the excess of air It is usually considered that 12 to 15 per cent. of CO_2 is about the maximum to be anticipated in the flue gases, and in order to get this percentage it is necessary that the boiler, if of the water tube type, should be enclosed by a thoroughly air-tight casing to avoid air being drawn through the brickwork, and so diluting the gases. The author hopes that engineers who have CO_2 recorders in use will tell the convention how many tons of coal they have actually saved by their adoption. The best way to make the setting of the boiler air-tight is to entirely enclose it in a sheet-iron casing, as it appears to be difficult to avoid air leaks with brickwork settings.

The author has found the underfeed type of mechanical stoker very satisfactory. In working this type of stoker the fire should, in a water-tube boiler, be 18 in. to 24 in. thick, and it is then difficult for an excess of air to pass through the fire unless it burns into large holes; with the forced draught in use the damper of the boiler can be kept very nearly closed, the opening being just sufficient to carry away the gases. The pull of the chimney on the casing of the boiler is then very much reduced, and less air passes through any leaks that there may be. The principal advantage with this type of stoker is that no moving parts are required in or near the fire, with the result that, if properly designed, the stoker costs very little for repairs as compared with those patterns where moving bars are used. Five boilers at Grimsby are fitted with underfeed stokers of two different makes; these have been in use for from two to three years, and have cost £7·35 per boiler per annum for repairs. This works out at 2d. per ton of coal burnt by the stokers, and includes substituting steel worms for those originally fitted. Interest and repayment on the capital cost works out at 5·2d. per ton of coal burnt, but the boilers have not been fully loaded.

The quality of the coal is an important point in the economical generation of steam, but the engineer of a station has very little control over it. Coal is usually sold, not by its calorific value, but by its size, and it would be very interesting to hear if any engineer has been able to make a contract, as suggested in a recent Institution Paper, with the calorific value as a basis.

Tests made at the works show that the efficiency of the boilers is about the same in the daytime as during the heavy load, and this is what might be expected, as boilers are added as the load comes on, each working at a moderate load as in the daytime. A certain amount of coal is used for stand-by purposes, for banking fires, &c., and on the tests published in the Paper previously referred to the amount of this varied from 2 to 5 per cent. A table in this Paper* showed the stand-by coal during one actual week and two estimated weeks, with different load factors, and how variations in the latter affect the amount of coal required for this purpose. A table showing the results obtained by Mr. Ruthven-Murray on the plant at Willesden, as stated by him in a letter to *The Electrician*, June 30, 1905, is useful for comparison.

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* See Roy. Soc. *Proc.*, Vol. LXXVII., p. 415, 1906.

† *Loc. cit.* p. 420.

* Paper read at the Eleventh Convention of the Incorporated Municipal Electrical Association, London, on June 22.

PLANT ECONOMY.

The total steam used in the station can be divided into three parts:—

A. The amount of steam supplied by the boilers when the plant is ready to generate current, but without actually giving a supply. This includes:—

1. Leaks from blowdown pipes, scum cocks, separators on boilers, &c.
2. Leaky drains on steam pipes, condensation in the ranges, blown through separators, &c.
3. Steam required by condensing plant maintaining a vacuum in the exhaust pipe.
4. Steam required for feed pumps, and any other auxiliaries it is necessary to run if the station is working at light load.
5. Steam required for one engine at light load, or supplying the current required for auxiliaries as above.

B. The extra steam required for auxiliaries to deal with the load.

C. The extra steam required by the engines to deal with the load.

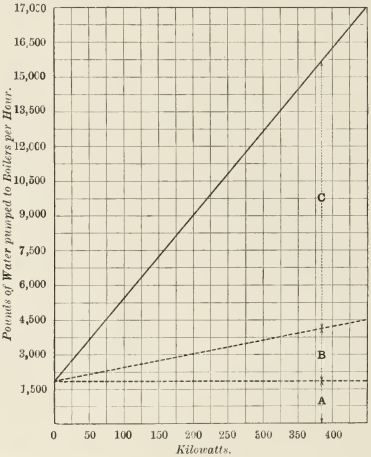

FIG. 1.—CURVE SHOWING STEAM CONSUMPTION PER KILOWATT AT THE GRIMSBY ELECTRICITY WORKS IN 1904–5.

The author made numerous tests a year or two ago of the amount of water pumped into the boilers per hour at various loads on the plant, some short tests of 2 hours' duration, others of 12 and 24 hours, and on plotting the water per hour against the average load it was found that the points lie fairly well on a straight line, this line starting at a point above zero indicating the minimum steam consumption. Fig. 1 shows this, and dotted lines have been added to show how the total can be divided as set out above. If the steam used at no load be deducted from the total, the steam per kilowatt-hour works out at 33·7 lb., and the total water to boilers per kilowatt-hour is 70 lb. at 50 kw., average load; about 52 lb. at 100 kw. and 37·5 lb. at 500 kw. This curve is very useful, and is accurate as long as the plant is maintained in the same condition; if the average load on the plant is known for any period, say a day or a week or a month, the curve shows what the average steam consumption per hour should be. If such a curve be made for a station when the plant is new, it forms a basis for comparison later on to show if the steam consumption is increasing from any cause.

During the past year, the steam consumption at these works has increased, and on making a series of tests at different loads it has been found that the points of the curve now lie above the first curve (see Fig. 2) pointing to some loss of steam at all loads. In order to find the cause of this increase, tests have been made with a view to analysing the steam consumption and measuring the losses.

The following table shows the results of two 24 hour tests, in which the various losses of steam are shown, as far as can be measured with the apparatus available. The steam used by the stokers is calculated from previous tests, the results of which indicated a steam consumption of 2½ per cent. of the total water supplied to the boilers. The steam actually condensed in the range and blown through the separators was measured in small condenser, as was the amount leaking from the blow-downs and gauge glasses. The amount of water returned by the air-pump discharge was also measured approximately by means of the tipping gear attached to the water purifying plant. There are, of course, several sources of error in these tests: the total water to the boilers being measured by a meter is not very reliable, and tests checking this give somewhat variable results, but the usual figure is 2 or 3 per cent. slow; but occasionally a test has shown the meter to be fast. It seems difficult at first sight to see how the meter can read fast, but on one occasion it was undoubtedly due to air being drawn into the suction pipe by the feed pump, the water for the test being taken through a temporary suction pipe. The tipping gear is not very accurate, and

Two 24 hour Tests on Plant at Grimsby Electricity Works.

Date of test	May 3, '06	May 5, '06
Duration of test	24 hours	24 hours
Plant running	20 ,,	20 ,,
Units—Total generated	3,057	3,328·2
Used by fan	70	71
,, ,, ,, total generated	2·29%	2 15%
Useful units generated	2,987	3,257·2
Coal—Total burnt (lb.)	29,120	29,624
,, ,, for stand-by ,,	426	448
Per unit generated ,,	9·54	8·9
Per useful unit generated ,,	9·75	9·1
Av. air pressure in main duct (in. water)	1·84	1·75
Av. air press. in ash pit while draught was in use ,,	0·72	0·78
Water—Total pumped to boilers (lb.)	192,300	174,400
,, Used by stokers ,,	4,810	4,360
,, Loss separator drains ,,	5,750	4,199
,, Loss blow-down & gauge glasses ,,	5,790	5,152
,, From condenser ,,	148,525	142,174
,, Balance unaccounted for ,,	27,425	18,515
,, Water per lb. of coal ,,	6·6	5·89
,, Water per unit generated ,,	62·9	52·4
Water from condenser per unit ,,	48 6	42·7
Per hour—Units: Total	152·8	166·4
Useful	149·3	162·9
Coal: Burnt per boiler (lb.)	832	871
,, ,, stoker ,,	416	436
Water: To boilers ,,	9,615	8,720
From condensers ,,	7,426	7,109
Used by stokers ,,	241	218
Loss, separator drains ,,	287	210
Loss, blow-down & gauge ,,	290	258
Balance unaccounted for ,,	1,371	925
Temperatures—Water: Into economiser (deg. F.)	88·2	74
Out of economiser ,,	232·5	243
Gases: Into economiser ,,	520	548
Out of economiser ,,	248·5	250

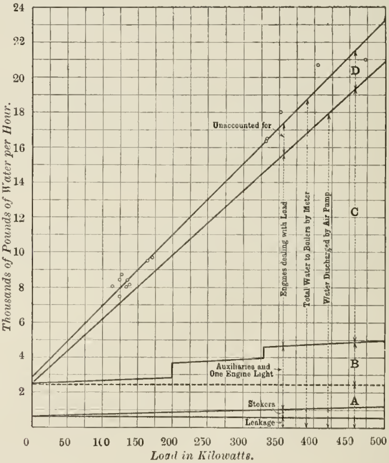

FIG. 2.—SHOWING ANALYSIS OF STEAM CONSUMPTION AT GRIMSBY ELECTRICITY WORKS, 1906.

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* *The Electrician*, Vol. LV., p. 41.

there may be an error of 5 per cent. in the amount of water measured through this.

The following table gives the average results of a number of tests of the water discharged from the condenser with the plant running light, ready to supply current, and also shows approximately how this total is made up :—

LOSSES AT LIGHT LOAD.

Average of a number of Tests.

	Lb. per hour.	
Leaks, blow-down gauge glasses, &c.	260	Included in water to boilers but not passing into condenser.
Condensed in range and blown through separators	340	
Engine driving pumps for condenser	800	Included in water from condenser.
One feed pump	650	
One engine running light	400	
Total	2,450	

The results of tests of the water discharged by the air pumps at various loads are shown by a line on Fig. 2, the starting point being the amount of water discharged by the condenser at light load as given in the table. The difference between this line and that showing the total water to the boilers is due to errors in measuring, to the make-up—*i.e.*, steam lost by leakage from the range, &c., and generally unaccounted for.

The steam consumption at the present time can therefore be analysed as follows :—

A. Stand-by losses, 2,450 lb. per hour, excluding 350 lb. per hour unaccounted for.

B. Extra steam required by auxiliaries to deal with the load, 5·1 lb. per kilowatt-hour.

C. Extra steam required by engines to deal with the load, 31·6 lb. per kilowatt-hour.

D. Unaccounted for, 350 lb. per hour plus 4·1 lb. per kilowatt-hour.

These figures show that the increase in the steam consumption is largely due to wasteful auxiliaries.

These curves may be compared with similar curves given by Mr. A. M. Taylor in his Paper read before the Birmingham Section of the I.E.E. on December 14, 1904, but which he worked out theoretically. Mr. Taylor proposed that his diagram should be built up by taking each item of plant and finding the steam required by, or the losses due to, that plant, and building the various items up to form a combined diagram. In the present Paper the process is reversed, the diagram having been made first and analysed afterwards.

A few remarks on the lessons to be learned from a consideration of the above tests may not be out of place. Firstly, the average load on the station is evidently very important, as the greater the load the smaller the stand-by losses are in proportion to the total. When the maximum load on the station approaches the capacity of the plant, the load factor is not very different to the average load divided by the capacity of the plant.

The load factor has very little effect on the water evaporated per pound of coal, but a small load factor increases the amount of coal required for banking fires during the day. The total steam consumption appears to follow the Willans law.

AUXILIARIES.

These tests bring out the enormous importance of the steam used for this purpose, and indicate the desirability of using electrically driven auxiliaries throughout. There does not appear to be much difference between the economy of steam and electrically-driven sets on the test plate. For example, a compound steam engine was installed at the Grimsby works a year or two ago, driving the air and circulating pumps; this took 808 lb. of steam per hour on test for the following duty: Pumping 68,000 gallons of water per hour against a head of 26 ft., and maintaining a vacuum of 26 in. of mercury while passing 7,000 lb. of water per hour through the condenser. A contract has recently been let for an electrically-driven plant of the same capacity, but to pump against a head of 35 ft, and the makers have guaranteed a maximum consumption of 27 units per hour under penalty. This, at 35 lb. of steam per kilowatt hour, would represent about 940 lb. per hour. If, however, there is no saving shown on the test plate, the author thinks a very large saving would be shown in practice owing to the reduction in the length of the steam pipes and the number of valves, drains, &c.

In the author's opinion, almost any electrically-driven feed pump would be more economical than a steam pump; but, at the same time, the mechanical question is very important, and a searching investigation should be made into this point before adopting one. No doubt there are satisfactory electrically-driven feed pumps on the market; personally, the author has had no experience with them, but this portion of the plant is one on which there should be no trouble in working, and great care should be exercised in its selection.

SIZE OF ENGINES.

The curves show the advantage of using large units, as the steam required for the engines dealing with the load (see C, Fig. 2) would be largely reduced, while the only advantage of using a small set would be to reduce the starting point of the curve slightly; as the steam used by the engine at light load is only a portion of the total, this is not very important—in fact, anything gained in this way would be lost by the waste in longer lengths of steam pipes, leaks at the extra valves, joints, &c., required by the larger number of sets.

As to the exact size of unit that should be adopted if a plant is to deal with only one class of load, the author would suggest three 500 kw. sets, one as spare, in the case of a load with an estimated maximum demand of, say, 1,000 kw. Each case must, however, be considered on its merits, and in very large stations the size of the unit is limited by the size it is practical to make. In cases where a traction load has to be supplied in addition to a lighting load, separate sets must be run to supply this, and sometimes, as at Grimsby, owing to peculiarities in the configuration of the town, the feeders have to be connected in the evening to two separate 'bus bars at different voltages, and this increases the number of sets required.

The author's ideal station would be one with everything arranged to run from one large engine, with a second as a stand-by, boilers close to the engine, very short length of steam pipes, small number of bends, drains, &c., and with all auxiliaries electrically driven. Capital cost of spare plant must be considered in this connection, and if three or four sets were installed this would no doubt be reduced, but in any case it would be desirable to adopt at once the largest unit that could eventually be economically used.

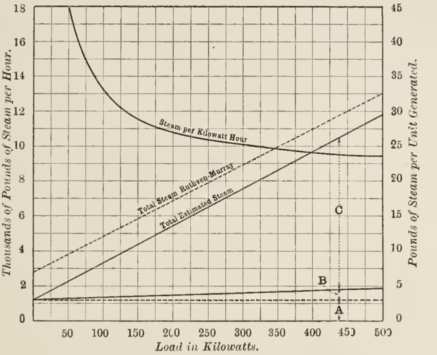

FIG. 3.—ESTIMATED STEAM CONSUMPTION IN A STATION RUNNING ONE 1,000 KW. SET. CONDENSING : NO SUPERHEAT, 160 LBS. STEAM PRESSURE.

Fig. 3 shows the estimated steam consumption in a station running one 1,000 kw. set, and equipped with electrically-driven auxiliaries, the curve being calculated for saturated steam, 160 lb. pressure. The losses at light load are as follows:—

Condensation in the range	100 lb. per hour.
Engine running light	700 ,, ,,
Extra steam for generating current required by condensing plant	300 ,, ,,
Ditto for feed pump	100 ,, ,,

The steam for stokers is taken as 2½ per cent. of the total, and the steam for the engines to deal with the load at 20 lb. per kilowatt-hour.

It will be noticed that this curve shows a very large reduction in steam consumption for any load, as compared with the other curves; a second curve on the same figure is the one given by Mr. Ruthven-Murray in his letter to *The Electrician*, June 30, 1905, as being the curve for the station under his control. In this case the double current generators used by Mr. Ruthven-Murray must be of great benefit in keeping the steam consumption down, as one large set can be used instead of two small ones.

CONCLUSION.

In discussing this Paper it must be remembered that all the tests were made on the plant under ordinary working conditions. The tests quoted are not given as being good examples of efficient working, as it is recognised that they show many points where economies should, and the author hopes will, be made, but the Paper is put forward as an attempt to show what goes on in a central station with a plant five years old. Great difficulties were experienced at times in getting one test to check with another, and at best the accuracy is not very great, but as much as possible has been done with the plant and staff available.

Probably to many the ground covered by this Paper is thoroughly familiar, but the author was encouraged to prepare it owing to the favourable reception given to his contribution to *The Electrician*, and to the fact that no Paper has yet been read at an M.E.A. Convention dealing with the efficiency of steam plant in the manner here attempted.

DISCUSSION.[*]

Mr. C. E. C. SHAWFIELD (Wolverhampton) said that it seemed curious that although it had been fully recognised in the engine room that in utilising steam it must be utilised in stages to get economical working, yet in generating that steam it was too often done in one vessel, which was used as a feed water heater and steam generator combined. There was one point which Mr. Wilkinson had not touched upon – viz., whether in those stations where superheaters were used, any further economy would be effected if, instead of bringing the steam for heating the feed water direct from the steam space of the boiler, one brought it in its superheated state from the steam range. Would it not be possible under these conditions to put the feed water into the boiler at a temperature at least equal to, if not slightly above, the actual temperature of ebullition. The only difficulty that he could see at the moment would be the possibility of steam being generated actually before the boiler was reached. Mr. Vignoles had inquired whether there were any instances of actual coal contracts being placed on the basis of calorific value. In Wolverhampton the coal contracts had been placed upon that basis, and that basis only, for the last four or five years. The samples submitted by the colliery were analysed and calorific tests taken. The colliery owners were required to supply fuel complying with the samples which they sent in before the contracts were let. The coal came in by boat from the colliery, and every boat load had 10 samples taken, and the mean of these samples was tested at once in the works for calorific value. If it did not come up to the standard, the boat was returned to the colliery at the expense of the colliery. In the last 12 months he had only to return two boats.

Mr. J. F. L. CROSLAND (Vulcan Boiler & General Insurance Co.) said that Mr. Wilkinson's remarks in one part of the Paper did not agree with the results of his own experiments. Mr. Wilkinson stated that "a Lancashire boiler 30 ft. long by 8 ft. 6 in. diameter with 1,100 sq. ft. of heating surface was deemed to be doing excellent duty when producing 7,000 lb. of steam per hour." Probably Mr. Wilkinson had calculated this at the rate of 25 lb. burned per foot of grate with a 7 lb. evaporation, but according to other figures in the Paper, with a Green economiser and a heated feed, he got practically 9,000 lb. In Lancashire practice they frequently got 9,000 lb. under these conditions when burning 30 lb. to 35 lb. of coal per foot of grate. Consequently Lancashire boilers were sold to do 10,000 lb., and there were hundreds evaporating 12,000 lb., and if Mr. Wilkinson would allow a higher rate of combustion per foot of grate, as was the case with the Lancashire boilers, he would get a greater output; although he himself would not recommend going much beyond what was being done at present without one of the conditions laid down by Mr. Wilkinson—namely, very perfect water. Water softening was a very important question, and it should be carried out wherever the water was bad. Therefore, he thought Mr. Wilkinson should correct his figures, in order that they should not go forth as representing the work of a Lancashire boiler. Anyone with experience of these boilers would confirm this statement. In the Paper there was a reference made to an apparatus by Mr. Hamilton, which was a system of trays placed in the steam space, the water being allowed to run on to the trays and trickle down. This was not by any means new. It had been patented and re-patented again and again, but it had the serious objection that all the work took place in the steam space, the very space where it was necessary to keep the temperature at the highest point. He thought there was a fallacy, also, in the statement that exhaust steam heaters and other feed-water heaters, such as Green economisers, always saved more fuel than could be accounted for by the heat units which they returned to the boiler in the feed water, and which Mr. Hamilton had given at 4 per cent. and upwards. Personally, he had never discovered this fact, and he thought he might venture to contradict it. There was one remark in the last conclusion with regard to the question of the use of heated air. This was a thing that had never been much done on land, which was singular, because it was so thoroughly used at sea – namely, forced draught combined with the heated air. If they wanted to increase their evaporative effect it was best to adopt a system of that kind. By doing so a very considerable increase in the duty of the boilers could be relied upon. He commended that to them, for he believed that there would be 15 to 20 per cent. more duty if they heated the air they admitted to the furnaces. In connection with the phenomenon observed in connection with the Green economiser, Mr. Wilkinson stated that "the flues and economisers became full of burning gas at a red heat, which, being generally distributed, gave a periodical increase in the efficiency of the plant." He fancied that in this case there must have been some obstruction in the flue, some place where the gases accumulated and did not go on rapidly. He should think that there had been slight explosions of the gas, which was not at all an uncommon thing. With regard to the live steam heating question, he certainly should be inclined to try such an apparatus, if he were in the position of a station engineer, in order to get absolutely steam temperature. This should be very nearly obtained if the apparatus was properly covered up and the pipes brought very close and every precaution taken to avoid loss of temperature.

Mr. J. K. BRYDGES (Eastbourne) said that Mr. Wilkinson seemed to get remarkably good results out of his boilers in the evaporation of water per square foot of heating surface. It was more than he himself had been able to get with Stirling water-tube boilers fired with Welsh coal, which had a very good calorific value. With reference to the perforated trays in the boiler, mentioned by Mr. Crosland, this system had been described in a Paper the year before last by Mr. Boot, who stated that he had used them at Tunbridge Wells, and that the fact of using them might be excused where the water was very bad, as was the case at Eastbourne. The Stirling Boiler Co. brought their feed water into trays in the back drum, which was in the steam space. The Eastbourne boilers had been altered, so that the steam was now taken from the back drum instead of from the front drum, and every time they were cleaned he always found a very considerable accumulation of deposit in the trays, which he would rather have there than in the tubes. Mr. Wilkinson stated that he did not know of any instrument which showed at sight both the draught of steam and the quantity of coal which ought to maintain it. Personally he did not see how any instrument could be made for that purpose, as it would have to depend entirely upon the quality of the particular coal which was being used at the particular works, and the scale would have to be calibrated for each particular case. Mr. Vignoles, in his Paper, had stated that in working one particular type of underfeed stoker the fire should, in a water tube boiler, be 18 in. to 24 in. thick, and at the same time be ran with the damper nearly closed. If this was so he thought the pressure must be very great; in fact, he should think that it would be necessary to have 2½ in. to 3 in. pressure of water to get any combustion at all. He presumed that this was the particular form of stoker that had no moving grate. Later on in the Paper Mr. Vignoles referred to another type of stoker which he said had steel worms in it. This must be the stoker with the moving bars, and he believed that all the trouble with this type of worm for feeding the coal forward had now been overcome. In reference to coal contracts, mentioned by Mr. Shawfield, he himself had recently issued his coal specifications, to be supplied on the basis of calorific value, and although the contractors had growled a bit, nevertheless he had found no difficulty in getting tenders.

Councillor SINCLAIR (Swansea) referred to an electrolytic action which he had noticed at different points where two different metals came into contact, distinct from purely chemical action, such as the pitting of boilers due to the impurities in the water. From some experiments he had made he had found an alloy which in contact with iron or steel in almost any surroundings was fatal to the iron, so much so that in common sea water the loss in the iron amounted to about 6 per cent. per annum. His experiments had covered a very large ground with regard to sea water, but, of course, that had nothing to do with steam, but he had made an experiment with this alloy in a steam range. It was true that it was not at high pressure, only 80 lb., and it had not been there long enough to warrant him saying that a danger existed, but if in time it was proved that what had happened in connection with the sea water happened in steam, he calculated that something like 4 per cent. of the iron would disappear in a twelvemonth. The alloy in question was 60 per cent. of copper, 39 per cent. of zinc, and 1 per cent. of aluminium. The experiments had led him to think that some other alloys might behave in a similar manner, and he had found another alloy containing 10 per cent. of aluminium associated with copper, from which the copper was rapidly disappearing.

Mr. C. E. STROMEYER said that the essence of the Paper was that observations made by Mr. Willans many years ago, and which had been corroborated more recently in the Berlin Technical Laboratory, showed that heat transmission was more rapid when the water was boiling than when it was being heated up to the boiling point. It was not so much a question of boiling as of circulation, for the same effects would be obtained if by any means whatsoever the hot water could be carried away rapidly from the plates. He doubted whether what the author proposed to do would really produce the very beneficial effects which he hoped for. He could not see that anything that had been tried would double the capacity of the present boiler, and it would certainly not fourfold it. Mr. Wilkinson relied to a certain extent on his trials, and this was the first point upon which he was afraid he would have to disagree with him. For instance, in the second test of Mr. Wilkinson's tabulated list, the efficiency of the plant was very low; 70 to 80 per cent. with the heater included. He had calculated, from the figures given in connection with these trials, that the chimney loss was 32·5 per cent., so that if these two figures were added together—and he thought they ought to be—it resulted in 103·3 per cent. for the total output of the boiler, which meant that there was a 3 per cent. negative radiation—namely, that the boiler was actually getting heat from the outside instead of losing it, which was quite impossible. In the fourth test of Mr. Wilkinson's list the boiler had not the special heating, and the efficiency was 61·1 per cent. with a chimney loss of only 11 per cent., which gave 72 per cent. as the accounted for heat production of that boiler, which left 28 per cent. for radiation. Thus in one case there was minus 3 per cent. and in the other case plus 28 per cent. and the difference was so enormous that there must be something wrong, and he would rather not trust to these trials seriously. Whenever experiments were being made and anybody had a belief in a particular theory the tendency always was to get the result aimed at. The people carrying out the tests knew that something special was being done, and they were far more watchful than usual in every respect, and generally a better result was arrived at, even without wishing it, than on other occasions. As the whole of the Incorporated Municipal Electrical Association consisted of comparatively young engineers who were very enterprising, he would suggest that this boiler question, which was always a serious one, ought to be considered seriously. He would like them to consider what actually took place in a boiler from the flame to the production of steam. The heat had to come through the hot gases to the plate and from the plate into the water. The best transmission from heat to water was about 12,000 British thermal units per one degree of difference of temperature and which was only obtained with very rapid circulation of the water on both sides of the plate. He had heard the suggestion before, that if we could increase the rapidity of the gases with which they blow over the heating surfaces (just as others had suggested increasing the rapidity of the water going on the other side), then they might be able to increase the boiler power very considerably without any detriment. He had reckoned out what the result would be supposing that the boiler was so constructed that the tubes were so close together that a very considerable pressure, say 10 lb. to the square inch, would be required to drive the combustion gases through the boilers. It would mean a loss of about 2 per cent. in the heat production, but he did not think this would be a serious matter if the boiler capacity could be increased, say nearly 10 times. There were many other points in the Paper upon which he would like to speak, but the time was so short that he would only mention one—namely, the question raised as to an instrument for comparing the fuel with the boiler output. At first sight it might seem an impossibility to do that, but he should say that it was not impossible to carry out that comparison almost directly if some instrument were introduced into the flues which indicated the volume of the gases going up the chimney. At present they only analysed the flue gases and compared them with the coal burnt in the furnaces, but if they measured the quantity of gases direct and added a continuous analysing apparatus it would be possible to tell exactly not only the heat going to the chimney at every instant but the amount of heat that had gone into the boiler from the amount of carbonic acid in the chimney. At any rate, without such an instrument he had got so far as to be able to determine from the gas analysis what the coal analysis was. This system had been adopted at the Nelson destructor works, where from the gas analysis they were able to tell the amount of moisture, carbon and hydrogen in the fuel.

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[*] The above Paper was discussed conjointly with Mr. Wilkinson's Paper on "Live Steam Heated Feed Water," reported on p. 416 of our last issue.

Mr. H. BOOT (Tunbridge Wells) said the speakers had scarcely touched upon the point as to whether our present boilers were constructed on the right principle. Mr. Wilkinson, in his Paper, had really raised the suggestion that the boiler should be used purely for steam and nothing else, and that the whole of the feed water, heating, &c., should be done outside the boiler. By that means he claimed to reduce the size of the boiler considerably. With reference to that question, he thought it would be a move in the right direction if it were a practice to keep the hot furnace gas at the hottest point until they come in contact with the steam, and gradually as the temperature of the gas went down to bring them into contact with the water, so that one could keep, so to speak, a superheater in the hottest part of the boiler. This made it possible to get a far greater efficiency than was obtained at present where a large amount of the coal was simply reduced to smoke through faulty combustion taking place, as it often did in water-tube boilers. Reference had been made by Mr. Wilkinson to the question of feed-water heating and the place where the feed-water heater should be put. He had made experiments for years on boilers, one of which he had had fitted with a special tray designed to avoid as far as possible all the Hamilton defects. He must say, from tests on two exactly similar boilers, one fitted with a system of feed-water heating in the drum of the boiler and the other without it, that he could not confirm Mr. Crosland's remarks that there was little to be gained by it. He had repeated the experiment two or three times during the last five years, and he found that there was undoubtedly a 4¾ per cent. saving; on one test it had gone up to 7 per cent. After all, provided the steam space was large enough, by heating the feed water in the steam space of the boiler, very little was lost because the water was carried round the steam space in such a way that any steam which might be condensed fell back into the boiler and was reheated, whereas with the other system a certain amount was being lost by radiation losses in the feed water heater. Again, this system saved very much in providing clean boilers. It was not an unusual thing where sulphates predominated in the water for them to be thrown down on the plates and do considerable damage to the furnaces, but with this system of trays it had been found that practically the whole of these sulphates were deposited in the trays, and with a proper arrangement for blowing down the trays every 24 hours it was possible to blow all the deposit away, because it remained in a soft state in the trays during the time the temperature was kept up.

Mr. J. BALKWILL (Messrs. Comber & Son, Stalybridge) confirmed Mr. Crosland's remark that Lancashire boilers frequently evaporated 9,000 lb. an hour. With regard to the paragraph in the Paper, which showed that Mr. Hamilton had got a larger percentage of saving than the theoretical, he had calculated that particular experiment with and without economisers, and had come to the conclusion that the formula was really wrong. As applied to economisers, he referred to an article in the *Practical Engineer* of October 15, 1897, in which an engineer of the Armour Packing Co. in America had made a dozen tests of 10 hours duration with and without economisers with 4,480 sq. ft. heating surface, and the fuel expenditure per 1,000 lb. of water evaporated without condensers was 193·4 lb. and with condensers it was 159·5 lb., a saving of 17·5 per cent., but by the formula it only worked out to 11·6 per cent. In reference to a point in Mr. Wilkinson's Paper concerning the high temperature gases entering the economiser, he had tested a good number of the boilers in the down-take at the back of the boiler and had got about 1,000 deg. to 1,100 deg. approximately. As Mr. Crosland had said, there must have been something in the way of explosions set up by the gases. Mr. Wilkinson also referred to a test on one 30 ft. by 8 ft. Lancashire boiler in conjunction with an economiser of 288 pipes. Of course, no engineer would put in such an economiser for one boiler. That boiler was capable of dealing with 22,000 lb. of water per hour and the ordinary practice would be to use about a 96-tube economiser, and this would have given a good practical test to which any electrical engineer could look, but the water left at 265 deg., due to the large economiser, and left less work for the live steam to do, and therefore, in this particular case, a very high efficiency was obtained.

Mr. W. H. BOOTH said there was very little in the Papers contrary to his own opinions. He would like to confirm as much as possible Mr. Wilkinson on the point of feed heating. He did not think he could do better in respect to this question than to say, generally, Don't heat the feed water in the water space. If they must heat the feed water inside the boiler, which in certain circumstances was good, then heat it in the steam space, because if they did it in the water space they completely destroyed the mobility of the water, and he believed that the efficiency of the boiler depended very largely on the mobility of the water. If the water was mobile good effects were obtained.

Mr. J. F. C. SNELL (Sunderland) said he was very glad that these Papers on boilers and boiler efficiencies had come before the Association, because while they were straining to get an extra ½ per cent. out of their engines apparently the boilers and their auxiliaries had been very much forgotten. One point which the authors had not spoken about was the question of air leakage. He had learned how not to set boilers some years ago when he used ordinary stock bricks for the setting, for he experienced considerable air leakage. By painting the bricks with a mixture of tar he was able to get a saving of 14 per cent. in fuel, and then in subsequent boiler settings by using glazed bricks very considerable further savings had been made. He now thought that they should go one stage further, and, no matter what the type of boiler, whether water tube or Lancashire, he thought that if they adopted cast-iron or steel-plate casing instead of brickwork—which was most prolific of air leakage—still further economies would be secured. It might interest Mr. Vignoles, who gave a table of losses in stations, to know that last year in working a bank of eight 30 ft. by 8 ft. 6 in. Lancashire boilers at 160 lb. pressure with superheat, he actually obtained a consumption of 31 lb. per kilowatt-hour in the station week in and week out, with all losses taken into consideration, and instead of the boilers evaporating only 7,000 lb., as mentioned for this size, they did 10,200 lb., with an induced draught at the base of the chimney of 1¾ in. He would like to ask Mr. Wilkinson where he proproposed to get 40 ft. by 11 ft. Lancashire boilers, how he would propose to set such a boiler, and how he would propose to tranship it. It seemed to him that it would have to be built in position, and really a boiler of this dimension and of that type was quite impracticable.

Mr. H. C. DAVIS (Halpin's Patent Thermal Storage, Ltd.) said he quite agreed with Mr. Wilkinson that the ideal method of working a boiler was to heat the feed water to the same temperature as the steam before it entered the boilers, so that the boiler would be evaporating only. The author had been misled as to the information he gave about the installation fitted to the boilers at the Wood-lane station of the Kensington and Notting Hill Electric Light Cos. These boilers were fitted with two thermal storage vessels which jointly contained a total charge of 46,000 lb. of feed water at boiler temperature, and with boiler steaming at a rate of 30,000 lb. per hour on the load, this would run them 1½ hours at this rate, which was quite sufficient for their peak load. These boilers had a heating surface of 3,654 sq. ft. and were rated at 12,000 lb. per hour, or 3·3 lb. per square foot of heating surface. To put a boiler up from 12,000 lb. to 30,000 lb. per hour was a fairly good performance. The author went on to say, assuming the temperature of the feed water contained in the vessel was at boiler temperature, as it contained 21,000 lb., this was equivalent to 6,800 lb. of steam her hour. This figure was rather misleading, for he had taken the total heat in the 21,000 lb. of feed water in the vessel, and then had deducted this amount from the total evaporation of the boiler per hour, which, he stated, left 23,200 lb. of steam per hour as the work of the boiler; but this was what would be if he evaporated from water at a temperature of zero degrees Fahr. If he took his temperature from the economiser at 200°F., which was a very reasonable one, he would find that he was getting an evaporation of 7·33 lb. per square foot of heating surface. The author had also taken 6·34 lb. of steam per pound of coal. As a matter of fact, the average evaporation was 9·2 lb., which gave 46 lb. of coal burnt per square foot of grate per hour, instead of the 56·7 lb. the author stated. They had obtained with these boilers, when working at the maximum rate on the top of a heavy load, as much as 36,000 lb. per hour, which gave, apart from the steam stored in the water, an evaporation of 8·5 lb. per square foot of heating surface, or, including the heat units contained in the water, 9·85 lb. per square foot of heating surface. On tests carried out on these boilers over a period of 24 hours they had obtained an efficiency of 72 per cent. throughout, and during the peak load it had reached as much as 86 per cent.

Mr. Davis has communicated to us also the results of some tests on boilers fitted with Halpin's thermal storage, and has also added some supplementary remarks on the Paper:—

——	Normal output. Lb.	Output with thermal storage.	Evap. per sq. ft. of heating surface.	Coal per sq. ft. of grate.	Efficiency.
Babcock boiler containing 3,240 sq. ft. of heating surface grate area	11,000	27,700	8·55	52	74% over 24 hrs.
Babcock boiler, 1,966 sq. ft. of heating surface	6,000	15,000	7·65	..	..
Davey - Paxman boiler, 2,200 sq. ft. of heating surface. Grate area 53·3 sq. ft.	13,000	25,400	11·7	..	77% over 12¾ hrs.
Niclausse boiler, 1,406 sq. ft. of heating surface. Grate area 40 sq. ft.	6,000	15,830	11·25	..	..

With reference to the test Mr. Wilkinson has made on the Harrogate boilers on high duty when the gases at the economisers are at 1,200 F., it would have been very interesting indeed if he had given us more figures, as the tests he has given are only on low and medium duty. I have recently carried out a test on a Lancashire boiler of the same size as those given by Mr. Wilkinson—namely, 30 ft. by 8 ft. 6 in.—fitted with thermal storage, and obtained an evaporation of 14,400 lb. per hour, which gives an actual evaporation of 13 lb. per square foot of heating surface, or, apart from the additional heat units stored in the thermal storage vessel, 11·3 lb. per square foot. The author states the disadvantage of Halpin's patent thermal storage is that it is only available for a short time, and when the supply in the thermal storage vessel is exhausted, the boilers drop down to their normal steaming power and the process of heating and storing must commence again. This is rather misleading. If the author will only consider a little, I think he will agree with me that when the charge in the thermal storage vessel is exhausted and you start your pumps again, pumping through the vessel we are heating our feed up in the same way, and the increased output is obtained, although the increase is not so high as there is a portion of the steam evaporated used for heating up the water. Mr. Halpin has just lately brought out a system for continuous working which gives very good results, and on a test recently made on a water-tube boiler with a heating surface of 1,400 sq. ft., we obtained a continuous evaporation of 12,300 lb. per hour, which gives an evaporation of 8·2 lb., or an increase over the rated evaporation of 100 per cent. There are one or two important advantages to be derived from thermal storage which the author has not dealt with. First, the amount of deposit that is precipitated in the thermal storage vessel in a soft state which can be easily got rid of by means of the blow-out cock. Mr. Wilkinson rather makes a strong point of this in his Paper when speaking of the live steam heater he has illustrated, but I fail to see how he can hope to get but a very small percentage of the impurities contained in the water thrown down in his heater, as we all know this operation necessarily takes time, and as he pumps his water through the heater at the rate at which it is being evaporated, there is no time for the whole of the deposits to be thrown down. Second, where Halpin's patent thermal storage is of very great advantage is when coming off the peak load. We all know the enormous amount of heat stored in the brickwork of a water-tube boiler, and that after a boiler has come off the load we start our pumps going to keep the steam from blowing off. The whole of this heat contained in the brickwork can be put into the water pumped into the thermal storage vessel which would, of course, be otherwise wasted. This has a very appreciable effect on the efficiency of the boiler during the light load. In conclusion, I would say that the quantity of the output of steam from a boiler has a very important effect upon the rate of transmission whether you are feeding with water at steam temperature or with your usual economiser feed temperature. I cannot agree with Mr. Wilkinson's contention that boiler-house plant designed for low duty cannot be fitted for high duty without considerable modification, including the cutting out of the tail end of the heating surface of a boiler, as with thermal storage fitted to boilers this is unnecessary and obtains the ends Mr. Wilkinson is striving for.

Mr. H. W. KOLLE (Messrs. Babcock & Wilcox) thought that Mr. Wilkinson had rather approached this subject from the wrong point of view. The contention was that it was impossible to get much more out of present day boilers because of the inefficiency of the heating surface. Speaking as a practical boiler manufacturer he could not help thinking that this was not quite right. The whole difficulty at the present time was that there was not sufficient grate area. With an ordinary hand-fired boiler, the length of the grate was limited to about 7 ft., because the man could not stoke more than that. It was only possible to burn a certain amount of coal per square foot, and consequently for any given width of boiler house the coal consumption was absolutely defined. They could not get evaporation without consumption of coal, and therefore the whole question resolved itself into getting sufficient grate area. This was got over to a certain extent by means of various mechanical stokers. There were stokers of the forced-draught type which were apparently limited to a useful depth of about 7 ft., and with stokers of that kind they could go up to evaporation of from 35 lb. to 45 lb. per square foot. With a type of chain-grate stoker it was possible to increase the evaporation, because they could employ a longer stoker—*i e.*, long from back to front. With a stoker of that kind they could have an active grate of 8 ft. 6 in., 6 ft. or even 12 ft. depth, so that for every foot run of the boiler house they were able to get a large grate area. He submitted that it was really a question of space that it was possible to get for stoking, and this must always determine the evaporative capacity of the plant. If they took the latest practice in respect to boiler-house equipment, such, for example, as the Paris Metropolitan, Carville and other places where they utilised short tubes for the reason that with that construction it was possible to occupy the whole space occupied by the boilers themselves as grate area, it would be found that the greatest evaporation per square foot was obtained.

Mr. A. G. COOPER (Colne) said he had had trouble with the feed pumps, and had experimented to see whether there was any increase in the coal consumption as compared with an injector. He found that the latter was every bit as economical as the feed pumps, which often got out of order owing to the gritty water. He would therefore recommend injectors in preference to feed pumps, although they cost more. The use of electrically-driven feed pumps increased the generating plant, buildings and everything in proportion all round, and, moreover, injectors cost practically nothing for upkeep.

Mr. F. A. NEWINGTON (Edinburgh) referred to Mr. Wilkinson's statement that there was a disadvantage in the thermal storage system in that the storage only lasted a certain time. Surely this was only a question of size of the storage tanks, and it seemed to him to be a great advantage to be able to store the hot water for the light-load hours of the day, whereas with the system of heating proposed by Mr. Wilkinson it would mean practically living from hand to mouth. The temperature of the water was only raised as it was to be used. With regard to the trials which Mr. Wilkinson had made, he could not find out whether any allowance had been made for the water or steam used for heating up the feed water. There was a possibility of this being counted in twice. Apparently in test No. 6,900 lb. of steam would be required per hour for heating the feed water to the temperature given. He could not see whether that was allowed for or not. In conclusion, he thanked Mr. Wilkinson for having put old facts in a new light.

Both authors reserved their replies for future publication.

POWER SUPPLY TO TRAMWAY SYSTEMS.[*]

BY S. J. WATSON.

(Chief Electrical Engineer, Bury.)

The number of street tramways constructed or reconstructed for electrical working during the last few years has necessitated a large increase in the capacity of existing generating stations, or the provision of separate stations to supply the power. In Papers read before this and kindred associations the pros and cons of separate versus combined stations have received attention. The principal argument advanced in favour of a separate station has been that provided the power required was above a certain amount, the cost of constructing a separate station would be as low and the costs of production much lower than with a lighting station, consequently no possible advantage could accrue to a tramway department by amalgamation with the lighting department for generating purposes.

With the rapid growth in the demands for light, power and tramways, and in the sizes of our generating stations and outputs, the costs of production have been considerably reduced, and an advocate for a separate station is rarely met with nowadays. It is still difficult to say what is the limit in the size of a station so far as low production costs are concerned; the issue appears to depend entirely on the size of the units installed.

The writer does not intend to bring within the scope of this Paper the question of supply to very large tramway undertakings; the following remarks are, therefore, intended to apply to small and medium-sized districts operating from 6 to 30 cars.

Capacity of Plant.—When the construction of a tramway system is decided on, one of the first points to be settled is that of the provision of sufficient generating plant to maintain the service of cars under the varying conditions that a tramway system is called upon to fulfil if it is to satisfactorily deal with the demands of the travelling public. The principal requirements consist of an early morning workman's service between 5 and 7 o'clock, a 10 to 20 minutes' service between 8 and noon, and a more frequent service from noon to 11 or 11.30 at night; also, and this is of considerable importance from a power supply point of view, a much-increased service for special local events. For a fairly hilly district the following curve may be used to obtain the approximate maximum loads required from a plant supplying one to 25 cars in service on a regular timetable

For a flat district the maximum would, of course, be considerably less than that shown, possibly by 25 or 30 per cent.

To take as an example a system with 24 cars in use. From the curve above the maximum load will be 465 kw., and where heavy special traffic has occasionally to be handled this should be increased by $33\frac{1}{3}$ per cent.—say 155 kw., making a total of 620 kw. A separate power station to meet such demands would require as a minimum 750 kw. of plant, divided into three sets each of 250 kw. normal capacity. Allowing for 20 per cent. overload for one hour, two sets would give a maximum of 600 kw., the other set standing by as spare. The cost of such a plant, including site and buildings, would be £19,750, equal to £32·9 per useful kilowatt installed. To put down a direct current plant capable of dealing with the same load in an existing station supplying alternating current, some reduction could be made in capital outlay. An extension of the buildings could be carried out for considerably less than the cost of an entirely new building. A full complement of boilers would not be necessary, as the new boilers would work in conjunction with those already installed. Altogether, a reduction in the cost of £3,500 should be made. The additional outlay to instal the plant in an existing alternating station would be £16,250, equal to £27 per useful kilowatt installed. A further saving in capital outlay will be possible if such a plant is put down in a direct-current station already supplying light and power at 440 to 480 volts, as one of the existing steam sets could be altered at little expense to serve as the stand-by for both lighting and tramways, in which case there would be a saving on generating plant of about £2,250. The additional outlay for the installation of tramway plant in an existing direct-current station supplying at 440 to 480 volts would be £14.000, equal to £23·3 per useful kilowatt installed.

Type of Plant—From the supply point of view, a small tramway system provides one of the most severe loads that has to be dealt, owing to the large and frequent fluctuations in the demand. With a system of the size mentioned, a variation from 50 kw. to 465 kw. in a few seconds is not uncommon. It is therefore necessary to run a plant largely in excess of the mean load requirements, which seriously affects the economical efficiency of the works.

It has been the usual practice to provide generators to compound up from 500 volts no-load to 550 volts full-load, to compensate for feeder resistance. Such design is approximately correct for lighting and power distribution, but for small tramway systems it has little practical advantage, as the maximum load on one feeder may and frequently does occur at the same time as the minimum load on another. A constant pressure of 525 volts at the generating station will give the least variation at the cars, taking the system as a whole.

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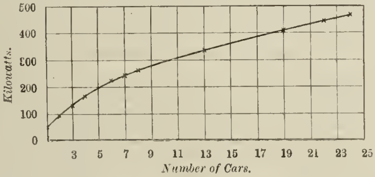
[*] Paper read at the Eleventh Convention of the Incorporated Municipal Electrical Association, London, June 22.

If there is one class of supply more than another where storage batteries can be used to advantage it is in connection with small tramway systems, but to enable the battery to be commercially successful in operation some regulating device is necessary to compensate for the difference in battery terminal pressure between the limits of full charge and full discharge. A considerable amount of attention has been given to the design of apparatus to obtain automatic battery regulation, and the cheapest and best method now in use is the reversible booster. With such a machine the full regulation mentioned above can easily be obtained, the line pressure can be kept nearly constant, and the generating plant run at practically constant load.

To supply a tramway of the size under consideration, a battery having a capacity of 250 kw. at the one-hour rate controlled by a reversible booster will be found an economical addition to the plant. It will then be possible to deal with the normal maximum loads of 465 kw. with the battery and one 250 kw. generating set running practically at constant two-thirds full load, instead of two 250 kw. sets each with a varying load averaging only one third full load.

In a Paper entitled "Economic Considerations in the Employment of Storage Batteries," read last session before the Manchester Section of the Institution of Electrical Engineers, Mr. J. R. Salter stated that there was no commercial advantage in using batteries in conjunction with steam plant when supplying power to a tramway undertaking using 28 cars, and in support of his contention put forward the steam consumption results obtained on steam plant when working with and without a battery. The conclusions arrived at by Mr. Salter did not appear such as could be generally applicable to other undertakings on account of the particular arrangement and cost of the plant tested. To obtain further information on the matter, the writer has carried out a number of tests on the plant under his charge, which is somewhat similar in size. The tests have been made to ascertain: (1) The cost per unit sold when running one 250 kw. set with a battery; (2) the cost per unit sold when running two 250 kw. sets without a battery; (3) the cost of running one 250 kw. set excited, but without load, including auxiliaries, such as condensers, pumps, &c. The object of the last test was to find the cost of running steam plant with little or no load in the early hours to supply workmen's cars and later at night for taking cars to the shed, which running is avoided if a battery is used.



The extra steam consumption when running two sets and auxiliaries without the battery compared with one set and auxiliaries with the battery was 4·75 lb. per unit sold. With an evaporation of 7½ lb. water per pound of slack and an output of 1,106,267 units this represents 234 tons of slack per annum, which, at a price of 7s. 3d. per ton, will be worth, say, £85. The steam consumption when running one set excited without load, together with auxiliaries, was 1,420 lb. per hour. With a battery installed, it should be possible to reduce the running hours of the plant at least 1½ hours a day, or 547½ hours per annum. The saving will then be 780,000 lb. steam per annum. Allowing for the same evaporation, this gives 46 tons of slack per annum, worth £17. The total gain in fuel is therefore 280 tons per annum of a value of £102. It may be noted in passing that the value would be double that amount if the price of coal was 14s. 6d. instead of 7s. 3d. If one set of plant is run instead of two there will be a further saving in oil and stores, repairs and wages of attendant, as the cost under these headings does not depend on output so much as on the actual running hours. These may be taken as follows:—Oil and stores £35 a year, repairs £40, and attendance £25; a total of £100 a year. The payments under a maintenance agreement for a period of years on a battery capable of giving 250 kw. at the one-hour rate would be about £150 per annum. The savings shown above in running one set of plant instead of two, total up to £202, so that there is a clear gain in favour of the battery of £52 per annum.

Charges for Supply.—The addition of a tramway load to a small existing lighting and power station undoubtedly has a beneficial effect on the costs of the producing department. This is not necessarily due to the tramway load in itself or to an increase in the load factor of the station, if such occurs, but is the result of the relatively large increase in the output when the tramway is started. The reduction in cost would probably be quite as much if the increased output was for light and power. Without wishing to depreciate the influence that high load factor has on the question of economical generation, the writer is inclined to think that sufficient importance is not attached to the effect of a large increase in the output. Published records only show the result of tacking on a tramway load to an existing light and power station; it would be interesting to see the result of adding a large power and lighting load to an existing tramway station. Although the combined load factor conditions would probably be worse, there is no doubt the cost sheet would show useful reductions.

From time to time the writer has had to go carefully into the charges for tramway supply. In order that the matter may be discussed the following particulars relating to an undertaking, together with the method employed of allocating the costs are given herewith.

The total capacity of the plant installed is 1,760 kw., and the generators are suitable for a direct-current working pressure of 440 to 525 volts. The capital expenditure to the end of March, 1906, was as follows:—

Site and buildings	£14,634
Generating plant and accessories......................	35,587
Mains, meters and public lamps, &c.	34,447
Total	£84,668

	Light and power.		Tramways.		Total.
Output	763,293	..	1,106,267	..	1,869,560
Maximum load..	468 kw.	..	676 kw.	..	1,144 kw.

The cost sheet for the year ended March last is as follows: Coal, £1,642; water and stores, £220; wages, £1,011; repairs, plant, &c., £555; repairs, mains and meters, £390; rates and taxes, £568; management, &c., £1,042; interest and sinking fund on the whole of the capital, £5,254; a total of £10,682. Several of these items will, however, require revision before allocating them as charges against either lighting or tramway supply. The capital expenditure on mains, &c., of £34,447 is exclusively for light and power. This represents a payment for interest and sinking fund of £2,138, which, deducted from £5,254, leaves £3,116. Repairs to mains, meters, &c., at a cost of £390 and £30, included in management expenses for collecting light and power accounts must also be eliminated from the cost sheet so far as the tramway department is concerned. Rates and taxes, management expenses, &c., depend principally on capital expenditure, so that a reduction from the sum of £1,580 must be made in the proportion that the capital outlay on mains bears to the total capital. This works out at £643, leaving £937 as the charge on account of the generating station and equipment. The total amount to be divided between lighting and tramways is therefore £7,481, made up of works costs, £3,428; rates and management, £937; interest and sinking fund, £3,116.

Dealing first with the costs for rates, management, interest and sinking fund, these charges are due to capital expenditure, and has lighting has demanded 468 kw., and tramways 676 kw., the allocation will be £2,395 to tramways and £1,658 to lighting, &c.

It is impossible to divide up the working costs without taking into consideration the load factor of the different classes of supply. The term "load factor" as usually used is the percentage obtained by dividing the actual output by the possible output, assuming the maximum load was used 24 hours a day. In the writer's opinion the figure obtained in this way is quite useless as a guide to the economical capabilities of a works. The maximum load invariably occurs during the month of December and is of short duration. It may be quite abnormal on more than one occasion without having any effect whatever on the total capital charges for the year or on the working expenses, yet the load factor taken from this maximum load is commonly used as being *the* important factor governing the costs for the whole year. An average of the weekly load factors would give one a good idea of the conditions under which a station is run if the plant is in regular use for 24 hours a day; but where batteries are installed and the steam plant entirely shut down for several hours, it would still be misleading.

To show the difference in the load factors when worked out by the two methods mentioned above, the values are set out below:—

—	Tramways.	Lighting.	Combined.
	%	%	%
Load factor	18·6	18·6	18·6
Average weekly load factor........	24·5	26·7	25·3
Maximum ,, ,, ...	29·6	32·8	29·8
Minimum ,, ,, ...	17·6	19·3	20·9
Average weekly plant load factor ..	32·0	36·5	32·1
Maximum weekly plant load factor.	38·6	46·1	39·1
Minimum weekly plant load factor.	24·8	32·0	27·0

Assuming that the contention put forward is correct, we have now to divide up the works costs of £3,428 on the basis of a 36·5 per cent. plant load factor for lighting and 32 per cent. for tramways.

The works costs divided by the total output gives an average cost of 0·44d. per unit. Plotted out on a load-factor curve it will be found that the difference in cost between a 32 and 36·5 per cent. load factor is about 4 per cent. The cost of the tramway units will therefore be rather less than 0·45d., say, a total of £2,060 and the lighting units slightly more than 0·43d., a total of £1,368. The total cost of the tramway supply is therefore £4,455, equal to 0·966d. per unit, made up of works costs £2,060 and rates, management and capital charges, £2,395. The charge made for the tramway supply has been £5,300, at an average price of 1·15d. per unit, metered at the switchboard. Deducting the cost from this amount there is a balance of £845 left for depreciation. In some towns the supply department has provided the tramway feeder cables and has consequently to include in the price a sum to cover the capital costs on such expenditure and also repairs. The capital for this work has in this case been found by the tramway department and the maintenance is also carried out at their expense. It may, however, be of interest to state that these charges would add 0·11d. per unit to the cost mentioned above, so that the inclusive cost of the energy delivered to the trolley wires has been 1·26d. per unit.

DISCUSSION.

Mr. E. E. HOADLEY (Maidstone) said the Paper rather resolved itself into the question of whether the supply to these small tramway undertakings, given chiefly from already existing lighting stations, could be best given by storage batteries and a reversible booster, or whether the plant should be run directly on the traction load. Some four years ago he had to go into this matter rather carefully, and came to the conclusion that in his own particular case it was more economical to run directly on the traction load, although there might be a good deal more plant running than was absolutely necessary for the mean average load. It meant a larger capital expenditure, with interest and sinking fund charges, against any saving that might be effected in the running costs. Further, he had considered what would happen if the reversible booster broke down for any length of time.

Mr. A. P. WOOD, of the Lancashire Dynamo and Motor Co., sent a communication, read by the secretary, in which he stated that Mr. Watson had evidently described a differential booster in his Paper, but, of course, the booster which he had working was one made by the Lancashire Dynamo & Motor Co. under the Turnbull and McLeod's patent. Mr. Watson also mentioned flywheel storage, and as he himself had brought out several patents in connection with this, it might not be out of place if he gave a short description of a flywheel storage scheme suitable for a tramway supply. For this purpose a shunt-wound continuous-current interpole machine was coupled to a heavy flywheel and acted alternately as dynamo and motor, according to the demand on the line. This flywheel machine was coupled up in series with an automatic reversible booster and simply took the place of the battery. In case there was a small demand on the line the booster would give a voltage in such a direction as to charge the flywheel set—that is to say, the voltage would gradually rise across the flywheel set until it attained, say, about 650 volts, and the speed would vary in proportion, thus storing energy in the flywheel. If there was a heavy demand on the line, the voltage of the booster would, of course, gradually reverse and discharge the flywheel set until the voltage across the latter was in the neighbourhood of, say, 400 volts. There were, however, only a few cases in which it would be advantageous to use a flywheel system. The battery had the great advantage of being available for moving the cars at night and the early workmen's cars in the morning without the aid of the generating plant. The flywheel system, however, could be advantageously used on railways where the number of cars running were small and the power required very large, and therefore large and sudden variations took place in the load. Also the flywheel system might be used to advantage in case it was required to drive, say, a rolling-mill motor off the tramway or lighting service. Rolling-mill motors, of course, stopped and started fairly regularly and required very large demands of power for short periods. It might interest the members to know that the cost of a flywheel set suitable for tramway service to develop 300 amperes for half a minute and 450 amperes momentarily complete with switchboard would be about £1,100. The flywheel would weigh 9½ tons and have a diameter of 8 ft. 6 in., the speed varying, according to the voltage, from 350 to 500 revs. per min. Messrs. Armstrong, Whitworth & Co. were supplying the flywheels made of armour plate, which they guaranteed to run at a peripheral speed of 28,000 ft. per minute and a factor of safety of three. It therefore might be an advantage to use a turbine type of flyweel set, as the weight of the flywheel could then be somewhat reduced owing to the large amount of energy stored up in the armature. Of course, flywheel sets were unnecessary, provided that the engines were fitted with flywheels in which a large amount of energy might be stored. Under these circumstances, the writer would recommend interpole generators and engines which governed to, say, 5 per cent. between no load and full load. Of course, unless the speed of the engine varied considerably on the overload it was impossible for the flywheel to do any large amount of work. This flywheel need not necessarily be of great weight, as cast-steel disc flywheels of large diameter could be used. He would therefore recommend all tramway engineers in specifying new plant for tramway purposes, where the total number of cars in use did not exceed 30 and where batteries are not used, to specify this construction of flywheel combined with interpole dynamos having an overload capacity of, say, 100 per cent. for one minute; by this means the number of cars which the generator would be capable of dealing with would be very largely increased.

Mr. V. A. H. McCOWEN (Belfast) had the matter under consideration in Belfast two years ago where he had a fairly large mileage—80 miles of track—and about 175 cars. A large addition was made to the plant at the lighting stations, and he was thus able to put in larger and more efficient units, and at the same time to have the benefit of the smaller units in the lighting station for helping in the varying load throughout the day. In that way he got fairly economical results and at the same time the lighting stations acted as a stand-by to the tramways. Possibly his position was unique in another way. Both the lighting and tramway departments were under one committee, so that he got rid of any little friction that sometimes arose where there were two separate committees. They did not, at Belfast, try to make a profit for the lighting department out of the tramways, but simply charged the cost of production. The tramways department paid all the capital charges on their expenditure, and the lighting department paid the capital charges on their expenditure. Then they charged for tramway supply the total cost of production, less the cost of maintaining the lighting mains, and, in addition, a separate account was kept of the cost of the upkeep of the tramway overhead equipment and mains. To March 31 the charge to the tramways worked out at 0·79d. per unit.

Mr. W. A. VIGNOLES (Grimsby) said the interesting point to him in the Paper was the question of the use of a battery for traction purposes. He, too, had gone into the question some time ago, and had decided that it was more economical to run the steam plant directly on to the system. If the district was at all hilly and regular peaks were obtained, then he had no doubt that it would be advantageous to use a battery, but where the peak was only twice, say, the average load, then it was more economical to run direct from the steam sets. He believed that in many towns where the number of cars was small, and where there were possibly only one or two hills, the peak might be three or four times the average load during one hour. If they only got a peak once in a week—on Saturday night—as some people did, then it was a different matter. With regard to Mr. Watson's remarks as to running one 250 kw. set with a battery, and two 250 kw. sets direct on to the tramway load, he did not think he was looking at the matter in quite a fair manner. He thought the only fair way would be to consider one 250 kw. set with a battery as against a 500 kw. set running direct. The latter would cost less to buy, the switchboard would be less and the cost of running would be considerably less. Mr. Watson had put down the cost of running two sets as: oil and stores, £35 per annum, repairs £40, attendance £25—*i.e.*, £100 per annum. By running one 500 kw. set practically all these items would disappear, because a 500 kw. set cost no more to run than a 250 kw. set. With regard to adding a power and lighting load to an existing tramway station, Mr. Watson thought the load factor would become worse, but that the cost would improve. He thoroughly agreed with this. At Grimsby he worked out the number of hours the plant was running each week, and then took the average load divided into that number of hours. When this matter was considered, it would be seen that this was a much better guide to the conditions of economical working than the load factor, because if the plant was shut down for a certain time per day there were very few losses going on.

Mr. A. H. SHAW (Ilford) thought that the curve given in the Paper was not altogether accurate in every case. At Ilford there were 22 cars running. It was a very flat district, and the maximum load was only 250 kw. This was hardly correct as shown by Mr. Watson's curve, which gave 58 cars for that load. At Ilford they started running with a lighting load, and had a battery for that purpose. Two years later the tramways were started, and a lighting set was run directly on the load all day. As the load increased, however, it was considered advisable to use a reversible booster. This enabled him to shut down a 100 kw. set for the tramway load, and to run with a 200 kw. set and a battery. He gained considerably by this, notwithstanding the loss on the battery. With regard to the charges for current, last year the price was 1¼d. per unit. The traction units at Ilford were in a very different proportion to that mentioned by the author, being about one-third the total units sold each year.

Mr. C. TURNBULL said that some of the remarks on boosters had rather pulled him up. The point about tramways was that they could not, as a rule, calculate out the load factor beforehand. A case might occur in which one engine was just too small to run the load. He felt quite sure that in many cases it would be found to be advantageous to put in a booster rather than to run the two engines on a load which was just too much for one. His next point was that most stations had a battery already on the lighting side. If this was so, why should they not use that battery on the traction side also? The battery could be used on the traction all day long, and it could be filled up at night and turned on to the lighting load in conjunction with a booster for regulating the pressure. A motor generator could be used as a link between the traction and lighting. Another point that arose in connection with the supply of traction from lighting stations was, that people usually specified dynamos that would give anything from 440 volts to 550 or 560 volts. If they did this, however, the volts were most horribly unstable for lighting at light loads. There were various ways of getting over this, however. At Tynemouth he had had this difficulty but had run his lighting machines compound. The results on the pressure were certainly good, but the complications were so exceedingly great that he would not do such a thing again if he could avoid it. Probably the best method of avoiding it would be to have separate excitation of the continuous current machines. In many cases this would be found a good thing, because if a little exciter were put on the end of a machine, a perfectly steady exciting current would be obtained, and the volts could be maintained steady for traction or for lighting. In fact, he thought they would get a very good pressure for traction without compounding if they wished to do so. Another point was that it was possible to regulate the exciters by means of some of the special regulators that were now obtainable, in order to absolutely ensure steady volts on the lighting side which was just about everything.

Mr. H. R. BURNETT (Barrow-in-Furness) thought it was desirable that engineers who had to run small tramway undertakings should agree on some method of working out the load factor. In his station he had 16 cars running, the maximum load was slightly over 300 kw. and the size of the plant required was about 150 kw. running in conjunction with a battery and reversible booster. Many people took the observed maximum load for working out the load factor. In his particular case this gave a load factor of 12 or 13 per cent. But taking the 150 kw., which he suggested was more correct, the load factor was over 20 per cent. This latter figure was adopted in connection with lighting, and he thought they should agree on the question of traction in a similar manner.

Mr. WATSON, in reply, said that the point raised by Mr. Vignoles was a very important one—viz., that the maximum load depended upon the nature of the district. In his own case the maximum load was about twice the mean load; in the case from which he obtained the figures for the curve in the Paper it was very nearly four times, and he had tried to make that clear when he stated in the Paper that for other districts the maximum would, of course, be considerably less than that shown, possibly 25 to 30 per cent. A point where Mr. Vignoles had differed from him was to whether one 250 kw. set and a battery should be used, or two 250 kw. sets. Mr. Vignoles had preferred a 500 kw. set to the latter. He agreed that the results would be different if this were done—they would be better—but Mr. Vignoles lost sight of the fact that two 500 kw. sets would be required, so that 1,000 kw. of plant would be necessary, and, of course, the capital expenditure would be more. In reply to Mr. Shaw's enquiry as to the loss on the battery, he had included 3½ per cent. for the booster, which included the battery. With regard to the saving in having a booster and battery it was very difficult to arrive at a fair figure, but if, for instance, only three engines were run instead of four, it was fair to deduct the full value of the man's wages. He, however, had split this over the number of engines and taken it in that manner. The point mentioned by Mr. Turnbull as to running lighting machines compounded, was rather an important one. He had done a little in that way himself and was quite sure that it could be done.

SYSTEMS OF ELECTRICAL SUPPLY APPROVED BY THE BOARD OF TRADE.

The following notice appeared in the *London Gazette* of the 3rd inst.:—

For the purposes of the Electric Lighting Acts, 1882 and 1888, and of the Electric Lighting (Scotland) Act, 1890, and of the Electric Lighting (Scotland) Act, 1902, and all provisional orders made and issued thereunder, and all special acts relating to the supply of electrical energy, the Board of Trade approve of the systems of supply described hereunder, subject to the Board of Trade regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy:—

1. A continuous-current direct supply at low pressure. The mains will be insulated. They will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground.

2. A continuous-current direct supply at low pressure between the adjacent conductors of a three-wire system, and a continuous-current direct supply at medium pressure between the outer conductors for special purposes; and a supply for traction at medium pressure. The mains will be insulated. They will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground.

3. A high-pressure alternating single-phase supply to transformers placed in some cases on consumers' premises or in street boxes, but mainly in sub-stations. From the transformers, where placed in street boxes or sub-stations, distributing mains will be laid for a single-phase alternating current supply at low pressure. The mains will be concentric. They will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground. The external conductors of the high-pressure mains will be connected with earth at the generating station. The external conductors of the low-pressure mains will be connected with earth at the sub-stations or transformers.

4. A high-pressure continuous-current supply to motor generators in sub-stations. From the sub-stations distributing mains will be laid for a continuous-current direct supply at low pressure between the adjacent conductors of a three-wire system, and a continuous-current supply between the outer conductors at medium pressure for special purposes, and a supply for traction at medium pressure. The high pressure mains will be concentric. The external conductor will be connected with earth at the generating station, and insulated at all other parts. The distributing mains will be insulated. The mains will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground.

5. A high-pressure alternating-current two-phase supply to transformers, placed in some cases on consumers' premises or in street boxes, but mainly in sub-stations. From the transformers, where placed in street boxes, or sub-stations, distributing mains will be laid for a single-phase alternating-current supply at low pressure between either phase and the neutral conductor, and for supply for special purposes at medium pressure between phases. The high pressure mains and the distributing mains will consist of two insulated conductors enclosed in an external conductor, or will consist of a pair of concentric cables. The mains will be laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground. The neutral conductors will be connected with earth at one point only. In the case of the high pressure mains they will be connected with earth at the generating station, and in the case of the distributing mains they will be connected with earth at the transformers or sub-stations.

6. A high-pressure alternating-current three-phase supply to motor generators, rotary converters or transformers placed in sub-stations, or to transformers placed in street boxes or in some cases on consumers' premises. From the sub-stations distributing mains will be laid for a continuous-current direct supply at low pressure between the adjacent conductors of a three-wire system; and a continuous-current direct supply at medium pressure between the outer conductors for special purposes; and a supply for traction. From the transformers an alternating-current single-phase supply at low pressure will be given (*a*) between phases, or (*b*) between a phase and a neutral conductor, and (*c*) a three-phase supply for power at medium pressure. The mains will be multiple core, armoured, and laid in troughing filled in solid with composition, or will be drawn into ducts or pipes, or will be armoured and laid in the ground. Where there is no neutral conductor, the neutral point of the high pressure mains will be connected with earth at the generating station, but insulated at all other parts. Where there are neutral conductors, they will be connected with earth at one point only. In the case of the high pressure mains they will be connected with earth at the generating station, and in the case of the distributing mains, they will be connected with earth at the sub-stations or transformers.

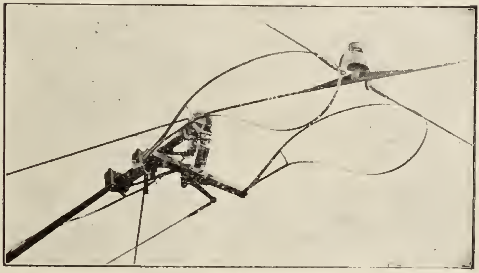
NOTE.—*Systems of supply other than those described above will require special approval by the Board of Trade.*

Signed by order of the Board of Trade, July 2, 1906.

T. H. W. PELHAM, Assistant Secretary, Board of Trade.

TESTING INSULATORS ON TROLLEY SYSTEMS.

To facilitate the testing of line insulators, which, according to the Board of Trade regulations, should be tested individually at least once a month, a convenient form of apparatus is being introduced by Messrs. Everett, Edgcumbe & Co. The principles involved in the test are that, if an ear insulator is faulty, a current will be indicated on connecting the span wire through a detector to earth, and if a strain insulator is faulty there will be an indication on putting the line pressure through a detector to the span wire. The necessary connections for such a test are made by an attachment devised jointly by the makers and Mr. A. H. Pott, of the Metropolitan Electric Tramways. This arrangement is shown in the accompanying illustration. A light aluminium frame is clamped to the end of the trolley boom and carries a wooden cross-arm pivoted at its centre, so arranged that it always remains at right angles to the trolley wire. At each end of this bar is a light steel spring of special shape, which makes momentary contact with each span wire as the car travels along the route. These contacts, which can be lowered immediately when necessary, are connected up to a detector consisting of a special moving-coil instrument provided with a scale reading from 0 to 600 volts, and with a direct-reading insulation scale up to 10 megohms. The usual speed at which a car is run during a test is 7 miles per hour, but the speed may be increased if desired, and thus a test of this kind becomes comparatively simple.



National Physical Laboratory.—After the ceremony on June 25th, when Mr. Haldane opened the electrical laboratory of the National Physical Laboratory, Sir John Brunner most generously placed the sum of £5,000 at the disposal of the committee towards the completion and equipment of the additional buildings for engineering, metrology and metallurgy, now in course of erection.

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ELECTRIC POWER SUPPLY IN LONDON.

In our last issue we were able to announce, briefly, that the Select Committee on the London County Council Electric Supply Bill had unanimously decided that the preamble of the Bill was not proven. The full report of the Committee, which we give on another page, presents many points of interest. First of all there are some expressions of opinion on the Bill itself. The Committee note that the Bill is solely permissive; that no obligation is imposed on the Council to give a supply to any of the Local Authorities or Companies; that, in fact, no obligation is imposed on the Council to carry into effect any of the powers sought by the Bill, and there is no prescribed time either for beginning or for carrying out the work. The Committee very rightly consider that the Council should be under such obligations, and that the adoption of such proposals, although altering the whole scope and intention of the Bill, would make the measure more practical and effective for all purposes. With regard to the clause whereby the Council were to have the power to make representation to the Board of Trade that the prices charged by any authorised distributor were excessive and ought to be reduced, the Committee doubt whether due consideration has been given to the fact that both Local Authorities and Companies have expended a great amount of capital, which has been raised under Parliamentary sanction, and they feel that any alteration of existing conditions ought to uphold in a fair and reasonable manner the interests of the authorised distributors. This opinion we fully endorse, for it is only fair that those undertakings which have borne the heat and burden of the day should receive adequate protection. New industries of a public character might be very adversely affected if it were felt that property could be practically confiscated by municipal enterprise as soon as days of prosperity had been reached.

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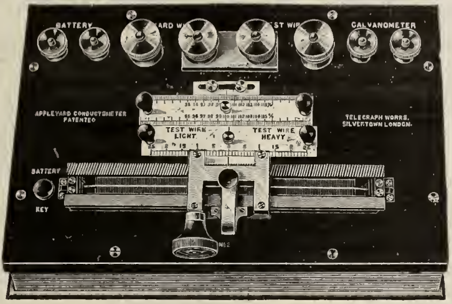
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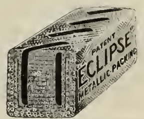

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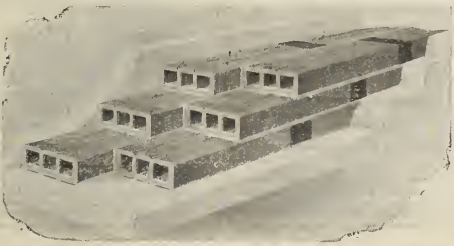

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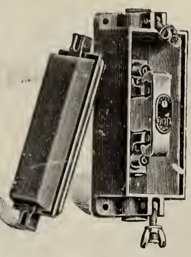

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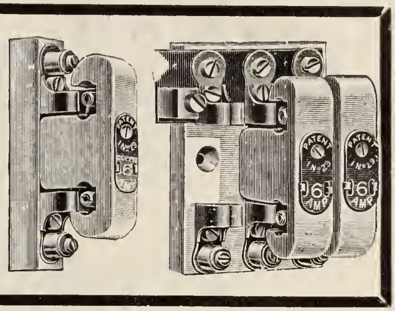

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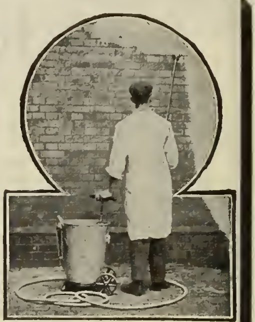

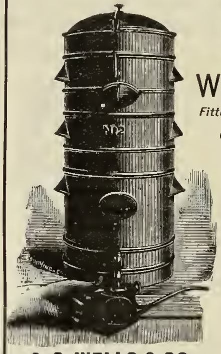

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July, 1906. Bulletin No. 10.

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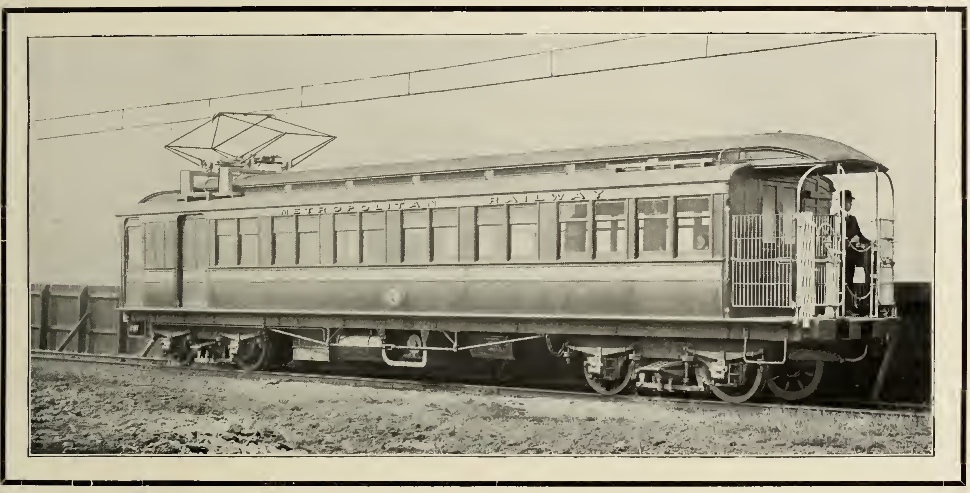
The Single-Phase Railway System



A single-phase Car on the British Westinghouse Exhibition Line, Trafford Park, Manchester.

THE direct-current railway system, excellent as it has proved itself to be in many respects, has limitations in voltage and speed control which are now beginning to be regarded as insurmountable.

It has long been understood that if a single-phase alternating current motor, which possessed certain of the characteristics of the direct-current series motor, could be perfected, it would be capable of many results impossible in direct-current traction.

With such a motor, limitations of voltage would be no longer necessary; any desired speed could be obtained economically; and a single overhead wire conductor, with track return—a most valuable feature—could be employed.

With this in view, experiments were made as early as 1893 by Westinghouse engineers. A car was equipped with two motors of this type and put into actual operation. Since then the system has been continually developed and refined in all its details; both motors and auxiliary apparatus have been perfected, and the Westinghouse system is now in use on several of the principal suburban and main line railways throughout the world.

The British Westinghouse Electric & Mfg. Co., Ltd.

Advantages of the Westinghouse Single-Phase System.

Absence of Voltage Limitations.

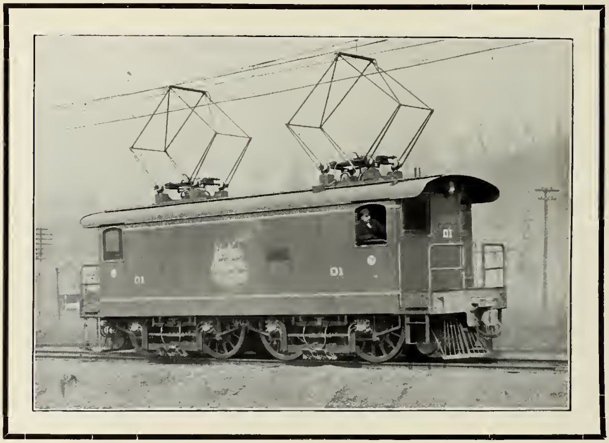
The high-voltage trolley construction developed by the Westinghouse Company is simple, strong, and thoroughly practical.

Twenty thousand volts can be safely used. High voltage distribution does away with expensive feeders, and enables the current to be carried to a greater distance from the power house or sub-station.

Elimination of Rotary Converters.

The sub-stations for a direct-current system require expensive rotary converters, and attendants to look after them.

With the single-phase system lowering transformers only are needed, and these operate satisfactorily without feeders and without attendance.



One of 35 Single-phase Locomotives supplied to the New York, New Haven, and Hartford Railroad.

The absence of rotating machinery renders the service less liable to interruption, and the losses in these machines are avoided. The transformer, also, has a far greater momentary overload capacity than a rotary converter.

Simplicity of Speed Variation.

The auto-transformer, which reduces the line voltage to that suitable for the motors, is provided with several taps on the low tension end which give the progressively increasing voltages required for accelerating the motors to full speed.

These transformer taps may be connected to the motors either through a hand controller of the drum type or through a group of unit switches on the Westinghouse multiple unit control system. In practice, two consecutive taps are always connected to the two ends of a preventive coil, except at the moment of changing to a higher or lower voltage, when one only is disconnected. The motors are fed from the centre of the preventive coil, whose function it is to prevent short circuits of the transformer taps whilst permitting the change from the lowest to the highest voltage tap (and vice versa) to be effected without breaking circuit. This method provides very smooth acceleration.

The absence of rheostats, moreover, makes every notch of the controller an efficient running position which may be held for any length of time, whereas the series-parallel control system, used on direct-current equipments, has only two running positions, "full series" and "full parallel."

Operation on Direct-Current.

Westinghouse single-phase motors will operate equally well both on alternating and direct current.

For operation on the latter, the motors are connected, two in series, for 500 volts; if there be four motors, the two pairs are connected first in series and then in parallel as in ordinary series-parallel control. The transformer is cut out, and the motors and control apparatus operate in the same way as ordinary direct-current equipments.

Adaptability to Multiple-Unit Control.

The multiple-unit system of control can be as readily applied to single-phase equipments as to direct-current ones.

Freedom from Electrolysis.

The absence of electrolytic action is an important characteristic of alternating-current. The use of the single-phase system therefore renders heavy expenditure on return conductors unnecessary.

The British Westinghouse Electric & Mfg. Co., Ltd.

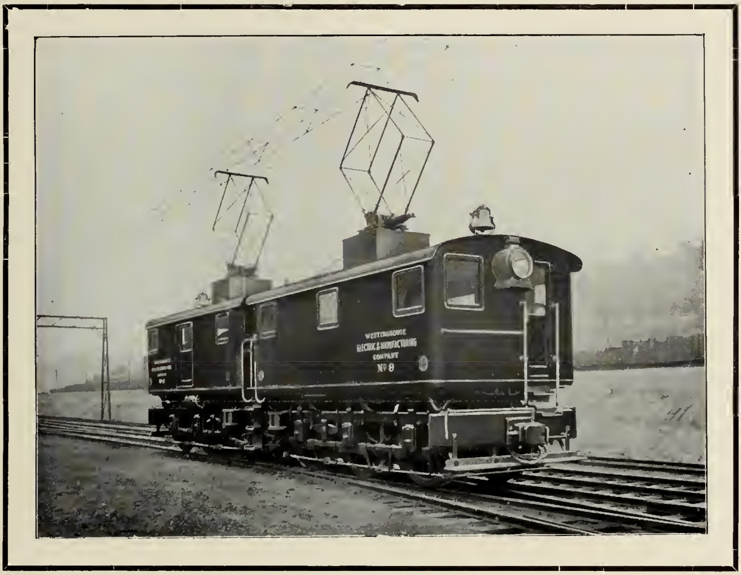
Advantages of the Westinghouse Single-Phase System.

First Cost.

The following figures show the approximate relative costs per mile of double track on direct and single-phase current systems.

	Single-phase. £	Direct-Current. £
Substation	320	2500
Contact Line	1350	1880
Transmission Line	370	440
Track bonding	80	80
	£2120	£4900

Difference per mile in favour of Single-Phase system, £2780.



135 Ton 1500 H.P. Single-Phase Locomotive.

Maintenance and Operating Costs.

In the case of one single-phase road now in operation it was estimated that with direct-current motors the complete line would have required at least ten rotary converter sub-stations. With the single-phase system only three transformer sub-stations were needed, resulting in considerable saving in attendance, maintenance, and repairs.

Westinghouse Experience

The British Westinghouse Company stands in a position of peculiar advantage among manufacturers of apparatus and equipment for single-phase railways, having at its service the combined American and European experience of the most successful single-phase engineers in the world.

In America, Westinghouse single-phase lines greatly preponderate in number and extent over those of all other European and American manufacturers together.

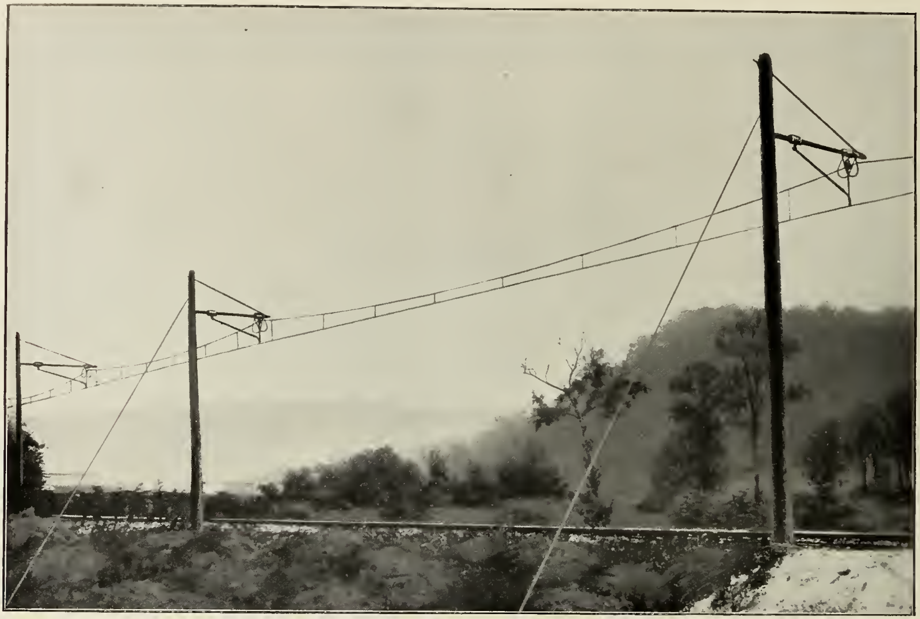
On the Continent of Europe, where single-phase railways are generally regarded as the traction system of the future, and where the particular attention of manufacturers and engineers is being directed to their construction and improvement, the Societe Anonyme Westinghouse of Paris and Le Havre, have been successful in securing several contracts for the equipment of single-phase lines. The recent Westinghouse-Finzi alliance, combining the Societe Anonyme Officine Elletro-Ferroviarie, of Milan, with Westinghouse interests is an additional witness to the progress of Westinghouse single-phase work on the Continent.

Westinghouse Installations.

It will be seen from the list of installations on the following page, that the Westinghouse single-phase system has already been adopted on thirteen railroads in various parts of the world, comprising about 300 miles of line, and requiring motors of an aggregate capacity of over 65,000 horse-power. Perhaps, the most noteworthy of these is the New York, New Haven, and Hartford Railway Co., which has ordered 35 single-phase locomotives capable of maintaining a speed of 60 to 70 miles an hour with a train weighing 250 tons.

Supplement to "The Electrician," July 6th, 1906.

The British Westinghouse Electric & Mfg. Co., Ltd.



Showing ordinary Overhead Construction of a Single-Phase Line, Single Track.

List of Westinghouse Single-Phase Railways in Operation or in course of Construction.

Line	Total Capacity H.P.	Miles	Line	Total Capacity H.P.	Miles
*Indianapolis and Cincinnati Traction Co.	6000	57	Villejo, Benicia and Napa Valley Traction Co.	130	
*Fort Wayne and Springfield Railway Co.	1200	18	*Long Island Railway - - - -	600	10
*Warren and Jamestown Street Railway	800	22	*Rome—Civita Castellana Railway - -	1200	32
*Atlanta Interurban Railway - -	1200	22	Bergamo—Valle Brembana Railway -	1500	19
Keeling and Ridge Railway Co. - -	800	5½	New York, New Haven and Hartford Railway - - - - -	35000	25
*British Westinghouse Co., Manchester Works	400		*Spokane and Inland Railway - -	8800	33
*Interworks Electric Railway, Pittsburg -	2200	5	Sarnia Tunnel - - - - -	4500	5
*Locomotive for Swedish State Railway-	300				

* Lines in actual operation are indicated by an asterisk.

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SHEFFIELD : Market Place Buildings.
SOUTH AFRICA : Johannesburg, Consolidated Buildings

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DUNEDIN : Noyes Bros. 1, Crawford Street.
MELBOURNE : Noyes Bros., 15 and 17 Queen Street.
SYDNEY : Noyes Bros., 109, Pitt Street.

For India, Upper and Lower Burmah, and Ceylon.

CALCUTTA : Jessop & Co., Ltd., 93, Clive Street.

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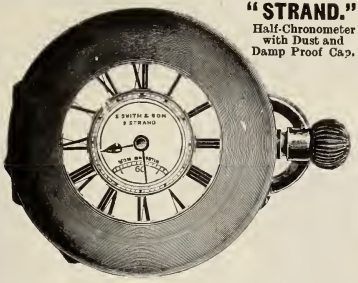

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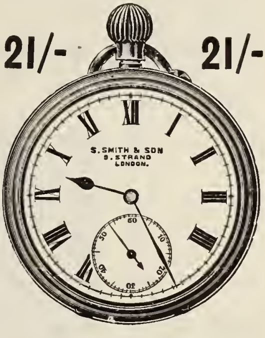

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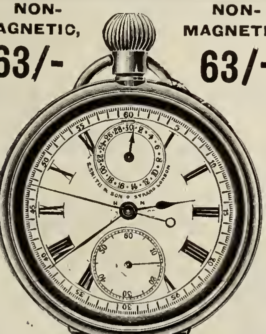
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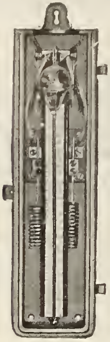

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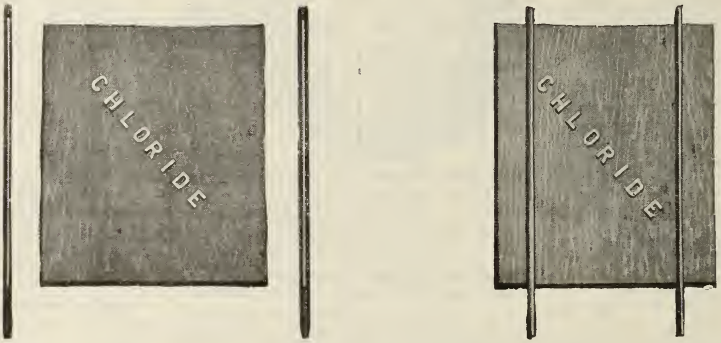

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GEIPEL & LANGE, Vulcan Works, St. Thomas St., LONDON, S.E.

With regard to the more technical details, the Committee are of opinion that further consideration should be given to many matters with a view to amend and improve the scheme, and that the suggestion of duplicated routes, as proposed in the scheme of the Administrative County of London and District Electric Power Co., is well worthy of attention.

Apart from the Bill itself, the terms of reference to the Committee included the very much larger question of the best means of providing for the supply of electrical energy in bulk in and around London. After alluding to the capital already expended in London on electricity supply undertakings, which expenditure is proceeding at the rate of £1,000,000 per annum, and also to the restricted area of each Local Authority, the Committee express the opinion that the best means of providing for the supply of electrical energy in bulk is by one large and inclusive scheme extending, not only over the entire County of London, but also to adjoining boroughs and districts. For the purpose of carrying out such a scheme some central authority is required, with ample statutory powers and corresponding duties; and, after full consideration, the Committee are of opinion that the London County Council should be the authority. It is also suggested that the Council might exercise its powers in more ways than one, as follows :—

(*a*) The County Council may undertake the whole work, providing every authorised distributor and every private consumer with electricity in bulk at a maximum scale of prices.

(*b*) The County Council may retain for itself one part of the undertaking while permitting a private enterprise to undertake another part.

(*c*) The County Council may lease for a substantial consideration the whole enterprise to a private enterprise, to resume possession of it when its initial stages are over.

The position, then, at present is that London has no complete schem eof power supply, though the whole question has been discussed in detail during two sessions. If it were not for an absurd rule of Parliamentary procedure, in all probability the Administrative County Company would have obtained its Bill a year ago. But the field being still open, the London County Council thought well to compete, and was so strongly supported by a socialistic Parliament that its competitors, and the originators of the whole scheme, were not given so much as a hearing. In fact the conflict degenerated into party politics, from which, however, the Select Committee has done something to rescue it. Next session will probably see another Bill brought forward by the Council, and supported by the Government to the exclusion of other measures.

The general question of a cheap power supply for London is, no doubt, important. The Committee fully realise this, and apparently have some misgivings that the question may be indefinitely hung up; they therefore urge that the Council should be prepared to make a decision as to their action early enough to allow other bills to be presented for next session. It is, however, quite possible to overestimate the importance of cheap power. As is well known, the cost of power is only one of the many factors in cost of production. The good that comes from cheap power may be more than counterbalanced by increased rates required to maintain a municipal undertaking. There is a large field over which local authorities can and should direct their efforts, and into which private capital cannot possibly enter. That being so, undertakings of a somewhat speculative nature are better left for private enterprise and in the hands of those accustomed to business methods until they become paying concerns. Reading between the lines of the report, this is probably the view held by the Committee, for at the end of clause 18 they refer to the scheme of the Administrative County Company as conceived on scientific lines and calculated to afford a cheap supply of electrical energy at private risk, though it was not clear to what extent the necessary paramount authority of the Council and the ultimate possession of the enterprise by the Council could be secured under this scheme. Nevertheless, the whole question is to be hung up for another year in order to gratify the ambition of the Council, and possibly for a good deal longer if a dog-in-the-manger policy is to be adopted. The Council will do well to consider whether some powers of general control in the future will not be preferable in every way to embarking on any risk which is condemned by their own Finance Committee, and which can be carried out on proper business lines by private capital without risk to the ratepayers.

VISIT OF KINDRED ELECTRICAL INSTITUTIONS TO GREAT BRITAIN.

The Circular Tour arranged by the Institution of Electrical Engineers, in conjunction with the visit to Great Britain of Kindred Electrical Institutions, commenced on Thursday last, the 28th ult., when a large and distinguished party left London by special train en route for Rugby, Birmingham, Manchester, Liverpool, Glasgow, Edinburgh, Newcastle and Leeds. An admirably-arranged programme included visits to the principal electricity works and manufacturing establishments in the districts mentioned, and provided for the visitors a selection of interesting electrical objects, which were also in every respect representative of current British electrical engineering practice.

Nearly 170 members, accompanied by 24 ladies, took part in the tour, including, among others, the guests in the following list :—

Société Internationale des Electriciens.—R. Alliot, P. Biles, M. Bouchet, E. Brylinski, E. de France, Mrs. E. de France, Rouet de Journel, Mrs. de Journel, R. Dongier, M. W. Herrero, A. Labour, Mrs. Labour, A. Legouez, P. J. J. Marsalès, M. C. E. Mestre, K. Sosnowski, Mrs. Sosnowski.

Associazione Elettrotecnica Italiana.—E. Barni, C. Barzano (Member of Council), M. Bonghi (Member of Council), G. Brunelli, U. Callegari, G. Carminati, A. Chizzolini, Mrs. Chizzolini, C. Clerici, E. Conti, Mrs. Conti, V. Crosa, C. Curti, D. Levi da Zara, E. de Benedetti, E. de Strens, Mrs. de Strens, E. Ferrua, N. P. Frassetto, G. Gadda, G. Giorgetti, T. Gonzales, G. Locatelli, C. Loria, Dr. S. Magrini, Mr. F. Minorini, C. Moretti, Prof. S. Pagliani (Member of Council), Miss Pagliani, L. Pizzi, L. Pontiggia (Member of Council), E. Rieti, L. Rizzoli, L. Salvadori, Mrs. Salvadori, G. Semenza (General Secretary), Mrs. Semenza, G. Stramezzi, Gian Carlo Stucky, A. Venzaghi, Miss Venzaghi.

Representatives of Firms.—Prof. T. Epstein (Felten & Guilleaume-Lahmeyer), S. Roos (A.E.G.),—Zschaeck (Felten & Guilleaume-Lahmeyer).

Elektrotechnischer Verein.—R. Boy, W. Fellenberg, Mrs. Fellenberg, F. Feyerabend, A. Heilborn, Mrs. Heilborn, M. Hermann, Miss B. Hermann, Miss E. Hermann, E. Jassey, E. Kempf, A. Kodermatz, G. Larson, Dr. Max Levy, Mrs. Levy, F. Lux, R. Moser, E. Naglo, J. Richter, Dr. E. Rosenberg, A. Rothert, H. Sauer, J. Schmidt, F. Schüler, Leo Schüler, Prof. Sengal, L. Spängler, Joseph Vater, E. Ziebl.

Verband Deutscher Elektrotechniker.—Dr. von Baeyer, Dr. R. Blochmann, L. Brandes, G. Dettmar (General Secretary), — Elliot, A. Eymess, R. Eymess, Mrs. Eymess, Prof. Feldmann, Mrs. Feldmann, F. Fuchs, Dr. Gehrcke, — Gentzsch, Dr. B. Glatzel, E. Goedecker, Mrs. Goedecker, Dr. Kath, — Khern, R. Kohler, E. László, A. Lynen, Dr. P. Meyer, H. Montanus, Prof. Niethammer, O. Queisser, Julius Raacke, Dr. Reichenheim, E. Rühmikorf, H. Scholz, O. Schöne, Mrs. Schöne, — Somborn, — Vogelsang, — Wachsmann, — Witzell, — Zimmermanns.

Schweizerischer Elektrotechnischer Verein.—C. Arquembourg, P. Dapples, Prof. J. L. Farny, W. J. Favre, L. Flesch, A. Girard, — Guillot, Dr. W. Hess, W. Koch, J. Martin, E. Respinger, A. Ritter, K. P. Täuber.

American Institute of Electrical Engineers.—H. M. Brooks, M. Brooks, R. O. Heinrich, J. W. Lieb, jun. (Past President), Mrs. Lieb, C. O. Mailloux, C. H. Mitchell, C. A. Perkins, R. W. Pope (Secretary), E. F. Schnuck, Clayton H. Sharp, J. H. Siegfried, Prof. Harrison W. Smith, F. H. Taylor, S. S. Wheeler (President), C. T. Wilkinson.

Thursday, June 28th.

The programme arranged for the Birmingham district lost much of its interest on account of incessant rain, which was first encountered at Rugby. At this latter place the manufacturing works of the British Thomson-Houston Co. and of Messrs. Willans & Robinson were visited, and a tour of the shops was made by two parties, which were conducted through the main buildings by special guides. The principal manufactures were closely examined and great interest was displayed in the steam turbine departments of both companies. The directors of each company personally received the visitors and a hearty welcome was extended, while every possible facility was afforded them of inspecting the apparatus under process of manufacture. In fact, the wet weather was the only unpleasant feature of the proceedings. A slight mishap occurred as the B.T.-H. group was leaving the works. A fly in which four Italian members were seated was upset by the driver turning the vehicle too sharply, but although the occupants were severely shaken, no one was hurt.

The Stratford-on-Avon party, which comprised about 40 guests, including most of the ladies, were also unfortunate as regards the weather, but in spite of this they expressed great pleasure and admiration in looking over the Shakespearean relics and visiting the spots so intimately associated with the birthplace of our great poet. Mr. R. Kaye Gray, who has done so much to ensure the success of the whole programme, was leader of the party, and contributed largely to the pleasure of the visit. Miss Gray, Mr. Matthew Gray and Mr. and Mrs. William Gray also kindly came down from London to accompany the party.

Those who proceeded direct to Birmingham in the morning found carriages waiting to convey them either to the works of Messrs. Belliss & Morcom, to the Summer-lane electricity works of the Birmingham Corporation, to the works of the Wolseley Tool & Motor Co., or to those of the Metropolitan Amalgamated Carriage & Wagon Co. In each case a most cordial reception was given. The inclement weather could not, of course, have been reckoned with, but no effort was spared to divert attention from its unpleasant influence. The Summer-lane electricity works, over which a numerous party was conducted by Mr. R. A. Chattock, the city electrical engineer, and his assistants, makes a fine extension to the Birmingham electricity department, and when completed will figure among the largest municipal stations in this country. The present equipment includes both continuous and alternating current plant placed on either side of an extensive engine room, there being one boiler room only for the supply of steam. The continuous-current section comprises four main generators, each of 1,500 kw. capacity, built by Messrs. Dick, Kerr & Co., and driven by medium-speed triple-expansion engines of 3,000 H.P., by Messrs. Belliss & Morcom. These engines have a very imposing appearance, and are built on substantial lines, their massive proportions, compared with turbine units, being much commented upon. The two Parsons steam turbine sets installed in the same line of machines, though only one-third the capacity of the larger units, seemed like toys beside them. The 1,500 kw. continuous-current generators (designed for 25 per cent. overload) excited great interest on account of their compact design and symmetrical proportions. They are compound-wound machines, and can be run with the series-winding cut out for the lighting load. The alternate-current plant at present installed consists of three 500 kw. Belliss & Morcom–Westinghouse units, which are now in service, and two 1,500 kw. sets by the same makers in process of erection. The station will be officially opened in September next, when we hope to present our readers with a fully-illustrated account of it. Its equipment is typical of one style of British practice, with high capacity, medium speed, reciprocating units, while the design of the buildings maintains the elaborate standard usually followed by municipal enterprise in this country.

At noon, on the arrival of the Rugby contingent, the members were entertained to luncheon at the Grand Hotel. After the toast of "The King" had been duly honoured, Sir Oliver Lodge extended to the visitors a hearty welcome, recalling the early days of electrical work and comparing them with present-day developments, which made the electric furnace commercially possible and enabled us to extract nitrogen from the air by electrical means. Prof. Gisbert Kapp indulged in some reminiscences of the Continental trip in a pleasing speech, and regretted that only one day could be given to the objects of interests in the City of Birmingham. President Wheeler and Signor Semenza replied on behalf of the visiting institutions, the latter speaking in English and striking a happy note in comparing the visit to seeing the original of a picture a copy only of which has been hitherto possessed. He said that they all knew the famous English electric scientists and engineers by repute and had seen copies of their portraits, but it was now their pleasure to meet them in person. Mr. Gavey and the Lord Mayor of Birmingham suitably acknowledged these compliments.

The rain continued throughout the afternoon, and hurried purchases of waterproofs and umbrellas were made by many of the visitors. Three parties were formed, and taken respectively to the works of the Birmingham Small Arms Co. at Sparkbrook, the General Electric Co. at Witton, and the new buildings of the University at Edgbaston. Each group represented about a third of the whole party, and in spite of the leaden sky and pouring rain the greatest good feeling prevailed. The percentage of Continental visitors to English and American was always high, but this did not prevent fraternising in any way. Broken English and spasmodic French, German and Italian formed the principal media of intercourse, serving their purpose admirably for the time being.

It is difficult to say which of the three visits above mentioned proved the most interesting. The Sparkbrook works were attractive on account of their famous rifles, and many of the Continental visitors imbued with the military spirit expressed their delight at what was shown them. There was an appreciative group at Witton, where the engineering and carbon works of the General Electric Co. are situated, the latter, which is the only one of its kind in this country, particularly presenting features which were obviously novel to many who followed the processes of carbon manufacture for the first time. The engineering shops were also not without interest, as was evident by the stream of questions constantly put to the guides.

The day's programme at Birmingham was brought to a close by a reception at the Council House by the Lord Mayor of Birmingham, after which a walk was taken through the picture galleries.

The Local Section of the Institution, presided over by Mr. J. C. Vaudrey, is to be complimented on its entertainment of the party considering the short stop made in Birmingham. The cordiality shown to English engineers when abroad was kept constantly in mind, and every opportunity was taken to reciprocate as fully as possible.

A special train conveyed the party to Manchester the same evening.

Friday, June 29th.

Friday was the day allotted to the Manchester Local Section for its welcome and entertainment of the visitors. At 10 o'clock in the Town Hall the Lord Mayor of Manchester and the Mayor of Salford, and members of the Local Reception and Electricity Committees, received the party and cordial feelings of welcome were expressed by the two officials first mentioned. To these Mr. Gavey replied on behalf of the Kindred Institutions.

In contrast to Birmingham there were no alternative items on the programme and the whole party kept well together. The large Stuart-street station of the Manchester Corporation was visited, a long line of special cars being in attendance in Albert square. Bright sunshine prevailed, and had a noticeable effect on the spirits of the party. Mr. S. L. Pearce, the city electrical engineer and chairman of the Local Section, had commissioned his assistant as guides, and on arrival at Stuart-street grouping of the visitors was resorted to for the inspection of the coal conveying and steam raising plant; but as soon as the engine room was reached a general *débâcle* took place, each individual member seeking and inspecting those features of the equipment which directly appealed to him. (The recent additions to this station were described lately in an article in *The Electrician*, Vol. LVI., p. 956). A large crowd assembled on the switchboard gallery, and was much interested in the running up and synchronising of a 3,750 kw. unit with a second machine of the same output which was running on load. The synchroscope is employed as the phase-indicating device, and a hand-operated oil switch is used for throwing the machines on to the bars. In series with this is the main motor-operated oil circuit breaker, having a time-limit relay controlling the tripping coil circuit. When synchronising the time factor is much reduced, so that the circuit is almost immediately broken in case of a bad switch-in. The view of the plant from the switch gallery formed an impressive sight, rendered all the more interesting by the obviously cosmopolitan groups of visitors dotted about the engine room. The large 6,000 H.P. triple expansion engines, built by the Wallsend Slipway & Engineering Co. called forth many appreciative remarks, and impressed the visitors with the solidity of construction common to the practice of British engine builders.

Return to the Town Hall was made by special cars, and luncheon was served amid a scene rendered brilliant by a bright display of flowers and bunting on tables and walls. The gathering was presided over by the Lord Mayor of Manchester, and after the loyal toasts had been honoured, the Lord Mayor expressed his great pleasure in welcoming the visitors and inviting the members of the Institution to drink heartily to their health and prosperity. He referred particularly to the thriving trade of Manchester and the great engineering works within its borders. President Wheeler, replying for the Kindred Institutions, attached great importance to the municipal works in Manchester on account of the somewhat heated discussion in America on the municipal ownership question. Mr. Gavey, Councillor Howarth and the Mayor of Salford were the other speakers.

The afternoon programme, like that of the morning, involved no division of the party, the British Westinghouse works at Trafford Park being the one point upon which the company concentrated. A complete tour of the many fine buildings, including the iron and steel foundries, was made. Interested groups were to be seen gathered round the principal apparatus under construction in the shops, the steam turbines especially receiving unusual attention. A 300 kw. machine for colliery work was running on the test plate, and was noticeable for its homo-polar exciter, connected directly to the generator shaft between the stator and the outer bearing. Its output was 6 kw. and the conductors carrying the exciting current were taken directly to the field windings from the two revolving copper discs constituting the armature of the machine. The advantage of the arrangement lies in the simplicity and economy of construction. Two 260 H.P. three-cylinder gas engines, direct connected to 175 kw. alternators, were running in parallel together, and with a large 750 kw. steam-driven unit supplying a portion of the light and power load of the works, and afforded an excellent opportunity to the visitors of witnessing the steadiness of the 'bus bar pressure. The engines themselves are of a new design and were operating on producer gas. A car equipped with single-phase commutator motors carried parties of the visitors over the special experimental track laid in the grounds, provided with an overhead single catenary suspension high voltage wire from which current at 3,000 volts was taken by a pantograph bow collector. The control is electro-pneumatic with unit switches coupled to tappings of an ordinary auto-transformer. This arrangement is now used in place of the original induction regulator.

Light refreshments were provided by the management, and each visitor was presented with literature relating to the works and their principal products. Cameras were carried by many of the party, but a courteous request, which was fully justified, forbade their use in the shops.

A steamer trip on the Manchester Ship Canal afforded a good opportunity for seeing, though at a distance, the fine docks and their equipment of electric cranes. The pleasure of the trip, however, was quite taken away by the malodorous state of the water, the effect being considerably heightened by the accident at Irlam the night before, which imprisoned a quantity of objectionable dock water.

A bright, busy day was brought to a close with a conversazione at the Manchester University, where the Vice-Chancellor, Dr. Alfred Hopkinson, K.C., received the members of the various Institutions. Many of the Local Section members were also present, and the evening passed pleasantly in the inspection of the Physical Laboratories in the Hopkinson Memorial Wing, where, among other interesting pieces of apparatus, are two Wilde single-phase alternators, representing an early successful type of dynamo-electric machine. A Duddell oscillograph in the alternate-current laboratory, and an electric furnace in the electro-chemical laboratory, were also among the attractions. The ladies were entertained during the day by a motor drive to Buxton, which was much appreciated in the beautiful weather prevailing.

Saturday, June 30th.

The gathering at Liverpool on Saturday was of a particularly happy character, and was favoured with brilliant weather. At the Lime street station the Lord Mayor and Lady Mayoress were in attendance with the members of the Local Reception committee, which included Sir Charles Petrie and the Vice-Chancellor of the University, and outside the station was a line of gaily decorated cars waiting to convey the party to different points of interest. The procession to Lister Drive station was led by a most elaborately bedecked car, tastefully covered with evergreens and bunting and carrying "fore and aft" busts of the King and Queen. The car body was also studded with hundreds of electric lamps. This car, which was appropriately dubbed "the band waggon" by the American contingent, contained a full brass band, which played international airs.

Mr. A. Bromley Holmes and Mr. A. Clough were prominent among hosts conducting the party round the large station at Lister Drive, and many interesting comparisons were made of the two distinct types of plant installed. The Willans-Siemens and Willans–B.T.-H. sets were much admired, though the steam turbines were generally looked upon as the more desirable type of unit to be employed. There are four turbo-alternators in use, all by the British Westinghouse Co., aggregating 7,200 kw., or only 1,200 kw. less than the twelve 700 kw. units in the older engine room.

A run from Dingle to Seaforth on the Liverpool Overhead Railway was much enjoyed, and the party was then taken back into Liverpool by the Lancashire & Yorkshire electric line. At the luncheon given in the Exchange Hotel by the Tramways and Electric Light and Power Committee of Liverpool Corporation, Sir Charles Petrie presided and welcomed the visitors in pleasing terms. Prof. T. Epstein, replying in German, aroused considerable enthusiasm in a stirring speech, emphasising the importance to Continental Institutions of not only inspecting the works of English electrical engineers, but also of mingling with and receiving the cordial welcome of Englishmen. Mr. P. J. J. Marsalès also supported these sentiments in a speech delivered in French.

A very successful visit to the Formby power house on the Lancashire & Yorkshire Liverpool–Southport electric line was made in the afternoon. The trip was arranged through the courtesy of Mr. J. A. F. Aspinall, the general manager, who very kindly allowed his engineers to personally accompany the party. The grouping of the members was much facilitated by the distribution of paper numbers which were pinned to the coats or hats. A special train to Liverpool brought back the party in time for the reception by the Lord Mayor and Lady Mayoress at the Town Hall.

Most of the ladies and many gentlemen availed themselves of the alternative trip to that including Lister Drive Station, and went by steamer down the Mersey to view the docks, going on board a Cunard liner lying off the pier.

Sunday, July 1st.

The one Sunday included in the tour was pleasantly spent in the Lake District. In the delightful weather which prevailed the lovely air and scenery were greatly appreciated, and came as a welcome rest after the hard work of the three previous days. A number of brakes and coaches met the train at Windermere, in which the party journeyed, to Keswick with a break at Grasmere for lunch. From Keswick the train was taken to Glasgow, which was not reached till a late hour.

Monday, July 2nd.

Glasgow weather, dull, rainy and cold, prevailed throughout the morning, and the drive to Pinkston and Port Dundas was somewhat marred. The equipment of these two large power houses was examined with great interest, the great engines of Pinkston especially coming in for comment. As the party had an opportunity of inspecting the 3,000 kw. Willans–Dick Kerr turbo units at Port Dundas, they were able to judge of the enormous difference in floor space and building accommodation needed as compared with plant driven by reciprocating engines. The luncheon at the City Chambers might almost be regarded as of historic significance. Lord Kelvin, who was chairman of the local reception committee, and Lady Kelvin honoured the assembly with their presence, and a distinguished gathering filled the hall. Lord Provost Bilsland was in the chair, and was supported on behalf of the Glasgow Corporation by Councillor Hugh Alexander and Bailie J. Willock, conveners of the Tramways and Electricity committees respectively. After honouring the loyal toasts Councillor Alexander proposed the "Institution of Electrical Engineers," and Mr. Gavey replied, briefly reviewing the many advances made in applied electrical science, and concluded by saying the Glasgow Corporation, by its entertainment of the Kindred Institutions, had converted the private hospitality of the institution into an act of international courtesy, which would not be lost on those present.

Bailie J. Willock, in the course of his speech proposing "The Kindred Institutions," welcomed those engineers who by their efforts had contributed towards the development of the steam turbine which made it possible to reduce the capital expenditure upon generating plant to so great an extent.

Signor Semenza, in replying for the Italian members present, referred to the strong feelings of friendship towards Great Britain held by his countrymen, and said that Italy was not only a land devoted to art and beauty, but had reached an advanced stage of industrial development.

Herr Naglo, speaking in reply on behalf of the German visitors, looked forward to the strengthening of that bond of friendship which already existed between Englishmen and Germans.

Lord Kelvin, who was down to propose the toast of "The Corporation of Glasgow," was received with great enthusiasm when he rose to speak. In a clear voice he delivered a most appropriate speech on the enormous strides made in electrical engineering since commercial inception of the art. More particularly he emphasised its influence on universal peace, which, though now regarded as a fanciful dream, would yet come to pass. The gathering of electrical engineers from many lands which he saw before him was an earnest of the ultimate fulfillment of this hope. In wireless telegraphy they had a development which would lead on to greater accomplishments than could now even be conjectured.

Lord Kingsburgh proposed "The Ladies" in a humorous speech, and remarked that they had practised wireless telegraphy since the beginning of things. The gathering was brought to a close in true Scottish fashion by the singing of "Auld Lang Syne."

The afternoon was devoted to the inspection of shipbuilding yards and engineering works, which were reached by special cars placed at the disposal of the visitors by the Tramways committee. The shipyard and engineering works of Messrs. Wm. Beardmore & Co. with its interesting gas-engine plant was visited, and also the Clydebank shipyard of Messrs. John Brown & Co., where the "Lusitania" was lying. Yoker Power station of the Clyde Valley Electric Power Co. (see *The Electrician*, Vol. LV., p. 368), Singer's Works, the North British Locomotive Works and the yard of the Fairfield Shipbuilding & Engineering Co. were also visited by other parties, while some of the ladies took a trip to Rouken Glen.

In the evening, Lord Kelvin, as Chancellor of the University and Chairman of the Local Section of the Institution, and Lady Kelvin, received the visitors at a conversazione at the University. Lord Kelvin was presented with two handsomely-bound volumes of reproductions of the works of Leonardo da Vinci, on behalf of the Associazioni Elettrotecnica Italiana, by Signor Guido Semenza. The latter asked his lordship to accept the volumes as a memento of their visit and a mark of their veneration for him. Prof. Pagliani also read an address from the University of Palermo.

In his reply, Lord Kelvin, who was deeply touched by this kindness, spoke of Italy as the mother country of electrical engineering, and generation after generation of British electrical engineers would look upon the bust of Volta, recently presented to the Institution with the greatest veneration. Their kind gifts he should value and treasure as long as he lived, and when he was gone they would be regarded as an historical memento of the alliance of Great Britain and Italy in the field of electrical progress and enterprise.

Tuesday, July 3rd.

The early part of Tuesday morning was occupied at the Renfrew Works of Messrs Babcock & Wilcox, which were generously thrown open by the management. A party of seven guides was in readiness at the gates, and the inspection of the works illustrated in a remarkable manner what specialised processes can do to cheapen the cost of production. Of particular interest was the work of forming and forging of the headers for the boiler tubes and the large amount of special machinery for carrying out several operations, such as milling, drilling and boring with one setting of the work. The main overhead travelling cranes are all electric and many of the lighter 3-ton types travel at very high speeds. A power house equipped with plant of a total capacity of 1,500 kw. furnishes the necessary energy for both power and lighting. A two-wire distribution is employed with the negative conductor earthed and the lead sheath of the cables is also bonded and earthed. In the boiler house supplying the steam a new pattern of worm-geared chain grate stoker was seen, which has several advantages over the discontinuous ratchet and pawl drive. This drive has been tried for several months past and will, we understand, be standardised for regular service. One of the advantages of this form of grate and drive lies in the low-class fuel which can be burned without causing excessive smoke. The group system of motor drive is employed in the works, but in one or two cases individual motors are used for special tools, such as portable grinders for special purposes.

The rest of the day was spent in cruising down the Clyde in the turbine steamer "Queen Alexandra," specially chartered for the visitors by Messrs. Babcock & Wilcox. The passage through the Kyles and round the Isle of Bute was greatly appreciated by the foreign visitors, many of whom were visiting Scotland for the first time. Mr. J. N. Rosenthal, managing director of the company, was the moving spirit in organizing the trip, and when three cheers were raised for him on board, he responded in English, French and German.

The stay in Glasgow concluded with a conversazione at the Art Gallery in the evening.

Wednesday, July 4th.

Edinburgh, which was the centre of attraction for Wednesday, came as a great contrast to Glasgow, and as but a few hours were allowed to become familiar with its beauties, the time was mostly given to sight seeing. Macdonald-road and Dewar-place stations were on the official list, but comparatively few took advantage of the opportunity to inspect the plant. The Castle, Holyrood Palace, Arthur's Seat and the Forth Bridge came in for a large share of attention.

The Corporation entertained the members to luncheon, at which function the Rt. Hon. the Lord Provost presided.

(To be concluded.)

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

(Continued from page 342.)

BLASTING IN SHAFTS AND TUNNELS.

Ignition by electric current ought to be the only permissible means of firing blasting charges in shaft sinking and tunnelling operations. Given a code of rules, as a protection against thoughtlessness and ignorance, it should, by the use of electrical methods and assuming that adequate provision is made for the enforced observance of the rules, be almost impossible for any accident to occur. In operations of the nature under consideration it is often necessary to fire a number of shots simultaneously, a dynamo exploder being the most suitable type of machine for this purpose.

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

Electrical connection between the bottom of a shaft and the surface may be made by suspending bare wires on insulators from the shaft mouthing to a point a few yards above the sump or shaft bottom. The lower end of the cable being specially liable to injury by flying debris, a separate length of twin flexible cable is used to make connection beween the shaft wires and the charges to be fired. This method necessitates joint making as the sinking of the shaft progresses. It is, therefore, often considered preferable to carry a length of twin insulated wire upon a drum situated at the surface of the mine. The cable, of which there should be sufficient to allow of damaged ends being frequently cut off, is lowered down the shaft whenever shots are required to be fired, and wound up after having served its purpose.

A useful type of drum is made for this purpose by Messrs. John Davis & Son. It consists of a wooden cylinder, having galvanised iron or zinc flanges, the whole being carried between two cast-iron uprights rigidly connected by tie bars. On one flange there are two brass terminals insulated therefrom by ebonite bushes. The inside ends of the firing line are securely attached to the terminal nuts inside the flange and the cable is then reeled on to the drum. In operation, the cable is lowered down the shaft by means of the cranked handle, a weight being hung on the end to facilitate its descent. The shots are connected together in series, the free ends joined to the firing line and the men withdrawn from the shaft. A flexible cable is then joined from the exploder terminals to those on the drum flange and the charges are fired. This loose surface connection provides an additional safeguard against accidents.

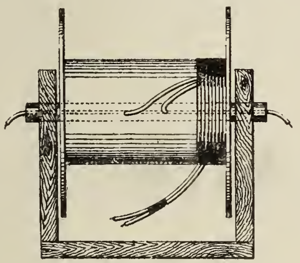


Fig. 20.—Cable Drum.

In localities where a reel of the kind described cannot be obtained a "makeshift" drum can be constructed on the lines indicated in Fig. 20.

In rock blasting, particularly in the excavations of galleries or tunnels, it is desirable to dislodge several portions of the rock in succession, first breaking that found at the face, and following this dislodgment with the successive breaking of layers progressively further distant from the surface, and to accomplish this at a single firing operation.

With tape-fuse it is easy to arrange each length, so that the shots will follow in proper rotation, but so many accidents have occurred in sinking shafts, where tape-fuse was employed, owing to some hitch in winding up the kibble after the fuses had been ignited, that attention has been strongly drawn to electrical methods of obtaining the required retardation. An American inventor of blasting apparatus, has devised a special exploder for firing shots successively, separate circuits being employed for each series, with contacts so arranged in the machine that a limited, though appreciable, space of time will elapse between the ignition of each set of shot holes.

BLASTING IN COAL MINES.

It is, then, primarily for collieries that manufacturers of explosives, electric shot-firing apparatus and fuses are constantly seeking to improve upon existing material and appliances, in order to lessen the inevitable risks and render more convenient the practice of blasting. The firing of a shot underground is so simple that, given even such a modicum of commonsense as can be expected to remain after having been to school, one might almost be excused for imagining that it was safe to the last degree. Nevertheless, accidents continue to occur and point to the necessity for technical knowledge and an intelligent application of it on the part of workmen engaged in these dangerous occupations.

The series of operations necessary for the dislodgment of a piece of coal or rock comprise: (1) Drilling the hole; (2) Stemming the explosive; (3) Connecting the electrical circuit; and (4) Firing the charge.

The hole is drilled to the required depth, 3 ft., 4 ft, or it may be 6 ft., and in general it should be only just sufficient diameter to pass the blasting cartridges without the application of force. The maximum rending effect is thus obtained. Gunpowder, being the most perfect known explosive for bringing down masses of coal with the least waste, may be used in bobbins as large as will enter the drill hole. Detonating explosives, on the other hand, since they act instantaneously and by their crushing action produce great waste of coal, will often prove more serviceable if placed in a large hole. A $\frac{3}{4}$ in. diameter cartridge resting loosely at the end of a $1\frac{1}{2}$ in. hole (with a tight stemming, of course, behind it) will on being fired lose a portion of its initial energy by expansion, and will be found to do less injury to the coal than if the entire borehole is solidly filled.

When the hole has been cleaned out and is ready to receive the explosive charge the latter is prepared in the following way: The wrapper in which the cartridge is contained is opened at one end, a hole about 1 in. deep and $\frac{1}{4}$ in. diameter is made in the mixture by means of a pencil or a prepared piece of stick, and into this opening an electric fuse or detonator is inserted. The wires are then turned back over the cartridge and secured to it by a "half-hitch" loop. The object of this manœuvre is to prevent the detonator from being accidentally withdrawn during the operation of stemming.

Another plan is to insert the detonator diagonally into the side of a cartridge and secure it there by means of a piece of string.

Stemming or *tamping* consists in filling up a shot hole above the charge of explosives, in order to oppose a resistance to the gaseous products of explosion in the direction of the borehole. Failure to carry this out properly results in the ejection of the stemming. The case must then be reported as a "blown-out shot."

It will be noticed in the section on Official Regulations that certain materials are conditionally prohibited for stemming. Certain specified tools, moreover, are required, particulars of which will be found in the same section.

After stemming a charge, the electric fuse wires are connected with the twin cable used as a firing line, an exploder is joined up to the other end and the charge is fired. When connecting it is desirable that one of the fuse wires should be made 2 in. or 3 in. shorter than the other one. It will then be impossible to "shunt" the fuse and so cause a miss-fire through an accidental pull at the shot-firing cable. All joints in wires should, of course, be clean and freed from tallow grease, and should be twisted tightly together instead of being looped, after the fashion of mechanical bell-pulls. Many other details of interest to practical shot firers will be found on studying succeeding sections on Official Regulations, Miss-fire Shots and Blasting Accidents.

(*To be continued.*)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Science Abstracts." June. Section A, Physics; section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Proceedings of the Royal Society." Series B. Vol. LXXVII., No. B521. Biological Sciences. (London: Harrison & Sons.) 3s.

"Transactions of the Junior Institution of Engineers." Edited by W. T. Dunn. Vol. XV., 1904-1905. Including the report of the "Coming of Age" Celebrations. (London: Percival Marshall & Co.) 10s. 6d.

"Lexikon der Elektrizität Elektrotechnik." Edited by Fritz Hoppe. Nos. 11 to 15, Kontaktdraht to Raasch. (Leipzig: A. Hartlebens Verlag.) 50pf. each.

IMPURITIES IN ACCUMULATOR ACID.

A long article appears in the *Centralblatt für Accumulatoren* for May 5th by Dr. Scmidt-Altwegg, upon the impurities in accumulator acid. He says the impurities may be present in the acid itself, or the acid to start with may be pure but impurities may get into it from the accumulator plates themselves. The acid employed should contain no chlorine, or at least so small a quantity that it can hardly be detected by analytical methods. Metallic salts must not exceed 0·01 per cent. of the actual sulphuric acid present; the same quantity of nitrogen may be allowed but no more, and only the least trace of organic matter.

He speaks strongly against the somewhat common custom of adding ordinary water instead of distilled water to make up the losses from evaporation and spraying. Tap water almost invariably contains considerable quantities of chlorides and if this is always used for refilling, of course the amount of chlorine will be continually increasing.

Outside impurities may arise from impure lead being used for making the grids or impure oxide for preparing the paste. In Planté-formed plates impurities such as perchlorates, hydrofluoric acid, nitric acid, &c., may get in from imperfect washing of the plates, as these substances are employed as electrolytes in forming the plates. The storage rooms for the finished plates should be airy and free from dust, and should not be near any place where ammonia fumes or other harmful gases are given off. This, of course, also applies to the position in which the charged accumulators are placed. It is, for example, no easy matter to keep cells in good condition which are used in a laboratory where the atmosphere almost always contains gases such as ammonia, chlorine, or sulphuretted hydrogen. Our own experience is that cells kept in a laboratory require the electrolyte to be changed about every nine months if the batteries are to be kept in good condition. Analysis does not generally show any great amount of impurity, but the plates are very apt to get "sick," and sulphating is inclined to occur.

According to Dr. Altwegg the cause of the harmful effect of chlorides is that they become oxidised to perchlorates. Now, perchloric acid has a very powerful oxidising effect upon lead, and therefore eats into the positive grids causing them to crumble down gradually. He makes a good deal of the energy loss in converting the chloride into a perchlorate, but this is surely hypercritical because in any case the amount of chloride would not be at all considerable.

Ammonia is very objectionable as has been shown by R. W. Vicary (*Trans.* Faraday Society, Vol. I., p. 271); in fact, it appears to be more harmful than almost any other impurity. Nitric acid is also harmful as it gradually becomes reduced at the negative plates to ammonia. Now ammonia is one of the most difficult impurities to eliminate, or, rather, to keep away from the cells. There is always more or less ammonia in the atmosphere, and accumulators are often placed in positions where considerable quantities of the gas are evolved—for example, in the neighbourhood of urinals or stables—and in such cases the cells invariably deteriorate.

Acetic acid is also objectionable because of its powerful forming action upon the grids of the positive plates. It may be produced in the cells from oxidation of alcohol—*e.g.*, if cells were kept in a wine cellar or in a distillery alcohol vapour might get into the electrolyte and then oxidising action of the current would oxidise it first into aldelyde and then into acetic acid. Plates formed in an electrolyte of acetic acid might contain traces of the acid from imperfect washing. When acetic acid is once produced it is, being a very stable substance, not readily decomposed.

The objectionable effect of arsenic has been noticed almost from the commencement of the accumulator industry. Chemically it is very closely related to nitrogen, and seems to affect the cells in much the same manner as ammonia It has already been mentioned that nitrates are reduced to ammonia, NH_3, by reduction at the negative plates, and in a similar manner compounds of arsenic are reduced to arsenuretted hydrogen, AsH_3. This alone might not perhaps matter, because arsenuretted hydrogen is insoluble in acids and will be partially evolved as gas, whereas ammonia dissolves in acids and so remains in the electrolyte. But arsenic has metallic characteristics, and therefore, partially at any rate, gets deposited upon the negative plates in a similar manner that copper, for example, would be deposited. A galvanic couple is thus produced, and this sets up gassing on the plates and thus causes discharge of e cell.

Dr. Altwegg describes a test for arsenic in which the accumulator acid is added to pure zinc and the arsenuretted hydrogen which is evolved tested by means of paper soaked in silver nitrate. The presence of arsenuretted hydrogen will turn the paper black. He says as pure zinc does not easily evolve hydrogen a few drops of platinic chloride should be added in order to cause the hydrogen to come off more readily. Certainly the hydrogen will be evolved more easily, but the test for arsenic is made very much less delicate. Iron and manganese are other impurities which may be found in accumulators. The iron generally gets into the electrolyte from carelessness, such as the dropping in of a nail, &c., the manganese from the oxides of lead used in preparing the paste.

Tests for all the various impurities are given in the article, but these would require to be treated of in detail and in a special article in order to make them clear and useful.

CORRESPONDENCE.

CAPACITY CURRENTS AND LEAKAGE INDICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The report of my remarks at the London meeting of the Mining Engineers—as reported in your issue of the 22nd—has only just been brought to my attention. Likewise Mr. Edgcumbe's letter in yours of the 29th in reference to the suggestion I made for a leakage indicator on a three-phase colliery installation with the neutral point earthed. In the diagram, Fig. 3, on p. 368, you have shown that I put a bell in series with the neutral point and earth. This, however, was not the case. I put a *relay* at that point which would *operate* a bell. As Mr. Edgcumbe says in his letter, if the bell were there it would immediately be burned out when an earth occurred. I am very glad to hear that Mr. Edgcumbe has already tried a similar device, and I am still more pleased to be able to state that I have to-day made arrangements with Mr. Edgcumbe to test his device. Should you consider it of any interest to your readers to have a result of this test I shall be very pleased to give you the benefit of my experience. From the description Mr. Edgcumbe has given me of his apparatus I am certainly inclined to agree with him that it will be infinitely better than my own suggestion.—Yours, &c.,

PHILIP C. POPE.

Lancashire Electric Power Co., Manchester, July 3rd.

LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the question Mr. Dalby asks in your issue of 29th ult., I can say that most of the conductors that failed had been in existence for terms varying from 20 to 60 years, had never been tested or repaired during that time, and were not in any cases in accordance with the rules of the Lightning Rod Conference.

The doubt in the public mind as to the efficacy of conductors is due, not only to the report your correspondent refers to and the book that claims to be a supplement to it, but to the fact that the statistics said to have been collected by the Lightning Research Committee were apparently communicated to the press before the report was published and naturally led to comments to the effect that, if out of an average of 38 buildings damaged by lightning every year 13 had conductors, modern protective appliances were not only useless but might be a source of increased danger—an inference that would have been warranted if the figures had been correct—but they were not!

This committee claimed to have received 40 reports of damage that occurred to "protected" buildings in three years, and it published in an appendix a list of 35 cases that purported to be a selection from these 40, but of these 8 were not damage to buildings fitted with lightning conductors; 1 is a case of long existing injury to a church spire that no expert would attribute to lightning, and 2 occurred before the committee was formed. This leaves 24 cases of so-called failure of lightning conductors, an average of 8 per annum out of about 400 buildings that are struck and damaged by lightning in this country every year.

I challenged the correctness of the committee's figures at the Society of Arts on May 24, 1905, and elicited the fact that the appendix is *a complete list and not a selection* and that the statement that 40 cases had occurred was incorrect. This committee, of which electricians formed the minority, started possibly with the assumption, as Mr. Dalby suggests, that knowledge on the subject of protection from lightning was seriously at fault and that conductors generally fail. If it really investigated the subject it must have found that, far from this being the case, failures were remarkably few in comparison with the number of buildings struck and that in every case where failure occurred serious faults existed that would have led a qualified expert to condemn them before the accident happened. Are we to presume that the exaggeration was due merely to carelessness, or to a desire to justify the existence of the committee? Those who know the history of this movement are disposed to suggest another explanation. The committee, unlike its predecessor of 1882, apparently took no steps to ascertain the methods adopted by experts. It was content to accept incomplete and largely incorrect reports from observers who, with few exceptions, were not competent to make the reports, and, after the first year, announced that it did not desire reports of cases when there were no conductors, so raising the percentage of failures to an extent that made the figures appear alarming. That it did not trouble to investigate the cases that were reported is obvious from the meagre details published.

Even if the recommendations of this committee were not so contradictory as to make it uncertain what they did or did not mean to convey, the fact that they were based on these reports makes them valueless, and they are so regarded by all who can read between the lines and judge of the objects of this report.
—Yours, &c., ALFRED HANDS.
London, July 3.

ELECTRIC TRANSPORTER BRIDGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue we note a short paragraph on p. 435 relating to an electric transporter bridge, which you there state is to be erected over Poole Harbour in connection with an extension of the tramways from County Gates, Bournemouth, to Canford Cliffs and the Sandbanks. This paragraph evidently refers to the Branksome Park and Swanage Light Railway, which scheme included a bridge such as you describe and for which we were the consulting engineers. We regret to state, however, that the Light Railway Commissioners, at an inquiry held at Bournemouth on March 26th last, were unable to grant the order in view of the opposition of some of the local authorities and others, and therefore we fear that the statement is, to say the least, a little premature.
—Yours, &c., EADY & FRECH.
Westminster, July 3.

PARLIAMENTARY INTELLIGENCE.

LONDON COUNTY COUNCIL (ELECTRIC SUPPLY) BILL.

SPECIAL REPORT FROM THE SELECT COMMITTEE.

The Select Committee to whom the London County Council (Electric Supply) Bill was referred, and who were instructed by the House on April 2 to consider, with special reference to the terms of the bill, the best means of providing for the supply of electrical energy in bulk and for power and motive purposes, and to report thereon, have agreed, with regard to the said instruction, to the following special report:—

1. The main general object of the bill is to enable the L.C.C. to supply electricity in bulk to authorised distributors (that is, local authorities or companies authorised by Act of Parliament or provisional order) within the administrative county of London and certain adjoining boroughs and districts in the counties of Essex, Kent, Surrey and Middlesex.

2. The bill proposes in addition to confer on the Council powers to supply electrical energy direct to railways, docks, tramways and various other undertakings.

3. And the bill also proposes to confer on the Council power to transform, distribute and use electrical energy in various buildings, works or undertakings belonging to, or maintained by them, or under their control; but this power is not to apply to schools and various other buildings, parks, open spaces, pleasure grounds or workmen's dwellings, without the consent in writing of the authorised distributor.

4. The Council do not, except as above, propose to supply electrical energy direct to any individual consumer wholly situate in the area of any authorised distributor without the consent of the authority concerned.

5. It is important to bear in mind that the supply of electrical energy in the administrative county of London and adjoining districts is now in the hands of various local authorities and companies. Powers for this purpose have been granted under the Electric Lighting Acts, and cover practically the whole of the county of London and the greater portion of the adjoining districts included in the bill. At the present time these powers are held within the county of London by 16 local authorities and 13 companies, and with regard to most of the latter the local authorities are entitled to purchase the undertakings in the year 1931.

6. The Tables "A" and "B" appended to this report, show the orders now held by local authorities and companies respectively, the areas to which such orders relate, and the extent to which competition within those areas has been authorised.

In addition to these orders, powers for the compulsory acquisition of land for power stations and other purposes have been obtained by special Acts of Parliament in respect of various parts of the County of London. The Table "C" appended to this report gives a list of these special acts.

These tables have been furnished to the Committee by the Board of Trade.

7. Up to the present the capital expended by the local authorities has been, in round figures, about £6,500,000, and by companies about £12,000,000, making a total capital expenditure of about £18,500,000. Capital expenditure is stated to be proceeding at the rate of about £1,000,000 a year.

8. At the time the Electric Lighting Acts were passed the principal question was one of light, and it was provided that in the area of each local authority there should be a distinct and separate understanding.

9. No doubt this system was adopted to maintain the power given to each local authority to purchase the undertaking in 1931. The effect has been to cause a large number of separate stations to be constructed.

10. The Committee are of opinion that the best means of providing for the supply of electrical energy in bulk, and for power and motive purposes, is by one large and inclusive scheme extending, not only over the entire county of London, but also to adjoining boroughs and districts.

11. For the purpose of carrying out such a scheme some central authority is required with ample statutory powers and corresponding duties. In addition to the proposal of the L.C.C., various other proposals have been placed before the committee. After giving full consideration to this question the committee are of opinion that the L.C.C. should be the authority.

12. The bill before the committee is solely permissive. No obligation is imposed on the Council to give a supply to any of the local authorities or companies; in fact no obligation is imposed on the Council to carry into effect any of the powers sought by the bill, and there is no prescribed time either for beginning or for carrying out the work. The committee consider that the Council should be under such obligations, and that under fair and reasonable terms and conditions any authorised distributor (whether a local authority or a company) should have the right to require a bulk supply.

13. The adoption of these proposals would alter the whole scope and intention of the bill, but it would, at the same time, make the measure more practical and effective for all purposes.

14. Authorised distributors made a most strenuous opposition to clause 35 of the bill. This is a most important clause, empowering the Council to make representation to the Board of Trade that the prices charged by any authorised distributor were excessive and ought to be reduced, or that the methods of charge ought to be altered, and after an inquiry such order was to be made as in the opinion of the Board of Trade would be fair and reasonable having regard to all the circumstances of the case, including amongst other things the terms upon which and the time within which the Council would be willing and in a position to furnish a supply.

15. The Committee doubt whether due consideration has been given to the fact that both local authorities and companies as authorised distributors have expended a great amount of capital in the erection and equipment of generating stations, and that this has been done, and the money borrowed under Parliamentary sanction. Any alteration of existing conditions ought to uphold in a fair and reasonable manner the interests of the authorised distributors.

It was contended that the words in the clause "having regard to all the circumstances of the case" were sufficient to safeguard these interests; but the Committee consider that in such a bill there should be contained a clear and distinct provision, so that the existing financial position and obligations of local authorities and companies as authorised distributors should be taken into account in any revision of prices, and it may be desirable that such prices when so revised should be made maximum and not actual prices.

16. With regard to the scheme generally the Committee are of opinion that further consideration should be given in regard to many matters pointed out during the course of the inquiry with a view to amending and improving the scheme.

17. The distribution system proposed by the Council is one which requires further consideration. The suggestion of duplicated routes is well worthy of attention. This was proposed in the scheme of the Administrative County of London & District Electric Power Co. The trunk transmission system should be on the highest voltage consistent with safety underground and the cost of insulation.

18. In recommending that the County Council should be the authority, the Committee desire to refer to the statement made by Mr. Llewellyn Smith, on behalf of the Board of Trade, which they regard as of great value. The Committee have in view the fact that the County Council, as this authority, may exercise its powers in more than one way.

(*a*) The County Council may undertake the whole work, providing every authorised distributor and every private consumer with electricity in bulk at a maximum scale of prices.

(*b*) The County Council may retain for itself one part of the undertaking, while permitting a private enterprise to undertake another part.

(*c*) The County Council may lease for a substantial consideration the whole enterprise to a private enterprise, to resume possession of it when its initial stages are over.

The Committee are of opinion that the report of the Finance committee of the County Council renders desirable a careful consideration of alternative schemes.

The Committee desire to say that the scheme put forward by the Administrative County Co. appeared to be conceived on scientific lines, and calculated to afford a cheap supply of electrical energy at private risk, though it was not clear to what extent the necessary paramount authority of the County Council, and the ultimate possession of the enterprise by the Council could be secured under this scheme.

19. Evidence was given at length regarding the generation of electrical energy at the coalfields and the transmission of it to London at a very high voltage by overhead cables along the public roads. The Committee were not able to regard this as a suitable scheme.

20. The Committee visited the County Council's generating station at Greenwich. The installation (apart from the question of the method of generation) appeared to them to be in all respects admirable and to reflect credit upon the Council's engineer, Mr. J. H. Rider.

21. The Committee consider that the provision of cheap electric power for London is so important and pressing that they do not view with favour the possibility of the question being indefinitely hung up; they therefore urge that the Council should be prepared to make a decision as to their action early enough to allow other bills to be presented for next session.

22. Having given full and careful consideration to all questions in respect to the bill the Committee have determined to report to the House that the preamble is not proved.

23. A memorandum relating to electric power and supply bills of the present session, which was presented to the House by the Commissioners of Works, was referred to the Committee, who considered it and took evidence upon the points raised in the Commissioners' observations. With regard, however, to all bills introduced into Parliament during the present session in respect to electric supply in London and the adjoining districts, the Committee are of opinion that, pending the introduction of a satisfactory Bill next session by the L.C.C.—or, in default of the L.C.C., then by some competent body of promotors—it is not advisable that any further progress should be made with such bills.

The report is followed by an appendix containing the tables referred to in the text.

[This report is commented on in the Leading Article on page 466.—Ed. *E.*]

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.

A Committee of the House of Lords, with Lord Camperdown in the chair, has had this bill under consideration since Wednesday last week. We reported the proceedings concerning the bill when it was before the House of Commons (*The Electrician*, April 27, May 4 and 11). In consequence of the decision given by that Committee, when important lines were rejected, the main interest now centres upon the proposal to run tramways over Blackfriars and Westminster Bridges and along the Victoria Embankment, thus affording intercommunication between the northern and southern tramways systems of London. The circumstances of this proposal are precisely similar to those which obtained when the bill was passed by the House of Commons, the opponents also being the same—viz., frontagers and the omnibus proprietors. The capital involved by the proposals of the bill now is £700,000.

The decision upon the bill, as in the Lower House, was deferred, pending the consideration of the City of London (Blackfriars and other Bridges) Bill, which came on later before the same Committee. This bill provides for the widening of Blackfriars Bridge in order to accommodate the proposed new tramway, and has also been passed by the House of Commons.

On Wednesday, both bills were passed, practically in the same form as they left the House of Commons.

LONDON COUNTY COUNCIL (GENERAL POWERS) BILL.

A Committee of the House of Lords, of which Lord Camperdown is chairman, considered the London County Council (General Powers) Bill yesterday. Part VI. gives powers to London borough councils authorised to supply electrical energy to undertake the hiring out of electrical fittings, motors, &c. The clause in question reads as follows, and has been passed in this form by the House of Commons.

"It shall be lawful for the council of any metropolitan borough being authorised to supply and supplying electrical energy to expend money upon the wiring and supplying with wires and fittings, motors and apparatus the premises of their consumers or prospective consumers, and to enter into and to carry into effect agreements and arrangements with respect thereto, and to make such charges therefor as they may think fit.

"Provided that nothing in this section shall be deemed to authorise the council of any metropolitan borough to manufacture any such fittings or apparatus.

"Provided also that every such council shall so adjust the charges to be made by them aforesaid as to meet any expenditure by them under the powers of this section (including interest upon any moneys borrowed under and for the purpose of this part of this act and payment of sinking fund in respect of such moneys).

"Every sum charged by any such council to a consumer in respect of the wiring and fitting of the premises of such consumer and the supplying of wires, fittings, motors and apparatus shall be clearly stated on every demand note by such council for payment for electrical energy supplied to such consumer distinct from the charge for such energy.

"The total sum received and expended by such council under this part of this act in each year (including the amount required for interest and repayment of sinking fund in respect of all moneys borrowed) shall be separately shown in the public accounts of the electric lighting undertaking of such council for such year.

"Any such council of a metropolitan borough may borrow, in the same manner and subject to the same conditions as though such expenditure were for the purposes of the Electric Lighting Acts of 1882 and 1888, as amended by the London Government Act of 1889, such sums of money as may be required by such council for the purpose of this part of this act."

The opponents to this part of the bill are the London Electrical Contractors' Association, for whom Mr. Page, K.C., appears. The point of the opposition is that the bill leaves it open for the borough councils to supply the fittings and to fix them themselves. The Contractors' Association ask that the councils should only be allowed to undertake this work through a contractor.

Evidence was heard on behalf of the proposal from the Islington Borough Council, and the Committee adjourned.

WIRELESS TELEGRAPHY IN THE ARMY AND NAVY.

In a printed reply to a question by Mr. Bellairs in the House of Commons on Thursday last week,

Mr. HALDANE said that the War Office is now experimenting with the Lodge-Muirhead and another wireless telegraph system, but they were not bound to the exclusive use of either one or the other. The Admiralty had an agreement with the Marconi Co. under which, except in case of war or emergency, no communication was to be made with the shore stations of the War Office which used any system other than the Marconi.

LONDON TUBE RAILWAYS.

In the House of Commons on Tuesday Mr. EMMOTT, Chairman of Ways and Means, moved that the Hammersmith, City & North East London Railway Bill be suspended until next session. The reason for this was, he stated, that owing to a misapprehension arising out of the report of the Royal Commission on London Traffic several similar proposals had not been deposited, and it was thought that the promoters of one bill should not have an advantage over the others. Some discussion took place, but owing to shortness of time the motion could not be put to the House. On Wednesday, however, the motion was agreed to.

MISCELLANEOUS.

The Nottinghamshire & Derbyshire Tramways Bill was read a third time in the House of Commons on Monday; the County of Durham Electric Power and the Newcastle-on-Tyne Electric Supply Bills were read a second time.

In the House of Lords on Monday, the Derbyshire & Nottinghamshire Electric Power Bill was read a second time.

The London United Tramways Bill, the Macclesfield & District Tramways Bill, and the North-East London Railway Bill were passed by the Unopposed Committee of the House of Lords on Tuesday. They have all passed through the House of Commons.

The Folkestone, Sandgate & Hythe Tramways Bill was read a second time in the House of Commons on Wednesday.

LEGAL INTELLIGENCE.

Umballa Residential Hotel Co. (Ltd.) v. County of London Electric Supply Co. (Ltd.)

On Wednesday in the Court of Appeal the Master of the Rolls and Lord Justice Cozens-Hardy heard an appeal of plaintiffs from an order of Mr. Justice Ridley in Chambers.

The plaintiff company was incorporated for acquiring and carrying on the Umballa Mansions Hotel from May 9, 1906. It then transpired that the vendor (Miss Mellon) was in arrears with her payments for electric light supply, and defendants, as soon as they became aware that the property had changed hands, set about inquiring regarding their account, but no arrangement had been made to pay it. The rights of electricity companies are regulated by statute, under which the incoming tenant is not liable, unless he contracted to become so with the outgoing tenant, for electric light supplied to the outgoing tenant. In the company's Electric Lighting Order, 1898, there is a provision that the undertaker shall, upon being required to do so by the owner or occupier of premises, continue to give a supply of energy for the premises subject to the condition that, if required by the undertakers, the applicant shall give security for payment of money which may become due for electric current. In the course of correspondence between the parties the Electric Supply Co. intimated that they were willing to continue the supply on a deposit of £25 being made by applicants. Plaintiffs tendered £20 in gold, and left with the company a demand for supply. Defendants refused to accept that sum as adequate security, and on May 29 the Hotel Co. issued a writ in view of the threats of defendant company to cut off supply unless arrears were paid. The Hotel Co. brought the action claiming an injunction to restrain defendants from discontinuing supply for lighting, and a declaration that having given notice for a supply and tendered reasonable security they were entitled to be so supplied as long as they paid the account when due. Plaintiffs applied to Mr. Justice Ridley for an interim injunction, but that judge refused. Hence this appeal.

Mr. Montague Lush, K.C., Mr. H. Simmons and Mr. A. Page appeared for plaintiffs, and Mr. J. B. Matthews for defendants.

At the conclusion of the arguments, the MASTER OF THE ROLLS said it was clear law that a new tenant of licensed premises was not, in the absence of agreement, liable to pay for gas or electric light supplied to the outgoing tenant but not paid for at the time of the change. The Electric Lighting Order provided that if the tenant of premises within a certain area from an electric main wished to be supplied, he was entitled to a supply as of right by giving notice to that effect. The company were not bound to comply with the demand unless reasonable security was found. It seemed to his lordship that what took place was quite consistent with the view put forward by appellants that they were perfectly willing the £25 cheque should be substituted for the £20 offered and refused by defendant company previously. The sum first deposited, in his lordship's opinion, was a reasonable amount, having regard to the fact that it was a summer quarter. Defendants' therefore were under a statutory obligation to supply to plaintiffs. In the circumstances he thought plaintiffs were clearly entitled to ask for the interlocutory injunction to restrain defendants from discontinuing the supply. Irreparable damage might be caused to plaintiffs' business if, in the London season, the hotel was left in darkness by defendants carrying into effect their threat to cut off the supply. The rights of the parties could be ascertained fully at the trial, but it was clear that in the interval defendants ought to be restrained from acting on their views of the rights, which, if they happened to be wrong, would lead to irreparable mischief being done to the plaintiffs' business.

Lord Justice COZENS-HARDY concurred.

The appeal was accordingly allowed and an injunction issued. £25, which plaintiffs paid to defendants, was directed to remain in the custody of defendants as security for the ensuing quarter's supply.

Ogden and Smith v. Gas Light & Coke Co.

In the Court of Appeal on Tuesday, the Lord Chancellor, the Master of the Rolls and Lord Justice Cozens-Hardy heard an appeal by defendants against the verdict and judgment entered against them in two actions brought by Miss Ogden and Mr. Smith for damages for personal injuries sustained by them through alleged negligence of defendants. The injuries were caused by explosions of gas which occurred in Regent-street, London, on October 15, 1903. Defendants denied their liability, and said there was no negligence on their part. It appeared that Miss Ogden was walking down Regent-street and an explosion occurred. The iron cover of a telephone manhole was violently blown up, and Miss Ogden received serious injuries. There were other similar explosions at the same time in other parts of Regent-street, and the other plaintiff, Mr. Smith, was also seriously hurt. The only question for the jury was whether the defendants could be held liable, in which case the amount of damages was agreed. Gas had escaped from defendant company's pipes, and had accumulated in the manholes of the telephone boxes belonging to the Post Office. Defendants were responsible for the construction and maintenance of their gas mains and supply pipes, and were bound to remedy any leakage of gas and to use all care that could reasonably be employed. There were also statutory duties imposed on them by Sec. 24 of the Gas Works Clauses Act, 1847, which provided that when there was an escape of gas, after receiving a notice in writing to that effect, they were to prevent the gas from escaping. Plaintiffs' case was that the defendants were negligent in allowing the escape and consequent accumulation of gas in the telephone boxes, and that they were liable for the injuries sustained by plaintiffs. It appeared that the Post Office telephone manholes were not ventilated, though electric light manholes were. The immediate cause of the explosion was that a jointer in the employment of the Post Office was at the telephone manhole on the day in question doing some repairs, and was using a blow lamp when the explosion occurred. According to the evidence, a letter was written to defendants in the preceding July on the instructions of the Post Office engineer, calling attention to the fact that there was a smell of gas in the manhole, and requesting them to see to it Defendants investigated the matter but failed to discover the cause. Further evidence was to the effect that it was impossible to avoid a certain leakage from the joints of gas mains because the gas had to be forced through them at considerable pressure. The jury found for plaintiffs in each case.

Mr. DANCKWERTS, K.C. (for appellants), now contended that there was no evidence of negligence, and even if there were, the negligence was not the effective cause of the accident, such effective cause being the act of the Post Office jointer in handling a light at the manhole which resulted in the explosion.

Mr. SALTER, K.C., for respondents, submitted that the judge was right in leaving the matter with the jury, and his submission was that respondents had proved to the satisfaction of the jury that there was a two-fold negligence on the part of defendant company. In the first place, when they received statutory notice of the escape they did not act in all the circumstances with sufficient energy and thoroughness. In the second place, the smell of gas was very bad, and the company ought to have known of it. It was said the telephone boxes had the effect of making an escape of gas more disastrous than otherwise might be the case, but those boxes were laid down under authority, and the presence of such chambers in the immediate neighbourhood of the gas pipes made it all the more incumbent on the gas people to carefully keep their gas under control.

The LORD CHANCELLOR, in giving judgment, said the case was one eminently for decision by the jury if there were any evidence upon which they could act. It was certainly not the function of the Court to set its opinion upon the balance of evidence against the opinion of the jury. Was there any evidence of negligence on the part of the defendants? In regard to the real point, to his mind there was notice given to the company of the presence of gas and ample opportunity for them to learn what others had learned, that gas was present and discerniable by a strong smell. It seemed to him there was a duty upon the company then to put an end to whatever created that smell. He thought this was evidence upon which the jury were certainly entitled to find negligence on the part of defendants. As to the "effective cause" of injury, he did not know whether anybody was prepared to give an exhaustive definition of what was "effective cause," but, as he understood Mr. Danckwerts' contention, it was that because this explosion was immediately caused by the application of a flame on the part of a servant of the Post Office, and because he was negligent in applying that flame to the pipe, the defendants were exonerated from their negligence in allowing the gas to be where it was likely to be affected by the flame. He could not accept that contention, and he was of opinion that the appeal ought to be dismissed, with costs.

The MASTER OF THE ROLLS and Lord Justice COZENS-HARDY concurred, and the appeal was accordingly dismissed, with costs.

Re Otto Electrical Mfg. Co. (1905) (Ltd.)

On Tuesday Mr. Justice Buckley was asked by the liquidator of this company to decide the question whether the company could, before commencing business, bind itself by any contract.

Mr. COLDRIDGE, for a creditor (Mr. A. C. M. Jenkins), said the company was registered on May 26, 1905, a prospectus was issued, but the response was small and the company did not go to allotment, and therefore never became entitled to commence business. Mr. Jenkins had before that date supplied money for preliminary expenses.

His LORDSHIP made an order declaring that, as the company was never entitled to commence business, any contract made by the company was not binding on it, and that Mr. Jenkins's claim must be disallowed.

Rhodes Electrical Mfg. Co. (Ltd.) v. Barker.

At Bradford County Court last week plaintiffs sued for damages for breach of an agreement entered into by defendant that his son Percy should serve a six years' apprenticeship to plaintiffs.

In October, 1902, defendant arranged with plaintiffs that his son Percy should serve an apprenticeship from Oct. 28, 1902, until June 25, 1908. A premium of £52. 10s. was paid, apprentice to receive a varying salary until the completion of his apprenticeship, the maximum being 10s. per week. The apprentice remained at work until March 16 last, the reason assigned for leaving being that he was not being taught his trade as provided by the agreement. When the apprentice left the firm's employ he was in receipt of 6s. per week, and the person afterwards engaged to do his work was paid 14s. per week. It was to recover this excess in wages that the damages were now asked for.

Mr. J. W. AXWORTHY, works manager, for plaintiff, gave evidence that the apprentice had been placed in various departments at different times, and had been provided with opportunities of familiarising himself with the methods of brass finishing, winding, costing, and the mechanical and testing branches.

For the defence it was urged that the apprentice had not been allowed due facilities for learning his trade.

The APPRENTICE (Percy Barker) said he had only been taught the manufacture of the brushes. He had been called upon to perform the ordinary routine of office work.

His HONOUR (Judge Bompas) gave judgment for the full amount claimed and costs.

Neale v. Electric & Ordnance Accessories Co. (Ltd.)—The Court of Appeal (the Master of the Rolls and Lord Justice Cozens Hardy) on Tuesday heard an application by defendants for security for costs of plaintiff's appeal. The action was brought for damages for personal injuries sustained by plaintiff while in defendants' employ. The trial took place at Birmingham before Mr. Justice Ridley and a jury, and ended in verdict and judgment for defendants. The case was reported in our issue for March 30. Their lordships directed that £20 security should be given.

Re London Electrobus Co. (Ltd.)—On Thursday of last week Mr. Justice Buckley made an order on an application on behalf of the company, asking that the register of members of the company might be rectified by removing therefrom the names of the shareholders mentioned in a schedule annexed to the notice of motion on the ground that those shareholders had been induced to apply for their shares by misrepresentations in a prospectus issued by the company. The shareholders affected numbered 1,026, and held about 48,000 shares in the company amongst them.

Price of Gas.—The Gas Light & Coke Co., which supplies the greater portion of gas used in the London area north of the Thames, has notified its consumers that for the June quarter the rates of discount allowed in respect of gas used and separately metered for gas engines has been fixed as under (the price of gas being 2s. 11d. per 1,000 ft.)

Accounts under £10 for the quarter	10 per cent. discount
,, from £10 to £25	15 ,, ,,
,, from £25 to £50	20 ,, ,,
,, from £50 and upwards	22½ ,, ,,

in all cases where payment is made by the 15th day of the second month in the quarter.

Gas users in London, north of the Thames, have much to thank electricity supply undertakers for in regard to these reductions.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrician is required by the Government of Mauritius, with experience as an electrical engineer and practice in telegraphy and telephony. Salary £400 per annum. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by July 16. See an advertisement.

The Bombay, Baroda & Central India Railway Co. require an assistant telegraph superintendent. Salary R.350 per month, rising to R.500. Applications to Mr. W. V. Constable, Gloucester House, Bishopsgate-street Without, London, E.C., by July 11.

An assistant lecturer in physics is wanted at Hartley University College, Southampton. Salary £150, rising to £200. Applications to Principal by July 12.

Battersea (London) Council require a shift engineer (salary £104) and a commercial assistant (salary £2 per week) for the electricity department. Applications by noon July 10.

Woolwich Council require a commercial assistant for their electricity department. Commencing salary £200. Applications by noon July 9.

Woolwich (London) Council require a commercial assistant in their electricity department. Commencing salary £200 per annum. By noon July 9.

London County Council require a principal electrical assistant in the engineer's department. Salary £500 per annum. Applications by July 13.

London County Council require a teacher of engineering and an assistant demonstrator in engineering for Paddington Technical Institute. Salaries £150 and £80 respectively. Forms of application from the Education Offices, Victoria Embankment, E.C. Applications by July 7.

Mr. T. R. Edge, mains superintendent at Doncaster, has been appointed mains superintendent and general engineering assistant at Ipswich. There were 155 candidates for the position.

Mr. J. Allward, senior shift engineer at Islington (London), was appointed in November station superintendent on probation for six months at £180 per annum. The electrical engineer (Mr. A. Gay) having reported that Mr. Allward had carried out his duties in a very satisfactory manner, his appointment is to be made permanent at a salary of £200 per annum.

Mr. Arthur Ernest Wilkins, resident electrical engineer at Chepstow, has been appointed to a similar position at Monmouth in succession to Mr. A. W. Blake, who recently resigned, but retains his connection with the borough as consulting electrical engineer.

The Governing Body of Battersea Polytechnic (London, S.W.), have appointed to the position of head of the department of electrical engineering, Mr. A. W. Ashton, M.Sc., of the University of Leeds. Mr. Ashton is a Whitworth exhibitioner, an 1851 exhibition scholar and obtained his B.Sc. in electrical engineering with Honours at Durham College of Science in 1898, afterwards graduating M.Sc. During the vacations he worked in different departments of Siemens Bros. & Co.'s works at Charlton, and prior to his appointment at Leeds was for five years assistant to the manager of the old Telegraph Manufacturing Co., Helsby (now the British Insulated & Helsby Cables, Ltd.) at Runcorn, where he also conducted evening classes in electrical and other engineering subjects.

Mr. H. S. Allen has been appointed senior lecturer in physics at King's College, London.

Mr. L. W. Woodman, the borough electrical engineer, has been appointed advisory engineer to the tramways department at an additional remuneration of £50 a year.

Personal.—Mr. H. W. Turner, after completing a two years' engagement at the works of the British Westinghouse Co. as engineer-in-charge of the winding and insulation section of the electrical engineering department and also as superintendent of the winding and insulation department in the works, has associated himself with Mr. H. M. Hobart, consulting engineer, Oswaldestre House, Norfolk-street, London, W.C., and will be engaged in advising with regard to manufacturing methods, machinery and shop organisation.

In the course of an experience of over 20 years in responsible positions in British, Continental and American works, Mr. Turner has reported and advised upon hundreds of questions arising not only in the manufacture, but also in the use of dynamo machinery, and he now proposes to independently advise clients (both manufacturers and buyers) in these and related matters. This arrangement does not interfere with Mr. Hobart's regular consulting practice.

EDUCATIONAL NOTICES.

University College of North Wales.—It is announced that in October next a systematic course of instruction in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineering will be commenced at this college, where the physical laboratory is fully equipped with machinery, apparatus and instruments of the most approved modern type. Some further particulars will be found in an advertisement, and prospectuses, &c., may be obtained from Mr. J. E. Lloyd, M.A., secretary and registrar.

City and Guilds of London Institute.—The entrance examinations to the Institutes' Colleges are held in September, and particulars of the examinations, scholarships and courses of study can now be obtained from the respective colleges or from the head office, Gresham College, Basinghall-street, London, E.C. Some interesting particulars relating to the course of study, fees, &c., will be found set out in an advertisement.

Argentina.—The "Review of the River Plate" says an application by Messrs. Lewis & Gandulfo for permission to run electro 'buses has been favourably reported upon by Buenos Aires City Council.

An agreement has been concluded for the acquisition of Messrs. Beausire & Cassels' Quilmes electricity works by the Cia. Electricidad de la Provincia de Buenos Aires, who also own the stations at Ardrogue, Tres Arroyos and San Nicolas.

Australasia.—The "Australian Mining Standard" says:—

Fremantle (W.A.) Tramways and Electric Light Board have received permission from the Governor-in-Council to extend their lighting mains to North Fremantle. The Board have decided to undertake hire-purchase wiring.

A poll of Auckland (N.Z.) ratepayers has resulted in approval of a proposal to spend £25,000 in establishing municipal electricity works.

At a recent conference between the Victoria Premier (the Hon. T. Bent) and representatives of the local authorities of Prahran, Malvern, St. Kilda, Kew, Camberwell and Hawthorn, districts on the outskirts of Melbourne, Mr. Bent expressed the opinion that the time had come when a joint electric tramway scheme should be carried out in those districts, and if the Councils did not form a trust to give effect to the proposal the Government would take the matter into its own hands, and he would get a vote of half a million for the work. The Prahran representative said his Council would never consent to the formation of a trust, but they had applied to Government for a delegation order to construct a line to Malvern. A resolution was carried recommending the municipalities who have a community of interests to join together to construct electric tramways.

Bacup.—On Wednesday the Council decided to apply for sanction to a loan of £7,000 for an electricity supply scheme. Current is to be taken in bulk from the Lancashire Electric Power Co.

Belgian Electric Traction Scheme.—A proposal to construct an electric railway between Antwerp and Brussels, at a cost of £600,000, has been put before the Minister of Railways.

Barking.—From July 1 the price of current for private lighting is to be reduced to 4d. per unit, with discounts.

Birmingham.—The Birmingham & Midland Tramways Co.'s lease of the Dudley-road route expired at midnight on Saturday last, when the line was taken over by the Corporation.

Bolton.—The salaries of the assistant electrical engineer (Mr. B. S. Hornby) and the station superintendent (Mr. Woods) have been increased.

Bridlington.—Sanction has been received to a loan of £2,558 for extensions of the electricity works.

Brighton.—The Lighting committee recommend that a show room be rented for electrical apparatus and fittings and for canvassers' and collectors' offices.

Bulgaria.—At Bourgas a scheme of electricity supply for the town and port is under consideration.

Telephonic communication has been established between Sofia and the principal towns of Bulgaria.

Carlisle.—An inquiry was held on Tuesday into the application of the Corporation to borrow £6,070 for extensions of the electricity works and for electric pumping plant at the sewage works.

The Inspector (Mr. H. Ross Hooper) inquired as to the financial position of the undertaking and as to what provision had been made for reserve and depreciation.

The Electrical Engineer (Mr. C. D. Burnet) said that pumping by electric power had been approved by the L.G. Board.

The Inspector said that at least the item of £250 for spare armatures would have to be deducted. Spare machinery must be paid for out of revenue.

There was no opposition.

China.—Towards the end of 1905 a Chinese syndicate established electricity supply at Chinkiang. The undertaking has not proved a great success, due chiefly to the indifferent management of the enterprise. It appears, however, that the inhabitants of the city are favourable to the introduction of electric lighting.

Customs Duties.—Under the new convention between Roumania and Belgium the duty on rails and points for railways and tramways imported into Roumania will be 3 Lei per 100 kilogs (=1s. 2½d. per cwt.), instead of the present duty of 5 Lei per 100 kilogs. On the ratification of the convention these duties will also apply to British goods.

Dundee.—Pending decision as to the site for the proposed new generating station, the city electrical engineer (Mr. H. Richardson) has been authorised to put down an additional generating set at Dudhope Crescent-road to meet next winter's demand for current.

Electric Motor Driving.—The City of London Electric Lighting Co. is issuing a pamphlet setting out the advantages of driving machinery by electric motors. A list of prices at which motors are supplied at various speeds is also given. This list provides for deferred quarterly payments. A draft form of agreement which has to be entered into between the company and the consumer is also set out.

Electricity in Dockyards.—Good progress is being made with the equipment of the new Clyde Trust dock at Clydebank. The whole of the plant will be operated electrically.

The erection of the boilers and machinery is now proceeding, as well as of an overhead crane in the engine house. The dock will have four electric hoists for coal loading, but at the outset only two will be erected. Six electric cranes are being completed. The turntables, capstans and weighing machines are under contract, and the work of putting these in position will shortly be commenced.

Erdington.—The Council have entered into an agreement with Aston Corporation for supply of electrical energy for traction in Erdington at 1½d. per unit. Erdington Council is to take supply for 21 years and to guarantee a minimum consumption of 250,000 units per annum.

Exeter.—On Monday the Council adopted a recommendation of the Joint Lighting committee to adopt electric lighting in those thoroughfares in which electric cables are at present laid.

Forthcoming Books.—Messrs. Whittaker & Co. will publish shortly a new book on "Polyphase Currents," by Mr. Alfred Still, M.I.E.E. "The Electrician" Printing & Publishing Co. (Ltd) will have ready next week the "Classification of Alternate-current Motors," by V. A. Fynn, M.I.E.E. Price 3s. net.

General Electric Co.'s Works.—The General Electric Co.'s works at Witton, near Birmingham, are described in an interesting manner in a pamphlet just issued. The illustrations show interiors of the various shops and a few of the numerous articles manufactured therein.

Gloucester.—At the Council meeting last week, Mr. Fream, in presenting the Light Railway committee's minutes, referred to the criticisms made at the previous meeting in regard to the tramways.

He said he was not alone in advocating the municipalisation and electrification of the old company's lines, as nearly every councillor at the time the scheme was adopted was in its favour, and the ratepayers also passed resolutions in favour of the scheme. He pointed out that if the tramways had not been municipalised a part of the loss would still have had to be borne, as the electricity works did not pay until the tramways were constructed. The electricity department made a gross profit of £685 and a net profit of £115 on the supply to the tramways. The tramways committee also relieved the Streets committee of the obligation of maintaining 4 miles of streets, which would cost at least £1,150 a year.

Heaton Norris.—The Council will lease to Manchester Corporation a double line of tramway, extending from the Levenshulme to the Stockport boundary, for 21 years, the rent reserved being £1,522. 7s. 4d. for the period between June 1, 1902, and June 1, 1905, and £907. 13s. 2d. per annum after. The lessees undertake to equip the line electrically.

Hull.—The Electric Lighting committee has decided to reduce the price of current for lighting from 4½d. to 4d. per unit.

Iceland Submarine Telegraph Cable.—The Great Northern Telegraph Co. anticipate that the new cable between Great Britain and Iceland, via the Faroe Islands, will be working by the late autumn. There will be about 20 stations in Iceland, and it will be possible to telephone as well as telegraph between them. The German Emperor is, we understand, landing at the Faroe Islands shortly.

Inquests.—At the resumed inquest on the deaths of E. H. Croad, H. Dyke, R. J. Durnford and C. C. Phippen, which resulted from the recent accident on the Swindon tramways,

The car driver, Lyons, said that on the first journey downhill he found the brakes were bad, and reported the fact to the traffic manager, who promised to see to it. He reported the defect again, but continued working the car with the faulty brakes all the afternoon. A fitter examined the car before it started on the last journey, but nothing further was done. The car was one of a new type, the chief difference being that, although carrying heavier loads than the old vehicles, they had only four brake blocks, whilst the old cars had eight. When he got part of the way down the hill his canopy switch blew, and the hand brake handle flew round and struck him. His opinion was that hand and magnetic brakes wanted taking up, and when he found that the wheels were skidding he saw something was wrong. He shut off the magnetic brake and reversed the current, and then put on the magnetic brake again, but without effect. He tried the hand brake but could not move it, and he then tried the magnetic brake again, but it would not act. He stuck to his post and was flung over the front of the car.

Mr. C. B. Collett, assistant manager of the Great Western Railway Works, said he examined the car after the accident, and found the magnetic slipper brake pulled away from the car and the springs supporting it extended, which was probably the effect of overturning. His opinion was that the magnetic brake had put the hand brake on to such an extent that they caused the wheels to skid.

Driver Lyons (recalled) said the shed foreman was responsible for the cars being fit to travel, and that was not part of a motorman's work, although the latter was allowed 15 minutes in which to examine his car. The present inspectors had no authority to change cars, but the previous inspectors had. Some of the duties of the previous inspectors had been put on the shoulders of the traffic manager (Mr. Metcalfe). On the day of the accident witness did not want to drive No. 11 car.

Neate, the conductor, said he had been in the employ of the Corporation 18 months, and had experience in driving. All the cars had been overloaded during meal hours, and also on Sundays and sometimes in the evenings.

Fitter Earthridge said he went to the Corn Exchange to examine car No. 11. Owing to its standing on a slope, and the adjustment of the brakes not being urgent, he did nothing, thinking that when it arrived at the depot the work could be done. When he examined the brakes at the Corn Exchange he found about ¾ in. between the throat block and the rocking lever. He could not tell what was the matter unless the hand brake had been released. If there had been a space of 1½ in. the magnetic brake would not be in coupling with the hand brake.

Walter J. Hill, a motorman, and Frederick Mellor, car shed forman, also gave evidence.

The borough electrical engineer (Mr. John George Griffin) said that three cars of type similar to the one which met with the accident were made by the Brush Electrical Engineering Co. Before the contract he inspected similar tracks in company with other tramway officials. The question of the type of brake had been discussed in committee. The brakes of the first seven cars were Westinghouse magnetic brakes. The Westinghouse Co. had developed a much stronger brake, and this was largely in use by London County Council. The specified weight which the cars of the last pattern were supposed to carry was about 4 tons. The week before the accident No. 11 car was tested with 5½ tons of sand and six passengers. It stood the test, and there was a good deal of brake power to spare. That test was taken on the most severe gradient. The total weight of the car, unloaded, was about 9¼ tons. The worst gradient in the town was 1 in 14. The specifications of the cars stipulated that they should be held up on a gradient of 1 in 11 by both hand and magnetic brakes. He did not think the car had skidded down the hill. He knew nothing of any complaints against the car. After he had tested the cars there was no doubt of their fitness for work on the Victoria-road route. He saw no difficulty in having the brakes adjusted at the Corn Exchange terminus. He considered the hand brake would have been sufficient if worked properly. He imputed the accident to an error of judgment on the part of the driver. He did not agree with the driver Lyons that the magnetic brake had gone wrong. He would swear the magnetic brake was in working order coming down the hill.

The inquiry was then adjourned until July 12.

The inquest on two men, who were killed through the overturning of a runaway tramcar at Halifax on Sunday evening, was opened on Tuesday by the coroner (Mr. E. H. Hill). Formal evidence of identification of one of the victims having been given, the inquiry was adjourned until Wednesday next. The Board of Trade have appointed Lieut.-Col. Druitt to investigate and report on the accident.

Japan.—The "Financial News" says a scheme is on foot to construct an electric railway between Osaka and Nara, with a capital of about £200,000.

Light Railways.—The Burton & Ashby Light Railway was opened for traffic on Monday.

The Light Railway Commissioners have granted an order to Hertfordshire County Council to construct electric tramways in Watford and Bushey to the border of the county at Stanmore. It is intended eventually to link up with Edgware and the Marble Arch tramways.

Messrs. Bruce Peebles & Co. have entered into an agreement to equip the Llandudno and district light railway, and have a section ready for traffic early in August.

Lincoln.—A loan of £13,000 for the electricity department has been sanctioned.

Liverpool Cotton Exchange.—The contract for wiring the new Liverpool Cotton Exchange and for the installation of electric motors is being executed by the Northern Electrical & Ventilating Co. of Liverpool.

Liverpool-Southport Electric Railway.—Messrs. Dick, Kerr & Co., Abchurch-yard, Cannon-street, London, E.C., have published a revised description of the electrified Liverpool to Southport branch of the Lancashire & Yorkshire Railway. This description is frontispieced by a map showing the route of the electrified line, the location of the stations on the line, the generating station and substations and the connecting lines which may some day be added to the existing electrified system. The total length of the line is close upon 60 miles of single track, including the extension from Southport to Crossens. A number of instructive diagrams, as well as a good assortment of rolling-stock illustrations, are given, making the description of this "suburban" line of railway very complete and interesting. The plant at the power house at Formby is also well illustrated, and the sub-station equipments and selected sections of the track receive particular attention in this way. As a literary landmark in connection with the pioneer electrified steam lines of railway in this country the book issued by Messrs. Dick, Kerr & Co. will find a conspicuous place.

Local Authorities and Provisional Orders.—A special report (under sec. 1 of the Electric Lighting Act, 1888) has been issued in regard to those applications for provisional orders for the issue of which the assent of the Local Authority has been dispensed with by the Board of Trade:—

East Barnet.—In 1899 the East Barnet Valley U.D. Council obtained an order authorising them to supply electricity in their district, but owing to default by the Council in executing works and supplying energy in accordance with the provisions of the order, the Board revoked the order on April 11, 1905. In the present session the North Metropolitan Electrical Power Distribution Co. applied for an order. The District Council refused their consent, but the Board, after considering the representations made on behalf of the Council and the promoters, decided to dispense with the consent of the Council and to grant the order.

Gomersal.—The Electrical Distribution of Yorkshire (Ltd.) applied for a provisional order in respect of this district, but Gomersal U.D. Council resolved to take no action in the matter, and the promoters requested that their consent might be dispensed with. The Board decided to dispense with the Council's consent and to grant the order.

Higham Ferrers, Rushden and Wellingborough.—The County of Northampton Electric Power & Traction Co. applied for a provisional order in respect of Higham Ferrers, Rushden and Wellingborough district. The local authorities for Higham Ferrers and Wellingborough consented, but Rushden Council refused consent, and the promoters requested that it might be dispensed with. The Board decided to dispense with the consent of Rushden Council, and to grant the order in respect of all the districts applied for.

Uxbridge and District.—The Uxbridge & District Electricity Supply Co. applied for a provisional order to extend their area of supply under the Uxbridge and District Electricity Supply Orders, 1900 and 1903, so as to include the Hanwell urban district, the parishes of Iver Hedgerley and Hedgerley Dean in Eton rural district, the parishes of Seer Green and Penn in the Amersham rural district, the parishes of Rickmansworth Rural and Chorley Wood in the Watford rural district and the Beaconsfield urban district. The promoters decided to abandon their application as regarded Hanwell. Amersham local authority consented, but Eton, Watford and Beaconsfield local authorities refused their consents. The promoters agreed to provide a compulsory area in the district, and the Board then decided to dispense with the consent of Beaconsfield Council and to grant the order in respect of their district as well as for the other districts.

London County Council.—At Tuesday's meeting a lengthy report was submitted by the Highways committee on the acquisition of the *London Southern Tramways* which became purchasable in 1903 but which, owing to the objection of Lambeth Council to contribute to the cost of street widening, was not purchased. Lambeth Council are now willing to agree to the overhead system and to contribute one-third of the cost of street widenings subject to the electrification being completed within three years. The owning company are willing to sell on arbitration terms. The committee anticipate the total expenditure for purchase and electrification at £274,430, exclusive of street widening (63,000).—Consideration postponed.

Greenwich Generating Station.—The Highways committee recommend that the Admiralty be informed that the Council will be glad to co-operate in the appointment of a small committee to inquire as to whether the working of the Greenwich Generating Station will have any injurious effect upon the Royal Observatory.

Capt. Hemphill, chairman of the committee, in reply to questions said that he understood that so far practically no damage had been done to the Observatory, and he believed that the generating station and the Observatory would both be at Greenwich 100 years hence. Sir Benjamin Baker had consented to represent the Council on any committee that might be appointed.

Loughborough.—On the recommendation of the borough electrical engineer (Mr. W. H. Allen) the Electricity committee propose to supply current for power all the year round at a flat rate of 1d. per unit, provided that consumers who avail themselves of this rate between Oct. 1 and March 31 also take current for lighting electrically the parts of their premises containing electrically-driven machinery. Current for lighting will be supplied at 3d. per unit with consumers' own wiring or 4d. with "free" wiring.

Municipal Telephony.—An important report of the Telephone committee was considered by Glasgow Corporation yesterday (Thursday.)

The report recommended the sale of the municipal telephone undertaking to the Post Office for £305,000, exclusive of stores and tools, which would be taken over at valuation. There was a sharp division of opinion in committee, and an amendment not to accept the £305,000 offered by the Postmaster-General, but to sell at a minimum of £310,000 (exclusive of stores, &c.), was only rejected by five votes to four.

After a long discussion the Corporation decided, on the motion of the Lord Provost, seconded by the convener (Mr. Jas. Alexander), to adopt the Committee's report accepting the Government offer.

The capital expenditure to date is about £360,000.

Marylebone (London).—£350 per annum is to be debited in future against the electricity undertaking in respect of central establishment expenses.

London County Council are willing to grant a loan of £60,000 on account of £136,162 applied for by the Council for electric lighting—viz., new machinery and mains, £45,600 (repayable in 42 years); meters and house services, £14,400 (repayable in 10 years).

The Finance committee of the Borough Council have asked the County Council to extend the time for the repayment of that part of the loan (about £7,000) required for house services from 10 to 42 years.

Oldham.—The Electricity committee have adopted a revised scale of charges for current for power, under which charge for energy not exceeding 2½ H.P. will be 1½d. per unit, except between 6 p.m. and 10 p.m., 1¼d. per unit if the demand is over 2½ H.P., and 1d. if over 5 H.P.

Paisley.—The Paisley & District Tramways Co.'s line from Potter-hill to Barhead, about three miles in length, has been officially inspected this week and was opened for traffic yesterday (Thursday).

Peru.—A new submarine telegraph cable, made in England for the Central & South American Telegraph Co., has recently been laid between Valparaiso and Chorrillos, near Lima. This makes the third submarine cable between Peru and Chile, and there are two cables between Chile and the republics lying to the north of Peru.

Portrush.—The Council have asked Curran Bros., electrical engineers, Belfast, to send a representative to meet the Lighting committee to discuss the question of electricity supply.

Portsmouth.—The price of current for lighting has been reduced from 4½d. to 4d. per unit.

Provisional Order Revocation.—The Board of Trade have revoked the Chorley Electric Lighting Order, 1898.

Ravensthorpe (Yorks.)—An inquiry was held on Tuesday into the application of the Council for sanction to a loan of £2,650.

The Council obtained a provisional order in 1905, and propose to enter into an agreement with the Yorkshire Electric Power Co. for a supply of electricity in bulk. The Mirfield Gas Co. opposed.

Spain—Nearly all the existing tramways in Barcelona have made small extensions to their lines during the past year, but in only one case has any considerable extension taken place. The Sarriá-Barcelona Railway Co., which has now completed the electrification of the line, has also built a funicular line connecting Sarriá, a suburb of Barcelona, with the mountain village of Vallvidrera. Already the building of this funicular line has had the effect of expanding the residential district which the line is to serve.

By the sale of the Barcelona Tramways Co. to a Belgian syndicate the entire system of electric tramways in Barcelona passes into the hands of German and Belgian joint stock companies. It is notable that foreign enterprise in Barcelona is increasing yearly, and that British enterprise, on the contrary, is diminishing.

In the Barcelona district is San Felui der Guixols, and here an electric generating station is in course of erection which will supply the town and district with energy for public and private lighting and power.

Stoke-upon-Trent.—Sanction has been received to a loan of £7,249 for electric lighting extensions.

The Council have given notice of intention to apply for a provisional order for Fenton.

Sanction has been applied for a loan, £1,998, for an additional boiler, steam piping, &c., at the electricity works.

Sunderland—The Electricity and Lighting committee recommend the Council to apply for sanction to a loan of £6,600 to provide new machinery for supplying the shipbuilding yard of Sir Jas. Laing & Sons with electrical energy, for general supply of works in Monkwearmouth, &c. It was also decided to obtain an oil extractor for the Electricity works.

It has been decided to hold an electrical exhibition shortly.

Sunderland District Tramways.—The Sunderland & District Tramways Co.'s new line (1 mile in length) has been inspected by Col. von Donop on behalf of the Board of Trade and approved.

Switzerland.—The "Feuille Fédérale Suisse" of June 20 publishes a decree granting to M. Lanz, of Niederbipp, a concession for an electric railway from Niederbipp to Vieux-Soleure.

Tower of London.—The electric lighting installation at this ancient and historic building is being extended by His Majesty's Office of Works.

Water Power in Mexico.—It is reported that a concession has been granted to a syndicate of capitalists (mostly American) to utilise a Mexican waterfall near Saltillo for generating electricity. Power will be transmitted to Saltillo for working a tramway and also for general manufacturing purposes.

Wimbledon.—After Oct. 1 meter rents are to be abolished.

Marriages.—On Tuesday last, at the cathedral church of St. Paul, Dundee, Mr. H. Richardson, the city electrical and tramways engineer, was married to Miss Mary Elizabeth Thomson, daughter of Col. William Gordon Thomson, Taychreggan, West Ferry. Amongst numerous presents were a handsome case of knives, and a gold bangle for the bride, from the employés of the Corporation electricity department.

Mr. Lancelot W. Wild, chief electrician of Westminster Electrica Testing Laboratory was married yesterday (Thursday) to Violet C. Forty (daughter of W. M. Forty, of Newton Abbot) at Holy Trinity Church, Paddington.

Outings, &c.—An enjoyable summer outing of the P. & O. Batti-Wallahs' Society took place at Hampton Wick on Saturday on the invitation of the president (Mr. L. M. Waterhouse), a large gathering of members and lady friends being present.

The river was well patronised. Two motor boats and other river craft were provided for the use of the guests, the president's new motor boat cruiser, "The Lady Kate," being much in favour. A vote of thanks to the president, proposed by Mr. M. S. Chambers and seconded by Mr. W. Riggs, was carried with acclamation.

Arrangements were discussed for a smoking concert later on in the year. The hon. secretary (Mr. J. Avila) will be pleased to hear from old P. & O. electricians who have not yet joined the Batti-Wallahs.

The annual outing and luncheon of the employés of the arc and incandescent lamp department of the Victoria Works of the Sir Hiram Maxim Electrical Co. took place on Saturday under the presidency of Mr. A. W. Hill, the works manager.

The staff and employés of Tunbridge Wells Corporation Electricity department had their annual outing at Portsmouth last week. On the return journey, a reserved saloon carriage was utilised for a smoking concert. Mr. J. P. Strange proposed success to the electricity undertaking, and the chief engineer (Mr. H. Boot) responded.

The annual sports of the employés of the London United Tramways took place last week at Brentford.

Dinner.—The first annual dinner of the staff of Marylebone Council electricity department took place on Saturday. The chair was occupied by the borough electrical engineer (Mr F. A. Wilkinson), the vice-chairman being Mr. C. H. Smyth.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Barking.—There is a deficit of £558 on the past year's working of the electricity department.

Bexhill.—The accounts of the electricity department for the year ended March show capital expenditure £54,046, an increase of £1,867.

The year's revenue was £8,655 (against £7,257). Working expenses were £4,999 (against £4,688), including fuel £1,602 (£1,517). Intalments of repayment of capital were £1,533 (£1,376), interest required £1,542 (£1,494). £96 was allowed for depreciation, and the net profit is £484, reducing the total deficit to date to £1,092. The cost of coal per unit sold was 0·79d. (against 0·885d.); working expenses were 2·46d. (2·70d.), and total costs (including capital charges) 4·22d. (4·38d.). 313,163 units were supplied for private lighting (249,572) and 172,211 for public lighting (161,687). There are 571 private consumers, with the equivalent of 30,496 8 c.p. lamps connected, against 490 and 24,489. The capacity of the plant is 650 kw. The maximum demand was 479 kw.(against 371 kw.).

Bradford.—The accounts of the electricity department for the year ended March show total capital expenditure £727,293 (increase £108,373).

The income was £98,095 (against £94,958 in the previous year), including £54,451 from private consumers (against £51,983), £662 for public lighting (£656), £36,969 for tramways (£36,182) and £3,954 for hire of motors and lamps (£4,221). Capital charges were £47,459 (£41,781) and net profit £3,568 (£8,709). The total number of units sold was 13,984,054 (13,733,651). The balance of unappropriated profits has been reduced from £19,158 to £2,631, depreciation of hired motors and arc lamps accounting for £7,925, while £5,670 has been written off balance of cost of six marine-type boilers and boiler-feed pump.

During the past year the municipal tramways carried 45,331,000 passengers. The traffic revenue was £220,147, compared with £223,541, a decrease of £3,394. The carriage of parcels brought in £2,195, and mails £48 more than in 1904-5. Owing to decreased operating expenses the gross profit is slightly in excess of previous year, but interest, sinking fund, &c., have increased, and the net surplus is £15,929, compared with £11,637.

Croydon.—A net profit of £4,000 has resulted from the working of the electricity undertaking for the year ended March last.

Dover.—The capital expenditure of the electricity department at March 31 was £173,670, an increase of £4,520 during the year.

The revenue was £18,301. Working expenses were £9,366, showing gross profit £8,935, and after adding £1,476 from previous year and providing £6,882 for interest and placing £2,875 to sinking fund, the balance is £654, which has been carried forward. 1,441,382 units were generated, 108,543 supplied to public arcs and 37,859 to public incandescents, 382,129 for traction and 672,315 to private consumers. The total maximum demand was 433 kw. alternating and 300 kw. direct. The total connections to mains are equivalent to 37,300 8 c.p.

Ilford.—During the year ended March 31 the number of passengers carried by the municipal tramways showed an increase of 686,272, with increased receipts of £1,200. The total increase, including amount received from East Ham Corporation for Ilford-hill running, was £2,320. The gross profit was £9,439, against £9,285 in previous year; and the net profit £1,530. 3s. 10d.

Islington (London).—During the year ended March 4,077,219 units were generated and the units sold for power and for day supply increased from 76,673 in 1902-3 to 629,906 in 1905-6.

Running costs decreased in the same time from 2·70d. to 1·81d. per unit, and the total cost from 4·44d. to 3·13d. per unit. The average price paid per ton for coal has fallen from 18s. 9d. to 12s., and the weight of coal consumed per unit has dropped from 12·94 to 10·23 lb. The Finance committee's report states that if the undertaking had been in the hands of a company the amount available for dividend for the year, assuming the amount applied to repayment of capital had been set aside as depreciation, would be £21,673 or at the rate of 5¼ per cent. The equivalent of 128,765 8 c.p. lamps is connected, against 68,545 in 1902-3.

The Lighting committee report that they have carefully considered points raised by the Borough treasurer with regard to the time allowed for repayment of loans, which is an equated period of 42 years. In view of the present position and the future prospects of the undertaking the committee think the time has arrived when the Council should take steps to make more adequate provision for depreciation and that this can best be done by adopting the suggestion of the Borough treasurer that in future the period for which money shall be borrowed shall not exceed the estimated life of the object of the loan. The surplus upon the 12 months' working of the undertaking amounted to £14,915, and the committee considered this surplus should form the basis of a depreciation fund.

Loughborough.—The accounts of the electricity department for the year ended March 31, which were approved by the Council on Monday, show a deficit of £251. 14s. 6d.

Maidstone.—At the last Council meeting the chairman of the Electricity committee (Mr. E. Vaughan), in moving the adoption of the report on the past year's working of the electricity supply and light railways departments, regretted the net profit on the electricity undertaking was not more than £678.

The number of consumers had increased by 99, and the demand for power had exceeded expectations. The annual income was £10,460. 992,924 units were generated, the works costs being 1·1d., and the average price received 2·4d. per unit. The report recommended that the price of current for shop lighting be reduced from 4½d. to 4d. per unit, and for traction from 2d. to 1¾d.

On the light railways undertaking there was a gross profit of £1,994, and a net profit of £475. The working costs per mile were less and the receipts more than the consulting engineer (Mr. Sellon) had predicted. 1,395,359 passengers had been carried.

Newport (Mon.)—The capital expended on the electricity department at March 31 was £235,766, an increase of £14,598 on the year.

The annual revenue was £26,625, against £22,768 in previous year. Working expenses were £13,154. Interest and sinking fund absorbed £13,374, leaving £97 net profit. 2,764,901 units were sold, against 2,265,217, 1,200,000 being supplied to tramways, 880,000 for private lighting, 380,000 for street lighting and 650,000 for power. The equivalent of 106,036 8 c.p. lamps is connected, against 90,390. The maximum load was 1,760 kw., against 1,546, and the load factor 17·95, against 16·70 per cent.

The capital expended on the municipal tramways is £118,301, an increase of £1,130. Traffic receipts were £30,437 and total receipts £31,245; working expenses £21,184; interest and sinking fund £8,289, leaving net profit of £1,772. The receipts per car-mile were 9·50d. (against 8·46d.), working expenses 6·40d. (6·20d.), gross profit 3·10d. (3·26d.) and net profit 0·57d. 1,103,050 units of current were consumed, or 1·40 units per car-mile. 7,252,535 passengers were carried (against 6,421,773) and 783,434 car-miles run (792,365). There are 40 cars and 14½ miles of single track in use.

Norwich.—The accounts of the electricity department for the year ended March show total receipts £30,109, or 3·22d. per unit (against £30,259 and 3·46d. per unit in the previous year). Working expenses were £13,386, or 1·43d. (against £13,684 and 1·56d.) Capital charges were £11,244, leaving £5,603 net profit. 2,246,319 units were sold (against 2,097,942), including 1,322,941 for private lighting (1,235,180), 38,009 for public lighting (20,536), and 885,369 for power (842,226). There are 3,663 private consumers (3,283), with the equivalent of 112,260 8 c.p lamps connected (102,000), and also 297 motors (equal 1,304 H.P.), against 260 (1,104 H.P.)

Oldham.—The working of the electricity department for the year ended March last shows a deficit of £450 (against £1,307 in the previous year). Several items of special expenditure had to be met during the year.

Warrington.—The capital expenditure on the electricity undertaking amounts to £81,418, an increase of £3,096 during the year to March.

The year's revenue was £14,758 (against £12,070). Working expenses were £6,789 (against £6,076). Sinking fund required £2,490 and interest £2,715, leaving £2,763 net profit (against £1,544), which has been carried to reserve. Working expenses were 46·02 per cent. of revenue (against 48·29). The average prices received were 2·41d. per unit for public lighting (3·05d.), 1 71d. for private lighting (2·08d.), and 1·58d. for traction (1·6d.) The capacity of the plant is 1,850 kw., and the capital outlay per kilowatt is £41. 0s. 2d. (£42. 7s. 6d.) The maximum load was 1,038 kw. (993 kw.) 2,212,492 units were generated, 1,376,823 sold to private consumers, 60,917 supplied to public lamps, and 557,169 to tramways. The works costs were 0·559d. (against 0·668d.) per unit sold, the total working expenses being 0·731d. (0·883d)

West Hartlepool.—The report and accounts of the electricity department for the past year were approved by the Council on Tuesday. The gross profit was £4,867. 11s. 11d., an increase of £862. 8s. 11d. over the previous year.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Sunderland Corporation invite tenders for the supply of (*a*) two 250 kw. synchronous motor generators, 5,000—240 volts ; (*b*) high-tension and low-tension switchgear for above. Specifications, &c., from the borough electrical engineer, Mr. J. F. C. Snell, M.Inst.C.E.. Town Hall, Sunderland. Tenders (addressed to the chairman of the Electricity and Lighting committee) to the town clerk, Mr. Fras. M. Bowey, not later than noon 27th inst. Some further particulars appear in an advertisement.

Hackney Borough Council require tenders for section A, arc lamp pillars; B, erection of arc lamp pillars and switch pillars; C, arc lamps and accessories, and D, switch pillars. Conditions, specifications, &c., from Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders to the town clerk, Mr. W. A. Williams, Town Hall, Hackney, by 4 p.m. July 26.

London County Council invite tenders for about 33 miles of high-tension three-core lead covered cable, telephone cables, &c. ; and about 25 miles of low-tension lead-covered cables, telephone cables, &c. Specifications, &c., from the County Hall, Spring-gardens, S.W. Tenders to the clerk (Mr. G. L. Gomme) by 10 a.m. July 10.

Kings Norton and Northfield Council want tenders by noon 16th inst. for reconstruction of permanent way of tramways and construction of new lines and for overhead electrical equipment. Specification from Mr. A. W. Cross, 23, Valentine-road, King's Heath, or Mr. C. H. Gadsby, 20, Victoria-street, London.

West Ham Council want tenders by July 13, for l., h. and e.h.t. paper-insulated lead-covered and special cable and 6,000 volt transformers. Forms of tender from the Engineer and Manager of electricity department, 84, Romford-road, Stratford, E.

Dundee Council want tenders by July 13 for six electric tramcar bodies. Specifications from the General Manager of tramway department.

Tenders are invited for the supply of carbons and incandescent lamps to the *Norwegian* State Railways. Tenders, marked "Anbud paa Kulspidser og Glodelamper" will be received at Jernbanestyrelsens Expeditionskontor, Christiania, up to 3 p.m. July 13. Conditions, &c., may be seen at the Commercial Branch of the Board of Trade, 73, Basinghall-street, London, E.C. Apart from the usual customs duties, a preference of from 10 per cent. to 15 per cent. is given to Norwegian manufacturers, and it is necessary that a resident agent should act for tenderers not residing in Norway.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey Borough Council have received the following tenders:—

For 700 yds. of 0·2 by 0·2 by 0·1 triple concentric cable: W. T. Glover (accepted) £335. 4s. 10d.; St. Helen's Cable Co., £338. 12s. 6d.; British Insulated and Helsby Cables, £343. 8s. 9d.; Johnson & Phillips, £343. 8s. 9d.; Siemens Bros. & Co., £346. 4s.; Callender's Co,, £354.

For an electrically-driven boiler feed pump the tender of the Brush Co. has been accepted at £95, with £8. 5s. extra for a water meter; Hayward Tyler & Co., tendered at £100. 15s. and £8; General Electric Co., at £118 and £51; Marples, Leach & Co., at £125. 16s. 6d.; Crompton & Co., at £140. 18s.; Mather & Platt at £183; and the Alliance Electrical Co., at £139.

Stepney Borough Council have received the following tenders for annual supplies:—

Meters up to 10 amperes: Reason Mfg. Co. (accepted) £262. 10s.; Electrical Co., £282. 10s.; British Thomson-Houston Co., £302. 10s.; Chamberlain & Hookham, £325; Ferranti, Ltd., £325. Meters above 10 amperes: Ferranti, Ltd. (accepted) £302. 15s.; Chamberlain & Hookham, £302. 15s.; seven tenders were informal. Demand indicators: Reason Mfg. Co. (accepted) £337. 7s. 6d.; Monté Callow & Co., £318. 10s.; one tender was informal.

Carbons: Sloan Electrical Co. (accepted) £568. 6s. 9d.; Improved Electric Supplies, £696. 12s. 5d.; Siemens Bros. Dynamo Works, £711. 5s. 3d. Eight tenders were informal.

Middlesex County Council have conditionally accepted the following tenders for the construction of tramways:—

Dick, Kerr & Co., railways Nos. 1, 4 and 15 at same prices and under same schedule as the same firm constructed the Edgware-road to Willesden Green station route. The contract for railway No. 7 has been let to Vimpey & Co. at same prices and under same schedule as railway No. 2 constructed by this firm.

Dartford Council have accepted the following tenders for annual electrical supplies: British Thomson-Houston Co., meters; Johnson & Phillips (Ltd.), house service cable, £120. 13s. 1d.; British Insulated & Helsby Cables, house service cutouts, £15. 17s.; F. Bird & Co., solder, fuse wire, files, tools, &c., £10. 18s. 11d.; S. W. Gibson & Co., oils, jointing rings, packing, &c., £11. 1s. 3d.

The South Metropolitan Gas Co. have placed a contract for a complete ammonium sulphate handling plant with the Chain-Belt Engineering Co., who are also erecting a coal-handling plant for Grays Gas Co. and two refuse conveyors for Southwark (London) Council.

R. B. Hungerford has received an order for the extension of the Western Electric multiple telephone switchboard at Sydney (N.S.W.) telephone exchange at £1,394, in addition to an allowance for £184 customs duty.

An order for the supply of 4½ miles of 14-pair rubber-insulated aerial telephone cable at £630 has been placed with Gibson, Battle & Co., of Sydney (N.S.W.), by the Postmaster-General's department, Melbourne.

Salford Corporation have placed an order with Willans & Robinson for a 1,000 kw. Willans-Parsons turbine, coupled to a Brown-Boveri d.c. dynamo, with condensing plant, &c.

Maidstone Council have accepted the tender of Styles Bros. & Wickings for one year's supply of coals for the electricity department at prices ranging from 19s. 4d. to 14s. 3d. per ton.

Wimbledon Corporation have accepted the tender of Foster & Co. for 12 "excello" arc lamps at £113. 15s., and that of W. Lucy & Co. for 12 lamp columns at £84.

Swansea Electric Lighting committee have accepted the tender of the General Electric Co. for a 600 kw. steam generator (McLaren engine) at £6,106.

Erdington Council have accepted the tender of R. W. Blackwell & Co. for the electrical equipment of the tramway route from Salford Bridge to Chester-road at £5,385.

In consideration of Fulham (London) Council taking at least 300 electricity meters during the year, the British Westinghouse Co. have agreed to reduce the prices for 5 and 10 ampere meters.

Torquay Corpration have accepted the tender of Browett, Lindley & Co. for supply, delivery and erection of condensing plant at the electricity works at £1,079. 2s.

Stoke-on-Trent Council have accepted the tender of the Stanton Iron Co. for steam piping at £159. 13s. 6d.

Ramsgate Council have accepted the tender of E. J. Philpott for an electric fan for the Royal Pavilion at £86. 10s.

Wrexham Council have placed an order with the Triplex Electrical Engineering Co. for wiring the free library at £78. 10s.

The tender of E Dewhurst & Co. has been accepted for wiring Chorley destructor works.

BUSINESS NOTICES.

Aron Electricity Meter (Ltd.) will remove on July 16 to new premises at 80A, Salusbury-road, Kilburn, N.W.

In future the northern district office of the Chloride Electrical Storage Co. (Ltd.) will be at Standard-buildings, City-square, Leeds. Mr. L. Brookman will be in charge of the office as branch manager.

The telephone number of the London Electric Wire Co. (Ltd.), Playhouse-yard, Golden-lane, E.C, has been changed to 3,105, Landon-wall.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination of Thos. H. Hunter, electrician, Victoria-street, Seaton Carew (recently carrying on business at York-road, West Hartlepool), was commenced at Sunderland bankruptcy court on Thursday last.

Debtor commenced business at West Hartlepool in November, 1897, with £400 capital. Failure attributed to bad trade, losses on contracts and heavy interest. Gross liabilities £2,522, of which £842 was expected to rank, against assets £530. The examination was adjourned. Mr. T. R. G. Rowland, 3, Scarborough-street, West Hartlepool, has been appointed trustee.

Claims against Jas. M. Vaughan, electrical engineer, Three Queen's-lane, Bristol, are to be sent by July 18 to Mr. F. L. Clark, 26, Baldwin-street, Bristol.

A meeting will be held on July 31, at 4, Adelphi-terrace, London, W.C., to receive an account of the winding up of the Catania Electric Lighting and Tramways Co. (Ltd.)

The Llandudno & Colwyn Bay Electric Traction Co. (Ltd.) is being wound up voluntarily. Mr. John Morris, 33, Brazennose-street, Manchester, is liquidater.

Electric Lighting Provisional Order Transfer.—Tiverton (Devon) Town Council are prepared to receive offers for the transfer of their powers under their electric lighting provisional order. Particulars from the borough electrical engineer, Mr. J. Siddalls, Town Hall, Tiverton, and offers to the town clerk, Mr. C. M. Hole, by Aug. 7. See also an advertisement.

Sales by Auction.—Messrs. S. Walker & Son will sell at the Mart Lothbury, London, E.C., on Thursday, July 19, at two o'clock, in, one lot, some valuable freehold factory property at South Norwood. Particulars can be obtained of Messrs. G. Newman & Co., 15, Station-road, Croydon; of Mr. E. A. Burnie, 1, Lombard-court, London, E.C.; or of the auctioneers, 22, Moorgate-street, London, E.C.

Messrs. Horne & Co., 8, Delahay-street, Westminster, S.W., are instructed to sell by auction at the Royal Arsenal, Woolwich, at 11 a.m. on July 19th, some unserviceable and obsolete stores, including quantities of copper, iron, steel, gun-metal, phosphor bronze, zinc, tin, &c., 2½ tons of electric cable, gutta percha, indiarubber, lathes, tools, &c. Catalogues may be obtained at the War Office, Pall Mall; the Ordnance Office, at the Tower; and at the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Mr. Frank Bowen has been instructed by the Receiver of Nicholson & Robinson (Ltd.) to sell by auction on Thursday, July 12, at 3:30 p.m., at his sale rooms, 62A, Aldersgate-street and Hare-court, London, E.C., electrical engineering plant and stock comprising massive brass and ormolu flower and table standards, wall brackets, pendants, drops, electroliers, &c., lamps, glass shades, lampholders, carriers, dynamo testing machines, &c. Further particulars are given in an advertisement.

Plant for Sale.—The New Spa & Gardens (Ltd.), Bridlington, have for disposal some electric lighting plant, consisting of a dynamo, gas engine, &c. See an advertisement.

Messrs. Paten & Co., 19, Long-causeway, Peterborough, advertise for sale a complete electric lighting plant, comprising a 10 B.H.P. Crossley gas engine, Cutting dynamo (30 amperes at 20 volts), driving belt, switchboard, &c.

Old P.O. Stores for Sale.—Tenders are invited for the purchase of a quantity of copper and lead in convenient lots. Some particulars will be found set out in an advertisement. Form of tender on application by letter to the Controller of Stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. of July 18.

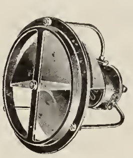
Premises to Let.—A factory or motor garage in the west end of London is advertised to be let in another column.

Messrs. B. R. Vickers & Sons, Gascoigne-street, Leeds, advertise for sale (or for letting) conveniently situated works on navigable river and near three goods stations, with good water supply, cheap coal, &c.

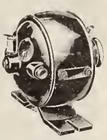
Delman's Welding Composition.—A correspondent wishes to know the name and address of the makers of Delman's welding composition. Replies will be forwarded.

Westinghouse Single-phase Railway System.—In the centre of the current issue of *The Electrician* will be found a well-illustrated description of the single-phase railway system owned by the British Westinghouse Co.

Catalogues, &c.—The General Electric Co.'s 1906 "Freezor" electric fan list is ready. The latest pattern fans of this type are illustrated in the list, and are claimed to represent the most advanced ideas in the development of electric fan motors, combining in one unit the three styles known as desk, trunnion and bracket fans. These fans can be adjusted to propel the air in any direction, requiring no extra parts or tools to adapt them for use as desk or bracket fans. The field cores are cast integral with the frame, making an unbroken circuit. The ceiling fans in this list have been improved in design since the last list was issued, and a new line of fans which the General Electric Co. are now offering is shown in the accompanying illustrations. These are exhaust and ventilating fans with "truss" patent blades. These fans run at a higher speed than the ceiling fans, are fixed in a ring by means of three arms, and are specially suitable for exhausting through a tube or duct. They give a much higher pressure than ordinary exhaust fans. The prices of many of these fans have been considerably reduced. There is also included in this list a new design of sewing machine motor outfit. The general design of these motors is the same as that of the fan motor, with which the list is chiefly concerned. The equipment consists of a motor with pulley, brake and switch mounted on a single supporting bracket, which can be attached to any style of table for use with all makes of sewing machines. The speed control is perfect, and by the arrangement adopted the use of a speed regulating rheostat is obviated.



FRONT VIEW OF 'FREEZOR' FAN WITH "TRUSS" BLADES.



G.E.C. SMALL ENCLOSED MOTOR.

A patent controlling finger, of the improved roller type, is placed upon the market by the Electrical Co. It is claimed to be simple in design, durable, economical, efficient and made to suit all types of controllers. A description of the device is given in leaflet 209 issued by the company.

Bishop's Safety Tread Co., of Blomfield House, London Wall, E.C., have issued a new list of their special type of safety treads for works and large buildings where there is much stairway traffic. It is claimed that these treads are safe, durable, clean and non-slipping. A list of establishments where the treads have been put in accompanies the catalogue.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from June 27 to July 3, with the ports of destination :—

Africa—Alexandria, £344 (including £116 telegraph material); Beira, £77 (telegraph material); Cape Town, £147 (including £91 telegraph material); Chinde, £23; Delagoa Bay, £212 (telegraph material); Durban, £971 (including £754 telegraph material); Port Sudan, £1,000; Sekondi, £24 (telegraph material). *Argentina*—Buenos Aires, £667 (including £555 telegraph material); Rosario, £1,166 (including £1,125 telegraph material). *Australasia*—Adelaide, £481; Christchurch, £125; Melbourne, £135; Napier, £20; Otago, £83; Perth, £187; Sydney, £915; Wellington, £578 (including £42 telegraph material). *Azores*, £37 (telegraph cable). *Belgium*—Ghent, £48. *Canada*—Halifax, £42 (telegraph material); Montreal, £10. *Ceylon*—Colombo, £319. *China*—Shanghai, £213. *Denmark*—Copenhagen, £7. *France*—Le Treport, £40. *Germany*—Hamburg, £90 (including £10 telegraph material). *Gibraltar*, £1,361. *Greece*—Piræus, £14 (telegraph material). *Holland*—Amsterdam, £269 (including £160 telegraph material). *Hong Kong*, £409. *India*—Bombay, £906 (including £663 telegraph material); Calcutta, £1,533 (including £62 telegraph material); Karachi, £147; Madras, £227 (including £202 telegraph material). *Japan*—Kobe, £255; Yokohama, £539. *Malta*, £22. *Russia*—St. Petersburg, £585. *Siam*—Bangkok, £290. *Spain*—Malaga, £40. *Straits Settlements*—Singapore, £121. *Sweden*—Stockholm, £12. *U.S.A.*—New York, £269. *West Indies*—Jamaica, £8. Total £16,968, against £12,291 in the corresponding week last year (June 28 to July 4).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 28, 1906.

12,369 KITSEE. Telegraphy.*
12,379 RAWORTH & RAWORTH. Regenerative control of electric vehicles.
12,385 ELECTRIC IGNITION CO. & HALL. Sparking plugs for internal-combustion engines.

12,395 Wallin. Electric furnaces.*
12,420 Imray. (Washington Licht Gesellschaft, Germany.) Vapour incandescence lamps.*
12,423 Lynch. Turbines.

May 29, 1906.

12,434 Newbery & Skipwith. Resistances for electric heaters.
12,450 Jones. Switches.
12,473 Heller, Stevens & Hare. (Cervenka, Austria.) Arc lamps.
12,477 Fairweather. (Electrical Devices Co., U.S.) Controller regulator.*
12,486 Solomon. Telephony.
12,488 Herde und Ofenfabrik Commandit-gesellschaft F. A. C. Gutjahr & Co. Electric stove. (Date applied for, May 9, 1906.)*†
12,491 Lamme. Dynamo electric machines. (Date applied for, 2/6/05.)*†
12,492 Hart. Electric motors. (Date applied for, June 12, 1905.)*†
12,493 Jackson. Connection system for supplying alternating currents of variable voltage. (Date applied for, June 12, 1905.)*†
12,497 B.T.-H. Co. (G.E. Co., U.S.) Control of dynamo electric machines.
12,498 & 12,499 Grote & Ely. Arc lamps.
12,500 Brown. Telegraph apparatus.
12,501 Swinehart. Pneumatic tyres.*
12,505 Martin. Switches operated by opening and closing of doors.
12,512 Riches. Telemeters.
12,537 Marshall. Electric junction and test boxes and the like.

May 30, 1906.

12,567 Williamson & Williamson. Shade devices for use with electric light.
12,587 Record & Bevis. Apparatus for measuring electrical resistances.
12,597 Bruncken. Single-phase alternating-current motors.*
12,600 Ingram & Ingram. Sparking plugs.
12,622 Ilgner. Supplying current to electric tramways in mines subject to firedamp.
12,625, 12,626, 12,627 and 12,628 Cowper-Coles. Electrolytic manufacture of copper wire, strip or ribbon.
12,636 Telegraphen-Werkstätte von G. Hasler. Speed indicators for vehicles. (Date applied for, May 31, 1905.)*†
12,638 Thomson. Electric current producers applied to toilet brushes, &c.

May 31, 1906.

12,685 Everett & Edgcumbe. Electrical recording instruments.
12,694 Brecknell, Munro & Rogers & Munro. Contact-making and circuit-controlling devices employed with signalling and point-shifting arrangements and time-recording devices of electric tramways.*
12,706 A.G. Brown, Boveri & Cie. Compound steam turbines. (Date applied for, June 2, 1905.)*†
12,720 and 12,721 Joel. Electric-mechanical propulsion of automobiles.
12,730, 12,731 and 12,732 B.T.-H. Co. (G.E. Co., U.S.) Machines for the manufacture of incandescent lamps.
12,735 Fullagar. Air compressors for use in turbine systems.

June 1, 1906.

12,736 Pass. Steam, gas and air turbines.
12,742 Michalke. Electric illuminated signs, advertisements and decorations.
12,748 Kitsee. Telegraphy.*
12,758 Cooper & Colley. Supporting broken trolley wires.
12,767 Harrison. Thermometrical and electrical devices for announcing attainment of predetermined heat.
12,773 Smith. Accumulators.
12,777 and 12,778 Barker. Magnetic compass.
12,797 Kennedy. Automatic signalling devices.*
12,802 Atkinson & Spikesman. Electric lamps.
12,819 B.T.-H. Co. (G.E. Co., U.S.) Igniting apparatus for internal combustion engines.
12,820 B.T.-H. Co. (G.E. Co, U.S.) Shaft bearings for electric railway motors.
12,821 B.T.-H. Co. (A.E.G., Germany.) Suspending the conducting wire of electric railways.
12,826 Marconi's Wireless Telegraph Co. (Pupin, U.S.) Telegraphy.*
12,828 Johnson & Brettell. Seats for trams, omnibuses and the like.
12,835 Berry. Apparatus for electrical production of heat for cooking, &c.

June 2, 1906.

12,855 A.E.G. Switches. (Date appled for, June 5, 1905.)
12,862 Morlock. Electrical brake for railway trains.
12,891 Babcock & Wilcox & Parker. Chain links of chain grate stokers.*
12,895 Harris. Starters for electromotors.*
12.896 Brecknell, Munro & Rogers & Munro. Bow trolleys.
12,907 Heideman. Operating points of rail or tramways from vehicles running thereon.*
12,918 Oppermann. Electrical controllers.
12,937 Serényi. Suction or pressure air nozzle for cleaning out plug-holes of telephone installations. (Date applied for, 2/6/1905.)*†
12,946 Parsons & Law. Brush sockets for dynamo-electric machines.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

23,857 Freakley & Bill. Wheels for tramway cars, motor cars, &c.
24,809 Parravano. System of syntonic radio-telegraphy.
25,288 Street. Electric signalling apparatus for house and like use.
25,636 Sims. Preventing the "live wires" from descending when broken.
25,826 Peticky, Cizek & Suchanek. Automatically connecting up telephone subscribers.
27,087 Richter. Turbines. (Date applied for, May 17, 1905.)

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.)

The tenth ordinary general meeting was held on Friday last, June 29 1906, Sir C. Rivers Wilson, G.C.M.G., C.B., in the chair.

The SECRETARY (Mr. Charles H. Dade) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: The accounts convey so much and such complete information as to the operations of the company that I think it will not be necessary for me to make a very minute analysis of the figures contained in these documents. It has been always the desire and the practice of the directors to supply shareholders with the very fullest information, keeping nothing back, and stating everything as clearly as they can as to the operations of the company. Indeed, I believe there is no other industrial company which gives more full and more complete information as to their proceedings than does the British Electric Traction Co. First of all I will refer to the reason for the decline in the dividend, and make some observations as to the future prospects of the concern. As to the first point, there has been a reduction in the profits, amounting altogether to £37,851, accounting for the reduction in the dividend. Three causes have led to that result. Although our earnings were in excess of last year, we have taken the prudent measure, which I think will commend itself to you, of writing off a much larger amount for depreciation than in the preceding year. We have written off £35,000, against £12,000 in the preceding year. This depreciation mainly refers to depreciation in respect of the undertakings and work done by the Company, and has no reference to our numerous associated companies, which all have their own provision for depreciation. We have also to meet increased prior charges to the extent of £17,409 in respect of additional capital raised in the shape of debentures and preference shares. These figures account for £37,851, or almost exactly a 3 per cent. dividend, which takes about £39,990. There is one item I want to explain. The total management and general expenses amount to £54,467. This is reduced by £50,874, of which £8,440 has been recovered from other companies and £38,542 has already been debited to profit and loss—that is to say, we might, by a different method of book-keeping, have made the management expenses appear in the account, instead of at £3,593, at £38,542; but in that case some of the profit appearing on the credit side would appear to be £38,542 larger. This, however, makes no difference to the net result. The remaining £3,891 has been charged to works in progress, and to this extent only is charged to capital. One interesting point is the steady reduction which has taken place in our expenses. In 1903 they amounted to £82,095, or 25 per cent. of the gross profits; for 1904 to £61,436, or 20 per cent. of the gross profits; for the past year £54,467, or 17·2 per cent. of the gross profits. Of course, we have not lately done so much pioneering work, and altogether the business has become more standardised. The result of increased activity would probably lead to increased expenses. One salient and interesting figure on the credit side is the profit on our Bombay undertaking. As you know, we were successful in forming a company with a capital of close on a million and a-half sterling to carry out the conversion of the Bombay tramways to electric traction, and to make important extensions of the lines, and also to undertake the supply of electricity for light and power in Bombay. We have now recovered the whole of our expenses in connection with this work, and have been able to make a substantial profit, commensurate with the important work which was done in building up the enterprise and with the heavy responsibilities which we undertook. The profit is £154,344, which we have taken in shares. During the last two years we have felt it our duty largely to reduce our capital commitments, and we have not taken up any large schemes, and our promotion profits, therefore, are less for the time being, but, on the other hand, our financial position has been strengthened. We shall not, of course, permanently continue the policy of the last two years, but we shall be guided by the circumstances of the moment. We received last year dividends on our investments £143,600, and interest earned £21,800, and we took in profit on undertakings worked by the British Electric Traction Co. £9,000, making altogether £174,400. You will see, therefore, that the dividend on the ordinary shares is in the main dependent on the increasing yield of our investments, supplemented by promotion profits. It is important that the shareholders should clearly understand the position in regard to the investments, because without doubt these constitute the mainstay of our business, We have investments costing £3,105,846, which produced last year a yield of £143,652, an average of 4⅝ per cent. There has been a slight reduction in the yield as compared with the preceding year. But it will be seen that there has been steady increase from £48,000, or 3·38 per cent., in 1901 to 5·1 per cent. last year and 4·62 per cent. this year. The investments, which were sold at a profit, represented the cost value of £329,105, and earned in 1904-5 £16,531, and during last year only £1,598, so that we lost £14,933 in revenue by reason of having parted with investments which were revenue-earning. In the case of both Poole and Yarmouth we could not help ourselves, as these undertakings were taken over by the local authorities. With regard to the County of Durham electric power business, we parted with an undertaking which had a very fine future, but which involved the spending of considerable sums of capital to adequately develop the business. There is still a large amount of investments (£1,438,000) which does not yet earn any dividend. But this proportion must be considered in comparison with the total investments, representing at cost £4,500,000. Of these over £3,000,000, or about two-thirds, are revenue earning. With regard to our investments generally, the stating our holdings in the report at cost price has the result of making some of them appear at rather a higher price than they would command on the market—for instance, our Consols stand in our books at a higher price than the market quotation—but I want you to bear in mind that we have a very large reserve (amounting to £575,000 at the present time) and that the directors have under contemplation the writing down of a certain number of these securities.

As regards the general operations of the company, I want the shareholders to thoroughly understand what the nature of the business is in which we are engaged. Our policy has been to assist existing tramway companies to carry out the conversion of their lines to electric traction. We have done the engineering and Parliamentary work for them at a moderate remuneration, we have assisted them financially by subscribing for their capital, and we have promoted entirely new schemes for new companies. These various services have, as a rule, resulted in profit to the British Electric Traction Co., and then we have assisted the companies in carrying on the operation of their lines. We have provided management for them and office accommodation, and in this way we have distributed our expenses and at the same time helped them to economise, and as the lines have become converted to electric traction a larger proportion of our investments have become remunerative, and the percentage return on these investments has steadily improved. The tramway mileage of all our various companies is at the present time about 381 miles. Our companies operate more than 15 per cent. of all the tramways and light railways in the United Kingdom but our capital expenditure is only about £12,000 per route-mile, compared with an average of £18,800 for all the lines in the United Kingdom. Looking back upon the 10 years of our working, I feel surprise, not unmixed with satisfaction, that so much has been done, in spite of numerous obstacles, that we have been able to maintain our company and establish it on such a sound basis. It is owing to the strenuous efforts of our general manager, Mr. Garcke, who, by his great ability and extraordinary industry, supported as he has been by his colleagues, Mr. Hilton and Mr. Madgen, as well as by our able secretary, Mr. Dade, that, in spite of these great obstacles, our company has been brought into the position it occupies to-day.

You will probably expect me to say something as to motor omnibuses, particularly as some shareholders entertain the apprehension that motor omnibuses will supersede electric tramways. I have spoken on this subject before, and still hold the opinion which I have previously expressed and which has also been affirmed by the Royal Commission on London Traffic. We consider that on routes suitable for tramways where there is a large traffic, tramways will continue to be the most efficient and the cheapest means of street conveyance. We have no doubt that motor omnibuses will speedily supersede horse omnibuses, and in some other directions also motor omnibuses will also find useful scope, but not in competition with well-established electric tramways. Speaking of the Brush Company, in which we hold so large an interest, I should like to take this opportunity of expressing our satisfaction with the steady improvement which has taken place in the affairs of that company during the past few years. The electrical manufacturers of this country are labouring under great difficulties. Many of the best foreign markets are closed against them, and on the other hand their home market is open to attack by foreign competitors, with the result that English manufacturers are not able to develop a very large output for export, and prices at home are kept very low. I now move the adoption of the report and accounts, and the payment of the dividends set out therein.

Mr. EMILE GARCKE seconded the motion.

Mr. TUCKETT expressed strong disapproval of the past financial policy pursued by the board. He moved as a protest "That the report and accounts be adopted, but that the dividend be not paid." He urged that the company had been drifting for many years, until its position to-day was a decreasing success. Taking the balance-sheet figures they had a reserve of £597,000. To the extent of all but £20,000, which was placed to reserve out of revenue, this reserve was built up out of premiums on the issue of debenture stock, preference shares and ordinary shares. That being so, it was essentially capital, and only available for capital purposes. To treat it in any other way means that you are, directly or indirectly, relieving revenue, and therefore paying dividend out of capital. As to the next item, £4,544,000 stocks at par less reserve, he had gone through the list and had found these shares were not worth the amount they stood for on the books. He wished to record his protest against these valuations and to suggest that in future they should not rely on profits in anticipation of the maturity of those profits. Mr. Tuckett then reviewed the general financial policy of the company, and urged the shareholders to forego the 3 per cent. dividend in the permanent interest of the company.

Mr. CROFT said, as one of the original shareholders, he must protest against Mr. Tuckett's statements. Mr. Tuckett did not give the directors fair credit for the policy they had adopted.

Mr. LEA SMITH said he thought it would be far better to pay no dividend. Everyone knew the enormous difficulties the companies had had in having to operate against the unfair competition set up by municipal trading. They had had to work side by side with rate-aided undertakings and with undertakings which were not under the tramway purchase clause.

Mr. NICHOLSON asked the chairman to say what increase had been made in the capital account by reason of the sale of investment and the reinvestment of the moneys so realised; also whether, and if so by what amount, the liabilities of the company had been increased. New enterprises were, of course, speculative. They might become valuable later on, and probably would, but in the meantime the company had to pay interest on its money, and these new companies did not.

Mr. GEORGE HERRING, as a very large shareholder, said they must remember that the British Electric Traction Co. was started as a promoting company, and so remained. It received its profit either in cash or shares in subsidiary companies. Being a promoting company, he did not see why their shares should not be reckoned as profit. What they had to do at the present time was to wait.

Mr. BRAITHWAITE, one of the largest shareholders, and representing one of the financial advisers of the company, said they all admitted that too much dividend had been paid in the past. Having made a mistake in the past, they would make a worse mistake if they paid no dividend. They were in a better position to-day to pay dividends than ever. The income derived from investments practically covered preference and debenture interest. They had £1,400,000 at present earning nothing, but this was gradually becoming remunerative.

The CHAIRMAN said Mr. Tuckett's criticism was strong and adverse to the directors, but no objection could be taken to it. Of course it was open to the shareholders to pass what Mr. Tuckett called a self-denying ordinance, and to decline to receive the dividend. Mr. Tuckett did not take an optimistic view of the future of the Bombay undertaking, but time would show that he was unduly pessimistic. There were other companies in which they were interested whose prospects were very bright. Mr. Croft and Mr. Lea Smith also contributed to the discussion of the accounts, and he was obliged to them and to Mr. Nicholson for their remarks. He was much gratified at the support the board received from Mr. Herring and from Mr. Braithwaite.

Mr. GARCKE said Mr. Nicholson had raised many points in the course of his comments, but the general tenour of his remarks was: "Why were they putting more money into investments which had not yet proved remunerative?" It should be explained that the increase in investments arose not out of new undertakings which they had taken up, but out of the completion of undertakings to which they were previously committed. It was true that the investments had diminished in yield, but the chairman made it clear that this small reduction arose out of investments which have been sold that were revenue earning. The majority of their investments were increasing in yield. With regard to their commitments to the Associated Companies, they were very much less than they had been.

The amendment was then put and lost by a large majority, and the resolution for the adoption of the report and payment of the dividend was carried.

The Hon. Sir Charles Fremantle having been re-elected a director, and Messrs. F. W. Smith & Co. and Deloitte, Plender, Griffiths & Co. reappointed as auditors, a vote of thanks to the chairman and directors terminated the proceedings.

Electric & General Investment Co. (Ltd.)

The seventeenth ordinary general meeting was held on Wednesday under the presidency of Mr. George Herring.

The SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting and the auditor's certificate.

The CHAIRMAN: I am sorry I have not our usual good report to place before you. It is not often that a chairman has to apologise for paying a dividend of only 15 per cent., but you have been so used to 30 per cent., 40 per cent., and 50 per cent., that I am obliged to apologise for it. And the unfortunate part of the matter is that we have really had a very good year. The difficulty we are under is that the depreciation in electrical securities is so great that we are compelled to put aside a sum of money to the contingencies fund which otherwise would have been distributed to you as dividend. There we have provision to the amount of £40,000 at least, and there will be this further sum now to be added to it. As regards the loan account, the amount last year was £66,000, and sundry creditors then stood at £56,000, but now those items stand at £64,000 and £26,000; that is, together £90,000 in this balance-sheet, against £122,000 a year previously. But there is nothing in that, because the amount fluctuates to a very great extent, and the higher it is the more business we are doing. On the other side, there are the investments at cost, and that is the point that has caused you not to receive your 30 per cent. dividend this year. All electrical and traction securities, as you know, are at the present moment in a very depressed state. My colleagues and I do not, I am sure, agree that the present price is at all equivalent to the worth of the articles, but there it is, and, as prudent men, your Directors are bound to take note of the fact that these shares are in that depressed state. But however low these securities are classed on the Stock Exchange, we receive dividends on all of them with two exceptions—one very small and the other not very large. At the present valuation of these securities and the contingencies fund we have got what we consider is amply sufficient to represent the amount of our investments. I now move the adoption of the report and accounts.

Mr. EMILE GARCKE seconded the motion.

Mr. H. CROFT asked if it was impossible to value the item shown in the balance-sheet of investments (£232,000).

The CHAIRMAN: No, it is not. Our securities are put in the balance-sheet at cost price. Nearly all of them have a value on the Stock Exchange. One or two are not quoted on the Stock Exchange, but even those are quoted on the American Stock Exchange, and as a matter of fact, therefore, we can approximately value our investments.

The resolution was carried unanimously.

The CHAIRMAN then moved that the dividends recommended by the directors be approved.

Mr. GARCKE seconded the motion, which was carried unanimously.

The retiring director, Mr. George Herring, and the retiring auditor, Mr. G. T. Rait, having been re-elected, a cordial vote of thanks to the chairman terminated the proceedings.

ASBESTOS & ASBESTIC CO. (LTD.)—Mr. T. F. Manville, at the meeting on Monday, said that last year was the most satisfactory they had had, the net profit being £6,812. The directors were about to contract for the supply of electricity to operate their mills in Canada. This would mean an outlay of £5,000 for electric motors and equipment. The contract they had entered into was considered by electrical experts to be a favourable one.

CHILI TELEPHONE CO. (LTD.)—The directors' report for the year ended March 31 last shows that the aggregate number of subscribers at all centres was 7,270, compared with 6,274. The gross revenue in Chili from all sources in 1905-6 was $1,090,569, compared with $978,746 in 1904-5, increase $111,823. Expenditure in Chili was $501,032, compared with $445,140, increase $55,892. Net income in Chili was $589,536, against $533,606, an increase of $55,930. The average rate of exchange for the year was 15·24d., compared with 16·30d., a decrease of 1·06d. Converted into sterling, the figures show £37,435 in 1905-6, against £36,227 in the previous year, an increase of £1,208. The balance to credit of revenue, including £2,467 from previous year, is £36,372, of which £16,119 has been carried to reserve. An interim dividend of 3s. per share (tax free) was paid in January, and the directors now recommend a final dividend of 5s. per share (tax free), leaving £2,653 to be carried forward. The total mileage of lines at March 31, 1906 was 12,373 miles 393 yds, an increase on the year of 1,613 miles 495 yds.

CLAUD HAMILTON (LTD.)—At the meeting last week the directors' report recommended that, after providing for the dividend on the 5 per cent. preference shares, writing a considerable sum off goodwill account, making substantial additions to the reserve funds, a dividend be paid on the ordinary shares of 5 per cent., making 7½ per cent. (tax free) for the year.

ELECTRICAL POWER STORAGE CO. (LTD.)—The directors' report for the year ended May 31, states that the profit (including £711. 1s. 1d. brought forward) is £9,314. 15s. 4d., out of which £1,000 has been carried to contingent fund, and £2,500 written off in respect of patents, goodwill, &c. The directors again recommend payment of a dividend of 6 per cent. on the ordinary shares, which will absorb £5,389. 13s. 7d., leaving £425. 1s. 9d. to be carried forward. Buildings, plant, tools, &c., have been maintained in thorough repair and condition at a cost of £3,663. 3s. 6d., which sum has been provided out of revenue. The directors are pleased to be able to record a successful year, notwithstanding the exceptional rise in the price of raw materials and the keen competition which still prevails.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—At the meeting on Friday Sir Walter R. Lawrence stated that, owing to an unprecedented congestion of traffic in Calcutta, their contractors were unable to start the supply of current in March. A member of the firm which represented the company locally had informed him that at Cawnpore a considerable consumption of electricity for private lighting was assured, while there would also be a good demand for light and power from the mills and factories in the district. The tramway routes were well selected, and a large traffic was anticipated.

NEW GENERAL TRACTION CO. (LTD.)—At the meeting on Wednesday, Baron E. d'Erlanger said the company's interest in the Mexboro' and Swinton Tramway undertaking had been disposed of at a net loss of £3,948, which they had debited to profit and loss. Their annual income from the different electric tramway companies in which they were interested amounted to £14,127, against £9,878 in the previous year. They had received an offer from one of the largest tramway companies in the United States to take over the whole of their systems near Philadelphia on a long lease on terms which would secure to the company the regular payment of interest at the rate of 4½ per cent. per annum on the £170,000 of bonds which they held, and a dividend on the shares of £139,000 which they held in the Philadelphia undertaking, as from July 1, 1906, at the rate of 1 per cent., for 1907 and 1908 2 per cent. for 1909 3 per cent., for 1910 4 per cent. and for 1911 and thereafter 5 per cent. per annum. The directors hoped that before the end of August they would be in a position to announce that the transaction had been completed and the actual conditions and terms of the contract settled.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—For the year ended March 31 the gross receipts in sterling in the River Plate were £181,085. 6s. 1d., against £151,084. 14s. 7d. last year. Deducting debenture interest, preference dividend and interim ordinary dividend, and adding interest on investments, &c., there remains £49,485. 0s. 10d., added to £2,591. 9s. 11d. from previous year, making £52,076. 10s. 9d. After putting £15,000 to renewal of plant and transferring £15,000 to reserve, the directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year (tax free). £2,076. 10s. 9d. is carried forward. During the year the cost of living in Argentina has steadily increased, and in consequence of this and the scarcity of labour in certain departments considerable advances in wages have taken place. The continuous increase in business has necessitated further capital expenditure, and to meet this it is intended to make an immediate issue of £100,000 in ordinary shares, which will be offered to the ordinary shareholders at par.

J. G. WHITE & CO. (LTD.)—At the meeting last week Lord Arthur Butler said the chairman (Mr. J. G. White) was prevented from attending the meeting by important business in the United States. The report and accounts spoke for themselves, and there was very little that he could add which would be of interest to them. The works which the company were carrying out continued to progress satisfactorily, and negotiations for procuring new business were progressing favourably. It was that the field for work in the United Kingdom might be somewhat restricted at the moment, due to competition and other causes, but, on the other hand, the company's business had expanded to a marked degree in connection with foreign contracts, and they would see from the report that they were represented in a good many parts of the world. He looked forward with confidence to their future progress, and judging from the present aspect of affairs they had every reason to hope that the company's operations during 1906 would be as successful during 1905.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

BRITISH ELECTRICAL TOOL CO. (LTD.) (89,294).—Reg. on June 28, capital £5,000 in £1 shares, to adopt an agreement with T. Crawshaw, and to carry on the business of manufacturers of and dealers in electrical tools, &c. First directors, T. Crawshaw (chairman), H. Bennett, J. Yeadon and A. Wilkinson. Reg. office, Cardigan Iron Works, Lennox road, Leeds.

HOME COUNTIES ELECTRICITY SUPPLY CO. (LTD.) (89,279).—Reg. June 27, capital £1,000 in £1 shares, to carry on the business of suppliers of electricity, electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical apparatus, &c. Reg. office, 137, Cannon-street, London, E.C.

IRISH ELECTRICAL AGENCY (LTD.) (89,281).—Reg. June 27, capital £50 in £1 shares, to carry on the business of an electric light and power company, electrical engineers, electricians, manufacturers of and dealers in electrical and other appliances, &c. Reg. office, Sanctuary House, Tothill-street, Westminster.

D. SANTONI & CO. (1906) (LTD.) (89,277).—Reg. June 27, capital £10,000 in £1 shares, to acquire and to carry on the business of electrical and general engineers, manufacturers of electrical and mechanical appliances, importers and exporters of electrical appliances and dealers in electrical goods and accessories carried on by D. Santoni & Co. (Ltd.). Reg. offices, 15 and 17, Beauchamp-street, London, E.C.

B. P. B. SYNDICATE (LTD.) (89,242).—Reg. June 25, capital £6,000 in £1 shares, to construct, equip and work railways, tramways, light railways and undertakings for the generation, utilisation, supply or distribution of electrical or other power, &c.

STATUTORY RETURNS.

SHEERNESS & DISTRICT ELECTRIC POWER & TRACTION CO. (LTD.)—Return to May 22 (filed June 7) gives capital as £50,000 in £10 shares, all of which have been taken up and paid for in full. Mortgages and charges, £15,000.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—Return to May 2, capital is £220,000 in 22,000 shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges, nil.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—According to return to March 27 capital is £1,500,000 in 200,000 ordinary and 100,000 preference shares of £5 each, of which 200,000 ordinary and 76,121 preference have been taken up. £5 per share has been called up on 195,936 ordinary and 76,121 preference and £1,360,285 has been received. £20,320 is considered as paid on 4,064 ordinary shares. Mortgages and charges, £470,000.

MORTGAGES AND CHARGES.

GENT & CO. (LTD.)—Issue on June 11 of £1,000 5 per cent. second mortgage debentures, part of series created May 22, 1905, to secure £6,500, charged on company's undertaking and property, present and future, including uncalled and unpaid capital. No trustees. Previously issued of same series, £5,500.

CITY NOTES.

MEMORANDA (July 5).—Bank rate 3½ per cent. (since June 21, 1906). Price of silver $29\frac{13}{16}$d. per oz. Consols $87\frac{11}{16}$—$87\frac{13}{16}$ for money, $87\frac{13}{16}$—$87\frac{15}{16}$ for account; 2½ per cent. annuities 86¼—86½. Consols Pay Day, August 1; Stocks and Shares Continuation Days, July 10 and 25; Ticket Days, July 11 and 26; Pay Days, July 12 and 27; Mining Share Carry-over Day, July 9.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Warrants in payment of a half-year's interest to June 30 on the 5 per cent. 1st and 4½ per cent. 2nd debenture stocks have been posted.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Warrants for the half-year's dividend payable July 1 on the 6 per cent. cumulative preference shares, for the dividend on the ordinary shares for the year ended May 31 and for the distribution by the trustees of the founders' and ordinary shares reserve funds have been posted.

NATIONAL TELEPHONE CO. (LTD.)—The directors have resolved, subject to final audit, to recommend the following dividends for the half-year ended June 30, after payment of the dividends on the preference shares:—At the rate of 6 per cent. per annum on the preferred stock, and 5 per cent. per annum on the deferred stock (less tax), carrying £120,000 to reserve and about £10,000 forward.

RAND CENTRAL ELECTRIC WORKS (LTD.)—During June 1,015,000 units were generated, yielding a gross revenue of £10,000, compared with 956,000 units and £8,900 in the corresponding month last year.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The transfer books will be closed from 2nd to 10th inst., both days inclusive, preparatory to payment of an ad interim dividend of 12s. per share.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.		Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	June	27	1,409	− 116	4	5,612	− 246
Airdrie	,,	22	224	+ 19	25	5,458	+ 563
Anglo-Argentine	July	1	12,581	+ 36	26	385,6 6	+ 86
Ashton-under-Lyne Corp.	June	23	848	+ 41	13	4,521	+ 519
Ayr Corporation	...		...	...	...	...	...
Baker St. & Waterloo Ry.	,,	30	1,419	...	16	23,118	...
Barnsley	,,	22	161	+ 16	25	4,003	+ 39
Barrow	,,	22	261	− 16	25	5,768	+ 868
Bath Electric Trams, Ltd	,,	27	858	+ 73	26	19,258	+ 2,853
Birkenhead Corporation	...		...	...	...	...	...
Birmingham Corporation	,,	30	620	+ 281	12	7,631	+ 2,856
*Birmingham & Mid.	,,	22	1,425	− 505	25	35,236	− 10,875
Blackburn Corporation	,,	27	1,102	+ 1	¶14	14,315	+ 810
Blackpool Corporation	,,	28	1,217	− 105	12	12,960	+ 598
Blackpool and Fleetwood	,,	30	873	+ 13	26	10,783	+ 971
Blackp'l, St. Anne's & Lytham	,,	28	544	− 105	§34	9,288	+ 1,030
Bolton Corporation	July	1	2,170	+ 228	12	28,411	+ 1,789
Bournemouth Corporation	June	24	1,628	+ 208	†13	20,708	+ 5,489
Bradford Corporation	,,	30	4,694	+ 202	13	60,840	+ 2,999
Brighton Corporation	July	1	1,020	− 72	13	12,711	− 500
Bristol Trams & Carriage	June	29	5,806	− 738	20	98,684	+ 3,192
Buenos Ayres & Belgrano	July	2	2,986	− 456	26	92,259	+ 5,503
Buenos Ayres Elec. Trms.	June	2	1,257	+ 185	22	30,885	+ 6,182
Burnley Corporation	,,	30	1,189	+ 40	13	15,925	+ 503
Burton Corporation	July	1	817	− 15	§13	3,965	− 237
Bury Corporation	June	24	1,018	...	12	12,196	...
Calcutta Tramways Co.	,,	30	R42,071	+ R1,095	26	R1,128,235	+ R102,759
Camborne-Redruth	...		...	...	...	...	...
Cardiff Corporation	,,	23	2,111	− 52	12	24,827	− 344
Carlisle Tramways Co.	...		...	...	...	...	...
Cavehill	,,	22	96	+ 30	25	1,842	+ 531
Central London Railway	,,	30	6,161	− 866	26	172,963	− 5,889
Chatham & Dist. Lt. Rys.	,,	28	643	− 42	†25	16,030	− 26
*City of Birm'gh'm Tram Co	,,	22	5,284	− 418	25	152,190	− 8,267
City & South London Rly.	July	1	2,555	+ 149	26	72,350	+ 329
Colchester Corporation	June	28	238	+ 11	48	9,059	− 1,291
Cork Electric Trams Co.	,,	28	558	− 55	26	11,695	− 303
Croydon Corporation	,,	29	1,062	+ 83	4	6,910	+ 746
Derby Corporation	...		...	...	...	...	...
Doncaster Corporation	...		...	...	...	...	...
Devonport & Dist. Trams	,,	22	442	− 31	25	10,758	− 442
Dover Corporation	,,	30	282	+ 15	13	8,226	+ 408
Dublin & Lucan Railway	,,	30	168	− 20	‡26	2,815	− 174
Dublin United	,,	29	5,794	− 139	‡26	125,488	+ 798
Dudley—Stourbridge	,,	22	832	+ 7	25	20,470	− 92
Dundee Corporation	,,	27	1,092	+ 214	§6	6,653	+ 1,324
East Ham Council	,,	30	957	+ 72	13	12,369	+ 1,303
Exeter Corporation	,,	29	305	− 14	13	3,727	− 191
Gateshead & Dist. Trams.	,,	22	918	+ 19	25	23,225	+ 1,096
Glasgow Corporation	,,	30	16,964	+ 5,283	5	77,827	+ 5,288
Glossop	,,	30	136	− 2	26	3,352	+ 310
Gloucester Corporation	...		...	...	...	...	...
Gravesend—Northfleet	,,	22	264	+ 15	25	5,548	+ 253
Gt. Northern & City Rly.	,,	30	1,752	+ 211	26	46,477	+ 2,740
Greenock & Port Glasgow	,,	22	809	+ 23	25	15,795	+ 890
Halifax Corporation	,,	27	1,817	− 15	13	21,931	+ 1,238
Hartlepool Tramways	,,	22	299	+ 57	25	6,813	+ 561
Hastings Elec. Trams Co.	,,	28	759	...	26	13,890	...
Huddersfield	,,	30	1,526	+ 169	13	20,066	+ 2,201
Hull Corporation	,,	30	2,310	+ 175	13	29,125	+ 695
Ilford Dist. Coun.	,,	30	529	− 2	13	6,684	+ 209
Ilkeston Dist. Council	,,	27	150	+ 15	13	1,688	+ 40
Ipswich Corporation	,,	30	460	− 51	13	5,625	− 80
Isle of Thanet Co.	,,	30	857	− 50	38	13,770	− 885
Keighley Corporation	,,	28	167	+ 1	51	7,415	...
Kidderminster & District	,,	22	108	− 19	25	2,653	− 46
Kilmarnock Corporation	,,	30	155	− 11	7	1,034	− 56
Kirkcaldy Corporation	,,	27	223	− 1	...	...	...
Lanarkshire Trams Co.	,,	28	912	+ 176	‡26	22,240	+ 5,080
Leamington	,,	22	203	+ 154	25	3,892	+ 2,175
Leeds Corporation	,,	30	6,285	− 166	13	81,238	+ 4,325
Leicester Corporation	,,	30	2,467	+ 74	26	56,107	+ 4,459
Leith Corporation	,,	28	519	+ 278	‡16	2,971	+ 1,607
Liverpool Overhead Rly.	July	1	1,528	− 100	26	26,989	− 2,659
Liverpool Corporation	June	28	11,035	+ 147	25	263,038	+ 5,848
*London County Council	,,	23	27,381	+ 11,278	12	319,591	+ 144,019
London United	,,	29	7,181	+ 455	†26	151,517	+ 8,921
Lowestoft	,,	30	177	− 31	40	5,361	− 325
Maidstone Corporation	,,	28	119	− 10	13	1,427	− 179
Manchester Corporation	,,	30	13,738	+ 204	13	176,896	+ 9,663
Mersey Railway	,,	30	1,745	+ 183	26	45,098	+ 3,015
Merthyr	,,	22	184	− 2	25	4,782	+ 23
Metropolitan Dist. Railway	July	1	8,103	+ 507	26	203,861	+ 14,785
*Metropolitan Elec. Trams	June	22	3,878	+ 536	25	80,457	+ 21,411
Middleton	,,	22	357	− 88	25	8,348	+ 430
Nelson Corporation	,,	30	145	− 1	14	1,978	+ 178
Newcastle-on-Tyne Corp.	,,	30	6,431	+ 548	13	53,712	+ 2,611
Newport (Mon.)	,,	30	627	+ 13	13	8,220	+ 370
Northampton Corporation	,,	29	461	...	13	5,743	+ 24
Oldham, Ashton & Hyde	,,	22	548	− 22	25	15,709	+ 532
Oldham Corporation	July	1	1,820	+ 211	11	25,034	+ 2,080
Perth (N.B.) Corporation	June	27	156	...	6	953	...
Perth (W. A.) Elec Trams	,,	29	1,401	+ 159	†26	38,937	+ 2,309
Peterborough	,,	22	133	− 9	25	2,838	− 259
Pontypridd District Coun.	,,	30	154	+ 3	13	2,238	− 19
Portsmouth Corporation	,,	30	2,148	− 300	13	25,733	− 179
Potteries	,,	22	1,689	+ 40	25	48,730	+ 2,342
Preston Corporation	,,	27	770	+ 26	...	...	...
Reading Corporation	,,	28	679	+ 9	...	...	...
Rochdale Corporation	,,	30	1,015	+ 173	13	13,881	+ 5,019
Rotherham Corporation	,,	28	483	+ 38	13	6,357	+ 6 0
Rothesay	,,	22	391	+ 171	25	3,090	+ 839
Salford Corporation	July	2	4,648	+ 161	13	60,862	+ 1,194
Sheerness	June	20	61	− 18	25	1,3 8	− 248
Sheffield Corporation	July	1	5,303	+ 407	14	73,752	+ 5,237
Southampton Corporation	June	27	1,084	− 32	†13	12,091	+ 51
Southend Corporation	,,	27	438	− 11	13	4,681	+ 161
Southport Tramways	,,	22	843	− 63	25	7,157	+ 102

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.		Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
			£	£		£	£
S. Staffordshire Trams.	June	22	781	+ 98	25	19,981	+ 2,521
Stalyb'dge, Hyde, &c., Jt. Bd.	...		...	...	...	...	...
Stockport Corporation	,,	29	1,001	+ 204	13	12,860	+ 4,140
Sunderland Corpn.	...		..	...	...	...	...
Sunderland & District	,,	27	435	...	26	9,628	...
Swansea Trams	,,	22	829	− 18	25	19,471	+ 4,412
Swindon Corporation	...		...	...	...	...	...
Taunton	,,	22	46	− 9	25	1,674	− 72
Tynemouth and District	,,	22	269	− 16	25	5,220	− 125
Tyneside Trams Co.	...		...	...	...	...	...
Wallasey District Council	,,	30	861	− 6	13	10,482	+ 843
Walsall Corporation	,,	30	540	+ 7	23	13,095	+ 949
Warrington Corporation	,,	28	391	+ 43	13	4,796	+ 492
West Ham Corporation	,,	28	2,427	+ 691	13	29,848	+ 9,087
Weston-super-Mare	,,	20	191	− 1	25	1,904	+ 68
Wolverhampton Corpn.	,,	27	815	...	...	...	...
* Wolverhampton District	,,	22	391	+ 35	25	10,111	+ 883
* Worcester	,,	22	255	− 33	25	6,489	− 602
Wrexham	,,	22	97	− 1	25	2,426	− 28
Yorkshire W.R. Trams	July	1	802	+ 13	26	20,385	...
Yorkshire Woollen District	June	22	1,059	+ 433	25	21,820	+ 6,613

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., July 4.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to July 4. Highest.	Business, Week to July 4. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	$6\frac{13}{16}$—$7\frac{1}{16}$	5 13 0	Ap, Oct	$7\frac{3}{32}$	$6\frac{7}{8}$
5	2/9	† Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	$5\frac{15}{16}$	$5\frac{27}{32}$
St.	6%	† Do. Permanent 6% Deb. Stock	139—141	4 5 0	—	..	..
St.	5%	† Auckland Elec. Trams 5% Deb. (red.)	102—104	4 16 3	—	103½	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—4½	5 11 6	—	..	..
St.	4½%	† Do. 4½ per Cent. Db. Prov. Cts.	96—99	4 11 0	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115—118	5 1 6	—	116	115½
St.	5%	Do. Pref. Ord. Stk	107—110	4 11 0	—	108	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107—110	4 11 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103—106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	$8\frac{5}{16}$—$8\frac{9}{16}$	4 18 0	—	$8\frac{3}{8}$	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5½—5¾	5 4 4	—	$5\frac{11}{16}$	..
5	8/0	Do. "B"	5—5½	5 7 0	—	..	—
St.	5%	† Do. 5 per Cent. Debs.	104—106	4 14 4	—	..	..
St.	5%	† Do. 5% 2nd Deb. (red.)	101—104	4 16 8	—	..	..
St.	5%	† Buenos Ayres Elec. Trams (1901) Ltd.	98—100	5 0 0	..	..	..
100	5½%	† Buenos Ayres Grand National 5½% Pref. Debs.	101—105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102—107	5 12 0	..	104½	101
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8¼—8¾	4 11 6	—	$8\frac{5}{8}$	..
5	2/6	† Do. Nos. 105,001 to 137,610	8—8½	4 14 3	—	$8\frac{1}{8}$	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103—105	4 5 9	—	104½	..
1	0/6	Cape Electric Tram Shares	½—¾	6 13 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100—102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	96—98%	5 4 2	..	97	..
St.	5%	† Kalgoorlie Elec. Trams 5% "A" Deb. Stock	91—93	..	..	..	..
St.	6%	† Do. 6% "B" Ditto	90—93	.	..	..	..
1	1/0	Lisbon Elec. Trams Ord. ex rights	$1\frac{3}{8}$—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref. ..ex rights	$1\frac{1}{8}$—$1\frac{3}{8}$	4 7 4	..	..	..
100	5%	† Do. 5% Reg. Mort. Debs.	98—101	4 19 0	..	..	..
St.	5%	† Madras Elec. Trams 5% Deb. Stk.	100—103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102—104	4 6 6	—	..	..
St.	5%	† Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105—107	4 18 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	142—145	5 10 0	..	143	..
..	5%	Do, 5% 1st Mt. $500 Dbs,	97%—99%	5 1 0	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	$5\frac{1}{32}$	5
5	5/3	Calcutta Elec (1–50,000)	$8\frac{1}{8}$—$8\frac{5}{8}$	4 18 0	—	..	..
10	5%	† City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48—50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92—94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	† Do. 5% Debs.	85—89	5 12 4	—	..	..
St.	6	† Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	110—113	5 6 2	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{27}{32}$—$\frac{29}{32}$	6 6 6	—	..	..
1	1/6	Rand Electric	$1\frac{1}{16}$—$1\frac{3}{16}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$1\frac{7}{16}$—$1\frac{9}{16}$	..	..	½	..
1	1/2⅔	Do. 6% Non. Cum. Pref	⅞—1	6 0 0	..	..	..
St.	5%	† Do. 5% Deb. Stock	100—102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1–12,000)	5⅜—5⅝	5 8 6	..	5½	..
100	4½%	* Royal Elec., Montreal 4½% 1st Mort. Deb	99—102	4 8 0	Ap, Oct	—	...
..	5%	† Shawinigan Water and Power 5% Bds., Scrip	99—101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., July 4.	Rate % Yielded.	Dividend Due.	Business, Week to July 4. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.		Highest.	Lowest.
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10¾–11¾	5 19 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	..	—
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	—
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛–5⅝	4 18 0	..	..	—
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	—	..	—
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 –9	5 11 6	—	8¾	..
5	3/6	Do. 7 per Cent. Pref.	7¾–8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 –5	5 0 0	Feb, Aug	4 7/16	..
5	2/3	Do. 4½ per Cent. Pref.	4¼–4¾	4 14 9	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 18 3	—	—	—
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	3¾–4½	5 6 0	—	..	—
5	2/3	† Do. Do. (1903)	3¾–4½	5 6 0	..	3⅞	..
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	5¾	5 5/16
St.	4½%	*† Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	..	—
10	7/0	City of London Electric Lighting Ord.	10½–11½	5 6 6	Feb, Aug	11	10¾
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	..	..
St.	5%	*† Do. 5 per Cent. Deb. Stock (red.)	121 –124	4 0 8	Jn, Dec ..	—	—
St.	4½%	† Do. 4½% 2nd Deb. Stock (red.)	99 –102	4 8 3	..	..	—
5	4%	County of Durham Elec. P. D. Ord. £3 pd.	3 –3 1/32	4 0 0	April, Oct	—	..
5	5%	Do. Do. 5% non cum. pref.	5 3/16–5 5/16	4 15 1	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8 –9	5 11 0	—	8⅝	—
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 18 0	Mar, Sept	..	..
St.	4½%	† Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 1 10	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	102⅝	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 6	—	—	..
5	5/0	Hove Electric Lighting Ord.	7¾–8¼	5 9 0	—	8 1/16	8
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 –11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 2	..	..	—
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	—	..	..
3	2/4⅘	London Electric Supply Ord.	2 –2½	4 0 0	—	2 3/16	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	—	..
5	10%	Metropolitan Electric Sup. Ord.	8¾–9¼	5 8 6	April, Oct	..	—
5	2/3	† Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 10	Jan. July	..	—
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	109	..
St.	3½%	† Do. 3½ per Cent. Mrt. Db. Stock (red.)	94 –96	3 18 0	—	..	..
100	4½%	† Midland Elec. Corp. for P. D. 1st Mort. Db.	98 –101%	4 9 1	—	101	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	12 –12½	5 11 1	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾–7⅞	5 2 6	Feb, Aug	7⅞	—
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞–6	4 1 0	Feb, Aug	6	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	—
1	8%	Northern Counties Elec. Sup.	1 3/32–1⅛	2 13 3	Mar, Aug	1⅛	..
100	4½%	Do. 4½% Deb.	101 –102	4 8 9	Jan, July	..	..
10	6/0	† Notting Hill Electric Ord.	13½–14½	6 4 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅜–6⅞	4 17 0	March ..	..	—
St.	4%	Do. 4% Deb. Stock	99 –101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 –80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 8 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	—	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1 3/16–1 5/16	5 9 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105 –106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3½–3¾	6 13 4	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100 –102	4 8 0	..	101½	101
5	6/6	Westminster Elec. Sup. Ord.	10½–11½	5 18 0	Mar, Sept	..	..
5	2/3	† Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 7/16	5 5/16
5	1/4½	† Do. Issued at 7/6 premium all paid	5¼–5½	4 11 0	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	92 –94	4 5 0	—	93¾	92½
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	1	..
1	0/6	† Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101 –104	4 6 6	—	102½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	98½	98
10	8½%	Bristol Tramways and Carriage Ord.	15½–15¾	5 8 0	Feb, Aug	—	—
10	4%	† Do. Cum. Pref. (fully paid)	10 –10½	3 18 0	..	—	—
St.	4%	† Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	—
10	6/0	British Electric Traction Ord.	5½–6	5 0 0	—	5 21/32	5 7/16
10	6/0	Do. 6 per Cent. Cum. Pref.	9 –9½	6 6 3	Feb, Aug	9 7/16	9¼
St.	5%	Do. 5 per Cent. Perpetual Debs	109 –113	4 8 6	..	112	110
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	90 –93	4 17 0	..	91	90½
St.	4%	Central London Ordinary Stock	85 –87	4 12 0	June, Dec	86⅜	85½
St.	4%	Do. 4 per Cent. Pref. Stock	99 –101	3 19 0	..	..	..
St.	4%	Do. Deferred Stock	74 –77	5 4 0	..	..	—
100	4%	Do. 4 per Cent. Debs.	110 –112	3 11 3	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	91 –93	4 6 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞–5⅛	4 9 0	..	..	—
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	39 –41	4 11 6	Feb, Aug	41¾	40
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	—
St.	5%	Do. (1901)	114 –117	4 5 3	—	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	14½	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼–3¾	10 13 4	..	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	—
10	6%	†‡ Do. 6 per Cent. Pref.	11½–12	5 0 0	Mar, Sept	—	—
St.	4½%	†‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	—	2⅛	2
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16–8 15/16	3 18 0	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	† London United Trams. 5% Cum. Pref.	7¾–8¾	5 14 0	—	8⅜	8
St.	4%	† Do. 4% 1st Mort. Deb. Stock	94 –97	4 2 6	—	95⅜	95¼
St.	..	Mersey Con. Ord. Stock	4 –6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	⅞–1	5 0 0	—	..	..
St.	4½%	† Do. 4½% Deb. Stock	100 –102	4 8 3	—	..	..
5	—	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	7 –8	6 12 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾–8¾	5 14 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	—	..	..
100	5%	† Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	90 –93	5 7 6	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	94 –96	5 4 0	—	..	..
St.	3½%	Waterloo and City Ord.	100 –103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	—	..	..
St.	4½%	† Do. 4½% 1st Debs.	93 –95	4 14 9	..	..	..
		ELECTRIC MANUFACTURING, &c.		£ s. d.		Highest.	Lowest.
1	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	—	½	..
1	2/4⅘	Babcock & Wilcox Ord	3¾–4	4 14 0	..	3 23/32	3 11/16
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6½–7	5 14 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6¼	16 0	Jan, July	6	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	—	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1⅛–1⅝	..	..	1 7/16	1¼
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	78	77
2	1/0	Brush Electrical Engineering	⅝–⅞	..	March	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	98½	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	—	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	—	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs. (rd.)	107 –109	4 2 6	Nov, May	..	..
1	9⅗d.	Castner-Kellner Alkali Co.	1 1/32–1 5/32	5 4 6	..	1⅛	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	—	100½	100
1	1/4⅘	† Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	—	1¼	—
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 3 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1 11/16–1 13/16	3 17 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94%–97%	5 3 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1¾–1⅞	5 8 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	—	..
St.	4½%	† Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅜–1⅝	4 13 0	Feb, Aug	1 9/16	1 15/32
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾–4¼	8 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4½–5	6 0 0	..	—	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 –106	4 5 0	—	..	..
2	1/7⅕	Electric Construction Co.	⅜–⅝	11 4 0	July	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 –2½	5 12 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	88 –91	4 8 0	Jan, July	..	..
10	5/0	† General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	12 7/16	—
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 1 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	108½	107
St.	22/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	..	..
10	5/0	† India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17 13/16	17¼
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 13 6	—	1	..
St.	4½%	† Do. 4½% Perp. Deb. Stock	96 –99	4 11 0	..	..	..
12	24/0	Telegraph Construction & Mainten'ce.	32 –34	5 6 0	Mar, July	..	..
100	4%	† Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16–2 9/16	5 15 0	..	2 17/32	2 15/32
1	6d.	Do. 5% Non-Cum. Preference	1 1/16–1 3/16	4 4 0	..	1 5/16	1⅛
St.	5%	Do. 5% Non-Cum. Preferred	114 –117	4 5 4	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 –105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	104 –106	4 5 0	—	105	104¾
5	—	Willans and Robinson Ord.	1 –1½	—	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾–3¼	—	Apr. Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	78 –83	4 16 6	May Nov	..	..
		TELEGRAPHS.					
10	—	Amazon Telegraph	3 –3½	..	Ju, Dec ..	..	..
100	5%	† Do. 5% Debs. (red.)	80 –85	5 17 8	..	..	..
St.	15/0	Anglo-American	65 –67	4 17 0	F, My, Ag, N	66¾	65½
St.	30/0	Do. Preferred	112 –113	5 6 2	F, My, Ag, N	113¼	112½
St.	10/0	Do. Deferred	23¾–24	2 2 0	F, My Ag, N	25 5/16	23 7/16
St.	4%	† Commercial Cable 4 per Cent. Deb. Stk	97 –99	4 1 0	Jn Ap, Jy, O	98¾	97¾
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	..
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	4/0	Direct United States Cable.	15½–16	4 13 9	Ja, Ap, Jy, O	15 13/16	15 9/16
100	4½%	† Direct West India Cable 4½% Rg. Db. (rd.)	99½–101½	4 8 9	Jn, Dec ..	..	..
St.	25/0	Eastern Ordinary	141 –144	4 17 2	Ja, Ap, Jy, O	144	142½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 16 0	Ja Ap, Jy, O	91	90½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	107¾	107
10	6/6	Eastern Extension	14 –14½	4 16 6	Ja, Ap, Jy, O	14⅜	14 7/32
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 4	Feb, Aug	107	106½
100	4%	Eastern & S. African 4% Mrt. Deb. 1909	100 –102	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) ex coupon 67	39 –41	5 17 0	Jan, July	40½	..
100	4½%	† Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½–101½	4 8 9	June, Dec	101	..
25	52/6	Indo-European	57 –59	5 10 0	May, Nov	58¾	58½
100	4%	Mackay Companies Common	71 3/16–71 7/16	5 9 6	Jan, July	—	..
100	4%	Do. Preference	72 5/16–73	5 9 6	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	..	..
100	4%	† Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	..
2½	—	West Coast of America	¾–⅞	..	—	¾	..
100	4%	† Do. 4 per Cent. Debs.	99 –102	3 17 0	Jan, July	..	..
10	—	West India and Panama	⅜–½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6 –7	3 11 4	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	*† Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	† Western Telegraph	14½–14¾	4 15 0	Mr, Jn, O, D	14½	14¼
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	102 –105	3 16 2	..	102¾	..
		TELEPHONES					
—	4%	† Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 –103	4 17 0	..	102½	102¼
5	8/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August	..	..
1	0/4	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	—	—	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	5%	National Co. Pref. Stock	110 –112	5 7 0	—	111¼	108
St.	5%	Do. Def. Stock	106 –108	4 12 6	—	108	106
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –14	4 5 6	Feb, Aug	13	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	..	..
St.	3½%	*† Do. Deb. Stock 3½ per Cent. (red.)	96 –98	3 11 6	June, Dec	97½	96
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	103 –104	3 7 0	..	104	10 ¼
1	0/9⅗	Oriental	1 1/16–1 3/16	4 8 6	April, Oct	1 5/32	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼–1⅜	4 7 0	—	..	..
St.	4%	† Do. 4% Red. Deb. Stock	97 –99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 7	..	..	..
5	8/0	United River Plate	7 –7½	5 6 8	July	7 5/16	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5½–6½	4 2 0	June, Dec	..	..
St.	5%	*† Do. 5 per Cent. Deb. Stock (red.)	108 –111	4 10 0	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	† Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	..	..	..
10	5/0	Globe Telegraph and Trust	10⅞–11⅛	4 10 0	Ja Ap, Jy O	11 1/16	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅞–15⅛	4 0 6	Ja Ap, Jy, O	14⅞	14⅝
10	6%	Submarine Cables Trust (Cert.)	127 –130	4 12 3	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these..

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NOTES.

It was a happy thought on the part of the Faraday Society to ask Prof. BIRKELAND for a Paper on the "Fixation of Nitrogen," and the Society were fortunate in having the author himself as the reader of the Paper. There is always an advantage in having Papers from those who are actually engaged in the work that is described, and therefore, at the risk of reproducing some points already given to us by Prof. SILVANUS THOMPSON, we give elsewhere Prof. BIRKELAND'S Paper almost in full. We also give an abstract of Prof. GUYE'S Paper dealing with the more commercial aspects of the same question.

◆

PROF. BIRKELAND is one of those rare workers in the domain of science who realise the commercial importance of the scientific work on which they are engaged. Until recently this physicist was known chiefly by his early work on those electric discharge effects in the atmosphere known as the Aurora Borealis, and by some very beautiful experiments on vacuum tubes. The latter depended upon the magnetic deflection of discharges in vacuo, and the pursuit of this line of investigation led to the discovery of the magnetically-controlled disc of flame now being used in the Birkeland-Eyde process of fixing nitrogen. As Prof. SILVANUS THOMPSON remarked at the meeting of the Faraday Society, it is difficult to say where Prof. BIRKELAND'S process will end, but it began undoubtedly in the Aurora Borealis.

◆

ON another page we reproduce an article by Dr. C. H. SHARP on the spherical reduction factor of tantalum lamps, from which it appears that these lamps, notwithstanding the high fusing point of tantalum, show a decided blackening of the glass bulb. The particular feature of this blackening is that it occurs only as a zone on the glass surrounding the network of filaments. If it were uniformly distributed over the whole of the bulb it would be less important from the photometric point of view, but a zone of this kind so alters the distribution of light that the spherical reduction factor does not remain constant, and photometric measurements taken in a direction perpendicular to the filaments will give results on a life test unfair to the lamp. Now that incandescent lamps are becoming so varied in type, it is important that photometric points of this kind should be cleared up, so that results on different types of lamp may be really comparable.

◆

MR. BURKE'S reply to Dr. BASTIAN'S letter on the origin of life, and the latter's rejoinder, will be found in our Correspondence columns. From these letters it appears to us that, even from the biological point of view, there is small chance of the radiobe obtaining a foothold in the class of things acknowledged to possess any kind of vitality. Incidentally, it is now sufficiently clear that the radiobes made by Mr. BURKE do not exemplify a phenomenon novel in character; they are, it would seem, merely "higher in the scale than those [cellular bodies] produced by other salts." This fact is worth noticing by those who recall the sensational manner in which Mr. BURKE'S discovery was originally announced. However, in the absence of additional and pertinent experimental evidence, further bandying of words is useless, so we must close the discussion and let the radiobe rest in peace.

◆

THREE years have elapsed since the Admiralty entered into an agreement with the Marconi Wireless Telegraph Co., and now at length the terms of the agreement, as given elsewhere, are made known. It may be doubted whether the Admiralty has done wisely in binding itself to one particular system for the next eight years, subject to patents being valid. Wireless telegraphy is still very youthful, and in young days competition may be most desirable; but when any one system is taken up by the State, competition becomes very much more difficult, and may die out for a time. Be this as it may, the Marconi Company is to be congratulated on securing from the Admiralty, in addition to other payments, a fixed revenue of £5,000 per annum, a sum which should have a material effect in producing a satisfactory balance-sheet.

At the annual general meeting of the E.P.S. Co., the chairman remarked that the business of the company in batteries for electric automobiles is still increasing, from which it would appear that the electric carriage for town use is still holding its own against the petrol car, notwithstanding the perfection to which the latter has been brought. But the most interesting remark, particularly in the light of recent events surrounding the "Electrobus," is that the company is giving special attention to the question of the electric omnibus, and hopes shortly to have a specimen omnibus running in London. Definite statements are deferred for the present, but the opinion is expressed that if success depended on the upkeep of the accumulators alone, there is no reason why the electric omnibus should not be the solution of the much-discussed question of motor vehicles in crowded traffic. In view of the freedom with which such statements have been made in the past without being justified by results, we shall look forward to developments with interest, the more so that the subject is being taken up by a responsible company.

In our last issue we announced briefly that the Corporation of Glasgow had resolved to sell their telephone system to the Post Office—a decision which will have the effect of removing the most important example of municipal telephony. From the reports that have now come in, it appears that the Corporation have been in a difficult position. Originally there seems to have been very good reason for a competing service. The charges of the National Telephone Co. were extremely high, and the telephones only numbered 7,000. Through the action of the Corporation this has been very much changed for the better. The National Telephone Co. now supply for £10 per annum what they used to give for £25, and they have introduced a telephone on certain terms at a very low figure indeed, with the result that the telephones now number 38,000. Now, however, the Corporation see difficulties ahead in the way of raising money for a short term, assuming that their licence would not be renewed after 1913, and we think they have done wisely in deciding to sell the undertaking.

From the negotiations that have taken place it appears that the Glasgow Corporation have a deep-rooted objection to anything in the shape of a private monopoly. This is perhaps only natural after their experience. It is a question, however, whether this objection is worth paying for, at least heavily. The purchase price to be given by the Post Office for the telephone system is £305,000, involving the Corporation in a loss of about £15,000, whereas the National Telephone Co. seems to have made an offer to buy the system at such a price that no loss would fall on the Corporation. But the idea of the municipal telephones forming part of a private monopoly was not to be tolerated, and though, for aught we know, the Post Office might subsequently sell to the National Telephone Co., the Corporation are to sell at a loss. Perhaps, however, the ratepayers will not suffer after all, for at the meeting of the Corporation the sentiment was expressed that there were "generous hearts who would find the money," and so the unfortunate difficulty may yet be solved satisfactorily to all parties.

After many efforts the London County Council have been successful in passing their General Powers Bill through both Houses of Parliament. Any metropolitan borough will now be able to wire premises, supply fittings and hire out motors. As the use of electric energy for power purposes can be much extended among a certain class of consumers if motors can be hired, the right to do so is important and is a legitimate extension of municipal business. But wiring by local authorities is a form of municipal trading that is by no means desirable; it is in direct competition with wiring contractors who may be ratepayers of the local authority, and there will be a good deal of difficulty in keeping accounts so as to show the true financial results.

Automatic Telephony.—It is stated in the *Western Electrician* that Mr. Andrew Carnegie has purchased from the Automatic Electric Co., of Chicago, a complete private automatic exchange equipment of 20 lines for his estate at Skibo Castle in Scotland. The first 13 lines are to be working by August.

National Physical Laboratory.—We are asked by Mr. T. Mather to state that the drawings of the standard ampere balance at the National Physical Laboratory were prepared by Mr. J. P. Gregory, of the British Thomson-Housten Co., Rugby, who was at the time a student at the Central Technical College.

Electric Ambulances for the City.—The Police sub-committee of the City Corporation have decided to proceed at once with a scheme of electrically-propelled ambulances for the City. Horse-drawn ambulances were originally proposed, but electric cars have been adopted on the score of economy, and as being better suited for the narrow thoroughfares which abound in the City.

Highgate Hill Cable Tramway.—Owing to the refusal by the police authorities to renew the licence of the cars of the Highgate Hill cable tramway as metropolitan stage carriages until they have been put in a thorough state of repair, the line has been closed. According to *The Times*, the Highgate Hill line was the first steep grade tramway in Europe, and the original cars have been in use ever since its construction in 1884. A proposal is now before the Light Railway Commissioners for electrifying and extending the line.

Single-phase Traction in America.—It is announced in the *Electrical World* that the directors of the Erie Railway have decided to equip their line on the single-phase system. It is intended, in the first instance, to equip the Rochester and Mount Morris division, a distance of about 35 miles, and a contract has been placed for the equipment of a transformer station and seven cars. Four Westinghouse single-phase 150 H.P. motors will be employed on each car and an overhead line with catenary suspension will be used. Power will be obtained from Niagara Falls.

Wireless Telegraphy.—In his report on the trade of New Orleans, Mr. Consul Crewe-Hunt states that the U.S. Navy Department has accepted the De Forest wireless telegraph stations at Panama, Guantanamo (Cuba) and Key West, these completing the chain of wireless stations built for the U.S. Government. The other stations are at Pensacola (Florida), San Juan, Puerto Rico and Colon. Three of the stations are of 1,000 miles radius and two of 450 miles. A wireless station is now in full operation at St. Augustine and Anastacio (Florida).

Efficiency of Steam Plant.—Mr. W. A. Vignoles writes as follows with regard to the discussion on his Paper on the above subject, read before the convention of the Incorporated Municipal Electrical Association on June 22nd, and reported in our last issue:—"There seems to be very little in the discussion calling for a reply from me, but, with reference to the remark by Mr. Brydges, I may say that the air pressure with a fire 18 in. thick is about 1 in. to 1½ in. in the ash pit. I must thank the various speakers for the information they have given about coal contracts, &c., and for the kind way in which the Paper was received."

The Junior Institution of Engineers.—The summer meeting of the Junior Institution of Engineers will be held in the Manchester district from July 14th to 21st. The headquarters will be at Southport, where the Corporation electricity, tramway and gas undertakings will be visited. Receptions will be held by the Lord Mayor of Manchester and the ex-Mayor of Southport, and the meeting will conclude with the Institution annual dinner at the Queen's Hotel, Southport. The following are among the objects of interest which it is proposed to visit:

The Works of the British Westinghouse Electric & Mfg. Co., the Manchester Municipal School of Technology, the National Gas Co.'s Works, and the Rose Bridge & Douglas Bank Colliery, Wigan.

Vol. XV. of the *Transactions* of the Junior Institution of Engineers, which has recently made its somewhat tardy appearance, records the proceedings of the session 1904-5. The volume contains a number of Papers of interest and accounts of visits to works, and is a great improvement on its predecessors in the matter of illustrations. A full report is also given of the "Coming of Age" celebrations held in June, 1905, together with some interesting statistical and historical matter relating to the growth of the Institution. The *Transactions* are in future to be issued in more frequent parts, so that Vol. XV. is the last of the yearly volumes. The publication of the new numbers was commenced without waiting for the completion of the volume before us, and the first of the parts in the new form was referred to in *The Electrician*, Vol. LVI., p. 575.

American Telephones and Telegraphs.—We have received a copy of the Special Report on Telephones and Telegraphs for 1902 which has just been issued by the United States Census Bureau. The publication is a quarto volume of some 170 pages and contains a mass of statistical and descriptive information. The first portion, devoted to telephones, contains, in addition to detailed general, financial and traffic statistics, some excellent illustrated descriptions of the various parts of telephone equipments, including an illustration of the Michigan Grand Rapids 6,000 line fully automatic exchange. A short history of the development of telephony follows, together with some notes on telephone systems of other countries. The second part, dealing with telegraphy is mainly historical and descriptive, including short sections on submarine and wireless working. The last portion of the report gives particulars relating to the very complete fire alarm and police patrol systems in use in some cities in the United States.

Electric Signalling at Victoria Station.—The new signalling equipment of the extensions to Victoria Station of the London, Brighton & South Coast Railway Co., which is described in the *Railway Engineer*, is on the Sykes interlocking system with electrically worked signals. The usual locking frame is, however, retained for actuating the points by rodding in the customary way. The circuits conveying the current from the accumulators to the signals are carried through the signal box, and these are opened and closed by means of contacts fixed on slides which are placed above the mechanical point levers, and which are connected by interlocking between the two frames. The electrical connections to all the signals pass through contacts on the fouling bars on the various sections, so that it is impossible to lower a signal when a train is already in possession. In addition to the ordinary semaphore signals, there are a number of an electrically illuminated circular type, with a diametrical "banner," which takes up different angular positions and is controlled by the armature of an electromagnet. The semaphore signals are driven by small motors through worm gearing, current being automatically cut off from the motor when the arm has reached the end of its travel. An electromagnet is also provided, which holds a tripping lever in position when the current is on, but causes it to disengage when the current is cut off so that the signal flies up as soon as the circuit is interrupted either accidentally or purposely. All the points are fitted with electrical detectors, whereby the accurate position of the points is assured before any signals can be lowered for a movement to be made over them.

International Mining Conference.—A meeting was held in connection with the recent International Colliery Exhibition, at which the following, amongst others, were present:—T. H. Holland, F.R.S. (president of the Mining and Geological Society of India, and director of the Geological Survey of India), H. M. Ridge (representing the Australasian Institute of Mining Engineers), Dr. Juengst and Herr Trippe (representing the Mining Association of Westphalia), Col. Yorke, R.E., and W. Russell, C.B. (secretary of the recent Royal Commission on Coal Supplies). It was unanimously resolved to hold an International Mining Conference in connection with the Fourth International Colliery Exhibition in 1908, and it was further resolved that an organising committee be at once elected, consisting of the following gentlemen, with power to add to their number:—

J. C. Cadman (President of the North Staffordshire Institute of Mining Engineers), Prof. S. Herbert Cox (Delegate of the British Association), William Cullen (Delegate of the Chemical, Metallurgical and Mining Society of South Africa), Prof. Dunstan (Director of the Imperial Institute), W. B. Esson (President of the Civil and Mechanical Engineers' Society), Prof. Gowland (Delegate of the British Science Guild), E. M. Hann (Past-president of the South Wales Institute of Engineers), T. H. Holland, F.R.S. (President of the Geological and Mining Society of India and Director of the Geological Survey of India), James Heppell Marr (Delegate of the Institute of Civil Engineers of Ireland), T. W. Mitchell (President of the Midland Institute of Mining Engineers), W. H. Patchell (Vice-president of the Institution of Electrical Engineers), H. M. Ridge (Delegate of the Australasian Institute of Mining Engineers), W. Rowley (Delegate of the Yorkshire Geological Society), W. Russell, C.B., Dr. Juengst and Herr Trippe, with H. Greville Montgomery, M.P., as chairman, and Allan Greenwell as secretary. We are requested to state that all communications should be addressed to the secretary at the offices (provisional) of the conference, 30-31, Furnival-street, Holborn, London, E.C.

The Melms-Pfenniger-Sankey Steam Turbine.—Some results of tests of a steam turbine of the Melms-Pfenniger-Sankey type carried out by Prof. Schröter are given in *Engineering*. The turbine was of a size rated at 1,000 B.H.P., but was only coupled to a pair of generators aggregating 500 kw. during the tests, so that the figures must not be taken as representing anything like full load conditions. The following figures are extracted from the table of results:—

Load in kilowatt	500	400	280	150
Revs. per min.	2,548	2,469	2,477	2,489
Absolute steam pressure lb. per sq. in.	191	189	192	182
Vacuum (absolute pressure in lb. per sq. in.)	0·48	0·43	0·34	0·36
Actual steam temperature °F.	603	594	587	583
Steam consumption in lb. per kw.-hour.	17·2	17·5	18·5	22·5

It will be seen that the above steam temperatures correspond to a superheat of over 200° F. The Melms-Pfenniger-Sankey turbine is based upon a combination of the impulse principle for the high-pressure end and the reaction principle for the low-pressure end of the turbine. At the high-pressure end, the fixed guide blades are arranged for the admission of steam over only a small portion of the circumference. In consequence of this the diameter of the drum can be made large at the high-pressure end, and, following this, there is a step-down caused by the smaller diameter of the first part of the reaction portion. The annular surface thus formed enables the axial thrust of the steam due to the reaction portion to be balanced in a remarkably simple manner. This arrangement results in a great reduction in the length of the drum, as compared with the ordinary reaction type. Not only does this considerably cheapen the construction, but practically obviates troubles due to "hogging" of the case due to differences of temperature and permits of smaller clearances being used.

Armstrong College, Newcastle-on-Tyne.—The new wing which completes the main building of the Armstrong College, Newcastle, was formally opened by the King on Wednesday last on the occasion of the Royal Visit to Newcastle, when the new High-Level Bridge and the new Royal Infirmary were also inaugurated. It will be remembered that the Armstrong College was originally founded in 1871 in connection with the University of Durham and the North of England Institution of Mining and Mechanical Engineers under the name of the College of Physical Science, and at first its classes were held at the Wood Memorial Hall. The foundation stone of the east wing of the present home of the Institution was laid by the late Lord Armstrong in 1887, and the first portion of the college was opened in the following year. Further buildings were inaugurated in 1894, and it was this new portion, owing its origin to a fund established in memory of the late Lord Armstong, after whom the college has been named, which was opened by the King on Wednesday. The new building contains the senior and junior electrical engineering laboratories, a photometric and standardising room besides numerous lecture rooms offices and other accommodation. The botanic and zoological departments are also housed in the new buildings, and a fine examination hall capable of seating 750 persons is provided. Prof. W. M. Thornton is the head of the electrical engineering department.

The Manufacturers' Association of Great Britain.—The Provisional committee of representatives of leading British industries which has been formed with a view to the inception of an Association to protect the interests of British manufacturers, has issued a preliminary statement setting forth the aims and objects of the proposed association, and inviting applications for membership. The committee is constituted as follows :—

Harold H. D. Anderson (Associated Portland Cement Manufacturers, London) ; Sir John E. Bingham, Bart. (Messrs. Walker & Hall, Sheffield) ; G. Byng, Esq. (General Electric Co., Ltd., London) ; Hugo Hirst, Esq. (Robertson Lamp Co., Ltd., London) ; Sir Joseph Lawrence (Linotype & Machinery, Ltd., London) ; Edward Manville, Esq., (29, Great George-street, Westminster) ; Reg. K. Morcom, Esq. (Messrs. Belliss & Morcom, Birmingham) ; W. C. Mountain, Esq. (Messrs. Ernest Scott & Mountain, Gateshead-on-Tyne) ; Sir John Turney (Messrs. Turney Bros., Ltd., Nottingham). The hon. treasurer (pro. tem.) is G. Byng, Esq , and the secretary is Mr. B. H. Morgan.

The circular calls attention to the inadequate way in which the interests of manufacturers have hitherto been represented in this country, as compared with such organisations as those of labour, with their large representation in the present Parliament, the Chambers of Commerce and Shipping and the railway organisations. Manufacturers' associations exist in Canada, the United States and Germany, which do much to protect the industries in those countries. It is pointed out that the work of the proposed body, in the direction of improving conditions between master and man, would have an enormous scope, without in any way overlapping the field of existing employers federations, &c. The following draft summary of aims is given, and we are pleased to see that a fundamental principle of the organisation will be that party politics in every form shall be rigidly excluded.

Draft Summary of Aims.—To represent to the Government and the country the principles, aims and needs of manufacturers. To bring about closer relations between employers and employés. To deal with matters of common interest affecting manufacturers, such as legislation, taxation, rates, &c. To deal with matters of International interest, such as tariffs, trusts, &c. To collect and disseminate knowledge affecting manufacturing industries. To promote social intercourse between members.

The offices of the Association are at Queen Anne's Chambers, Westminster.

Mercury Arc Rectifiers and Magnetite Lamps.—Amongst the Papers read at the recent convention of the American National Electric Light Association at Atlantic City, was one by Mr. W. S. Barstow describing a system of street lighting in use at Portland, Oregon, in which magnetite lamps are used in conjunction with mercury arc rectifiers. Over 800 lamps and rectifiers have been working at Portland for several months and the installation is being rapidly increased. Considerable difficulty in the form of static discharges and short life was at first experienced with the tubes. The tubes, which were of small size, were subjected to very rigid requirements on account of the alternating-current pressure of 18,000 volts, a pressure which was very much higher than anything yet attempted with mercury arc rectifiers. The tubes have now averaged over 650 hours and several have exceeded 730 hours. A very considerable gain in efficiency is claimed for the system as compared with motor generators feeding ordinary arc lamps. A simple description of the system as installed is as follows: The transmitted energy at 10,000 volts, three-phase, 33 cycles enters constant-current single-phase transformers, the primaries of which are wound for 10,000 volts and the secondaries for 16,000 volts. In the secondary is a centre connection for the rectifier. The mercury arc rectifier is mounted upon a switchboard panel directly above the oil switch. It is excited by a small electrical current at 115 volts. This current is sufficient to start the rectifier after the same has been moved slightly with a handle for that purpose in order to establish the mercury arc. It requires but a few seconds to start up a circuit, and, when once started, it is not necessary to maintain the exciting circuit in operation, although this has been the practice up to the present time. In each side of the alternating current of the transformer is placed a reactance and another in the continuous-current side. The lamps themselves require 4 amperes at an average of about 80 volts, or 320 watts and give an equal illumination to the old-type open lamp requiring 500 watts. The efficiency of the system is given as 88 per cent. at full load (at 10 per cent. overload, 89 per cent.) ; at three-quarter load, 85 per cent. ; at half load, 81 per cent. ; and at one-quarter load, 80 per cent. The efficiency of the motor generator which was superseded by this arrangement was only 62 per cent. at full load. Some trouble was experienced at first due to lack of uniformity of the magnetite sticks, but this has now been got over by the use of special machinery for packing the magnetite ore into the iron tubes.

A New Multiple Unit System.—A system of multiple unit electric train control has been patented in the United States by Messrs. H. M. Harding and C. M. Clark, the main feature of which, according to the *Electrical Review* of New York, is the use of one pilot wire, which, when combined with the main train line and the track, is able to stop, start, reverse the motors, or run the train at any intermediate speed. On each car is a magnetic device for operating the regulating apparatus of that car. This device has a double winding upon it, the extreme ends of the winding being connected, the one to the train line and the other to the ground or truck frame. The middle point of the winding is connected to a single pilot wire. The winding of this device is arranged so that under this arrangement current will pass through it in opposite directions in the two halves, each half thus neutralising the magnetising effect of the other. The controller takes the form of a rheostat divided into two sections, one of which is connected to the train line and the other to the ground. There is a contact bar which can be thrown so as to come in contact with a number of points on each of these sections. When it is brought in contact with any section, a circuit is completed between the pilot wire and the train line or the track, which shunts one or the other section of the magnetic device. When this contact lever is in a central position it makes no contact and the magnetic device is held by springs in a central position. The operation of the device is as follows : Supposing the handle of the pilot controller to be moved so as to make contact on the first position of the rheostat connected to the train line, a circuit is thus completed, partially shunting that section of the magnetic controller which is connected between the pilot wire and the train line. On this account the current flowing through the other section winding will be greater than that flowing through the first-mentioned section, and therefore the controller will be moved by this preponderant magnetic force. A further movement of the pilot controller in the same direction causes a still greater difference between the two currents and a further movement of the magnetic controller. When the pilot controller is on the last position the magnetic controller has moved in one direction to the extreme point. Throwing the pilot controller to the off position allows the magnetic controller to come again to its central position, while if the pilot controller be moved in the opposite direction the other winding of the magnetic controller preponderates and reverses the direction of motion.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.*

BY W. MAURICE.

(*Continued from page 471.*)

MISS-FIRE SHOTS.

Where the practice of electric shot firing is well established, failures of any kind only happen at rare intervals, and even then they are more likely to have been brought about by some lapse on the part of a man new to the duties than to any defect in materials. Difficulties often arise where electric shot-firing is introduced for the first time owing to the use of ill-assorted apparatus. The low tension system may, for example, be adopted. A dry cell is obtained, along with 30 yds. or 40 yds. of shot-firing wire. Perhaps a thin single strand wire, say No. 22 S.W.G., is used. After firing comparatively few shots further ignition becomes impossible, and the fact is frequently lost sight of that the greater part of the energy of the cell has been used up in overcoming the resistance of the line.

It is often noticed too, that, under the conditions already referred to, there are frequent complaints as to the number of bad "caps," that is to say, electric fuses or detonators. Electric fuses are, however, now so well made that as a general rule the fault may be safely assumed to be elsewhere.

In the report for 1905, just issued, of the Chief Inspector of Mines for the Midland district (comprising the counties of Bedford, Berks, Buckingham, Cambridge, Derby, Hertford, Huntingdon, Leicester, Middlesex, Northampton, Nottingham, Oxford, Rutland and Warwick), Mr. A. H. Stokes, gives the total number of shots fired (in his district) as 2,305,591, or 162,904 more than in the year 1902. The percentage of miss-fire shots are: high tension 0·42 per cent., low tension 0·23 per cent., and gunpowder 0·25 per cent.

The average percentage of miss-fired electrical shots is thus 0·3 per cent., it being assumed that the gunpowder shots are fired by means of tape fuse.

And only a small fraction of even this small percentage of failures will, as a rule, be traceable to defects in fuses or explosives. In all but a very few, perhaps two or three misses per thousand shots fired, the failure may be traced to one or other of the following causes:—

In the exploder, the electrical pressure may have fallen below that intensity necessary to overcome the resistance of the circuit.

The firing cable may offer too great resistance, owing to: (*a*) badly-made joints or (*b*) defective insulation, arising either from mechanical injury or absorption of moisture.

In a low-tension fuse, (*a*) the bridge may be severed, as in Fig. 21; (*b*) the bridge may be shunted, as in Fig. 22; (*c*) there may be insufficient priming, or the latter may be damp, in which case the bridge would incandesce without causing ignition; and (*d*) if fuses are tested before firing a defective bridge may then give way without firing.

In high-tension fuses, the wires in the fuse heads (*a*) may make contact with each other, thus passing a current without decomposing the priming; (*b*) they may not make sufficiently good contact with the priming, in which case the electrical resistance is too high for an ordinary high-tension exploder.

In either variety, if a charge be left overnight in a wet hole, the insulation of the fuse wires may be destroyed. Consequently, none but guttapercha-covered wires should be placed in wet holes, unless the shot is to be fired immediately after having been stemmed.

Accidents of manipulation, in tamping and connecting up, may result in missed shots, thus:—

Whilst tamping, (*a*) the insulation of the fuse wires may be abraded and short-circuited. This is especially liable to occur in anthracite mines, where the particles of coal are sharp edged and hard, and may easily cut the wires during operation of stemming. On testing such a circuit in situ, by means of, say, a Holden firing apparatus or rack-bar exploder, the indicator would show continuity and lead one to suppose that the fuse was in good order.

(*b*) A wire may have been inserted in the shot hole kinked; then, upon tamping, the strain put upon the wires by an inexperienced operator causes the weakened point to straighten out and give way inside the insulation.

(*c*) The wires may be partly carried into the hole by an advance stroke of the tamping rod; they are pulled out again forcibly, thus bringing about result (*a*) or (*b*).

(*d*) Manipulative accident (*c*) may result in the detonator being withdrawn from the cartridge, or the fuse from the detonator. (This may be entirely obviated by inserting the detonator in the cartridge, then doubling back the wires alongside the primer and making a half hitch with them round the same. The detonator end of the primer leads into the blast hole.)

(*e*) Splicing fuse wires in a shot hole. (A miner will have caps with, say, 36 in. wires. He has occasion to bore a 48 in. hole and so he twists pieces of old fuse wire on to the new, lays the joints side by side, and proceeds with his stemming. The fireman comes along, applies his exploder, and "wonders why it won't 'go off'"!)

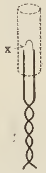

Fig. 21.—Diagram of Low-tension Fuse with Severed Bridge.

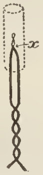

Fig. 22.—Diagram showing Low-tension Fuse with Short-circuited Bridge at Point *x*.

In connecting the fuse and the exploder—(*a*) the joints between the fuse and the firing line may be dirty, or covered with tallow grease. (They should be rubbed bright between thumb and finger, with a pinch of coal or shale dust, before splicing.)

(*b*) The manner of jointing may be mechanically but not electrically good.

(*c*) The joints, though properly made, may have been inadvertently brought into contact with each other, whilst reeling off cable.

(*d*) The firing line may have been kinked and afterwards forcibly straightened out, thus breaking a wire.

(*e*) The exploder ends of the firing line may require cleaning; as may also the binding terminals or contact studs on the exploder itself.

(*To be continued.*)

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* From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

MANCHESTER CORPORATION ELECTRICITY WORKS ACCOUNTS.

The annual report of Mr. S. L. Pearce, chief electrical engineer to the Manchester Corporation, records the completion of a considerable amount of new constructional work. The greater part of the additional plant has been already described in *The Electrician* (Vol. LVI., p. 956) and some further extensions are in progress. The maximum loads for the year are given below:—

	Lighting load.	Traction load.	Combined simultaneous load.
Dickinson-street..	5,683 kw.	1,500 kw.	5,683 kw.
Bloom-street	5,515 ,,	2,597 ,,	7,370 ,,
Stuart-street	3,800 ,,	5,780 ,,	9,580 ,,

The total plant capacities of the three stations are now as follows:—

Dickinson-street	10,600 kw.
Bloom-street	7,200 ,,
Stuart-street	16,500 ,,
Total	34,300 kw.

Substantial extensions have been made to the distributing system and sub-stations during the year under review, and as many as eight Bruce Peebles–La Cour motor converters, with the necessary switch gear, are on order to keep pace with the increasing demand. The final arrangements in connection with the taking over of the Gorton Electric Lighting Order have been completed and a feeder has been laid to supply the district. 610 new consumers have been connected to the mains during the year, besides extensions to existing installations on consumers' premises. The new lamp connections are equivalent to 48,852 8 c.p., and the new motor connections to 63,300 8 c.p. lamps, or a combined total of 4,810 H.P. The motor-hiring business has again made substantial progress during the year. The number of motors out on hire at the present time is 563, totalling some 2,337 H.P.

The table below shows the total units sold and the subdivision of the working costs under various headings :—

	Year ending March 31, 1905.		Year ending March 31, 1906.
Units sold for private lighting	9,939,381	..	11,248,739
Units sold for power	4,739,992	..	7,006,574
Units sold for tramways	18,926,305	..	22,267,858
Units sold for public lamps	81,032	..	94,613
Total units sold	**33,686,710**	..	**40,617,784**

COSTS PER UNIT SOLD.

GENERATING COSTS.			
Coal	0·260d.	..	0·236d.
Oil, waste, water and stores	0·035d.	..	0·029d.
Wages and salaries	0·108d.	..	0·092d.
Repairs and maintenance	0·086d.	..	0·076d.
Sundries	0·011d.	..	0·008d.
	0·500d.	..	0·441d.
DISTRIBUTING COSTS.			
Wages and salaries	0·103d.	..	0·087d.
Repairs, stores, &c.	0·133d.	..	0·091d.
Sundries	0·017d.	..	0·010d.
	0·253d.	..	0·188d.
TOTAL WORKS COSTS	**0·753d.**	..	**0·629d.**
MANAGEMENT COSTS.			
Rents, rates and taxes	0·142d.	..	0·144d.
Salaries, stationery and establishment charges	0·059d.	..	0·052d.
Insurance, legal charges, &c.	0·015d.	..	0·007d.
	0·216d.	..	0·203d.
TOTAL COSTS (excluding capital charges)	**0·969d.**	..	**0·832d.**
Interest	0·457d.	..	0·386d.
Sinking fund, &c.	0·385d.	..	0·602d.*
Instalment of loan repaid to Public Works Commissioners	0·037d.	..	0·032d.
TOTAL COSTS (including capital charges)	**1·848d.**	..	**1·852d.**

The costs of generation in the above table are averages for the three stations expressed in pence per unit sold. The following figures, which are given in the report, serve to show the difference in costs for the various stations, but it must be understood that they are based on the number of units generated and not units sold, and therefore do not compare directly with the table above, as the units sold only form 73·7 per cent. of the aggregate units generated.

Generation Costs.

——	Per unit generated.		
	Dickinson-street.	Bloom-street.	Stuart-street.
Coal	0·234d.	0·168d.	0·158d.
Oil, waste, water and engine-room stores	0·043d.	0·022d.	0·025d.
Repairs and maintenance	0·101d.	0·047d.	0·041d.
Wages and salaries	0·133d.	0·072d.	0·045d.
Total	0·511d.	0·309d.	0·269d.

The following tables contain an analysis of the capital expenditure up to March 31st, each generating station being dealt with separately :—

Dickinson-street.

Account.	Total March 31, 1906	£ per kw. (for each station).	Per cent. of total.
Land	£47,546	4·47	16·9
Buildings	53,056	5·00	18·8
Machinery	180,762	17·05	64·3
Total	£281,364	26·52	100·0

Bloom-street.

Account.	Total March 31, 1906	£ per kw. (for each station).	Per cent. of total.
Land	£15,083	2·09	7·5
Buildings	57,947	8·04	22·0
Machinery	126,876	17·60	63·5
Total	£199,906	27·73	100·0

Stuart-street.

Account.	Total March 31, 1906	£ per kw. (for each station).	Per cent. of total.
Land	£9,982	0·60	1·9
Buildings	207,472	12·56	40·1
Machinery	300,161	18·18	58·0
Total	£517,615	31·34	100·0

Stuart-street Railway.

Account.	Total March 31, 1906	£ per kw. (for each station).	Per cent. of total.
Land	£2,997	..	3·7
Viaducts, permanent way, &c.	77,862	..	96·3
Total	£80,859	..	100·0

The remaining items of capital expenditure are as follows :—

Account.	Total, March 31, 1906.	£ per kw. (total).	Per cent. of total.
Generating stations as above	£1,080,126	31·45	47·7
Distributing stations	282,167	8·23	12·4
Mains	797,064	23·25	35·1
Meters	51,829	1·51	2·3
Motors	14,403	0·42	0·6
Electrical instruments	4,092	0·12	0·2
Cables, stores and workshops	30,532	0·89	1·4
Cottage property	3,993	0·12	0·2
Office furniture	2,288	0·07	0·1
Street lighting (Gorton)	633	0·00	0·0
Total	£2,267,127	66·06	100·0

The cost of generating and distributing the 40,617,784 units sold amounted to £106,761 ; rents, rates and taxes came to £24,307 ; management charges, £8,772 ; insurance, legal expenses, &c., £1,278. The total of these figures is £141,118. The receipts were £329,199, and thus there is a balance of £188,081. Of this £40,000 was carried to renewals suspense account, £65,333 was absorbed by interest, and £61,216 by sinking fund. £5,326 was repayed as instalment of loan from Public Works Commissioners, and £593 was carried to revenue account for transfer of interest on investment. Interest on investments produced a revenue of £606, so that the final net profit for the year's working was £16,219.

THE SPHERICAL REDUCTION FACTOR OF TANTALUM LAMPS.*

BY DR. CLAYTON H. SHARP.

On the introduction of a new type of lamp, such for instance as the Nernst or the tantalum, a question should be immediately raised whether the ordinary methods of testing, such as are commonly employed with previously existent types can properly be applied. It is well known, for instance, that the illuminating value of the Nernst lamp cannot be properly estimated from a measurement of its luminous intensity in a horizontal direction, as is done with the incandescent lamp of the ordinary types, but that the more complicated determination of its mean spherical or mean hemispherical candle-power must be made. In the case of the tantalum lamp it is not evident that the mean horizontal candle-power taken in connection with a single determination of the horizontal reduction factor (the ratio of mean spherical to mean horizontal candle-power) is not a sufficiently good criterion of its luminous flux. In other words, it is not clear that the method of photometering which is ordinarily applied to the carbon filament lamp cannot and ought not to be applied to the tantalum lamp. In the case of the carbon filament lamp this method is satisfactory, since it has been thoroughly established that the spherical reduction factor has substantially the same value for all the lamps of a given type. In passing from one type to another the existent difference between their spherical reduction factors must be taken into account. This is more important than is usually supposed.

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* Including £40,000 carried to renewals suspense account.

* From the *Electrical World.*

If, for instance, a comparison is made of the useful life of carbon filament lamps having a spherical reduction factor of 0·82 with those having a factor of 0 80, operating them so as to give the same mean horizontal candle-power with the same watts, it will be found that the life of the lamps with the lower reduction factor is approximately 10 per cent. longer, provided they are equally well-made lamps. This is easily explained. The lamp with the smaller reduction factor gives less total flux of light when yielding the same horizontal candle-power than does the other type. Hence its watts per mean spherical candle-power are higher, and it is operating actually at a lower efficiency, and the lower the efficiency the longer the life. If operated at the same mean spherical efficiency as the other lamp it would give a higher horizontal candle-power, but at the same time a candle-power in other directions enough lower to counterbalance it, the total light emitted being the same and the life being the same.

An inspection of the tantalum lamp would lead one to suppose that its spherical reduction factor would be substantially as unvarying as is that of a given type of carbon filament lamp. Moreover, since the theory indicates that the spherical reduction factor of a filament consisting in a straight, black, non-lustrous rod must be 0·785, the factor for the tantalum lamp should be lower rather than higher than this, its surface being metallic, smooth and bright when the lamp is new. As far as the writer knows, all tests of tantalum lamps which have been published are based on horizontal candle-power values, no attention being given to the fact that this procedure, while allowable with carbon filament lamps, may not be valid with the new lamps. As has been said, there is nothing to indicate that this is not the case. Values of the spherical reduction factor have been published in at least one instance (Kennelly and Whiting, *Electrical World and Engineer*, March 25, 1905), these values being smaller than 0·785 and varying considerably among themselves.

In the course of tests of a considerable number of these lamps it was found that the spherical reduction factor of tantalum lamps is by no means constant, but varies considerably from lamp to lamp. This variation is so large that a typical value for the reduction factor of these lamps cannot be established. It follows, therefore, that the value of the mean spherical candle-power of a tantalum lamp cannot be accurately obtained from a measured mean horizontal candle-power multiplied by a typical reduction factor, as is done in the case of the carbon filament lamp, but the mean spherical candle-power must in every case be measured.

Moreover, it was discovered in the course of a life test of these lamps that the spherical reduction factor attains a larger and larger value as the lamp ages. Data on this point are contained in the following table:—

Spherical Reduction Factor of Tantalum Lamps.

	New.	Old.	Change.
	0·764	0 856	12%
	0·715	0·878	23
	0·760	0·886	16·5
	0·738	0·938	27
	0·726	0·888	22
	0·688	0·864	25·5
	0·716	0·909	27
	0 742	0·924	24·5
	0·707	0·902	27·5
	0·711	0·925	30
Mean	0·726	0·897	23·5

It will be seen that the variation with age is a very large one, amounting in one case to as much as 30 per cent. of the initial value. This indicates that a smaller and smaller proportion of the total light of these lamps is emitted in the horizontal plane and, operating unfavourably to the lamp if the test is made on a horizontal candle-power basis, is of great importance in testing. The decrease of candle-power with age, as shown from horizontal readings alone, is exaggerated. In fact, it was found that in making measurements of mean spherical candle-power instead of mean horizontal, the light yielded by several of the lamps was actually greater near the end of their life than it was initially. It should be stated, however, in this connection, that the candle-power usually rises very rapidly at first, and that the intensity of the old lamp is always lower than the maximum intensity which the lamp yields. This effect is increased by short circuits occurring between adjacent spires of the filament which cause the remainder of the filament to glow with an increased intensity. In any case, the conclusion is strongly emphasised that tests of tantalum lamps, if they are to represent the facts, must be made on a basis of mean spherical candle-power readings.

Evidently this change in spherical reduction factor must be accompanied by a change in the distribution of the intensity of the light in a vertical plane. That this is the fact is illustrated by the two curves of the accompanying figure, which show the distribution for a new lamp and for an old one.

It is interesting in the next place to inquire the explanation of this peculiarity. One reason is obvious from an inspection of an old lamp. The bulbs of the tantalum lamps become blackened with age, just as the bulbs of carbon filament lamps do. There is, however, this difference, that whereas the black deposit on the bulb of a carbon filament lamp is distributed in a fairly uniform manner on the whole interior of the bulb, the deposit on the tantalum bulb is much denser in a horizontal zone of a width substantially equal to the length of the spires of filament stretched between their supports. In other words, the deposit is most copious in those parts of the glass which are parallel to the spires of filament and nearest to them. This effect is clearly shown in Fig. 1. The effect of this zonular deposit is to decrease the horizontal intensity of the light in much greater degree than the intensity in the other directions, and so to effect a redistribution of the luminous intensity in the proper sense to make the spherical reduction factor larger than before. Another reason can be found in the changes which the surface of the filament undergoes with use. The filament of a new lamp looks under the microscope like a polished steel wire with a surface entirely smooth except for slight pittings here and there. As has been indicated above the spherical reduction factor of a straight filament must be theoretically less than 0·785. The better the reflecting power of the surface of the filament, the lower will be the factor. In accordance with this law it is found that the spherical reduction factor for the new tantalum filament varies about an average value of approximately 0 73.

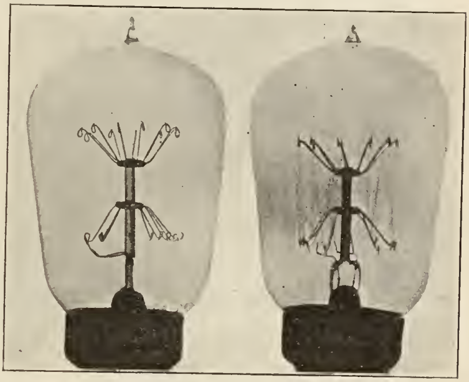

FIG. 1.—NEW AND OLD TANTALUM LAMPS.

It has been found, however, that the nature of the surface of the filament changes radically with age. The smoothness disappears and the outside becomes scarred and pitted and broken. This change must result in a relative increase in the radiation in directions not at right angles to the filament and hence in a larger spherical reduction factor. These two changes, the localised blackening of the bulb and the roughening of the filament, taken together account for the large increase in the spherical reduction factor. Of these two causes, the blackening is of much the greater importance. It would be of practical interest to ascertain the effect of enclosing the tantalum filament in much larger bulbs, perhaps spherical in form. If the distance between the filament and the glass is greater than the mean free path of the tantalum particles expelled, the blackening might be decreased or uniformly distributed over the surface, either of which would result in an improved efficiency of the lamp.

The procedure in photometering tantalum lamps differs in another particular from that practised in dealing with carbon filament lamps. It is the usual practice in this country to determine the mean horizontal candle-power of the carbon lamp by rotating the lamp on the photometer at a rate of about 180 revs. per min. The statement has been made that on account of the zig-zag shape of the filament of the tantalum lamp its intensity is the same in all directions in the horizontal plane. If this were the case the mean horizontal candle-power could be determined by measuring the candle-power of the lamp in any horizontal direction. It is found, however, that this is by no means true. The horizontal distribution curve of this lamp, far from being a smooth circle, is rather after the nature of a circle with a great many long saw teeth running from it. That is to say, the lamp gives a great many bright streaks of light in the horizontal direction, just the same as the carbon filament lamp does, only that there are many more of them with the tantalum filament lamp.

It follows from this that the mean horizontal candle-power must be determined by some method which will yield an integrated value on the photometer disc. The natural procedure is to treat this lamp exactly as the carbon filament lamp is treated, placing it in a rotator running at 180 revs. per min. and photometering it. It is found, however, that when this is done the action of the centrifugal force on the vertical spires of the filament is sufficient to cause them to bow outward perceptibly. This results in a change in the vertical distribution curve of the lamp, the candle-power in the direction of the tip being strengthened at the expense of the horizontal candle-power. It will be seen, therefore, that this also works to the disadvantage of the lamp if the horizontal candle-power is taken as the criterion. The filaments which have been bowed by too rapid rotating will come back to their normal form if allowed to burn for a while stationary.

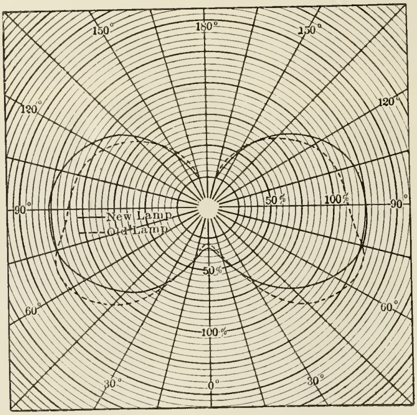

Fig. 2.—Curves of Distribution of Light from New and Old Tantalum Lamps.

One way to obviate this difficulty is to reduce the speed to 40 revs. per min. when this effect is no longer apparent. Another way to obviate the difficulty is to make measurements on some form of spherical integrating photometer. The Matthews photometer may, with advantage, be used for this purpose. Evidently the indications of this instrument are independent of the form of the filament. At the same time it is deemed better practice to reduce the speed of the rotator to the lowest practicable limit even when the integrating photometer is used, as this reduces greatly the mechanical stresses which otherwise might endanger the lamp.

ON THE OXIDATION OF ATMOSPHERIC NITROGEN IN ELECTRIC ARCS.[*]

BY PROF. KR. BIRKELAND.

After referring to the address of Sir William Crookes[†] to the British Association in 1898, and to the work of Priestley and Cavendish, Spottiswoode and Dewar, Lord Rayleigh,[‡] Naville and Guye,[§] Dougall and Howles,[||] Kowalski and Moscicki,[¶] Bradley and Lovejoy,[**] Muthmann and Hofer,[††] the author gives the following description of the Birkeland-Eyde process, which depends upon the use of a special form of electric flame :—

This flame, which has never before been employed in technics, has already proved to be a powerful technical aid in producing various chemical reactions, and is therefore deserving of a detailed description.

When two pointed copper electrodes, attached to a high-tension alternator, are placed equatorially between the poles of a powerful electromagnet, in such a way that the terminals of the electrodes are in the middle of the magnetic field, an electric disc-flame will be formed such as is shown diagrammatically in Fig. 2 and as photographed in Fig. 3. The photographed flame, which represented about 250 h.p., was established between water-cooled electrodes made of copper tubing of 15 mm. diameter.

Fig. 1.

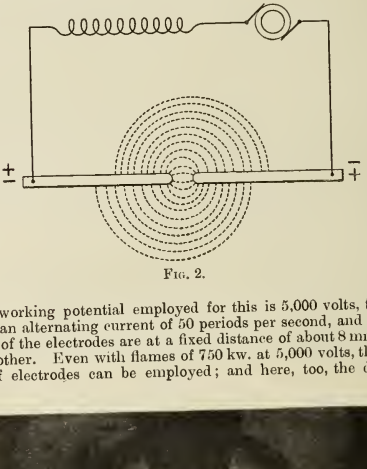

Fig. 2.

The working potential employed for this is 5,000 volts, the current is an alternating current of 50 periods per second, and the terminals of the electrodes are at a fixed distance of about 8 mm. from one another. Even with flames of 750 kw. at 5,000 volts, the same kind of electrodes can be employed; and here, too, the distance between the terminals of the electrodes is not more than about 1 cm. By the cooling of the electrodes with water, about 7·5 per cent. of the electric energy engaged between the electrodes is removed by the water as heat.

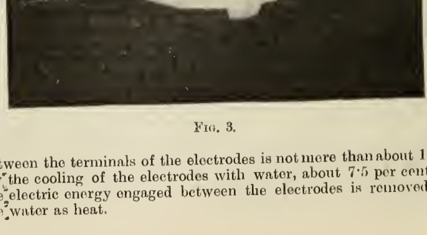

Fig. 3.

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[*] Paper read before the Faraday Society July 2, 1906. Slightly condensed.

[†] *Nature*, No. 1,506, Vol. LVIII.; *The Electrician*, Vol. XLI., p. 653, 1898.

[‡] *Journal of the Chemical Society*, Vol. LXX., 1897.

[§] *D.-R.-P. Nr.* 88,320 (1895).

[||] *Manchester Memoires*, 44 (1900).

[¶] *Société Internationale des Electriciens*, 2nd series, Tome III. (1904).

[**] *Electrochem. Industry*, 1 (1903).

[††] *Chem. Ber.*, 36 (1903).

The formation of these disc-flames may be explained in the following manner: At the terminals of the closely adjacent electrodes, a short arc is formed, thus establishing an easily movable and ductile current-conductor in a strong and extensive magnetic field, *i.e.*, from 4,000 to 5,000 lines of force per square centimetre in the centre. The arc thus formed then moves in a direction perpendicular to the lines of force, at first with an enormous velocity, which subsequently diminishes; and the extremities of the arc retire from the terminals of the electrodes. While the length of the arc increases, its electric resistance also increases, so that the tension is heightened until it becomes sufficient to create a new arc at the points of the electrodes. The resistance of this short arc is very small, and the tension of the electrodes therefore sinks suddenly, with the consequence that the outer long arc is extinguished. It is assumed that while this is taking place the strength of the current is regulated by an inductive resistance in series with the flame.

In an alternating current (see Fig. 2), all the arcs with a positive direction of current run one way, while all with a negative direction run the opposite way, presupposing the magnetising being effected by direct currents. In this way a complete luminous circular disc is presented to the eye.

The flame extends farther along the *positive* electrode than along the negative.

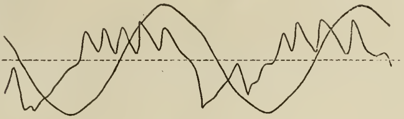

Fig. 4.

The extremities of an arc may sometimes appear like glowing spots upon the backs of the electrode. The spots of light on the positive electrode are small, and lie exceedingly close to one another, while those on the negative electrode are larger, and the distance between them is greater. The reason of the appearance of these spots of light is that the arcs, so to speak, melt or solder themselves to the electrodes, so that the magnetic force can only make the extremities of the arcs move along the electrodes in tiny leaps. It is evident from the curvature of the arcs that they cling more closely to the negative than to the positive electrode; and, therefore, the flame extends farther along the positive electrode than along the negative.

When the flame is burning it emits a loud noise, from which alone an impression may be obtained of the number of arcs formed per second in the flame. If the matter is to be more minutely investigated, this may be done by the aid of an oscillograph, by means of which the tension-curve for the electrodes, and the current-curve, can easily be drawn.

Fig. 4 shows the tension-curves for the electrodes; with the disc-flame in operation the jagged curve is obtained, while the comparatively regular sine curve gives the tension-curve when the electrodes are screwed so far from one another that the flame is extinguished.

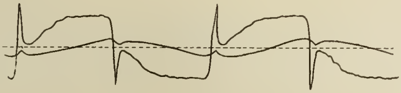

Fig. 4a.

It will be seen that in this case several arcs are formed in the flame at each reversal of the current, and, therefore altogether, several hundred arcs per second, as the alternating current employed had 50 periods per second. This occurs when the magnetisation is too high, or the distance between the electrodes too small; for, as a rule, with large, steadily-burning flames only one arc is found at each reversal of the current, as shown in Fig. 4a.

Here the curve with the sharp points is the tension-curve, the other being the current-curve. Unfortunately these curves were not taken simultaneously, but one after the other, as the oscillograph employed was not a duplex one. It will soon be altered, however, so that current and tension curves can be taken simultaneously; and careful investigations will then be made, in order to throw light upon various questions of theoretic interest. The current and tension curves we have already taken show, moreover, that the electric conditions in the flame may change very considerably with the relative proportions of the working current and the magnetic field.

Before passing on to consider the technical arrangements that have been made for the manufacture of saltpetre, we will briefly mention a newly patented arrangement for an electric arc for oxidising nitrogen.* The patent is taken out by the firm of Badische Anilin & Soda Fabrik, at whose head are men who, as experimenters also, are second to none. Within the last few weeks, the sad news has been received of the death of one of these, the celebrated Dr. Rudolf Knietsch.

The flame in question is a single arc, drawn out to a length of several metres in a long vertical tube, through which air is blown, while at the same time a certain whirling motion is imparted to it. Little is known about the experiments made by the patentees with this very interesting flame, so that it is too early to express any opinion as to their process. At our trial works at Arendal, we have, of course, made experiments on a large scale with this arrangement in order to compare it with our own, but we naturally have no right to say anything on the subject.

Electrotechnical Processes for the Manufacture of Saltpetre.

The first to attempt a wholesale, synthetic production of nitric acid from air, were, as we know, Messrs. Bradley & Lovejoy, who formed a company with a considerable capital for that purpose, called the Atmospheric Products Company, and built a small trial factory at the Niagara Falls. The electrical apparatus employed there has already been briefly described; it was rather complicated, and not sufficiently stable, so that both the cost of erection and maintenance per kilowatt were disproportionately large. The great expectations that had been raised for a time by this American undertaking were doomed to disappointment, as the company ceased operations in the summer of 1904.

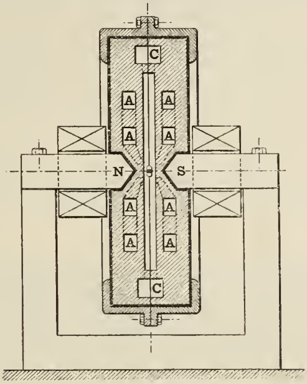

Fig. 5.

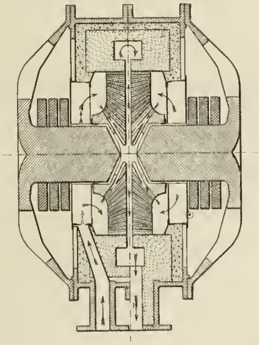

Fig. 6.

Nor do MM. Kowalski and Moscicki seem to have been successful. Their previously-mentioned electric arrangement, with alternating currents with a tension of up to 50,000 volts, was brought into use in some experimental works at Freiburg; but these seem already to be closed.

While thus the attempts begun before 1903 did not result in any method for a wholesale production of saltpetre that could take its place in practical life as a commercial method, Eyde and the author, in combination with the Norwegian Nitrogen Company, were able in 1904 to display results that immediately convinced the experts that had been called in that the saltpetre problem had now been solved in a satisfactory manner; for we succeeded, with simple and easily-regulated apparatus, in working with so large an amount of energy, that the quantity of nitric acid produced was, for the first time, sufficiently large to justify a direct transfer of results and calculations to industrial undertakings.

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* French Patent No. 357,358.

The alternating-current disc flame already mentioned was enclosed in a special furnace, which was lined with firebrick, and furnished with a metal casing. Figs. 5 and 6 show two such furnaces, one of an older, the other of a newer type. The fire chamber of the furnace is narrow, in the direction of the lines of force—from 5 to 15 cm. wide—made partly of perforated chamotte, air being conveyed to the disc flame, in an evenly-distributed supply, through its walls. The system of magnets is composed of two powerful electromagnets, their extremities turned in towards the fire chamber. The magnetic circuit is closed either as in a horse-shoe magnet, or through the shield-like, cast-steel casing of the furnace. The air is driven into the central region on both sides of the flame by gentle pressure from a Root's blower; and after passing in a radial direction arrives at a peripheral channel, whence it is conducted away. The horizontal electrodes are made of copper tubing, 15 mm. in diameter; whose terminals are within about 1 cm. of one another, and are cooled by water in circulation, which keeps them from fusing. The electrodes are exchanged and repaired after being in use for about 300 hours, the exchange itself taking about 15 minutes to accomplish.

At the Notodden Saltpetre Manufactory there are three such furnaces (see Fig. 7) in constant activity, each employing 500 kw. These furnaces burn with an astonishing degree of steadiness, with a variation in energy of only 2 or 3 per cent., although the electrodes have no automatic regulation. It often happens that the assistant who attends to the furnaces does not need to touch any of them all through his watch; and it has happened that a furnace has burned for 40 hours without being attended to. The furnaces themselves give notice of anything going wrong, for the flame then begins to roar, and the warning comes in ample time to allow of an adjustment before the flame is extinguished. The furnaces work with a power factor of 0·7. With a working potential of 5,000 volts, 3,500 volts and more are obtained on the electrodes.

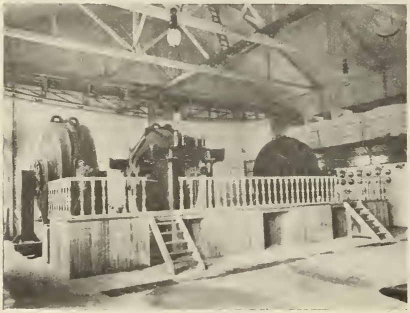

Fig. 7.

As already mentioned, the furnaces are lined with firebrick. Even the large, inner surfaces of the furnace have shown that they remain very stable, the reason of this evidently being that, in spite of the enormously high temperature of the disc flame, the temperature on the walls does not rise above 700°C. during normal working, owing to the cooling effect of the current of air.

We have estimated that two or three firebrick linings would be required per annum for each furnace; but this will certainly prove to be too high an estimate on the average, and the firebrick furnaces will last longer than they are assumed to do. In the new saltpetre manufactory at Notodden, which is to obtain about 30,000 H.P. from Svælgfos, 5 km. distant, it is decided that the furnaces shall be of 750 kw. under normal conditions, while during flood time they will be put up to 850 kw. With a working tension of 5,000 volts, the power factor of these furnaces will be about 0·75.

We have had an opportunity of testing this type of furnace with as much as 1,000 kw., but not yet for a sufficient length of time, as the alternator employed was too heavily laden.

The cost of these furnaces, including inductive resistance, is at the present moment 18,000 krones, or just £1,000, fully complete, and capable of being immediately attached to an ordinary alternating current with the tension of 5,000 volts. The cost per kilowatt of the erection of furnaces can thus, at the present time, be put at 18 krones, or £1, which is, of course, surprisingly low.

There is reason to believe, however, that this low cost of erection per kilowatt will at some future time be further considerably reduced. From the experience gained up to the present, it would appear that in larger works the furnaces should be made to take larger quantities of energy than 1,000 kw. If, for instance, 2,000 kw. per furnace were absorbed, a considerable saving would be effected in the cost of erection and the working expenses.

There would be a gain in the power factor which would probably attain to 0·8, and there is no indication—if we draw conclusions by analogy from the experiments made with from 250 kw. to 750 kw. per furnace—of any loss in the output per kilowatt-year; on the contrary, a small gain might rather be expected there also

Furnaces of 2,000 kw. such as these would cost, complete, between 20,000 and 22,000 krones, or about £1,100 to £1,210, including induction resistance; so that the cost of erection would then be from 10 to 11 krones per kilowatt, an exceptionally low cost for the installation of electrical apparatus.

But it is now necessary to speak of the products of the process. The nitric oxide fumes which are formed in the furnaces and conducted away with the hot gases, fixate, after cooling, a further quantity of oxygen from the unconsumed part of the air, and turn into nitric peroxide; and this, when treated with water, combines to form nitric acid.

The volume of air thus treated at present in the Notodden Saltpetre Manufactory is 75,000 litres per minute; and as it contains only about 1 per cent. of nitric oxide, it will easily be understood that in discussing the question of obtaining nitric acid from the air, it has frequently been pointed out that the great rarefaction of the gases to be worked with, greatly enhances the difficulties of the problem to be solved.

The gases that come from the furnaces with a temperature of 600°C. to 700°C. first pass through a steam boiler, the steam of which is employed in the further manufacture of the ultimate product, calcium nitrate. In the saltpetre manufactory now in course of erection, the gases will be conducted directly through the evaporation tank, an arrangement which implies such an important saving of heat, that the employment of coal may presumably be avoided.

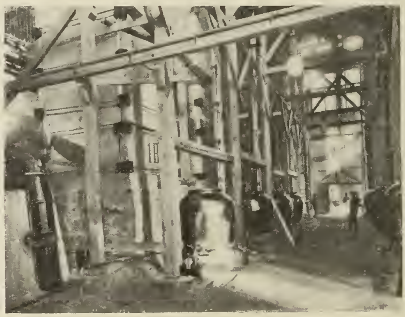

Fig. 8.

After the gases are discharged from the above-mentioned steam boiler, their temperature is reduced to 200°C, whereupon they are conducted through a cooling apparatus to be further cooled to about 50°C. The more the gases are cooled, the more easily are they absorbed by water. The gas then enters two large oxidation chambers with acid-proof lining. Here, as already mentioned, takes place the oxidation of the compound formed in the furnaces, nitric oxide becoming nitric peroxide, which is then conducted farther into an absorption system, where the gas is converted into nitric acid (Fig. 8).

The absorption system consists of two series of stone towers, whose internal dimensions are $2 \times 2 \times 10$ metres, each series containing five towers, two of granite and two of sandstone, filled with pieces of quartz, over which water, and the nitric acid formed, are made to trickle, while the fifth tower in each series is filled with ordinary bricks, over which trickles milk of lime. The milk of lime quickly absorbs the rarefied nitrous gases remaining, and is converted into a compound of calcium nitrate and calcium nitrite.

The first tower yields a 50 per cent. nitric acid, the second about 25 per cent., the third 15 per cent., and the fourth 5 per cent. The liquids from the fourth tower are raised by compressed air to the top of the third, those from the third to the second, and those from the second to the first, thus gradually increasing in concentration up to 50 per cent., at which density the acid is conducted into a series of open granite tanks, where it is temporarily stored.

Some of this acid is employed in the decomposition of the nitrate-nitrite combination obtained by absorption by milk of lime. By the addition of nitric acid the nitrous anhydride contained in the nitrite is driven out and carried back to the system of towers.

The solution resulting from this, containing pure calcium nitrate, is carried, together with the rest of the stored-up acid, into another series of granite tanks, where this mixture of acid and acetous calcium nitrate lye, reacting on ordinary limestone, is converted into a solution of neutral calcium nitrate. This neutral lye is carried farther into vaporisation chambers of iron, where it is vaporised to a boiling point of 145°C., answering to a concentration of from 75 to 80 per cent. of calcium nitrate, containing about 13·5 per cent of nitrogen. This substance is then run into iron drums containing about 200 litres, where it congeals, and in that form appears on the market.

Instead of vaporising the calcium nitrate right to a boiling point of 145 deg. it may be allowed to crystallise after being vaporised to a boiling point of 120°C. The crystallised calcium nitrate is treated centrifugally, when a crystalline substance is obtained as the final product, which is mainly used commercially as a fertiliser. Its composition is $Ca(NO_3)_2 + 4H_2O$, and is a salt with hygroscopic properties. In order, therefore, to make the salt more suitable for a manure it is converted into basic nitrate, which keeps dry, thus allowing of its being scattered with a sowing machine. For the suggestion of basic nitrate we are indebted to Dr. Rudolph Messel, of London.

A number of manuring experiments with calcium nitrate have been made at various agricultural Institutes. The results show that lime saltpetre is quite as good as the natural saltpetre, and on sandy soil even superior to it. This last fact must be ascribed to the importance of the lime contained in the saltpetre to plants in soil that is so deficient in lime.

In order to obtain a satisfactory idea of the degree of success attending the solution of the nitrogen problem, it is necessary to know approximately the cost of production of calcium nitrate produced by the process here described.

The present cost is hardly likely to be published, but there are already available various official data from which fairly definite conclusions may be drawn.

At the opening of the new Chemico-Technical Institute at the Royal Technical College in Berlin, the director of the Institute (Prof. Otto N. Witt), spoke of the utilisation of atmospheric nitrogen.[*] In doing so he gave a detailed description of the Birkeland-Eyde process, which he knew from personal experience, having been one of the experts who visited Notodden. With regard to the practical output, he stated that, according to his observations, the yield was between 500 kg. to 600 kg. of anhydrous nitric acid per kilowatt-year.

Now, we have observed that the output of the furnaces is considerably higher than 600 kg., if it is measured by analysing samples of gas taken out, and including in the calculation the amount of air blown through the furnaces.

The measurement of large volumes of air such as those in the present case requires large, expensive, accurate gas meters. We have used a "Duplex" from the "Cie. pour la Fabrication des Compteurs et Matériel d'usine a Gaz" of Paris, which can take a maximum of about 21,000 litres per minute. By special test determinations this meter, after being mounted in a separate little building, has proved to be correct to within ½ per cent.

The reason of the considerable difference observed between the output of the furnaces and the practical output has not yet been made quite clear, and investigations into this matter are, therefore, still being persevered with.

In the estimate for the new factory of about 27,000 E.H.P. at Notodden by a commission of famous foreign experts, among whom we may mention Grandeau, Schloesing, Silvanus P. Thompson,[†] Turrettini and Otto N. Witt, a practical output of 500 kg. of anhydrous nitric acid per kilowatt-year has been taken for granted.

In the prospectus issued on the formation of the company that now owns the works just named it was stated that the cost of production per ton of calcuim nitrate, containing 13·2 per cent. of nitrogen, would be 72·30 krones (£4), while the selling price per ton is put at 145·20 (£8), this having been reckoned from the present price of 1,100 krones (about £60) per ton of combined nitrogen.

As the building of the new factory is already far advanced, there has been ample opportunity of seeing that the cost of the works has been very correctly estimated.

Theoretical Remarks on the Oxidation of Nitrogen.

In 1903 Muthmann and Hofer published a treatise in which, on the principles of thermochemistry, they endeavoured to throw light upon the chemical process here treated of. They there maintained the view that the oxidation of nitrogen in electric arcs is exclusively an effect of heat, and that there appears in the arc a chemical equilibrium between oxygen, nitrogen and nitric oxide, the constants of which they tried to determine.

Most valuable investigations and attempts to come to greater clearness on the subject have since been published by Nernst,[*] Brode,[†] Haber,[‡] Franz Fischer and Braehmer.[§]

If we adopt the views of the thermochemists, we must assume that in the electric arcs in which nitrogen is oxidised, all that is wanted is the capability of greatly heating the air. It is taken for granted that the electric phenomenon itself—namely, that electric currents permeate the air, plays no part of any consequence in the nitrogen reaction. The oxidation of nitrogen is, then, no specific electric, but only a thermochemical action. We shall return to this point when we are discussing the degree of ionisation of the air in the electric flame.

If we take 1 kg. of oxygen, and mix it with 3·3 kg. of nitrogen, this, according to the conceptions of modern chemistry, will no longer be just a mixture of oxygen and nitrogen. Chemical combinations of these elements form by themselves, among them nitric oxide. In this case, it is true, at an ordinary temperature, the nitric oxide formed will be an unmeasurable amount, namely, according to calculation, 10^{-10} gramme, taking Guldberg-Waage's law and Van't Hoff's equation for granted.[||]

But when the temperature rises to 1,500 deg., 2,000 deg., and 2,500 deg., it can be proved and measured that at each temperature a certain quantity of nitric oxide is found in the gas; an equilibrium, as we say, appears, corresponding with each temperature. At 3,000 deg., for instance, an entire 5 per cent. of the composition will be nitric oxide.

One imagines that with each temperature when in equilibrium, NO is constantly being formed and constantly decomposed, so that the amount always existing in the compound is constant.

Now if our air-compound—say from 3,000 deg., and containing 5 per cent. of nitric oxide—be cooled sufficiently slowly, *e.g.*, down to 700 deg., the amount of nitric oxide contained will gradually diminish to a definite amount corresponding to each temperature, and it will sink to almost nothing, corresponding to 700 deg.

If, on the contrary, the cooling can take place with very great rapidity, it should be found that the 5 per cent. of nitric oxide is retained; there is no time for it to be decomposed; and when once the gas has gone down to 700 deg., all the changes take place with such extreme slowness that the 5 per cent. of nitric oxide is imprisoned and can be retained. It is just this instantaneous cooling of the greatly heated air that we achieve so well in our furnaces.

In all experiments in which an attempt is made to fit the theory to the experimental results obtained by the oxidation of nitrogen in the electric arc the greatest difficulty met with is in the little knowledge we possess of the temperature of the arc. In this respect we know for certain little more of the peculiar electric flames now used in technics, with thin, mobile arcs 1 yd. or 2 yds. long, than that the temperature must be extraordinarily high. Thin threads of zirconium oxide, for instance, can be melted in the high-tension electric arcs.[¶] But the means and methods adopted in order to indicate temperatures—*e.g.*, when it is a question of the positive or negative pole of an arc between carbon points, or of judging the temperature of the sun, will scarcely even approximately suffice for the determination of the temperature of an electric arc in atmospheric air. The basis of these methods is to measure the radiation and examine the spectrum given by the radiating bodies, which, as such, are supposed not to be very different from a black body. But the power of the air to radiate bright rays, and even dark heat rays, is remarkably small even with high temperatures, a fact which may be concluded from experiments made by Hittorf, W. Siemens and Paschen.

The arc flame shown in Fig. 3, for instance, gives little light as compared with the large amount of energy in it. One can quite well look right into the flame, and when being photographed it was astonishingly difficult to take snapshots of it. This, of course, is also due to the rapid movements of the arcs.

I have tried to form some opinion as to the temperature conditions in the disc flame produced by first endeavouring to make out whether the long arcs that are always in active motion in the flame are to be considered as well-defined current-strings in the air, whose thickness, in that case, might be determined.

With this object in view, the conditions were first investigated in a small high-tension disc-flame, which was produced by spreading out the discharges from a large induction coil with mercury interrupter, into a disc in a magnetic field, just as in Du Moncel and Plücker's well-known experiment. A faintly illuminating, violet disc-flame was thus produced, more or less semi-circular, and of about 6 cm. in diameter.

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[*] "Das neue Technisch-Chemische Institut der Königlichen Technischen Hochschule zu Berlin," von Dr. Otto N. Witt. Berlin, 1906.

[†] Prof. Thompson delivered a most interesting discourse on the electric production of nitrates from the atmosphere, at the Royal Institution, February 2, 1906. [*The Electrician*, Vol. LVI., p. 666.]

[*] "Nachrichten d. Konigl. Gesellsch. d. Wissensch.," Göttingen, 1904.

[†] "Oxydation des Stickstoffes in der Hochspannungsflamme," Halle, 1905.

[‡] "Thermodynamik technischer Gasreaktionen," München, 1905.

[§] "Berichte d. Deutschen Chem. Gesellsch.," 1906.

[||] The laws of thermochemistry probably do not hold without considerable modification for air of common temperature. Molecules of air break up and re-combine under influence of many agents other than heat. All processes by which air is changed into a conductor of electricity will possibly also to a certain degree influence the chemical reactions taking place in the gas. Ozone is, for instance, produced from oxygen by rays from active radium preparations.

[¶] Nernst, *loc. cit.*, *p.* 1.

The flame was very thin; with a microscope magnifying 20 times, it was judged to be about $\frac{1}{10}$mm. It was a little thicker on the negative electrode than on the positive, which is probably accounted for by the fact that the arc-fibres of about $\frac{1}{10}$mm. in thickness, which form the disc, cling or fix themselves more firmly with their roots to the negative electrode than to the positive. Compare the previous description on p. 494. The negative electrode also becomes warmer than the positive. In this experiment the electrodes were formed of 3 mm. thick brass wire.

In order to test the thickness of the arcs, small pieces of thin tissue paper were quickly inserted in the flame. Holes were pierced in these by the arcs, several arcs in succession often going through the same hole in the paper, which then became larger than the others. Fig. 9 shows a photograph of three such pieces of paper about five times enlarged: No. 1 taken close to the positive electrode, No. 2 in the middle, and No. 3 close to the negative electrode. The holes show diameters of from $\frac{1}{20}$ to $\frac{1}{7}$ of a millimetre.

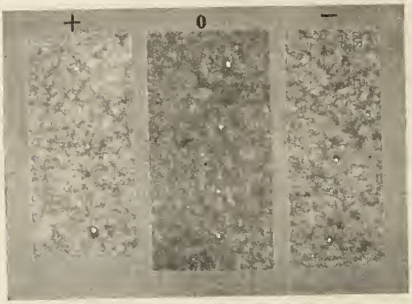

Fig. 9.

It was proved by these experiments that the arcs, which could attain a length of about 10 cm., remained in the air everywhere in the form of very fine threads, of a thickness of about $\frac{1}{10}$ of a millimetre.

I have now made further endeavours to obtain some knowledge of the thickness of the arcs forming the flames in our furnaces, partly by measuring the size of the marks produced on the electrodes under various conditions and partly by taking instantaneous photographs of the flames.

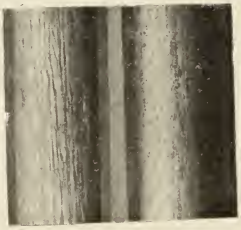

Fig. 10

The marks of the arcs were taken by screwing new electrodes—immediately after the flame had begun to play upon them—as quickly as possible apart from one another, so as to extinguish the flame again. Of course, in these experiments, some rapidity is required, as the arcs record their marks 50 times per second on each side of the electrodes. In this way I have succeeded in obtaining a number of good arc prints from various flames, from which it is easily demonstrated that, even with flames of great energy, the arcs *issue* from the electrodes as fine arc threads.

Fig. 10 shows positive and negative arc prints of electrodes for a flame of 500 kw. The pieces of the electrode are photographed in their actual size. The diameter of the flame was about 140 cm. and the strength of the current employed 150 amperes.

It will be seen that the positive arc prints are continuous bands of about 0·5 mm. in width, while the negative arc prints consist chiefly of very close series of round spots about 0·6 mm. in diameter.

Fig. 11 is a photograph of the disc flame of 500 kw., taken in $\frac{1}{75}$th of a second parallel to the electrodes, looking in towards the centre of the furnace and in the plane of the disc flame.

By comparing the thickness of the arc disc with that of the electrode, which is 15 mm, it may be concluded that the former is about 35 mm. to 4 mm. thick.

The arcs that form the disc thus have in the air a considerable width of section as compared with the arc prints on the electrodes.

Probably carriers of different kinds are at work in carrying the negative electricity into the flame from the small hot spots on the negative electrodes. If we assume that near these spots positive and negative ions—travelling with velocities whose sum is V and charge e of constant number n (of either sign) per cubic centimetre—carry the current, then $i = \mathrm{V}ne$.

Now i was 150 amperes through a circular spot of 0·6 mm. in diameter, thus about $1{\cdot}59 \times 10^{14}$ electrostatic units was passing per square centimetre. For e we take the charge carried by an ion according to the last determination of J. J. Thomson: $e = 3{\cdot}4 \times 10^{-10}$ E.S. units. Now even if we put n equal to $2{\cdot}8 \times 10^{18}$, approximately the number of molecules in 1 cubic cm. of air at standard pressure and 3,200°C. (compare the following), we find that V must be equal to $1{\cdot}7 \times 10^{5}$ cm./sec. The greatest value which has been observed for the negative ions at atmospheric pressure is the value obtained by H. A. Wilson in the case of flames at a temperature of about 2,000°C., and is equal to 1,000 cm./sec. for a potential gradient of 1 volt per centimetre. It results from this that the velocity at the ions near the negative electrode must be exceedingly large, for n is certainly taken much too high in the above calculation. The great velocity of the negative ions at this high temperature points to the conclusion that the negative ions start as electrons and gradually get loaded by molecules condensing round them; at temperatures as high as 3,200°C. the time they exist as free electrons is an appreciable fraction of their life; while they are free corpuscles they have an exceedingly large velocity, which they gradually lose in producing ionisation in the air by collision.*

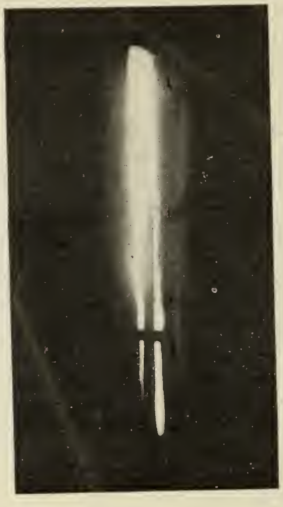

Fig. 11.

In the long arcs in the air there is reason to believe that the current-density along the axis of the arc is greater than through the rest of the section, and that the arc's comparatively large section is a consequence of diffusion phenomena. The rate of diffusion in a radial direction reckoned transversely away from the axis of the arc must be enormous with the differences of temperature in question here.

It is certainly this diffusion of hot air out from the arc, and of cold air into it, which in the first place determines the temperature of our flame.

It is also certainly this volume of air that is thus treated directly by the arcs that takes up the greater part of the energy of the flame in the form of heat. As already mentioned, the cooled electrodes take up only about 7·5 per cent. of the energy of the flame, and the heat radiated directly from the arcs can hardly be relatively great.

* J. J. Thomson, "Conduction of Electricity through Gases," Camb. Univ. Press, 1903, p. 204.

I have not made measurements, but I conclude this from the fact that one is able to look right into a flame of 750 kw. from a distance of a couple of yards, even when the eye is in the plane of the disc flame.

For use in the following calculations I have estimated the loss of rays in the flame approximately to equal the loss of energy in the electrodes, so as to make the total loss equal to one sixth of the electric energy. This is, of course, a very arbitrary estimate, but it can hardly be so wrong as really to disturb the results of the calculations. It may be useful to remember in this connection that R. Helmholtz has measured the radiation from a hydrogen flame, and found it to be 3·63 per cent. of the combustion heat generated.

In order to compare the amount of nitric oxide formed per minute in our furnaces with the amount of NO that should be formed in the electric flames according to the laws of thermochemistry, it will be necessary for us to take our bearings with regard to the temperature of the flame, as this means, in a certain sense, an average temperature.

With this object in view, and as a starting point for the following calculations, I select a series of experiments made a year ago at our trial station at Arendal with a 300 kw. furnace. During several days' continuous working the energy of the furnace was kept very exactly at 300 kw., while 12,500 litres of air (reduced to zero and standard pressure) were blown through the furnace per minute. The outflowing gases had a temperature of 700°C., and contained a volume percentage of 1·07 of NO, which answers to 179 grammes of NO per minute.

Various experiments have been made with about the same energy in the furnace, the air blown in per minute having varied from 40 litres per kilowatt to 80 litres, without making the output vary appreciably.

Experiments have also been made with various potentials from 2,500 volts up to 7,500 volts, without making any essential change in the output.

As already mentioned, the arc disc imparts five-sixths of its energy to the gas that is treated directly. This gas therefore absorbs 60,000 gramme-calories per second.

It is assumed, moreover, that the air near the arc, which is brought into the flame by diffusion, or is treated directly by the flame, has a temperature of 700°C. immediately before it is taken up into the arc.

Further, with regard to the heat capacity of the gases, it is assumed that the mean specific heat C_p for a molecule of permanent gases may approximately be expressed as follows:—

$$C_p = 6{\cdot}8 + 0{\cdot}0006.t^{*}$$

In order to obtain a general idea of the output of NO per minute that would be theoretically probable under these assumptions, I have calculated the output for various assumed temperatures in the flame, taking as my starting point Nernst's equation:—

$$\log \frac{x}{\sqrt{\left(79{\cdot}2 - \frac{x}{2}\right)\left(20{\cdot}8 - \frac{x}{2}\right)}} = \log 0{\cdot}0249 - 2{\cdot}141\frac{2200 - T}{T}.\dagger$$

The result of these calculations, and a statement of the calculated volume of gas treated by the flame per second with each temperature, will be found in the following table:—

——	2,500°C.	3,200°	4,200°	5,200°	6,200°	8,200°
Number of grammes of NO per minute............	187	264	311	333	321	274
Volume percentage of NO..	2·7	5·6	10	14 7	18·4	23 6
Number of litres of gas in the flame per second ..	880	747	634	564	516	449

This table is calculated upon the assumption that the arc's influence upon the air has been sufficiently long to allow of the establishment of an equilibrium, and that the cooling of the gases treated has thereupon taken place so rapidly that the nitric oxide formed has not decomposed to any appreciable extent.

It will be seen from the table that the output of NO per minute with 2,500°C. is 187 grammes, while the actual output from the furnace was 179 grammes. It will be seen, moreover, that the theoretical output with an inconceivably high temperature might also be of the same magnitude.

That the temperature of the flame should only be 2,500°C. is a result, however, that seems to be a good deal too low; for, according to Nernst, the rate of reaction with this temperature is so small that the chemical equilibrium can scarcely have appeared at all in those gases that are in the arcs themselves only for a very short space of time.

For the lengths of time within which half the possible NO concentration is formed by heating of the air, Nernst has deduced the following values:—

With 1,200 deg., very long.
With 1,538 deg., 97 seconds.
With 1,737 deg., 3·5 seconds.
With 2,600 deg., 0 018 second.

The length of time for 50 per cent. of NO to appear with 2,500°C. would thus be about 0·02 second. In this time, however, *a whole arc disc is formed*, so that the air in our furnaces is not heated nearly so long in the arcs themselves.

The rates of reaction given by Nernst may possibly be too low, but it is most probable that the temperature of the arc is considerably higher than 2,500°C.

With a temperature of 3,200°C., 264 grammes of NO should be formed per minute, whereas in reality the furnace gives only 179 grammes. This difference, however, is not so great but that it can well be explained by the assumption that the equilibrium in the furnace is not quite established, or that the NO formed in the arcs has again been partly dissociated.

The author assumes the average temperature in the arcs to be about 3,200°C., and that the mass of the air directly treated by the arcs in this experiment was about one-fourth of that of the air blown through the furnace. The remaining three-fourths of the air is necessary for cooling that portion directly heated by the arcs in the quickest possible way down to a temperature at which the nitric oxide formed remains stable.

The maximum theoretical output coincides, as will be seen from the table, with about 5,200°C.

If in practice one could choose between such high temperatures, it would be most natural to try to get up to about 4,000°C., as it is probable that the radiation and other losses consequent on such enormously high temperatures would displace the maximum output, so that it would correspond with a considerably lower temperature than 5,200°C. It seems even not unreasonable to think that when we are adjusting the magnetic force by our furnaces so as to give their highest output, we then arrive very closely at the best temperature conditions that may practically be obtained.

It may be interesting to compare the number of litres of gas that, according to the table, are treated in the flame with the previously-mentioned instantaneous photographs showing the thickness of the arc.

According to these, the disc-flame appears to be about 35 mm. thick, with an energy of 300 kilowatts. Now 50 discs are formed per second, and their diameter is about 0·9 metre. The volume of these will be 1,113 litres per second, a result which seems to accord ill with the table. It must be remembered, however, that all the gas particles in the disc flame are not heated equally long during the movements of the arcs; they are more or less in contact with the arcs; and, in the next place, the temperature of the arcs themselves is not, of course, constant all through their section. In the centre of the section the temperature is certainly very high, and diminishes towards the peripheral parts. It is possible that the photographic plate takes comparatively much of the more faintly-glowing air envelope round the inner part of the arc, where most of the nitrogen fixation takes place.

We can here apply a thought that was evolved by Nernst*, which clearly shows the importance of a rapid cooling of the gases treated. As the temperature from the axis of an arc falls very quickly towards the peripheral parts, the partial pressure of nitric oxide answering to the central parts of the section of the arc will be considerably higher than that answering to the periphery. It follows, therefore, that a continuous and rapid diffusion of NO will take place from the central, hottest parts of the arc, out towards the colder parts.

It is assumed in the foregoing that the arcs are always moving through new volumes of air. It is probable, however, that the ions that conduct the electric current through the gas, to some extent at any rate, follow the movements of the arcs. We may form an approximate estimate of the order of the number of the molecules in the arc that are split up into ions.

Assuming first, for the purpose of illustration, that the 90 amperes that pass through the 300 kw. flame are a constant "saturation current" by uniform ionisation between two parallel plates, so that the volume of air acted upon is 747 litres, corresponding to 3,200°C. in the flame (see the table).

If q be the total rate of production of ions in the gas

$$q = I/e$$

I being the current and e the charge of an ion.†

In his last determination, J. J. Thomson found that—

$$e = 3{\cdot}4 \times 10^{-10} \text{ electrostatic units.}$$

From this we find that—

$$q = \frac{90 \times 3 \times 10^{9}}{3{\cdot}4 \times 10^{-10}} = 8 \times 10^{20} \text{ per second.}$$

From experimental data given by Townsend, the number of molecules present in 1 cubic cm. of gas at 15°C. and standard pressure is found to be—

$$N = 3{\cdot}6 \times 10^{19}.$$

Now if one molecule produces two ions, and we assume that no other molecules than those that form ions are decomposed at 3,200 deg., the proportion of gas ionised to the whole amount of gas heated will be about $1{\cdot}8 \times 10^{-4}$. This then is not more than $\frac{1}{300}$ of the ratio between the NO formed, according to the table, and the amount of gas heated.

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* See Haber, *loc. cit.*, p. 251.

† *Loc. cit.*, p. 15.

* *Boltzmann-Festschrift*, Leipzig, 1904.

† See "Radio-Activity," by E. Rutherford, Cambridge, 1905, p. 54.

Now 90 amperes is certainly very far from being the "saturation current" for gases under such conditions as these, so that the number of ions in our flame will probably be very much greater than about 10^{15}, and perhaps so great that the concentration of mono-atomic gases (N) and (O) may be comparable with the concentration of (NO). The chemical equilibrium should then be determined between the five gases (N_2), (O_2), (NO), (N) and (O), and not only between the first three of them.

Let us compare the above number with the number of ions that may be produced by pure radium of an activity of 1,000,000 times that of uranium Rutherford (*loc. cit.*) deduces from an experiment that 7×10^{11} ions per second may be produced per 1 cubic cm. of air at standard pressure and 150°C. It would seem not impossible with pure radium to arrive at considerably higher figures, perhaps to 10^{15} per 1 cubic cm. per second (*loc. cit.* p. 434).

Radium rays show chemical actions of many kinds. S. and P. Curie* have shown that rays from active radium preparations change oxygen into ozone. I do not know whether traces of NO can be detected in air ionised by pure radium, in a way corresponding to the ordinary "hot-cold" treatment of air in the production of NO, but, if so, it would be very interesting to find out whether the same concentration of NO is formed when the air is ionised by radium as when it is ionised to the same degree by heat.

If that is the case, the proportion of gas ionised to the whole amount of gas will be of determinative importance to the chemical equilibrium in gas compounds.

THE ELECTRO-CHEMICAL PROBLEM OF THE FIXATION OF NITROGEN.†

BY PROF. PHILIPPE A. GUYE.

The author first gives some figures showing the extent to which nitrogenous bodies are required and the importance generally of the subject. In addition to the very large quantities of Chili nitrate, ammonium sulphate is used to a considerable extent, and is being produced increasingly as a by-product.

As regards the commercial value of the nitrogen contained in Chili saltpetre and ammonium sulphate, compared with that of the nitrogren in nitric acid, this may be expressed in the following figures which are based on the market of Great Britain for 1905:—

Product.	Value.	Value of 1 kg. N.
Chili nitrate, containing 16·5 p.c. N.	10s. 4½d. per cwt.	1s. 3d. = 1·55fr.
Sulphate of ammonia, containing 21·2 p.c. N.	£12. 10s. per ton	1s. 2½d. = 1·45fr.
Nitric acid, containing 22·2 p.c. N.	£2 per 100 kg.‡	1s. 7½d. = 2·25fr.

Having sketched the general position, the author proceeds to a detailed consideration of calcium cyanamide, nitric acid and nitrates.

CALCIUM CYANAMIDE

General Considerations.—In the course of their researches on the cyanides, Drs Frank and Caro observed that barium carbide, BaC_2, heated to a high temperature, combines nearly quantitatively with nitrogen to form barium cyanide.§

$$BaC_2 + N_2 = Ba(CN)_2.$$

When they tried to apply this reaction to calcium carbide they were surprised to find that the quantity of cyanide formed was much less than the theoretical amount. Further study revealed the fact that the reaction is different from that which occurs in the case of barium carbide and that in the case of calcium carbide, it is represented by the equation—

$$CaC_2 + N_2 = CaCN_2 + C.$$

The carbide gives off half of its carbon and changes, not into cyanide, but into calcium cyanamide. This body can be considered as a derivative of ammonia (cyanamide):—

$$\underset{\text{ammonia}}{NH_3} \qquad \underset{\text{cyanamide}}{NH_2-CN} \qquad \underset{\text{calcium cyanamide.}}{Ca=N-CN}$$

When cyanamide is heated with water under pressure, ammonia is set free according to the reaction:—

$$CaCN_2 + 3H_2O = CaCO_3 + 2NH_3.$$

When distributed on the ground the same reaction goes on more or less slowly, and it is therefore easily understood that cyanamide has given very interesting results when used directly as a fertiliser.

Theoretically, the mixture of calcium cyanamide and carbon produced by the reaction given above should contain about 30 per cent. of nitrogen. As a matter of fact the content of nitrogen in the raw calcium cyanamide is less than this amount, either on account of impurities in the calcium carbide or of the changes which it undergoes during the process of transformation. According to the communications of Dr. Frank, the content of nitrogen varies from 14 to 20 per cent. The product of recent manufacture is stated to contain about 20 per cent.* From this it will be seen that this amount approaches that of sulphate of ammonia.

The economical future of calcium cyanamide is clearly dependent on its cost price. According to the manner of manufacture this cost price itself depends—(1) On the cost price of calcium carbide; (2) On the cost price of nitrogen; (3) On the cost of transforming the carbide into cyanamide.

Calcium Carbide.—The author gives detailed figures of the cost of production, from which he deduces the price of 134·30fr. (£5. 6s. 5½d.) as a net minimum per ton of carbide. Giving full consideration to the average conditions in Europe, it is preferable to take the cost at 140fr. to 150fr. in the best situated works, rising to 180fr. or 185fr. (£7. 6s. 7½d.) where the circumstances are less favourable. These prices include 8 per cent. depreciation, and 5 per cent. on the capital.

Cost Price of Nitrogen.—It is still difficult to give an exact valuation of the cost price of atmospheric nitrogen obtained by the liquefaction and distillation of air. The calculations published on this subject are all based on installations of considerable size and greatly exceeding those which one might expect for a long time to come in the industrial manufacture of calcium cyanamide. In these large installations the cost price would be only a few tenths of a penny per cubic metre or kilogramme of nitrogen. For the relatively restricted production which we are discussing now, it would be wise to estimate the nitrogen at at least 10 centimes, or 1d., per kilo.†

Cost Price of Calcium Cyanamide.—No precise information has yet been published on this subject. It is possible, however, to make a first estimate which ought not to be far from facts, based on the following considerations: The raw material being calcium carbide, the first thing to take into account is the extreme limits of the price of this product—viz., 140fr. per ton for large scale factories and and 185fr. per ton for the average European factories. We need not discuss works at which the price would exceed 185fr.

Cost Price of a Ton of Calcium Cyanamide containing 20 *per cent.* N; *Carbide at:*—

—	140fr. £5. 11s.	185fr. £7. 6s. 7½d.
1 ton carbide, containing 80 per cent. CaC_2 (‡).	140	185
200 kg. nitrogen	20	20
Manufacture, pulverisation of carbide, charge and discharge of retorts, heating retorts	20	20
Necessary repairs of mills, retorts, liquefying machines	25	25
General expenses	10	10
Packing	20	20
Transport (§)	20	20
Depreciation and interest on capital invested	15	15
Cost price per ton	270 £10. 14s.	315 £12. 11s. 2½d.
The price of 1 kg. nitrogen amounts to	1·35fr. 1s. 2d.	1·57fr. 1s. 3½d.

At first sight, the price of a kilogramme of nitrogen amounts approximately to the same as that of ammoniacal nitrogen or that of nitrate nitrogen. But in order to make an exact comparison we must also take into account the coefficient of the agricultural utilisation. According to the different experiments the value is not yet determined with great accuracy; it seems to depend on the nature of the body and on the manner of utilising the calcium cyanamide as manure. The figures given are between 0 64 and 0·95, Chili nitrate being taken as unity. Adopting, for instance, the average 0·85, it will be seen that the kilogramme of nitrogen, with carbide at 185fr. per ton, is already more expensive than the nitrogen of ammonium sulphate; in this case, the manufacture of calcium cyanamide appears to be industrially possible only with carbide at 140fr. per ton. At this price it is evident that the carbide works have every interest in using for this purpose only the excess they are unable to sell for the production of acetylene, carbide intended for lighting purposes giving them a higher profit; at the present time, this product is taken on the average at 200fr. per ton (without packing). It realises even higher prices in France and Italy.]

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* *Compt. Rend.* 129, p. 823, 1899.

† Paper read before the Society of Chemical Industry May 21, 1906. Slightly condensed from the *Journal* of the Society, issued June 30, 1906.

‡ Corresponding to 50fr. per 100 kg. of acid of 100 per cent. HNO_3, a price realised in a great number of factories. This price is a little lower in Germany.

§ This process was patented by Readman and Parker, and is in operation at the works of the Scottish Cyanide Co., at Leven, Fifeshire.

* This high percentage of nitrogen is obtained only with calcium carbide of good quality.

† It is necessary to note that a carbide factory of 5,000 kw. power, able to turn out 10,000 tons carbide a year, and disposing of, for instance, 20 per cent. of its production to transform it into calcium cyanamide—namely, 2,000 tons, would consume only 400 tons of nitrogen—in other words, a little more than a ton a day. However, in accordance with the calculations published the nitrogen could not be obtained at a price of a few centimes the kilogramme unless the daily production reached 40 to 50 tons.

‡ By the addition of certain salts, such as calcium chloride, only 800 kg. carbide would be consumed; but the value of these salts would have to be added, from which we can calculate the average cost of 1 ton.

§ The transport expenses are calculated for factories working on a small scale. For factories working on a large scale we would have to take into account that the area supplied would be much larger and the expenses of carriage would be proportionately higher.

ELECTROCHEMICAL NITRIC ACID.

General Considerations.—The second way of fixing atmospheric nitrogen is by the action of the electric discharge, and many attempts have been made to devise a commercial process of this kind. The first attempt of this kind, made in Switzerland, was due to Aloys Naville in 1893, who proposed to me shortly afterward to study this problem in collaboration with him and Prof. C. Eug. Guye.

The principal results of this collaboration have been condensed in patents taken out in 1895 and 1896, in which we formulated for the first time a principle which appears to us fundamental; it is *that the yield is notably increased when the electrodes are placed in a narrow part of the chamber, in which the reaction takes place, in order to submit the whole of the gas to the action of the electric energy and to draw off as rapidly as possible the gases which have been subjected to this action.*

The results of this work were taken up in 1896 by the "Société d'Etudes Electrochimiques," in Geneva, and tests have been carried out continually since that time on a moderately large scale. Other experiments in the same direction have been made by the Atmospheric Products Co., at Niagara Falls (Bradley-Lovejoy method), the "Groupe d'Initiative," in Freiburg, Switzerland (method of Kowalski), and the Hydro-elektrisk Kvælstofaktieselskab), in Norway (method of Eyde and Birkeland). Recently we have heard about projected plants which will be worked by Pauling in Austria, and by the "Badische Anilin und Soda Fabrik" in Germany. Independently of these developments, which have a more or less industrial character, very interesting laboratory researches have been made by Crookes (1897), Lord Rayleigh (1897), McDougal and Howles (1900), Muthmann and Hofer (1903), von Lepel (1903), Nernst (1904) and Scheuer (1905).

At the beginning of these researches contradictory results were often announced. It appeared as though the effects produced would be different, according to whether the arc is produced by alternating or direct current, or whether the arc is elongated or shortened. Some have recommended currents of small intensity, others currents of large intensity. The presence of water vapour in the air has sometimes been claimed to prove favourable, sometimes unfavourable. Even the form of the electrodes appeared to play a more or less important rôle. To sum up, the combustion of nitrogen at the temperature of the electric arc appeared to be subject to very peculiar, capricious and mysterious laws, and seemed to depend on new and strange factors.

All the factors mentioned above are now known to be secondary and accessory. The detailed study of the problem has proved that the phenomenon is strictly governed by the fundamental laws of chemical dynamics. This method of looking at the problem has not only the advantage of simplicity, but it also furnishes valuable indications of the possibilities which may be realised, and so far there exists good agreement between theory and experimental results. The following discussion is based upon this point of view:—

CHEMICAL PHENOMENA DUE TO AN ARC IN AIR.

The chemical phenomena which occur when an electric arc passes through atmospheric air, may be suitably discussed under three different headings: First, the initial reaction; second, the influence of temperature; third, the reverse reaction.

Initial reaction.—At the high temperature of the electric arc in air, the molecules of nitrogen and oxygen dissociate into their atoms, which is followed by the combination of these atoms to form nitric oxide. Like most chemical reactions, this reaction is incomplete. That means that for a given temperature and for given initial conditions of pressure, composition, &c., the reaction stops when the content of nitric oxide reaches a certain value. The underlying reason of the stoppage of the reaction is its reversibility. The stoppage will take place when the above reaction—the combination of the N and O atoms to nitric oxide—and the reverse reaction—the dissociation of the nitric oxide into N and O atoms—hold each other in equilibrium—*i.e.*, when in the same time the same number of NO molecules are formed by one reaction as are dissociated by the opposite reaction. It is difficult to measure the content of the nitric oxide gas in the state of equilibrium, since in the presence of an excess of oxygen (which is always the case in these experiments) the nitric oxide changes rapidly into peroxide at temperatures below 500°C. or 600°C.

$$NO + O = NO_2 \; *$$

The results of analysis are, therefore, generally given in the form of NO_2. But this does not modify the preceding conclusions.

Effect of temperature.—The reaction proceeds the further the higher the temperature, other things being equal. The following figures were found by Nernst and controlled by calculation on the basis of the law of mass action:—

Absolute temp.	Per cent. by volume of NO, observed.	Per cent. by volume of NO, calculated.
°C.	per cent.	per cent.
1811	0·37	0·37
2033	0·64	0·67
2195	0·97	0 98
3200	5·0	4·4

The time in which the limit of NO gas is formed—*i.e.*, the time in which the condition of equilibrium is reached at a certain temperature, is the shorter the higher the temperature. We give some figures of the same author indicating the time during which the reaction is half completed—*i.e.*, the time in which half the above limiting values are reached. It is 100·0″ at 1,540 deg. and 3·5″ at 1,737 deg. It follows that a double advantage is derived for the combustion of nitrogen from the use of as high a temperature as possible. First, the content of nitric oxide is increased, and, second, the transformation occurs more rapidly.

It is true that these advantages are partly compensated by the fact that considerably more heat energy will be required at an elevated temperature, since the electric arc has to furnish the calories, raising to the desired temperature not only the nitrogen and oxygen which combine, but also the excess of the two gases which do not combine. A careful calculation shows, however, that the larger expenditure of energy required at the higher temperature represents an expense which is more than counterbalanced by the better efficiency obtained thereby. The use of a high temperature is therefore an advantage.

Prof. F. Haber † gives the following figures:—1 kilowatt-year (of 365 days of 24 hours each) can theoretically yield the following maximum amounts of nitric acid by combustion of atmospheric nitrogen:—

1,850 kilos. HNO_3 at 4,200°C.
819 kilos. HNO_3 at 3,200°C.

A decrease of the temperature by 1,000°C. results, therefore, in this case in a reduction of the efficiency by more than 50 per cent.

Reverse reaction.—The formation of nitric oxide at the high temperature is followed by the dissociation of the oxide into nitrogen and oxygen during the period of cooling. This is a necessary consequence of the laws of chemical dynamics applied to reversible reactions. If, for instance, the fundamental reaction

$$\tfrac{1}{2}\,N_2 + \tfrac{1}{2}\,O_2 \rightleftarrows NO$$

is carried out at a temperature of 3,200 deg., whereby the limit of formation of nitric oxide in volume is 5 per cent. (Nernst's figure), and if the gas mixture is then cooled very slowly to 2,200 deg. and equilibrium is again established at this temperature, the volume of the NO will be reduced to 1 per cent. During the slow reduction of the temperature by 1,000 deg., therefore, 80 per cent. of the NO which was produced before at 3,200 deg. is lost. This is the phenomenon of the reverse action.

We have already seen that by raising the temperature, equilibrium establishes itself with greater speed at higher than at lower temperatures. In the same way, when the temperature is diminished, the reverse reaction proceeds more rapidly at higher temperatures than at lower temperatures This is also a consequence of the general phenomenon of reversibility.

It follows that the most dangerous temperatures—those in which the reverse reaction during cooling will undo what has been performed before—are higher temperatures, near the temperature of the primary reaction. From this results the necessity of cooling the gas mixture as suddenly as possible from the temperature of the arc, in order to bring it in the shortest possible time to temperatures at which the velocity of the reverse reaction is practically zero. In the case of combustion of nitrogen this condition is realised more easily, for the reason that below 600 deg. NO combines gradually with the excess of oxygen to form nitrous vapours which escape the reverse reaction.

In practice, the tendency has been to obtain this result first by rapidly sweeping the gases out of the region of action of the arc, while more recently use has been made of electrical or mechanical devices by which the arcs were successively lighted and interrupted several thousand times per second, or the arc has been forced to play in different regions of the space. In all these cases the gas mixture which has been brought instantaneously by the arc to a very high temperature is also cooled instantaneously in the mass of surrounding cold air, and the effects of the reverse reaction are, if not suppressed, at least considerably diminished.

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* Some authors have assumed that nitrogen peroxide is directly formed. But this assumption is untenable in view of the experiments of Richardson, who found that the gas NO_2 dissociates completely into NO and $\frac{1}{2}O_2$ at a temperature between 500°C. and 600°C., which is much below the temperature of the electric arc.

† F. Haber, *Thermodynamik technischer Gasreaktionen* (München, 1905), p. 251.

To sum up, the fundamental considerations which govern the combustion of atmospheric nitrogen are the following:—First, it is necessary to work at a high temperature in order to increase the efficiency and the velocity of the reaction; second, to cool the gas instantaneously in order to avoid the reverse reaction. It is at once evident that it is rather difficult to realise simultaneously these two conditions in practice. According to whether the experimenters have satisfied more or less one or the other condition, the results have apparently been contradictory. This explains the very peculiar results to which we referred above.

The gases obtained in this way contain some 1 or 2 per cent. by volume of nitric oxide when they pass out of the arc chamber, and must then be treated in order to transform the nitric oxide gas into nitric acid or into nitrates and nitrites. These operations are more of chemical than of electrochemical interest, and it will be sufficient to indicate their principle, although the practical operation involves certain difficulties. It is, indeed, necessary to handle a considerable dead weight of inert or indifferent gases. By cooling the nitric oxide gas, NO is transformed into N_2O_3 and N_2O_4 as soon as the temperature falls below 500 or 600 deg. Proper reactions with water, or with alkaline solutions (caustic soda, lime water, &c.), give either dilute nitric acid or nitrates or a mixture of nitrates and nitrites.

(*To be concluded.*)

SHUNT AND COMPOUND-WOUND SYNCHRONOUS CONVERTERS FOR RAILWAY WORK.*

BY W. L. WATERS.

The question of shunt or compound-wound excitation for synchronous converters has been discussed so much that it is of interest to compare the relative merits of the two. As the shunt winding is obviously the simplest and cheapest and most convenient way of exciting a synchronous converter, it would be well to begin by considering why a compound winding is ever used.

In a direct-current circuit it is often an advantage to have a system which is to a great extent self-regulating as regards voltage. This is especially the case where the load changes frequently, and in such cases a compound-wound generator is used. A series winding on the generator field-coils tends to make the voltage at the generator terminals rise as the load comes on the machine. This rising tendency is used to counteract the increasing voltage drop in the feeders and mains due to increasing load. By changing the series winding on the generator the rising tendency of the terminal voltage can be varied to almost any extent.

In a synchronous converter the ratio of the voltages at the terminals of the two sides of the machine is approximately constant, and independent of the load on the machines or the magnitude of the excitation; that is, when transforming from alternating current to direct current, the direct-current terminal voltage bears an almost constant ratio to the alternating-current terminal voltage under all conditions. So the only way of varying the direct-current terminal voltage is to vary the alternating-current voltage supplied to the machine. If the direct-current voltage is to rise as the load comes on the machine, then the alternating-current voltage which is supplied to the machine must be made to vary in the same way. Assuming that approximately constant voltage is supplied at the generator end of the alternating-current feeders. and that the circuit between the generator and the synchronous converters contains sufficient inductance, then the voltage at the synchronous-converter end of the alternating-current line can be raised or lowered by introducing a leading or a lagging current into the system. A leading or lagging current can be introduced into the system by over or under-exciting the converter. So by putting a series winding on the magnets of the converter the excitation of the machines will be increased as the load comes on, and a leading current approximately proportional to the load introduced in the alternating-current system. This will tend to raise the alternating-current voltage supplied to the converter and, in consequence, the terminal voltage at the direct-current side. By means of this system a synchronous converter can be compounded in a manner similar to that employed for compounding a direct current generator. The voltage at the direct-current terminals can be made to increase as the load comes on.

Here then is a system that gives automatic control of the voltage as the load varies. Such a system is obviously extremely useful and convenient. Unfortunately this system presents a number of disadvantages in practice: a series winding is needed on the converter magnets, artificial reactance coils are practically always needed to insert in the alternating-current line so as to bring its reactance up to the required value, and there is need for extra switchboard arrangements. This means increased complications and cost, and a loss of efficiency. A compound-wound converter costs about 7 or 8 per cent. more than a shunt-wound converter. Reactance coils usually cost about 5 per cent. of the cost of the converter. The efficiency of the system is lowered probably 1 to 2 per cent. And in addition the system is more complicated, and in consequence more liable to break down. There is also liable to be trouble in operating the system. A series field winding on a synchronous converter is always a source of danger on account of the liability of its reversing. When starting a converter the series fields can be short circuited and the danger at that time avoided; but if the attendant forgets the short-circuiting switch at any time, there is liable to be trouble. And if at any time when the series coils are in use the alternating-current supply fails or is cut out, and the machine is left connected to the direct-current circuit, the series coils will reverse and the converter is likely to run away, especially if the direct current voltage is varying. A speed-limit device should take care of this, but as automatic devices usually go wrong when they are most needed, so the fact must be accepted that a series winding introduces a possible source of serious trouble in any synchronous converter system.

The automatic compounding obtained by a series winding and reactance coils is not so satisfactory as would be expected. It is natural to expect that the most useful application of this system would be to over-compound converters in a small sub-station, to compensate for a large feeder-drop in case where the load fluctuates violently. The results in such a case are, however, not always satisfactory.

To over-compound a converter and to change the voltage at the direct-current side means that the magnetic flux in the field magnets of the converter must change; as solid steel field magnets are always used in converters the magnetism cannot change quickly, there is therefore often a considerable time-lag before the voltage changes to correspond with the change in load. The result of this is that when the load is varying quickly the voltmeter needle is kept wandering aimlessly about the scale, indicating anywhere from, say, 500 to 650 volts, the voltage apparently not having any relation to the load on the machine. However, when the converter is flat-compounded instead of over or under-compounded, the result is more satisfactory, as the natural tendency of the solid poles is to hold the magnetism and voltage constant.

Usually, however, small sub-stations are supplied from comparatively small power stations; and with a varying load on the converters one of the main effects noticed in the sub station is the fluctuation of the speed of the engines, and consequently the speed of the converters and the alternating-current voltage. The effect of this variation in speed often completely masks all the results of the compound winding.

In addition, this method of compounding is often a nuisance. There must be careful adjustment of the series winding and of the reactance coils at the sub-stations before getting the desired effect. Then, if the converters are changed to another station, or if the line conditions are changed, the adjustment has to be made again. If other compound wound converters are installed in the same sub-station, there is trouble to adjust them so that they divide the load properly at all loads. Equalizer connections are used, but the results are rarely altogether satisfactory. The different characteristics of the converters and the variation in the brush-contact resistance and the temperature of the machines all tend to upset the adjustment. If shunt-wound converters are not dividing the load properly, varying the field rheostat will quickly adjust the load. And in any case shunt-wound converters, just like shunt-wound generators, have a much greater natural tendency to divide the load properly than have compound-wound machines. With this automatic compounding the power-factor of the converter system varies, and often varies widely, with the load. The power factor cannot be interfered with without upsetting the complete system of regulation. A shunt-wound converter tends to keep the power factor the same at all loads. In any case the power factor can be adjusted by means of the field rheostat without in any way upsetting the regulation.

The result of all the complication and disadvantages of a compound-wound converter with reactance coils is that often after the system has been in operation for some time the series magnet coils and the reactance coils are cut out, and the converter is run as a straight shunt machine. The machine is then more in the control of the operator and is less liable to give trouble.

Probably the best system for general work is to have shunt-wound converters, standard transformers and no reactance coils. Somewhat over excite the converter so as to keep the power factor a leading one at all times, and then leave the machines to take care of themselves, only adjusting the excitation in case they fail to divide the load properly.

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* Paper read at the Convention of the American Institute of Electrical Engineers at Milwaukee.

In the case of a large station the feeder drop is small and the fluctuations in load are unimportant, so that the voltage keeps fairly constant at all times. The only work then for the attendant is to cut in or out an extra converter as the load requires it, and to see that each converter in circuit carries approximately its proper proportion of the load.

In the case of small sub-stations the voltage will vary with the load on account of the feeder drop. The direct current voltage will be high on light loads and will fall on full load. For a line with sub-stations at various points this is an ideal condition. When the load is light on such a station it will mean that most of the load on the system is being carried by other stations. The voltage will then be high at the lightly loaded station and lower at the more heavily loaded stations. The lightly loaded station will then tend to help out the heavily loaded one, resulting in ideal conditions—a tendency to distribute the load proportionately between the stations at all times. The converter should be excited so as to get either unity power-factor or a leading power-factor at all loads, and then the feeder drop will automatically take care of everything else and there will be a tendency always to divide the load proportionately between all the stations.

Thus with shunt-wound converters instead of compound-wound machines with reactance coils, there results a cheaper, more efficient, and less complicated outfit, an outfit less liable to give trouble and which will give better results both in large and in small stations. It is hardly to be wondered at then that the present tendency is to make all converters shunt wound. And I think the time is not far distant when the compound-wound converter will be considered as a special type of machine to be used only to meet exceptional requirements. The shunt-wound converter will then be standard for all railway work.

WIRELESS TELEGRAPHY LICENCES.

A return has been issued, as a Parliamentary Paper, "of Applications for Licences under the Wireless Telegraphy Act, 1904, showing how each application has been dealt with, and of statistics of messages to ships at sea exchanged between the Post Office and the Marconi Company during each quarter from January, 1905, to March, 1906, inclusive." The first part of the return gives a complete list of the "commercial," "private business" and "experimental" applications. We give below particulars of some of the most important cases :—

(1) Commercial applications in respect of installations which were already in existence when the Act was passed :—

Marconi Company.—1. Poldhu, Cornwall. 3,000 miles and upwards. For communication with America and with ships at considerable distances. 2. Lizard, Rosslare, Crookhaven (or Browhead), Caister, Niton, Holyhead, North Foreland, Haven, Withernsea; also on board ships. About 100 miles. For communication with ships at comparatively short distances. Terms of licence not yet settled.

Lloyds.—Malin Head, Inishtrahull, Fastnet, and certain stations of the Marconi Company which the Postmaster-General was informed would be worked by Lloyds, and for which a licence will also be granted to the Marconi Company. About 100 miles. Terms of licence not yet settled.

Eastern Telegraph Co.—Porthcurno, Cornwall. 50 miles. Maskelyne–De Forest system. The company wished to be licensed for communication with their own cable ships and with ships generally. A licence was given for the former purpose, but refused for the latter on ground of risk of interference with other stations.

(2) Commercial applications in respect of proposed installations :—

Allgemeine Elektricitats Gesellschaft (German).—South coast of England. Telefunken system. Distance not specified. Application refused on ground of risk of interference with existing naval and commercial stations.

De Forest Wireless Telegraph Synd.—1. Numerous points on coast of Great Britain and Ireland, afterwards reduced to Hartland Point, Mouth of Tyne, and Porthcurno, Cornwall. Licence granted for Hartland Point and Mouth of Tyne. At Porthcurno the syndicate wished to take over the Eastern telegraph Co.'s station and use it for communication with ships generally. Application refused on ground of risk of interference with other stations. 2. Between London, Manchester, Liverpool, Glasgow and Belfast. For communication for press message purposes. Further information asked for but not furnished.

General International Wireless Telegraph & Telephone Co. (Ltd.)—Walters Ash, Bucks, Moorgate-street-chambers, London, and other places. Orling-Armstrong system. It was stated that these stations would be partly experimental and partly commercial. Licence refused on ground that installations were designed for the purpose of establishing exchanges which would be in contravention of Postmaster-General's ordinary telegraphic monopoly.

Lloyds.—St. Catherine's Point, Dunnet Head, Tory Island, Flannan Islands, Butt of Lewis. It is contemplated that if wireless telegraphy is worked at St. Catherine's Point, the Marconi Company's Niton station will be closed. About 100 miles. Marconi system. Terms of licence not yet settled.

Lodge-Muirhead Wireless & General Telegraphy Synd.—Dover, Isle of Wight, Lizard and Fastnet. For communication with ships. Refused on ground of risk of interference with other stations, but licence offered for sites on other parts of the coast.

Marconi Company.—Clifden, Connemara. 3,000 miles and upwards. For communication with America and with ships at considerable distances. Terms of licence not yet settled.

The "Private Business" licences granted include the following :—

Eastern Telegraph Co. (Maskelyne–De Forest system), for communication with their cable ships. 50 miles.

London, Brighton & South Coast Railway Co. (Rochefort system), for communication between Newhaven and Dieppe, and between the Company's steamers and those of the Western of France Railway Co.'s steamers. About 60 miles.

Commercial Cable Co. (Marconi system), communication between c.s. "Mackay-Bennett" and shore stations of United Kingdom. 100 miles.

Midland Railway Co. (Lodge-Muirhead system), for communication with steamers plying between Heysham, Douglas and Belfast. About 150 miles.

Rev. P. O'Loughlin (Orling-Armstrong system), Ballinasloe and Taughmaconnell. 50 miles.

A licence has also been granted Messrs. J. & E. Hall, of Dartford, and one is being prepared for Sir W. G. Armstrong, Whitworth & Co. for communication with ships on their trials in the Tyne by the de Forest system.

Applications for experimental licences include the following for communication with America (about 3,000 miles) :—

Anglo-American Telegraph Co.—Valentia, Ireland. Licence offered.

Commercial Cable Co.—Waterville, Ireland. Licence offered for site near Western-super-Mare.

De Forest Wireless Telegraph Synd.—Ireland or Scotland. Under consideration.

National Electric Signalling Co.—Machrihanish Bay, Scotland. Fessenden system. Licence granted.

Of the other applications for experimental purposes, out of a total number of 68, permission has been or is about to be granted in 47 cases, 5 are still under consideration, 14 were not proceeded with and 2 were refused, licences having been offered for alternative sites in both of these cases. The distances range from 300 feet to 100 miles.

In 42 minor cases permission has been given for the use of apparatus of very small range for lecturing or other similar purposes.

The return of statistics of messages to and from ships at sea exchanged between the Post Office and the Marconi Company during each quarter from January, 1905, to March, 1906, is as follows :—

—	Number of messages.	
	To ships.	From ships.
1st quarter, 1905	111	1,655
2nd ,, ,,	136	2,912
3rd ,, ,,	154	2,844
4th ,, ,,	140	2,886
1st ,, 1906	128	2,452

The revenue accruing both to the Post Office and the Marconi Company in respect of messages *to* ships diminished from £7. 15s. 1½d. for the former and £55. 2s. 6d. for the latter for the first quarter of 1905 to £4. 12s. 6½d. and £53. 7s. 3d. respectively for the first quarter of 1906. On the contrary, the revenue from messages *from* ships increased considerably.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Manufacture of Lubricants, Shoe Polishes and Leather Dressings." By Richard Brunner. Translated from the sixth German edition by Chas Salter. (London: Scott, Greenwood & Son.) 7s. 6d net.

"The Calendar of the University Correspondence College," 1905-6, and the "London Matriculation Directory," No. XLIII., June, 1906. (Cambridge and London University Correspondence College). 1s. net.

"Trade Marks in the United Kingdom under the New Act of 1905." By H. Allen Pryor. (London: Mewburn, Ellis & Pryor.) 6d.

"Technological and Scientific Dictionary." Edited by G. F. Goodchild, B.A., and C. F. Tweney. Part 13. (London: George Newnes.) 1s. net.

"Wissenswertes aus dem Dynamobau für Installateure." By Ernst Schulz. No. 2 of "Bibliothek der gesamten Technik." (Hanover: Dr. Max Jänecke). 2.20m.

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THE FIXATION OF NITROGEN.

The recent Papers by Prof. GUYE and Prof. BIRKELAND draw attention to the very important developments which are being made in electrochemical methods of "fixing" nitrogen on a commercial scale. Probably everyone who has worked on high-tension electrical discharges where much power was absorbed has observed the electrical oxidation of nitrogen, though not to any very great extent. The very marked inertness of nitrogen lends interest to the problem from the experimental point of view. There is no question that nitrogen will "burn" under certain conditions, but, fortunately for the human race, the combustion discontinues if those conditions are not maintained. Not only must the electric discharge be continued, but the content of nitrogen oxides produced must not exceed a certain limiting value.

Apart, however, from the physical interest of the problem, its commercial importance, as pointed out by Sir WILLIAM CROOKES in his Presidential Address to the British Association in 1898, is very great indeed. The population of the world is increasing so rapidly that there may be some difficulty in the near future in supplying all the wheat that will be necessary. The land available for wheat-growing may become inadequate. This difficulty may be postponed by rendering the land already in use more fertile than it is at present; and in any case, such increased fertility is a great advantage if the price to be paid is not too heavy. To this end, sodium nitrate, or Chili saltpetre, is being extensively used with considerable success. Indeed, the greater part of the nitrate produced is used in agriculture, the proportion used for chemical purposes being comparatively small, and amounting to less than 15 per cent. of the whole. At present the output stands at the high figure of $1\frac{1}{2}$ million tons per annum, and, as this figure is rapidly increasing, it is not unlikely that the Chili deposits will be exhausted within, say, 25 years or less. The problem was, therefore, one that required an early solution.

In the comparatively short time of eight years since Sir WILLIAM CROOKES drew attention to the subject, two commercial processes have arisen for the fixation of nitrogen, and both are closely connected with the electrical industry. That of Dr. Frank is only just about to begin its commercial career, and only indirectly depends upon electrical production, calcium carbide being the starting point of what is otherwise a chemical process for the production of cyanamide. The Birkeland-Eyde process, on the other hand, is essentially electric, the atmospheric gases being acted upon directly by a special form of electric flame, and nitric oxide being the direct result. From this oxide nitric acid is readily obtained, but such an acid being unsuitable as a fertiliser, it is converted into basic calcium nitrate as the final product. This process is now being worked on a considerable scale at Notodden, in Norway, as described in Prof. Birkeland's Paper which we give on another page.

The ultimate success of these processes depends, of course, upon two factors. First of all, the cyanamide, calcium nitrate, or other fertiliser must be proved beyond all doubt to be effective. It is a little too soon for very definite opinions to be formed, and in the minds of some there may be a doubt as to continual treatment with nitrogenous bodies being altogether desirable. But in any case the field for nitric acid is assured, quite apart from the question of nitrates. Secondly, there is the question of cost. Chili nitrate stands at present at £10 to £11 per ton, and it is proposed to sell the basic calcium nitrate at £8 per ton. In the event of competition it remains to be seen to what extent the price of Chili nitrate would fall. Doubtless it would fall to some extent, but, according to the investigations of Sempers and Michels, the price could not fall below £8 per ton in London. In that case the prices per ton would be equal, but as sodium nitrate contains 16·5 per cent. of nitrogen and the basic nitrate contains only 13 to 14 per cent. of nitrogen, the Chili nitrate would still have some advantage. As to how far that could be maintained would depend on the efficiency of the electrical process, which is likely to be increased as time goes on, and upon local conditions. Among the more important factors is the cost of electric energy, for it appears that the yield per kilowatt-year is only between 500 kg. and 600 kg. of anhydrous nitric acid. In the discussion on Prof. Birkeland's Paper the author gave the cost of electric energy as 16s. 7d. per horse-power-year. There are few places where electric energy could be obtained at so low a price as this, and therefore the electrical manufacture of nitrate is likely to be restricted to localities which are particularly favourably placed as regards power unless the efficiency of the process is materially increased.

The fixation of nitrogen is one solution of the agricultural question, but there may be others. In a recent Paper M. Grandeau has shown that the quantity of nitrogen abstracted from the ground annually by the crops harvested in France amounts to about 600,000 tons; and, further, that the nitrogen returned in stable manure, if it were all taken to the fields, would not represent more than 327,000 tons per annum. It may, perhaps, be doubted whether the confiscation of atmospheric nitrogen can be allowed to go on indefinitely for the replenishment of the soil, the more so when Nature's economy provides a simple solution. At the present time our most civilised communities are casting away or burning to destruction large quantities of valuable nitrogenous matter in the shape of sewage sludge. We are aware that efforts have been made to utilise this material, but so far very little progress has been made. Whether an electrical solution is possible or not—and that is more than doubtful—this is one of the many problems that still remain to be solved by the combined efforts of the engineer and the chemist.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Report of the Electric Railway Test Commission to the President of the Louisiana Purchase Exposition. (New York: McGraw Publishing Co.) $6. (25s.)

Opportunities for making accurate tests of electric cars or trains under service conditions are not common, and such opportunities as arise can rarely be utilised to full advantage, for commercial and other reasons. Much less easy is it to make tests of vehicles and equipments of various styles and types under strictly comparable conditions.

The results of such tests would frequently be of great value to engineers designing or specifying electric rolling stock.

The St. Louis Exhibition produced, among other things, a collection of cars and equipments from the leading American manufacturers, and it was a bright idea that prompted the exhibition authorities to organise a series of tests with some of the exhibits. A Commission was appointed, of which Mr. J. G. White was the chairman and Mr. Vreeland, treasurer, both well-known names on this side of the Atlantic.

An Executive committee, chosen from the teaching staffs of technical colleges, carried out the work with the assistance of a corps of students from the colleges, so that the testing was in neutral hands, whilst committees representing manufacturers and users offered suggestions and criticisms as to the nature of the investigations undertaken. Thus the results should be unbiassed answers to the questions considered most urgent and important by the practical man.

The present book sets out the nature, object and methods of the various investigations and summarises the results in appropriate ways. Sixteen chapters embody sixty-one "tests." These vary from service tests, in which certain cars were run over the experimental tracks to predetermined schedules, representing service conditions; to tests of single items of the equipment, such as a motor compressor for air brakes. A special test car was built and used mainly for the measurement of air resistance, different shaped vestibules being fitted to compare their effect on the ahead pressure and rear suction. A most important and novel set of measurements was made upon alternating-current losses in steel rails and in track and trolley. These tests, made through wide ranges of frequency and current density, afford more complete experimental data on this subject than has heretofore been published. Calculation is complex and based on assumptions which may not be true for the rails actually used in any given case. The results given in this report do not afford a simple expression from which the impedance of rails may be computed, but they will be found to indicate the order of the loss under practical conditions for rails of ordinary sections and quality.

The arrangement of the matter has been well done. The objects of the tests described in the chapter are first set out, the special tests enumerated, and the test conditions stated. Descriptions of the vehicle or item tested follow. A synopsis of the results occupies an early paragraph in most cases, a handy feature for reference, as there is no occasion to look through the chapter or the individual tests in the search for a particular item. No such synopsis appears in the alternating-current rail loss tests, for they are not susceptible to summary. The descriptions of the methods of observation and measurement are full and clear, and show the attention to detail and accuracy to be expected from the learned body who directed the experiments. The detailed results are given in tabular and graphic form or both as well as in the synopsis mentioned.

The Exposition Company provided two experimental tracks in the grounds, and the Indiana Union Traction Co. put 8 miles of track at the disposal of the Commission, thus enabling runs to be made at high speeds under practical conditions, in addition to shuttle runs on the experimental lines. The Commission has made good use of its opportunities, and the report now described is of great interest and value to all traction engineers. It is, as well, a good example of systematic scientific investigation of commercial machinery. The thanks of the industry is due to all who contributed to the inception, organisation and execution of the work, and to the publication of its results. The book is well printed.

Die Elektrolyse geschmolzener Salze. Part III.: "Elektromotorische Kräfte." By Richard Lorenz. No. 22 of the "Monographien über Angewandte Elektrochemie." (Halle: Wilhelm Knapp.) 1906. 10s.

Parts I. and II. of this extremely valuable work have already been reviewed in the pages of *The Electrician.* Not only is Dr. Lorenz looked upon as the greatest authority at the present day upon the electrolysis of fused salts, but he has rendered a great service to the scientific and technical world by the publication of these monographs.

A great deal of the pioneering work which was done upon the electrolysis was largely carried out haphazard. It was essential that it should be so, because nothing was actually known of how the reactions took place. At the present time, wherever cheap electrical power is to be had, attempts are made to deposit metals on an industrial scale from their fused salts. But there is little need now to work haphazard; the engineer and the chemist, or we should reverse the order, would be wise, in the first place, to study the works of Dr. Lorenz—time and money will thus be saved. This will require hard, patient and careful study, however, because the books are by no means easy reading.

The volume before us is devoted to the study of E.M.F., and it is shown that such laws as hold good in the case of aqueous solutions of salts are also applicable to molten electrolytes. For example, in the passage of the electric current through an aqueous solution of a salt, polarisation takes place at both electrodes. This polarisation rises to a maximum, and may readily be measured. Exactly the same phenomenon takes place in the case of fused salts, but here the difficulties of accurate measurement are increased a hundredfold. The various influences, such as temperature, current density, &c., are discussed at detail, and they are always supported by tables of diagrams and curves worked out from actual experiment.

The completed work is one of great value, and the author deserves our thanks for this very important compilation. But although we say compilation, the expression must be used with reservation, because a great part of the work is from the author's own experiments.

VISIT OF KINDRED ELECTRICAL INSTITUTIONS TO GREAT BRITAIN.

(*Concluded from page 470.*)

Thursday, July 5th.

A somewhat heavy programme was arranged for the only day given up to Newcastle. As a great engineering centre the Tyneside could have occupied the interest of the visitors for many days, not the least important features being the extensive electric power developments in the district. The visitors had to be accommodated in no less than six different hotels in the town. This was, however, the only occasion on which they were so widely separated.

The time was so short that the work of sight-seeing in the morning necessitated the formation of three groups. One of these journeyed by special tramcar to the Elswick works of Sir W. G. Armstrong, Whitworth & Co., where they remained until 11 o'clock. At that time a special steamboat was in readiness and dropped down the Tyne to Fish Quay, near the Swingbridge, where a party of ladies, which had been inspecting the old castle and museum, joined the steamer, and the two groups were finally landed at Messrs. Swan, Hunter and Wigham Richardson's shipyard.

Another group, which was so large that it was divided into two, was conveyed in special tramcars to the works of Messrs. J. H. Holmes & Co. and Messrs. C. A. Parsons & Co. At the former the main departments were visited and much interest evinced in the company's methods of manufacture of motors and dynamos. A prominent feature of the products is the Holmes-Clatworthy system for the electrical operation of printing machinery, the motors and controlling gear for which are made at the company's works.

At Messrs. Parsons' works, the interest taken in steam turbines and turbo-generators was of the keenest, and both American and Continental engineers were busy asking questions. The main turbine assembling shop and the testing and winding departments were included in the tour of inspection. A notable feature of the continuous-current generators is the compensating windings, which are let into teeth in the face of the ordinary shunt pole and connected in series with the armature circuit. We were informed that this method was found to control the armature reaction within wide limits of overload and no load, and dispensed with the necessity for separate auxiliary poles. Some 350 kw. 100 volt machines were seen under construction on this plan, and the compensating windings appeared very massive in consequence of the heavy currents to be carried. Great interest was taken by the visitors in the blading, both of the rotor and stator of the turbines, and nothing but the highest admiration was expressed for the methods in vogue. Among the turbines in the assembly shop was a small unit undergoing alteration, in so far as the generator windings were concerned, from single to three-phase, and as its previous period of active service had extended over seven years the turbine was opened up for inspection. With the exception of a turning down of the rotor blade tips in one or two rows, the vanes appeared none the worse for wear and looked equal to many more years of arduous duty. In the test house two large generators were running, one a 300 kw. continuous-current unit and another a 1,500 kw. machine of which the turbine alone was undergoing test. The generator portion of this machine was interesting in that the ends of the stator windings were very firmly secured to the frame by substantial insulating clamps which obviated, by reason of their solid construction, all tendency of the coils to spread under the influence of short circuits. The impression left on the minds of the foreign visitors, after the tour of inspection of Messrs. Parsons' shops, was, as far as we could gather, most favourable, and one of the Americans summed up his opinion in the expression that with steam turbines we had the engineers of hydroelectric plants on the other side "skinned to death" as far as economy of operation and low price to the consumer were concerned.

The visit to the shipyard of Messrs. Swan, Hunter and Wigham Richardson brought the morning's programme to a close. The visitors gathered on the "Mauritania," the sister ship to the "Lusitania," inspected three days before in Glasgow, and were kindly permitted to walk on the top deck of the vessel, and also to inspect those portions between deck which were completed. The use of portable electric tools about the vessel was very marked, and in addition electric lamps were to be seen lighting up every dark corner where work was to be done. The entire vessel is spanned by a huge steel structure which permits of the employment of overhead electric travelling jib cranes. These were handled with the greatest dexterity and had an almost human appearance as they travelled along above the scene of operations, swinging round into position simultaneously with the longitudinal motion. The control cabin is placed near the end of the boom on a girder, run out from the carriage, so that the craneman always travels round with the jib and is constantly altering his position though he regularly remains by the load and can look vertically downward upon it. The position is advantageous so far as raising and lowering are concerned, because the cranes are used for work between decks, and it is necessary to look clear down on the object to see if it clears the sides of the hole in which it is being manipulated. The men in command have wonderful powers of gauging distance and can run all the crane motions simultaneously at very high speeds.

An adjournment was made at noon for luncheon in the Wallsend Drill Hall, a function which was presided over by Mr. H. L. Riseley, chairman of the Local Reception committee. Responding to the toast of the Local Section, he remarked that there was still great engineering activity in Great Britain, and from what the visitors would see on the Tyneside it would be evident that there were a few kicks left in the old country yet. Herr E. Naglo also made an excellent speech in English, in which he echoed the sentiments of the foreign visitors regarding the excellence of the tour arrangements, upon which Mr. G. C. Lloyd and his assistants were to be highly congratulated. The reception of this compliment to the indefatigable secretary of the institution was hearty in the extreme.

The last items of engineering interest on the Newcastle programme were visits to the Carville power station and the works of the Wallsend Slipway & Engineering Co. The former was but a few minutes' walk from the Drill Hall, and the members proceeded there en masse, there being no alternative visits. Three units were running, the two 3,000 H.P. sets and one of 7,000 H.P., and, judging by the reading of instruments, all three were heavily loaded. The arrangement of the plant, the iron buildings, unpainted generators and compact switchgear; in fact, the plainly practical nature of the installation deeply impressed the visitors, who were not slow in commending the policy of use before ornament so severely yet so effectively embodied in the design of this station. Mr. C. H. Merz, who was with the party at luncheon, personally accompanied the members round the plant. From Carville a steamboat took the visitors down the river to the Wallsend Slipway & Engineering Co.'s works, where the boilers and turbines for the "Lusitania" were in process of construction. There will be 24 of the former, each of 3,000 H.P., and four of the latter having a total capacity of 70,000 H.P. Half the boilers were completed and erected in position on either side of a central gangway in one of the shops. The turbines also were in an advanced stage, the huge castings for the stators being inspected with much interest. An enormous wheel lathe with a face plate some 25 ft. in diameter, was at work turning up the barrel of one of the rotors, which was bolted securely to the carrying spiders and shaft. The extreme simplicity of marine turbine construction, compared with the more familiar huge quadruple and triple expansion reciprocating engines was very pronounced, and the enterprise and determination shown by the constructors of such enormous turbine units for ship propulsion excited great admiration. A most instructive day's programme was concluded with a steamer trip to Tynemouth, past a number of large shipyards, all of which appeared to be busily engaged on important construction work. The evening was one among the very few during the tour which left the party entirely free. At Whitley Bay, near Tynemouth, we noticed a de Forest wireless telegraph station in course of erection. We were informed that the antenna mast, which was 220 ft. high, and built up of four sections of creosoted pitch pine, had been raised into position complete, though only with great difficulty. It was also stated that signals were to be transmitted across the North Sea from this point to a station in Holland.

Friday, July 6th.

The last day of the tour devoted to serious engineering work was spent in Leeds, and a hearty reception was given to the visitors by the Electricity and Tramways committees of the Corporation. The morning was occupied in journeying from Newcastle, so that only the afternoon remained for visits to manufacturers' works. Previous to these, however, luncheon was partaken of at the Town Hall, where a warm welcome was extended by the Lord Mayor of Leeds, who hoped that the city, though the last engineering centre to receive the visitors, would afford them some opportunity for instruction and interest. Mr. Gavey referred in pleasing terms to the lessons of the tour, particularly to our foreign visitors, and also drew attention to the remarkable evidence of confidence in the work of electrical engineers which the visits to various manufacturing works had afforded. Prof. J. L. Farny, speaking in French, expressed gratitude for the splendid reception given the visitors by the Institution, and eulogised the great engineering works they had been privileged to inspect. Mr. Robert Hammond, Alderman Matheson, Sir John Ward and Mr. J. H. Patchell also made brief speeches.

The afternoon was spent in looking over the tramway and lighting power stations and the works of Messrs. Greenwood & Batley, Messrs. Kitson & Co., and Messrs. Joshua Buckton & Co. The manufacture of De Laval steam turbines attracted a large number of engineers to Messrs. Greenwood & Batley's shops and every detail of the manufacture of these machines was followed with the closest interest. The necessary electrical energy for motive power and lighting in the shops is furnished by two separate installations of De Laval turbines, one of 190 H.P. in three units and a larger of 850 H.P. in five units. In the turbine machine shop the processes of cutting the helical gears and grinding them in true were inspected and the special machine tools employed in this connection were much admired. The larger pairs of gear wheels require a month to cut but the work is done with such accuracy that in actual service there is practically no wear. The evening was occupied at a conversazione, given by the Pro-Chancellor of the Leeds University. The different departments of the University were thrown open to the visitors, who took full advantage of the opportunity to examine the machinery in the electrical and textile laboratories.

Saturday, July 7th.

The concluding day of the tour was given up almost entirely to pleasure. Harrogate and Fountain's Abbey, thoughtfully selected by the Leeds Local Section, proved great sources of enjoyment after the almost continuous round of engineering works during the previous nine days. The 30-mile coach drive to and from the Abbey was much appreciated, especially as favourable weather prevailed. Mr. G. Wilkinson, chief electrical engineer, Harrogate, and chairman of the Leeds Local Section, ably presided over all the arrangements, and appropriately included, as the last item on the programme, a special complimentary concert, in which selections from the works of American and Continental composers were given by the municipal orchestra in the Kursaal.

The return journey to London was made safely the same evening, and before reaching King's Cross the President of the Institution and Mrs. Gavey walked through the train and shook hands with each of the visitors in bidding them farewell.

We cannot conclude this report without expressing publicly a sentiment which was given individual utterance many times on the tour, upon the excellence of all the arrangements and the regularity with which the entire programme was carried out. The feeling of comfort and the ready response to all requests for assistance may be attributed to the personality and effort of Mr. G. C. Lloyd, secretary of the Institution, and his assistants. Of the latter we may mention Mr. P. F. Rowell, assistant secretary, whose knowledge of French rendered him indispensable to the members of the Société International des Electriciens, and Mr. R. Tree, who ably supported the Institution staff. Every credit is also due to Mr. A. K. Langridge who so effectively controlled the baggage arrangements. Not a single package was lost, and even on the train it was possible to obtain anything from portmanteau or box without disturbing piles of other luggage. The London & North Western Railway Co., to the courtesy of whose officials the party was greatly indebted, also made the necessarily long journeys by rail as comfortable as a special train with modern appointments and cuisine permit. The steadiness of the train, especially when travelling at high speeds, was not the least of the interesting items which impressed themselves upon the foreign visitors.

WIRELESS TELEGRAPHY IN THE NAVY.

The following is the full text of the agreement between the Admiralty and the Marconi Wireless Telegraph Co. which has just been published:—

This indenture made July 24, 1903, between Marconi's Wireless Telegraph Co. (Ltd.) (hereinafter called "the company") of the one part and the Commissioners for executing the office of Lord High Admiral of the United Kingdom of Great Britain and Ireland (hereinafter called "the commissioners") of the other part. Whereas the company have supplied to the commissioners 32 installations of Marconi's wireless telegraph apparatus, which installations were supplied and are maintained on the terms of a deed of agreement dated February 20, 1901, made between the company and the commissioners. And whereas the commissioners have fitted up other installations, and may require further installations.

Now this indenture witnesseth that it is agreed by and between the parties hereto as follows that is to say:—

1. In this indenture unless otherwise expressly provided or unless the context otherwise requires the following expressions shall have the meanings hereby assigned to them:—"The Company" shall include the assigns of the Marconi Wireless Telegraph Co. (Ltd.); "installation" shall mean an equipment of instruments, stores and appliances necessary for wireless telegraphy according to the system from time to time adopted by the company; "long-distance station" shall mean a station capable of transmitting a message 500 miles and upwards to vessels fitted with suitable receivers; "maritime signalling" means the collection by wireless telegraphy, publication and diffusion of intelligence and information with respect to merchant shipping, cargoes and insurance; "sea telegraphy"

means the receipt and transmission by wireless telegraphy of messages to and from passengers on vessels, messages of public news transmitted to or from vessels and generally messages transmitted to or from vessels which could not reasonably be described by the expression "maritime signalling."

2. The said deed of agreement of February 20, 1901, is hereby cancelled and shall be null and void as from March 31, 1903.

3. The company hereby admits that the commissioners have, by virtue of sec. 27 of the Patent Act, 1883, full right upon the conditions mentioned in the said section to use and exercise for the purposes of His Majesty's Navy, which purposes shall be deemed to include the employment (at the user's risk) of wireless telegraph apparatus ashore by naval officers and men, for military purposes, the inventions comprised in the British letters patent dated July 2, 1896, No. 12,039, and the British letters patent dated April 26, 1900, No. 7,777, and also any further patented inventions to which the company are or may become entitled, and of which they are or may become possessed, or over which they have control and power to use, or which may be used by the company, and all improvements in any such inventions for the period of 11 years from April 1, 1903, and (if and so far as such user shall not be contrary to the provisions of the existing or any future international telegraph convention) the right to require the company during the said term of 11 years in each day, for a time not exceeding 20 consecutive minutes, to forward and receive at the current transatlantic rate for ordinary public messages not exceeding 5d. per word, to the exclusion of all other messages, such messages to and from one of the company's long-distance stations in Great Britain or Ireland as the commissioners or their officers may require them to forward or receive. The company will, when any of H.M. ships may be in communication with any of the company's stations at any time receive at any such station messages from any such ship and forward them to their destination, and also forward messages from any such station to any such ship at the rates from time to time applicable to Government messages and in any case not exceeding current rates for ordinary messages. The commissioners upon payment or tender of such rates shall be at liberty if necessary to require the company to forward messages from any station in Great Britain or Ireland to the extreme range of which such station may be capable. The time of the day during which the commissioners shall have the exclusive right above-mentioned shall be such time between the hours of 6 a.m. and 11 a.m. Greenwich mean time as may from time to time be appointed by the company and the long-distance station from or at which the company shall forward or receive the said messages shall be from time to time appointed by the company. No alteration in the time or substitution of another long-distance station shall be made except after the expiration of two weeks' notice in writing given by the company to the commissioners.

4. The company hereby agree with the commissioners—

1. That they will subject to the rules for the time being in force by virtue of the Berne Convention give priority to Admiralty messages in case of emergency of the existence of which the Admiralty shall be the sole judges. II. That they will to the exclusion of all other messages forward or receive all messages which the commissioners or their officers may require them to forward or receive during the time and at the long-distance station appointed under the provisions of the last preceding clause and will with reasonable despatch forward all messages received to the destination to which they may be addressed or for which they may be intended. The company will once in each week forward to the secretary to the Admiralty upon a form to be agreed upon between the parties hereto a return setting forth copies of the messages sent or received in the preceding week, the date upon which the same were sent or received and the sums claimed in respect of the same. III. That they will with reasonable despatch after the same has been discovered from time to time communicate to the Commissioners any improvement in apparatus intended to be used for wireless telegraphy or in the methods of signalling within their knowledge and to which they are or may become entitled and of which they are or may became possessed or over which they have or may have control and power to use, or which may be used, by the company. IV. That they will supply to the commissioners any further installations, or parts of installations, that they may order from the company during the said period of 11 years all such installations or parts of installations to be supplied at current trade prices, except the articles specified in the schedule hereto, which articles are to be supplied at the prices set opposite to them respectively in such schedule, and also will supply to them when required duplicate parts of any such installations not mentioned in the schedule hereto at the then ruling trade prices. All parts so supplied shall be interchangeable with the corresponding parts of all other installations of similar pattern. V. They will make and deliver at current trade prices, and if required, at the commissioners' expense, fit to any installation for the time being of the commissioners, whether made or supplied by the company or not, all improvements in wireless telegraphy apparatus within their knowledge, and of or to which they are or may become entitled, and of which they are or may become possessed or over which they have or may have control and power to use or which may be used by the company, and which shall, in the opinion of the commissioners, be applicable to ship purposes. If the commissioners require the company to make, deliver, and or fit any device which they may deem suitable for ship purposes but which the company shall be of opinion is not suitable, then and in that case the company shall be released from their obligations in respect of the installation to which such device is fitted for so long as the said device is used. VI. That for so long a time as the commissioners shall think necessary they will supply, at a charge of £1 per day, and reasonable travelling expenses, competent instructors in the art and practice of wireless telegraphy to teach persons selected by the commissioners and to give advice in drawing up written instructions for operators and others, and in tuning all their installations for the time being, whether manufactured or supplied by the company or not, and will allow officers of the commissioners specially employed for wireless telegraphy duties from time to time to visit the company's stations and workshops (in the case of long-distance stations upon giving 24 hours' notice) in order to keep themselves acquainted with the latest developments thereat, and will exhibit from time to time to such officers all the newest apparatus in use at such stations.

5. The commissioners hereby agree with the company—(*a*) That they will pay to the company on the execution of these presents the sum of £20,000 in consideration for the rights and privileges hereby granted and conferred, and will also pay to the company within three months from March 31, 1903, on production by the company of the certificates stipulated for in the agreement of Feb. 20, 1901, the further sum of £1,600, being the amount of the royalty payable to them in respect of the said 32 existing installations calculated up to that date. (*b*) That if the company shall duly perform its obligations under this indenture they will pay to the company on or before April 30 in every year during the said period of 11 years the sum of £5,000, the first of such payments to be made in April, 1903, and to cover the period until April, 1904. (*c*) That they will not purchase the duplicate parts specified in the schedule hereto or any other parts which may hereafter be agreed to be treated as included therein from any person or company other than the company so long as the company are in a position to supply and do supply the same in a reasonable time after the order is given. If the company shall not be in a position to supply or shall fail to supply the same within a reasonable time after the order is given the commissioners may without making any further payment themselves manufacture any such apparatus. Nothwithstanding anything contained in this clause the commissioners shall at all times be at liberty to obtain from other sources such apparatus used for wireless telegraphy as is not enumerated in the schedule referred to.

6. If and so long as the commissioners shall conduct the business of maritime signalling or sea telegraphy at any station or stations within the United Kingdom belonging to or controlled by them, they shall conduct such business in conformity with the system adopted at similar stations under the control of the company, provided always that the commissioners shall be under no obligation to continue the business of maritime signalling or sea telegraphy at any of their stations if the conduct of such business interferes with the efficiency of communication with H.M. ships. So long as the commissioners conduct such business at any station or stations within the United Kingdom, they shall in each month report to the company on a form to be agreed, the number and length of any messages forwarded or received in the preceding month, and will pay over to the company any payments made to them in respect of such messages. The company shall be at liberty to send a duly authorised person to inspect the apparatus in use at any station at which the commissioners are conducting the business of maritime signalling and sea telegraphy and the working thereof.

7. Except in time of emergency, of the existence of which the commissioners shall be the sole judges, or war, or in the case of war-ships of all nations or of distress signals, the Admiralty shall not use Marconi wireless telegraphy apparatus fitted in stations in the United Kingdom worked by them for the interchange of signals with or for forwarding signals to vessels or stations not equipped with apparatus supplied by the Marconi Company, provided always, that in the event of the commissioners failing to observe the provisions of this clause in consequence of any legislation which either expressly or impliedly releases them from the obligation to observe the same, the company shall be entitled to compensation (to be settled by arbitration in accordance with the provisions of clause 16 hereof) in respect of the profit which they would have made had the commissioners continued to observe such provisions during the whole term of this agreement. The company shall from time to time furnish the Admiralty with a list of ships fitted with apparatus supplied to them.

8. In order to render naval operators proficient in all branches of wireless telegraphy and qualify them to carry out commercial signalling when required, the company will give free of charge instruction and practice to naval operators at any stations for shipping purposes worked by the company or under their control.

9. The commissioners shall at all times during the said term of 11 years, or for such portion or portions thereof as the company shall desire them to do so, regard as confidential all apparatus and articles specified in the schedule hereto, or which may hereafter be agreed to be treated as included therein, and also all advice, information and instructions given by the company or by any person or persons on their behalf to them or to any of their officers or employés, and also any contracts disclosed to the commissioners under the provisions of clause 4 (2) hereof, and will not teach or communicate the details of working of, or except in case of emergency without the consent of the company, transfer any such apparatus or article to any person not belonging to H.M. naval service or not employed or not about to be employed by the commissioners in connection with wireless telegraphy for such service, and will issue general instructions to all concerned to observe the provisions of this clause.

10. Provided always, and it is hereby agreed and declared by and between the said parties hereto, that if at any time during the said period of 11 years either of the said Letters Patent, hereinbefore specified, shall be proved to be invalid, the commissioners may give one month's notice in writing under the hand of their secretary to determine this agreement and thereupon all their obligations hereunder shall absolutely cease and determine. In the event of the commissioners for the above or for any other reason ceasing to make further payments under this indenture prior to April 1, 1913, the company shall be released from all their obligations under this indenture.

11. The payment of the before-mentioned sums of money to the company shall not be regarded or taken as an admission by or on the part of the commissioners that any of such patents are valid, or that the user of the installations or of any apparatus or thing constituting parts of such installations as covered by such patents or any of them is a lawful user thereof within the limits (if any) within which the user thereof may under any statues now in force be unlawful.

12. The payments hereinbefore mentioned shall be in full satisfaction of all claims that the company might otherwise have for royalty on all the wireless telegraph apparatus at present in use, or which may in future be brought into use for H.M. naval service whether supplied by the company or not, and the company shall have no further claim to royalty against the commissioners, nor any claim for royalty or for damages for infringement of patent in respect of any wireless telegraph apparatus manufactured for the commissioners against any contractors whom the commissioners may employ to manufacture for H.M. Naval Service such apparatus not included in the schedule to this agreement. The maintenance of all installations shall be at the expense of the commissioners.

13. The company shall indemnify and hold harmless the commissioners against all claims, suits and demands in respect of any matters arising out of the exercise by the commissioners of any of the powers conferred upon them by this indenture or otherwise arising out of the same by the Marconi International Marine Communication Co. (Ltd.), or any other person or company whomsoever or whatsoever.

14. Notwithstanding any of the provisions hereinbefore contained, the company shall not be under any liability in consequence of any error in messages forwarded or received by the company, or in consequence of the non-receipt at its intended destination of any messages intended to be so forwarded or received.

15. If the company at any time during the term of this agreement shall cease to maintain a long-distance station in the British Isles the company shall on demand, at the option of the commissioners, either sell to the commissioners one of the long-distance stations theretofore maintained by the company, or erect and equip another long-distance station at the commissioners' expense, or assist them in doing so in any part of the British Isles. Any such station shall be used solely for the purposes of H.M. Naval Service. In default of agreement as to the price to be paid for any long-distance station purchased under the provisions of this clause, the same shall be settled by arbitration in accordance with the provisions of clause 16 hereof.

16. If any dispute shall arise between the company and the commissioners touching the meaning of this indenture or any part thereof, or touching any matter or thing arising out of the same, or in anywise connected therewith, the same shall be determined by a single arbitrator appointed under the provisions of the Arbitration Act, 1889. In witness whereof the company have caused their common seal to be hereunto affixed and the commissioners have hereunto set their hands and seal the day and year first above written.

THE SCHEDULE HEREINBEFORE REFERRED TO.

	£	s.	d.
Short Wave:			
Transmitting jigger No. 5	5	1	6
Condenser for same (tray of 6 Leyden jars)	6	4	0
Receiving jigger No. 306	0	10	9
Long Wave:			
Transmitting jigger No. 17	4	14	0
Condenser for same (tray of 15 Leyden jars)	14	10	0
Receiving jigger No. 345	0	17	0

The Common Seal of the company was hereunto affixed in the presence of
(Signed for the Marconi Company) H. CUTHBERT HALL, ALBERT OCHS, } Directors.
HENRY W. ALLEN, Secretary.
(Signed on behalf of the Admiralty) W. H. MAY (Rear Admiral).
J. DURNFORD (Rear Admiral).
Lords Commissioners of the Admiralty.
(Witness) GORDON W. MILLER, Director of Navy Contracts.

CORRESPONDENCE.

"THE ORIGIN OF LIFE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A word or two in reply to Dr. Charlton Bastian's interesting letter in *The Electrician* seems necessary, as he labours under the same difficulty that some other of my critics do, chiefly with regard to the solubility of radiobes in warm water, which he thinks is "of itself damnatory to their claim to be regarded as living things."

Dr. Bastian is no doubt aware that all I claim for radiobes is a resemblance to what we may expect the most elementary forms of life to have been like when they first made their appearance on this planet, probably in the polar regions, possibly at the bottom of the sea. But when we come to such elementary phenomena, resembling as they do life in many respects, it is necessary that we should expect that word to stand for something simpler than it does when applied to the life of a man, for instance, and I should say also even of a bacillus.

It would take me far beyond the limits of space which I could possibly expect you to accord to me if I were to enter into a discussion of the various definitions which may be and have been given of life. Those who are interested in the subjust will find what I have to say in my book on "The Origin of Life: Its Physical Basis and Definition."

Life as we see it to-day is, I maintain, the result of natural selection in matter itself. And such bodies that can withstand the temperature of our environment do so largely on account of the fact that they have been chosen for it by that process of selection. All the unfit types have been eliminated; but if any of them had been soluble at the ordinary temperature of 25°C. they, too, would have been eliminated, and that indeed very long ago. They may, however, as I say, have thrived at the bottom of the sea or in the polar regions. And it seems to me somewhat amazing that those who are in search of the first beginnings of life should expect so much from those very first beginnings.

Now I may, perhaps, once more venture to emphasise that I do not think the forms of living cells we see around us in Nature were ever brought into being by radium, but rather by that other substance *biogen*, for whose presence in Nature I have given several reasons, notably those based upon extrapolation, of the results obtained by radium and other bodies.

In my letter in your columns on June 15th, I pointed out that the soluble cellular bodies produced by radium may be regarded as higher in the scale than those produced by other salts and lower than bacteria. We cannot, therefore, do more than ascribe to them a place in the borderland between living and dead matter as familiarly understood.

Dr. Bastian asks whether the bodies produced by the action of radium on bouillon do actually sub-divide, or only undergo a modification in shape suggestive of fission. The answer is as follows: The sub-divisions are not due to change of shape alone, but to actual cleavage, when a certain size has been attained.

The cleavage is first along one diameter, then across another at right angles to it, without any further change of shape or size. This takes several days to occur. I have watched the process for several hours at a time for days.

The real point, upon which Dr. Bastian does not touch, is whether the division takes place from the interior outwards or vice versâ, and I am of opinion that the sub-division is due to some internal strain, most probably brought about by the emanation from the radium. But of this I propose to discourse some other time. The progress of these experiments has been much retarded by the fact that it is the salt itself and not a solution which produces the effect, since the cells are soluble. Those who have tried solutions have failed, and failed deplorably. Mr. Rudge, for instance, has made experiments with *solutions* of radium salt on gelatin (not bouillon). He, moreover, heated this gelatinous body, and obtained what he very rightly describes as insoluble precipitates. But this, of course, has no marked characteristics whatsoever and is so far as I can see irrelevant to anything I have described.—Yours, &c.,

Cambridge, July 3. JOHN BUTLER BURKE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am indebted to your courtesy for sending me a proof of Mr. Butler Burke's reply to my note concerning his "radiobes."

My belief that they have nothing whatever to do with the origin of life is founded, in the main, on the facts that they are soluble in water and that they seem to betray the real nature of their constitution by ultimately resolving themselves into aggregates of minute crystals.

It is difficult to see how Mr. Burke's disquisitions concerning definitions of "life" can help him here. Life is not an entity existing of and by itself, and is known only as it presents itself in certain forms of matter. Definitions of "life," then, after all, are simply generalisations founded upon the properties manifested by living things; and I have yet to learn that a tendency to resolve themselves into crystals is to be regarded as a property of any known living things. This sequence, indeed, seems to me to be quite as alien to their nature as that other unfortunate property of radiobes—their solubility in warm water.

Mr. Burke says he claims for radiobes "a resemblance to what we may expect the most elementary forms of life to have been like when they first made their appearance on this planet, probably in the Polar regions, possibly at the bottom of the sea." When he says "we may expect," I am inclined to demur.

So far as mere appearance goes, his radiobes closely resemble Cocci and Sarcinæ, which are about the most elementary forms of life known, and I at least do not need to go to the "bottom of the sea" for their place of origin; and as for the Polar regions, if radiobes are to be regarded as the rudimentary beginnings of life, I am afraid they could not have made their entry upon the scene there in the remote past. Surely Mr. Burke must have forgotten that in the early days of the earth's history, and for very long after living things appeared upon its surface, there was no such distinction as exists now between polar and equatorial temperatures. The solubility of his radiobes would have been against them generally in those days!

Mr. Burke's mention of "Natural Selection" carries no weight in this connection. This phrase is only too apt to be used as a mere catchword. No one has yet shown that the lowest existing living things (known to be such, and altogether apart from radiobes) really come under the influence of natural selection. As I have said elsewhere ("The Nature and Origin of Living Matter," p. 191):

> "It seems clear, in fact, that so long as organisms multiply by mere 'discontinuous growth' (fission or gemination) there is absolutely no reason to appeal to heredity except in the form of 'organic polarity.' This would be all-sufficient for the preservation of their likeness under similar conditions; and for their reversion (as with crystals and double salts) to old forms on renewal of old conditions—a class of facts among organisms with which the researches of many bacteriologists have made us perfectly familiar. . . . It is, then, not till we get out of the great Ephemeromorphic plexus and come to organic forms which habitually multiply by sperm-cells and germ-cells (or occasionally by the latter alone) that heredity, as postulated by Darwin and Weismann, comes into play: and it is consequently not till we reach such forms that it would be possible for Natural Selection to be influential as a cause of evolution." (*See* also pp. 99 and 131.)

Judging from what Mr. Burke now says, it is obvious that the cleavage of radiobes is an excessively slow process, which has not yet been watched through all its stages. It is thus wholly unlike the rapid processes of fission that may easily be watched from beginning to end in the most elementary known forms of living matter. More than that, the mere fact of their cleavage, as I pointed out in my last note, gives them no title to be regarded as living things. And when such cleavage is associated, as it is, with solubility in warm water, and an ultimate tendency to resolve themselves into minute crystals, we need not attach a very high value to this peculiarity, on which so much stress was laid at first.

Mr. Burke says: "The real point, upon which Dr. Bastian does not touch, is whether the division takes place from the interior outwards or vice versâ." Truly, I said nothing on the subject because, as it seems to me, that is a matter of little consequence, and one concerning which neither he nor I can have any actual knowledge. Still on this subject Mr. Burke tells us that he proposes "to discourse some other time." I am rather afraid Mr. Burke's speculations and disquisitions are somewhat tending to befog a subject which is already only too obscure, and to divert enquiry away from the real points at issue in regard to the origin-of-life question.—

Yours, &c., H. CHARLTON BASTIAN.

[This correspondence is now closed.—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

LONDON BOROUGH COUNCILS AND ELECTRIC FITTINGS, &c.

The section of the London County Council (General Powers) Bill (Section VI.) which authorises any London borough council supplying electrical energy to engage in the wiring and fitting of consumers' premises, the hiring out of motors, &c., was passed by Lord Camperdown's Committee of the House of Lords on Friday. The facts were set out in our last issue.

SHROPSHIRE, WORCESTERSHIRE AND STAFFORDSHIRE ELECTRIC POWER BILL.

Seven notices of motion were down for the rejection of this bill on second reading in the House of Commons on Tuesday, the object being to secure the insertion of a clause binding the promoters to secure the consent of the local authority in practically every district before a supply of electricity could be given to any consumer. As a fact, all opposition on the part of local authorities has been withdrawn since the bill was passed by the House of Lords (*The Electrician*, May 18 and 25). When the second reading came on for debate on Tuesday, however, the only questions asked were as to the financial bona fides of the promoters, and an assurance being given by Mr. Kearley, as the representative of the Board of Trade, that that department considered the financial position ample, the second reading was not opposed.

THE LONDON TELEPHONE SYSTEM.

In the House of Commons on Tuesday, Mr. ACLAND ALLEN asked the Postmaster-General if he could state what were the precise difficulties standing in the way of the establishment by the Post Office of a telephone exchange to serve the districts of Finchley and Hendon; and whether, in view of the inconvenience caused by the absence of such an exchange, he could hold out any hope that these difficulties would be overcome at an early date.

Mr. SYDNEY BUXTON, in a printed reply, stated that a scheme had been drawn up some time ago for providing an exchange service in the districts of Finchley and Hendon, but the final settlement of the plans had been considerably delayed by the unwillingness of the local authorities to grant necessary wayleaves. A site had been purchased and plans prepared for the exchange building, the erection of which would be begun at an early date. If the local authorities would render reasonable assistance, as now appeared probable, the exchange system would, he hoped, be ready for use during the first half of next year.

MISCELLANEOUS.

The Kent Electric Power Bill was read a second time in the House of Commons on Monday.

The Oldham and Saddleworth Tramways (Abandonment) Bill was read a third time in the House of Commons on Friday last week.

In the House of Lords on Monday, the North-East London Railway Bill, the Huddersfield Corporation Bill and the Metropolitan Railway Bill were read a third time.

The Unopposed Committee of the House of Lords passed the following bills on Tuesday: Ascot and District Electric Lighting, Twickenham and Teddington Electric Supply, Baker Street and Waterloo Railway and Derbyshire and Nottinghamshire Electric Power. All these bills have passed through the House of Commons.

The Folkestone, Sandgate and Hythe Tramways Bill is now unopposed in the House of Commons. The bill has already been passed by the House of Lords (*The Electrician*, May 25 and June 1).

The Folkestone Electricity Supply Bill was passed by the Unopposed Committee of the House of Commons on Thursday last week. The bill, which has already passed through the House of Lords, confers certain additional powers upon the Folkestone and District Electricity Supply Co. in the way of legalising agreements entered into with the Hythe and Sandgate Urban District Councils, &c.

The West Yorkshire Tramways Bill, which was opposed in the House of Lords, was before the Unopposed Committee of the House of Commons on Thursday last week. The proposals of the bill are to construct a network of tramways connecting up Huddersfield, Halifax and Brighouse, and running powers are asked for over the lines of the Huddersfield and Halifax municipal tramways. The gauge of the company's lines is 3 ft. 6 in., and as the gauge of the Huddersfield tramways is 4 ft. 8½ in. it is proposed that an additional rail should be laid on those portions of the Huddersfield lines over which running powers are asked. No opposition is offered by the Huddersfield Corporation to this. The capital of the company is £120,000, with £40,000 borrowing powers, and interest is to be paid out of capital during construction at the rate of 3 per cent. to the extent of £5,000. The promoters of the scheme are the National Electric Construction Co. The Committee passed the bill.

The Unopposed Committee of the House of Commons passed the Cumberland Electricity and Power Gas Bill on Thursday last week. The House of Lords has already passed the measure, the objects of which are to erect three generating stations in Cumberland for supplying electrical energy and power gas. The equipment of the electrical portions of the stations will be gas engines, driven by the waste gases from the blast furnaces, and agreements have been entered into with the owners of three furnaces for the supply of such gas. We reported the proceedings fully when the bill was before the House of Lords, including the terms of agreements that have been made with the West Cumberland Electric Tramways Co. and the Whitehaven Corporation (*The Electrician*, May 11, p. 145).

The South Wales Electrical Power Distribution Co.'s bill was passed by the Unopposed Committee of the House of Commons on Tuesday. It enables the company to raise £1,500,000 additional capital in consequence of the acquisition of the Carmarthenshire Electric Power Co. last year.

LEGAL INTELLIGENCE.

The King (Drury) v. Dublin Corporation.

Judgment was recently delivered in this case by the King's Bench Division, Dublin (the Lord Chief Baron and Justices Johnson and Gibson). It appeared that the town clerk (Mr. H. Campbell) had refused (on instructions of Dublin Corporation) to produce certain books to the L.G. Board auditor (Mr. J. W. Drury) for the annual audit of the municipal accounts, and thereupon an application was made for a mandamus to compel the production of the books.

In delivering the unanimous judgment of the Court, the LORD CHIEF BARON said it was admitted that a public duty was imposed upon the town clerk, by the Public Bodies Order of 1904, to produce the books and documents, but he declined to do so and he sheltered himself behind two resolutions passed by the Corporation forbidding him to do so. He held that the authorities cited in support of the contention that the auditor ought to proceed against the town clerk by indictment did not apply, and the mandamus must therefore go. Further, as the auditor was charged with a statutory duty to audit the accounts, and as that duty could not be performed without the production of books and vouchers, he (the auditor) had a sufficient interest in the performance of the duty imposed upon the town clerk to maintain the application. For the Corporation it had been said that there had been no sufficient demand upon or refusal by them to perform their duty, that the auditor on former audits and in reports made upon them wilfully and corruptly exceeded his duty with the object and effect of injuring the credit of the Corporation; that he intended to persist in the same course at the present audit, and, therefore, his object in applying for the writ was wholly, or at least in part, illegal, and to effect that illegality the Court would not assist him, and, further, that the remedy, if any, against the Corporation was by indictment and not by mandamus. The Court were of opinion that a duty to produce the books was imposed upon the Corporation not by the Local Government Order but by the Act of 1871. As the Corporation could only act through its officers, the town clerk was the proper officer to produce the books. The duty of the auditor was a public duty, and even were there misconduct by him in the performance of his duty in the past it was impossible to rely on that misconduct as an answer to the performance by the Corporation of a duty. The past conduct of the officer was irrelevant to the present inquiry. The duties of the auditor in that case were much more extensive than in the case of a company. An auditor under the Local Government Act had to report upon the accounts, and the main object of his report was the information of the ratepayers. For instance, in the controversy as to the alleged depreciation of electric lighting plant, a certain sum was taken credit for as representing assets in hand, and consequently the larger that amount was the less would be the amount which the account would represent to have been the expenses of the year. If the auditor was of opinion that the electric lighting plant at the date of any of his reports did not fairly represent the sum at which it was valued in the accounts it would have been plainly within his competency to reduce the valuation to what he conceived to be its true amount, or if the figure was allowed to remain in the accounts as presented by the Corporation, to report in full detail the reasons why he was of opinion there was an over-valuation. The surcharges made by the auditor need not necessarily appear, but the auditor was clearly entitled, and was often bound, to call attention to them in his report, and to explain the reason why they were imposed. Again, the auditor should call attention to irregularities in the keeping of accounts, or in the transactions they recorded. A system such as appeared to have existed for years in Dublin of largely overdrawing one account and of allowing large cash balances on another account to remain in bank without producing interest on an arrangement that the bank would not charge interest on the overdrawn account, was entirely illegal. It was borrowing where no borrowing power existed, and it was the auditor's duty to call attention to such a practice. Having referred at great length to the reports of the auditor upon the accounts of the Corporation, including Mr. Drury's report as to the value of the electric lighting plant, the Lord Chief Baron said he was glad the L.G. Board had acted as they had done in refusing to entertain the Corporation's application for the removal of Mr. Drury, and in his opinion they would have been guilty of a breach of duty if they had yielded to the application. Mr. Drury had a clear jurisdiction as to what he had done, and he (the Lord Chief Baron) would like to remark that he thought the auditor had got himself into all this difficulty by not plainly, when he saw a sum was illegal, having the courage to surcharge every member who signed or directed the cheque for the illegal payment. All through the auditor appeared to have been too lenient to the Corporation. The Council were trustees of the ratepayers and the latter were entitled to full knowledge as to the corporate funds, and he could only express astonishment that a Corporation of such a city as Dublin should, in consequence of the auditor's reports, have thought themselves justified in passing a resolution directing that the books for the audit should not be produced to the auditor. The charge against the auditor wholly failed, and they made the order for a mandamus absolute, with costs.

A stay of one week was granted, to give an opportunity to consider the question of an appeal.

Electrical Power Storage Co. (Ltd.) v. Patents Exploitation (Ltd.)

The Court of Appeal (Lords Justices Vaughan Williams, Romer and Moulton) on Friday last concluded the hearing of this appeal of defendants from the judgment of Mr. Justice Joyce.

The facts of the case were given in our issue of March 17. Plaintiffs were exclusive licencees (under agreement of Feb. 20, 1892) from defendants of a patent for the manufacture of dry batteries (dated Jan. 27, 1890). In an action for infringement against Siemens Bros. & Co. the latter paid £3,000 into Court in respect of the inquiry as to damages, and the question was whether plaintiffs were entitled to share in the damages and to recover a contribution made by them to the costs of the action. Plaintiffs agreed to pay £250 towards the costs, and, in the event of a favourable decision being obtained, out of the amount of the damages and costs they were to be reimbursed. Defendants contended that the agreement did not in any way refer to the Court of Appeal and the House of Lords, and alleged that as the case failed in that Court on first instance plaintiffs had lost the £250, and their interest in the damages and costs had gone. Mr. Justice Joyce held that the construction put by plaintiffs on the agreement was the correct one, and that all costs must be dealt with and the ultimate residue of the damages divided in the way prescribed by the agreement.

Mr. Astbury, K.C., and Mr. Shaw appeared for appellants, and Mr. Hughes, K.C., and Mr. Graham for respondents.

Lord Justice VAUGHAN WILLIAMS, in giving judgment, said he was of opinion that the agreement did not in any way refer to the Court of Appeal or to the House of Lords, and therefore the appeal must be allowed.

The other Lords Justices concurred, and the appeal was accordingly allowed with costs.

Market Bros. & Co. and Others v. F. Krasa & Co.

On Monday before Mr. Justice Phillimore, Market Bros. & Co. and the Auto Claw Co. sued defendants for £65. 10s. damages alleged to have been sustained by reason of defendants' failure to deliver 179½ gross pairs of fuse bases and clips in accordance with contract. Defendants pleaded that they simply accepted plaintiffs' order as the agents of Mr. L. Pohl, of Tellnitz, Bohemia, and subject to his confirmation, and that he was, in fact, the principal to the contract.

After evidence and counsel's arguments, Mr. Justice PHILLIMORE decided that the contract was one between plaintiffs and defendants as principals, and gave judgment for plaintiffs for £51. 17s. and costs.

Leyton Urban Council v. North Metropolitan Tramways Co.

This was a special case (before Mr. Justice Bigham) stated by the arbitrator appointed to determine the price to be paid by the Council for the purchase of 1½ miles of tramway owned by the North Metropolitan Tramways Co. within the Leyton district. Before the arbitrator the point was raised whether the Council were compelled to purchase a large car manufactory which had been erected by the company within the district, where the company manufactured and repaired cars, harness, &c., for their whole system of 62¼ miles.

For the Council it was argued that what they had to purchase was the company's "undertaking or so much of the same as is within their district," and that that meant the tramway undertaking and not a business of constructing or selling tramcars. The company contended that the factory was a legitimate part of the tramway undertaking, that it was eminently suitable to and certainly used for the purposes of the whole system, and that as these purposes were also the purposes of the undertaking within the district it was suitable to and used for that undertaking. They further contended that there was no power in either the special or general act which enabled a local authority to purchase a part only of the building, and that, therefore, the Council was compellable to purchase the whole factory.

Mr. Justice BIGHAM, after hearing arguments, said what the Council had to pay for was buildings and works suitable to and used by the tramway company for the purposes of their undertaking within the district. There did not appear to him to be anything in those words showing any question of law at all. They involved only questions of fact. Whether these works were suitable to the undertaking within the district or not was a question of fact, and the case must go back to the arbitrator to decide the questions of fact.

Overhead v. Underground Telephone Wires.

At Marylebone (London) Police Court on Friday, Mr. Paul Taylor sat as arbitrator in a dispute between the Post Office authorities and St. Pancras Borough Council, in regard to the proposal by the former to erect three 8½ in. iron pillars, 35 ft. high, in Camden Town, to carry overhead wires for fire alarm and telephone purposes.

The Council refused sanction as they considered the posts would be a serious obstruction to traffic, that overhead wires were a source of danger to the public, especially in times of storm or snow, and that therefore the wires should be placed underground.

Mr. MARTIN P. ROBERTS, assistant engineer-in-chief to the Post Office, said the Postmaster-General would have put the wires underground if the number of wires required had justified the extra expense that would have been incurred, but as only a few wires were needed it was unreasonable that the Post Office should be put to the expense, especially as there was no valid objection to the overhead system. During the past 25 years not a single accident had happened that had caused serious injury to any person from overhead wires, while a number of accidents had occurred through the underground system, most of them arising from explosions of gas that had escaped into the boxes. There was reason to think that the majority of the borough councils were taking concerted action in the matter of overhead wires.

Mr. W. T. RICKETTS (for the Council) urged that the question of expense should not be considered. It was in the public interest that the wires should be put underground.

Mr. WILLIAM N. BLAIR, borough engineer, said the Council felt that was only the thin end of the wedge, and that, if the Post Office were successful, they would press the principle further.

Mr. W. F. LOVEDAY, borough engineer for Stoke Newington, said there was an overwhelming opinion among the borough councils against overhead wires.

Sir ROBERT HUNTER, solicitor to the Post-Office, said if the Postmaster-General was to be restricted in the way suggested, either the telephone service would have to be carried on largely at a loss or a great number of people would be debarred from having the advantage of the service, because of the extra cost involved.

Mr. PAUL TAYLOR said that, if there was anything in the point raised that overhead wires were dangerous and objectionable, the matter ought to be brought before the legislature, and the whole system of overhead wires should be prohibited. The evidence went to show that the system was attended with less inconvenience and danger than the underground system. He gave his award in favour of the Postmaster-General, and directed the Council to pay the costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The District Council of Annfield Plain require the services of a competent person to report on the question of electricity supply for the district. Particulars from the clerk to the Council, Mr. T. L. Watchman, until July 21. See also an advertisement.

An electrician is required by the Government of Mauritius, with experience as an electrical engineer and practice in telegraphy and telephony. Salary £400 per annum. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by July 16.

There are vacancies at Portsmouth and Malta Dockyards for thoroughly good men for the following positions: Three switchboard attendants and two jointers at Portsmouth; two station supervisors, one mains and distribution supervisor and one jointer at Malta. Particulars from the Electrical Engineer, H.M. Dockyard, Portsmouth, on or before July 21. See an advertisement.

The Council of the University of Leeds invite applications for the appointment of assistant lecturer and demonstrator in electrical engineering, to date from Sept 1. Salary £175. Applications by Aug. 1 to the Registrar, from whom particulars can be obtained. See also an advertisement.

An assistant lecturer and demonstrator in electrical engineering is required at the University of Birmingham. Stipend £150 per annum. Applications to the secretary, Mr. Geo. H. Morley, by July 20. See an advertisement.

The directors of the Metroplitan Railway Co. invite applications for the position of engineer to the company. Applications to the secretary, 32, Westbourne-terrace, London, W., by 10 a m. 20th inst.

A shift engineer is required at Leicester tramway power station. Applications to Chief Engineer by July 23.

Mr. B. Andrews, motor 'bus traffic superintendent at Eastbourne, has been appointed tramway traffic superintendent at Southend.

On the termination of his period of service as assistant-instructor of electric lighting at Plymouth, Capt. F. W. Robertson, R.E., has been appointed to Pembroke Dock for duty.

EDUCATIONAL NOTICES.

University College of North Wales.—It is announced that in October next a systematic course of instruction in electrical measurement and practical electricity for students proposing to enter the profession of electrical engineering will be commenced at this college, where the physical laboratory is fully equipped with machinery, apparatus and instruments of the most approved modern type. Some further particulars will be found in an advertisement, and prospectuses, &c., may be obtained from Mr. J. E. Lloyd, M.A., secretary and registrar.

City and Guilds of London Institute.—The entrance examinations to the Institute's Colleges are held in September, and particulars of the examinations, scholarships and courses of study can now be obtained from the respective colleges or from the head office, Gresham College, Basinghall-street, London, E.C.

Ayr.—The Corporation have entered into an agreement with the Harbour authorities for supplying electric current for lighting the harbour at 2½d. per unit, the minimum annual consumption being 35,000 units.

Beverley (Yorks.)—The Council are negotiating with Messrs. J. & J. S. Enright for the transfer of their 1901 provisional order.

Birmingham.—Sept. 26 has been fixed for the formal opening of the Summer-lane power station. The Lord Mayor will inaugurate the works.

Brandon (Durham).—The Council are negotiating with the local colliery companies for a supply of electric current for public lighting.

Brighton.—Last week the recommendations of the Lighting committee to rent showrooms for electrical apparatus and fittings, and premises for canvassers' and collectors' offices (mentioned in our last issue) were adopted by the Council.

The Chairman of the Lighting committee (Councillor Butt-Thompson) said, the committee had had the matter under consideration for some years, and considered that the scheme, if adopted, would facilitate the collection of the accounts, give them the opportunity of getting into contact with customers who could thus be afforded information, and they could show up-to-date electric appliances, &c. At the proposed showroom they would have no power to sell or supply articles exhibited: they merely wished to introduce people to what was best for their use, and to refer them to the installation contractors. The Ironmongers' Association had protested against the proposal and urged that it was in contravention of an agreement made by the Council with them, but they were under a misapprehension. It was said that the Council had agreed to supply them on loan with electric cooking and heating apparatus and meters. In the resolution of the Council he found no mention whatever of cooking or heating apparatus. The only thing they had promised was the loan for three months of small motors. The Council promised to give, on condition that the ironmongers made a good show, a 3d. flat rate, the good show to be subject to the approval of the borough electrical engineer. The committee desired their own show room, as they considered it would be one more means of getting business.

Councillor Braybon moved an amendment, and said the committee would next want to do the work of supplying fittings themselves.

Ald. Blaker thought the committee had never made a more sensible proposal. He could not see why electrical engineers should object, because business would be made for them.

Councillor Jarvis said the questions of a show room and separate collection should have been kept apart. As to the stocking of the proposed showroom, did they suggest that it should be used to exhibit the goods of patentees or manufacturers without cost to them? The scheme must involve a serious annual expenditure.

Councillor Griffith and Ald. Buckwell also opposed, the latter maintaining that the committee ought at least to have estimated the cost of the two proposals. It would cost nearly £1,000 a year. Were they going to make an additional £1,000 profit to meet this expenditure?

Ald. Carden admitted that the cost might be £1,000, but the committee might save quite that amount. With that £1,000 a year they could carry on the business with more efficiency than at present. The gas company had collectors and canvassers to find out new houses, changes in tenancy and the committee asked for a similar staff. He was surprised to hear that the wiring contractors were objecting to the establishment of a showroom, as the committee could not sell a single article.

Eventually the recommendations were adopted by 19 vote to 16.

B.T.-H. Glow Lamps.—In the course of the inquiry now being held at Poplar (London) into the charges of extravagance brought against the Guardians, a statement was reported to have been made on Monday having reference to B.T.-H. electric glow lamps. We have received the following communication from the British Thomson-Houston Co. on the subject:—

Statement re B.T.-H. Glow Lamps.

In the report of the evidence on the Poplar inquiry in the "Daily Telegraph" of the 10th inst. the following paragraph appears, which is apt to be misinterpreted by a great many:—

> "Mr. Oxley said he did, and proceeded to give items. In 1905 16 dozen B.T.-H. glow lamps were tendered for at 12s. 6d. per dozen, and 36 dozen were supplied, *whereas the price in the current tender was 6s. a dozen.*"

While in the above it is not stated in so many words that the current tender of 6s. a dozen was for B.T.-H. glow lamps, it may readily be assumed to apply to B.T.-H. lamps, which is decidedly wrong, as no B.T.-H. glow lamp can be bought at this price, even though the quantities required were very large. The cost of producing the high quality B.T.-H. glow lamps absolutely precludes the possibility of their being sold at 6s. a dozen. The B.T.-H. Co. have never yet tendered for B.T.-H glow lamps at 6s. a dozen.

We should appreciate it if you would publish this in an early issue of your journal.

Burnley.—The salary of the borough electrical engineer (Mr. J. E. Starkie) has been increased from £250 to £300 per annum.

Cape Colony Customs.—The following notice has been issued concerning the duty on catalogues, price lists, &c., sent into Cape Colony. This is a matter in which *Electrician* readers are much interested:—

An impression exists that the duty imposed under the Customs Union Convention of 1906, on catalogues, price lists, &c., may be evaded by having such articles addressed abroad and posted direct to persons in this colony. In order to remove any such impression it is pointed out that such catalogues, price lists, &c., on arrival through the Post Office will be charged with a duty of either 25 per cent. ad val., or 2d. per lb., whichever shall be the greater, and, moreover, that in each case the usual clearance fee of 6d. per packet, &c., will be payable. It is further pointed out that should the above course be persisted in, the addressee would in all probability refuse to accept delivery at a cost of the duty and the clearance fee, with the result that such catalogues, price lists, &c., would eventually be destroyed by this Department.

Cape Town, June 2, 1906. A. H. Wilshere, Collector of Customs.

Clacton.—The Council have received sanction to borrow £1,000 for the purchase of the electric lighting plant of Mr. Ainslie, provided any sums received from sale of the plant will be immediately applied in reduction of the debt.

Cleckheaton.—For the past year there was a net deficit of £95 on the electricity undertaking.

Colchester.—The Lighting committee have asked the borough surveyor to report to their next meeting upon the cost of converting gas into electric lamps.

The borough electrical engineer had reported to the Electricity committee that the cost of fitting complete D type Nernst lamp was £2. 10s. 11d.; incandescent 16, 25 or 32 c.p. lamp, £2. 5s.; and A type Nernst, £2. 17s. 11d. Accordingly, the Electricity committee offered to undertake the work at these prices, and disclaimed responsibility for the cost (£4. 10s. 4d.) heretofore charged for the conversion of lamps, the average charge made during the past three years for the materials supplied and portion of the work executed by this committee being £1. 14s. 1d.

The salary of the borough electrical engineer (Mr. A. R. Sillar) has been increased to £315 a year (with annual increases of £10 to £355) and the premiums of pupils.

Companies Struck off Register.—The "London Gazette" for July 10 contains a list of companies removed from the Register of Joint Stock Companies, amongst them the following:—

Blakey, Emmott & Co., Electric Locomotive & Power Co., Electro Metal Extracting, Refining & Plating Co., London Battery Co., Patent Electric Fire Lighter Co., Standard Time Co. (Reg. Oct., 1886), Telephone Association.

The following are to be struck off unless cause is shown to the contrary before Oct. 10:—

Dessolle Electro-Plating Co., Domestic Battery Synd., "Eclipse" Electric Lighting Synd., Humboldt Electric Power & Mining Co., Lighting Corpn., Marylebone Electric Supply Co., Mazarron Electric Light Co., Norwich Mutual Telephone Co., Redditch District Electric Traction Co., Ward Electrical Car Co., Windsor & Eton Electric Light Co.

Customs Duties.—Under the new South African tariff which came into force last month, imports of telegraph and telephone instruments and material (formerly free) of "foreign" origin are subject to a duty of 3 per cent., while British goods remain free. Railway and tramway material (British) is still free, whilst the duty on similar "foreign" material is increased from 2½ to 3 per cent.

Dublin.—The Irish Electrical Agency Co., of London, is promoting a scheme for the supply of electricity in Blackrock, Kingstown, Dalkey and Killiney in the county of Dublin; and the various Councils have been asked by the consulting engineers (Messrs. Tomlinson & Mills) to support the company's proposals.

German Exports.—A lengthy report has been prepared by Mr. Consul-General Oppenheimer, of Frankfort, relating to the trade of Germany during the past year. From this report, amongst other items of information, we learn that the export of electric cables from Germany to the United Kingdom during 1905 were valued at 2,900,000 marks, an increase of 2,000,000 marks, compared with 1904. The exports of electrical machinery from Germany to the United Kingdom in 1905 were valued at £21,498, out of a total export of £142,724. The figures for 1905, in regard to machinery, show a reduction of nearly £4,000, compared with 1904, and of nearly £15,000, compared with 1903. The report, so far as it deals with the electrical industry, points to an entire recovery from the depression of previous years. Interest attaches to a tabulated statement in Mr. Oppenheimer's report relating to the number and length of submarine telegraph cables owned in part or in whole by the German Government, and by German telegraph and cable companies. This list includes the new cable from Shanghai to the Carolines, which was inaugurated in November last. The list shows that there are 13 cables exceeding 100 km. in length, in which Germany is interested. The first of these cables was laid in 1871.

Great Yarmouth.—In future consumers of 10,000 units of electrical energy per annum will be allowed 10 per cent. discount.

Halifax.—On Tuesday Lieut.-Col. Druitt conducted a Board of Trade inquiry into a tramcar accident which occurred here on July 1. The proceedings were private.

Health Exhibition.—A notable feature in connection with the twenty-third congress of the Royal Sanitary Institute, held at Bristol, from July 9 to July 21, is Stand No. 19, occupied by Ed. Bennis & Co., of Little Hulton, Bolton, and 28, Victoria-street, London, S.W.

The display consists of a "Bennis" and "Miller-Bennett" chain grate stoker, a "Bennis" mechanical stoker and compressed air furnace, and a "Bennis" new patent coking stoker. The first named apparatus obtained one of the highest awards at the Smoke Abatement Exhibition, 1905, and is specially applicable to furnaces of steam boilers, refuse destructors, &c. This type of grate has been working successfully in several boiler-houses of electric light and power stations, manufacturers' works, &c. The "Bennis" machine-stoker and compressed air furnace is of the self-cleaning type, and adjusts the supply of air to the evaporative requirements of the boiler, ensuring the complete burning of the fuel, increasing the capacity of the grate and boiler 30 per cent. This mechanical stoker and compressed air furnace is installed in hundreds of boiler houses, not only in this country, but on the Continent of Europe, in India and the colonies. In the "Bennis" new patent coking stoker the coal is first supplied through an incandescent arch to a supplementary coking chamber with an independent controllable air supply, and is then pushed by means of the bars in the coking chamber on to the main bars, where it meets another independent controllable air supply, which can be regulated to burn up the coal at any desired speed. This coking stoker will burn coal (large lumps), coke, dust, or any other kind of fuel; is absolutely smokeless and smutless.

Hornsey.—The council will hold an electrical exhibition in the autumn.

Inquests.—On Wednesday the inquest was resumed into the circumstances attending the death of the three persons who were killed on the 23rd ult. as a result of the tramway accident in the Archway-road, *Highgate*, London.

At the request of the foreman of the jury the driver's certificate from the training school of the Metropolitan electric tramways at Hendon was produced and read. It stated—"I hereby certify that E. H. Cone, has been thoroughly instructed in the duties of a motor-man and is now competent to take charge of a car."

Driver Cone, stated in reply to his legal representative (Mr. Ashby) that he always used the magnetic track brake coming down the Archway hill, after starting from the compulsory stop at the top of the hill near the Archway. If he had used it otherwise except in case of emergency he would have been exceeding instructions. He could stop the car at the compulsory stop with the hand brake, and after starting again use the magnetic brake for going down the hill.

The Coroner: With the magnetic brake the wheels would not skid?—Oh, yes, they would. The blocks go on the wheels as well as the shoe on to the rails.

You did not use the magnetic brake?—No. I tried to stop at the compulsory stop with the hand brake, but could not do so. If I had stopped I should have used the magnetic brake for the rest of the journey down, and would have been able to proceed at a slow pace.

Mr. Bramall (for Islington Council): At the top of the hill you tried to stop the car with the hand brake?—Yes.

And the hand brake would not hold the car?—No.

The Coroner: Did you put it on with great force?—No.

Mr. Bramall: You kept the hand brake on and signalled to the conductor to put the brake on at his end?—Yes, but the wheels skidded.

Then he tried the magnetic brake, and to do that he had to release the hand brake. He put the magnetic brake on to the second notch, and afterwards on to the sixth notch, but all this time he was gaining speed. Then he reversed the motion, but found that the reversing action would not hold the car. He reversed a second time, and that did not succeed.

Then if the reversing key was found in the position for reversing when the car reached the bottom of the hill, it is clear that it must have come down the hill without any brake whatever, because with the reversing key in that direction the magnetic brake could not act?—(After some hesitation) Yes.

It could not act because you had reversed the action?—No.

Then when you jumped off the car there were no brakes on?—No.

You say the wheels were skidding all the way down the hill?—I can't say whether all of them were skidding, but I knew that some were because of the row they made.

The Coroner: But they would not all skid?—I should think not.

Mr. Bramall: If you had put the reversing key back to its ordinary position after having tried to reverse the action, the wheels would have revolved and the magnetic brake would have acted?—I don't know, because the switch was blown at the conductor's end.

But that would not have affected the magnetic brake. As I understand it the magnetic brake is worked by motors on the bogies themselves?—I don't know.

Are not the magnetic brakes independent of the current?—I don't know.

In reply to the Coroner the witness said he believed the current for the brakes was generated by the car itself.

The Coroner: And if you had the current shut off the brake might still have acted?—Yes, I think it would.

Mr. Bramall: Do you blame the local authorities and the road watering for the state of the rails?—It was very wet and muddy.

Mr. A. H. Potts, chief engineer to the Tramway Co., was recalled.

The Coroner: Do you say these flats found on the wheels of the runaway car were caused in the one journey?—Yes.

What is your opinion of this accident? Why did the car run away? Was not what happened on the outward journey and again at Muswell Hill-road sufficient warning for the driver not to go on?—Yes, if he had been sure he had properly tried his brakes. But he might have thought he had put them on a little too hard and caused the skidding and that with a little more attention he would avoid it in the future. At the top of the hill, if he had thought his hand brake was inefficient, he should not have used it, but have pulled up at the compulsory stop with the magnetic brake. The magnetic brake requires a little head.

The Coroner: You think there was a misapplication of the brakes? You speak with confidence?—Yes. The magnetic brake was the most powerful brake they knew of.

Mr. Avory (for the company): Since the Board of Trade inquiry you have examined the wheels of this car? What was the condition of the car?—There was a flat on the driving wheel of the rear bogey and another slight flat on one wheel of the front bogey. That slight flat was not consistent with skidding all the way down the hill, as it was too small and only on one wheel. The flat on the wheel of the rear bogey was possibly consistent with skidding all the way down the hill. He was satisfied that not more than one pair of wheels skidded for any distance. If any pair of wheels was revolving the magnetic brake would act. The brake was recognised by the Board of Trade and engineers generally as the best known brake for the purpose. If the reversing key was pointing in the reverse direction to the car the magnetic brake would not act.

Mr. Ashby: The driver has sworn that he tried to reverse the motion, and to do that would he not have to reverse the key?—Yes.

He then put the magnetic brake on?—He says he did, but he did not, or at least there is nothing to show that he did.

If he had used the magnetic brake to pull up at the compulsory stop he would have been exceeding his instructions?—No.

But your regulations say it is only to be used in cases of emergency?—When that book of regulations was issued there was no magnetic brake on the road. After that, when the brakes were put on and the book became obsolete, a motorman was told off to board every car and tell the men verbally to use the brake going down the hill.

But he was right in using the hand brake?—Yes, if it was in order; but his evidence is that it was wrong. Clearly, that was a case of emergency.

There was a great impact with vehicles at the bottom of the hill; was it not possible that in one of these impacts something might have struck the key and knocked it round to the position in which it was found and make it describe a circle?—It is just possible, but no engineer would believe it. It would not describe a circle.

May these magnetic brakes go wrong at any moment even in the hands of experienced men?—No.

Did the Board of Trade ever suggest that you should have hand track brakes instead of these magnetic brakes?—No. They would be much cheaper, and if they had we should have fitted them.

Don't you consider them the safer of the two?—I consider the magnetic brake is very much better.

Could you not have them as an additional brake?—There would not be room for them. The magnetic brake takes up all the space behind the wheels.

Mr. Bramall: If the driver put the magnetic brake in No. 6 notch, would that bring the car to a standstill?—If he did it properly it would. If it was going at a moderate pace. That is the secret.

Walter E. Day, inspector in the Tramway Co.'s service, said that whilst riding on another car on the day of the accident he saw the car, but the driver never stopped or called his attention to anything. He had taken Cone down that hill and shown him how to apply the brake.

William Wisen a driver of two years' experience, said he had been down Archway-road in all conditions of weather, and he had never known the brakes to fail.

The Coroner: Have you known the brakes not to act?—Only through applying them too quick and hard. I have never known the magnetic brake to make the wheels skid when it is properly applied.

If you get a skid before coming to the Archway it would be no use applying the magnetic brake?—I should apply sand.

But if sand did not stop the skidding the magnetic brake would be of no use?—I have never known wheels skid over sand.

Frederick Davis, conductor of the car, said the driver signalled to him to put on his hand brake, and he did so. As the car increased its speed the driver jumped off. He should say it was then travelling at 15 miles per hour.

After a brief address by the Coroner the jury returned a verdict as follows:—"We are agreed that the deceased died from injuries received during a collision when an electric tramcar, over which the driver lost control, was proceeding downhill in the Archway-road from the Highgate Archway to the terminus, and the sad deaths were from an accidental cause. The jurors further say that the accident appears to have been caused by the wheels skidding, and by the brakes failing to act when they were applied without due skill by the driver, who, in the opinion of the jury, did his utmost to stop the car, but was insufficiently trained in his duties."

The adjourned inquest into the cause of the deaths of two men, caused by the tramcar accident at *Halifax* on the evening of July 1 was resumed on Wednesday.

William Duffy, conductor of the car at the time of the accident, said that during the afternoon the car seemed to be under complete control. They reached the top of New Bank from Shelf at about 7:5 p.m. Soon after leaving this point he noticed the driver applying the brakes and the car seemed to skid and gain speed. The application of the slipper brake at his end of the car appeared to have no effect. He then shut the door of the car upon the passengers. It was customary to collect fares when going down hill, and on one occasion he had to get from the top of his car to apply the brake.

Mr. James Lord, borough engineer, gave evidence as to the lengths of the various gradients in New Bank, the radius of the curve at the bottom of the hill, &c. The rails at the curve were in good condition. In his opinion, if the brakes had been taken off at the finish the car would have stuck to the metals.

Mr. F. Spencer, tramways manager, said the driver, Chadwick, had been in Corporation employ about five years. About a year ago, after training, he was put on driving regularly as a spare driver. The brakes on the Halifax cars were hand or wheel brake, which acted on the wheels by means of iron blocks, two slipper brakes, which acted on the rails, and an electric brake. Only the slipper brakes could be used by both the driver and conductor at the same time. The electric brake turned the motors into generators, and thereby tended to reduce the speed of the car, but the brake could not act unless the wheels of the car were revolving. Drivers were trained in the use of all the brakes. The electric brake had a sudden effect, but there was a risk of the wheels skidding at first. Personally, he did not believe in the electric brake, and it was never used as an ordinary working brake. He could find no flats on the wheels when he examined them on the Monday after the accident. He agreed with Mr. Lord that, had the driver let the car go at the finish it would have kept the rails. He thought the driver allowed the car to attain a high speed and applied the slipper brake too late to pull up the car. At the same time he thought he pressed the wheel brake too hard, causing the wheels to skid. That was, he thought, the real cause of the accident. The same car travelled down hill afterwards at a speed of about 20 miles an hour with no alteration in the brakes.

Mr. John Waugh, C.E., had inspected the car and the line on behalf of the Corporation. All the appliances were in order. At the driver's end the slipper brake and the wheel brake were tight on, whilst at the conductor's end the slipper brake was quite slack. The hand brake, which had 13 in. of surface on each wheel, was so tight that the wheels had locked and skidded. Skidding of the wheels lessened retardation, and to alter that the brake would have to be taken off and put on again. It required a good deal of courage to do that. A car could be brought down New Bank at 10 miles an hour and be pulled up by the brakes. The car was very well equipped with every approved appliance. Personally, he preferred the electric brake used at Halifax to the magnetic brake employed on the Huddersfield tramways.

The Coroner: Have you formed any opinion as to the cause of this car getting out of control?—Yes. Improper and too late use of the brakes.

Theodore Chadwick, driver of the car, said that after leaving Prospect-street, he released his hand brake and kept on the slipper brake, allowing the car to roll down to the cross-over at Beacon Hill-road, which he passed at the rate of 3 miles an hour. A pole length below the cross-over the car began skidding, and he released the hand brake, applied sand and reapplied the hand brake. There being no diminution of speed he once more released the hand brake and applied as much slipper as possible, signalling to the conductor to do the same. Glancing round he saw the conductor doing that as hard as possible. He still dropped sand and applied the electric brake, but without effect. He reversed the current and continued to drop sand, but to no purpose. As the car overturned he put on the hand brake again. The car seemed to skid all the way down the hill.

The Coroner: How was it skidding if the hand brake was off?—The wheels must have been locked.

What could lock the wheels?—Witness made no reply.

In summing up the Coroner said he could not see any evidence which would fix criminal liability on any person. He thought the conductor was deserving of high praise.

The jury returned a verdict of accidental death, making no recommendations.

At *Wednesbury* on Monday, an inquest was held into the death of Frank Davis, an electrician, who was killed on Friday last at the works of the Patent Shaft & Axle-tree Co.

Evidence was given that deceased and another workman named Greatrex were assisting Mr. James L. Andrews, engineer in charge of the electricity department of the company, in discovering a leakage of current at the Brunswick Wheel Works, and in the course of operations it was necessary to disconnect the low-tension system. The party went into the sub-station, and deceased stood near a transformer to allow Mr. Andrews to pass him. As he did so a flash was observed, and it was seen that deceased, while resting his right hand on the transformer, had with his left taken hold of a live cable connected with the high-tension side. Mr. Andrews at once pulled him away. He was carried out and artificial respiration applied, but without result.

Mr. Andrews said he could give no reason why deceased should have touched the live cable, as to do so he had to reach nearly a yard in front of him. Deceased was a steady and experienced workman, and quite competent at his business. Gloves were worn when dealing with anything that was alive, but in that instance it was considered unnecessary.

The Coroner said he was informed that within the last few days a Home Office expert had visited the works, but made no suggestion, so that it seemed clear the firm had not neglected any precaution.

A verdict of accidental death was returned.

Kingston (Jamaica).—The Governor in Privy Council has approved of the plans of the West India Electric Co. for the construction of certain extensions of its electric tramway system.

Light Railways.—The Light Railway Commissioners have postponed their inquiry into the application of the Highgate Hill Tramways Co. for permission to electrify the Highgate Hill cable tramway and to construct an electric tramway to join up the line with the Middlesex light railway.

London County Council.—On Tuesday it was resolved to purchase the undertaking of the London Southern Tramways Co.

Paddington Technical Institute.—The Education committee recommended that electric lighting plant be installed at this institute at an estimated cost of £2,050, and that tenders be obtained.

Loughborough.—In future electric current is to be supplied for power from April 1 to Sept. 30, during the 24 hours at 1d. per unit, and during the remainder of the year at 1d. per unit to those consumers who light with electricity the premises in which the power is used.

Acting on the advice of the consulting engineer (Mr. C. H. Gadsby) the Electricity committee have decided to raise the turbines at the generating station and to place under each a cushion of sheet lead, wood and felt at an estimated cost of £25 per set, but at the outset only turbine set is to be treated as an experiment.

Luton.—An unopposed inquiry was held last week into an application for sanction to a loan of £7,000 for extensions of the electricity undertaking.

Mobile (U.S.A.)—There are 44 miles of electric street railway in operation in the city and suburbs of Mobile. The lines carried 10,000,000 passengers in 1905. The population is 60,000.

Municipal Telephony.—As reported in our last issue, Glasgow Corporation decided on Thursday of last week to sell their telephone undertaking to the Post Office for £305,000, exclusive of stores and tools, which are to be taken over at cost price.

In presenting the minutes of the Telephone committee recommending the sale, the Lord Provost said that he, along with Treasurer D. M. Stevenson, Councillor W. F. Anderson, and the Deputy Town Clerk (Mr. Walker), met in London with several Members of Parliament for that city to discuss the offer of the Government, and subsequently they had a long meeting with the Chancellor of the Exchequer and the Postmaster-General and strongly urged that the Government offer should be increased to at least £310,000. The Chancellor of the Exchequer stated that both he and the Postmaster-General had carefully considered all the representations made by or on behalf of the Corporation, and he could not see his way to recommend the Treasury to pay more than £305,000. He also stated that, while he made a formal offer of that sum, he could not keep the offer open for any length of time. He, however, agreed that the offer should remain open for a reasonable time, so as to give the Corporation an opportunity of considering it. After hearing the report of the Lord Provost, and again carefully considering the whole circumstances, the Telephone committee agreed to adhere to the recommendation which, at the meeting on 27th ult., was carried by a majority, subject to the substitution of the words "cost price" for the word "valuation" appearing therein. The altered recommendation was as follows: "That the committee recommend the Corporation to sell the telephone undertaking to H.M. Government for £305,000, exclusive of stores and tools, which would be taken over by the Government at cost price, and on the understanding that the Government will conduct the Corporation undertaking as a branch of their Post Office service." The committee further recommended that it be remitted back to them to adjust with the Postmaster-General the details of the agreement, including the taking over of the employés of the Corporation, and that it be remitted to the committee and the Finance committee to consider the question of any deficit which may arise, and to report how this deficit is to be met.

Mr. James Alexander, in moving the adoption of the recommendation, said that when in 1893 the Corporation were considering the question of telephones they had before them the fact that the National Telephone Co. were steadily endeavouring to build up a huge monopoly in telephony, and the Corporation were satisfied that the telephone question was one which, in the interests of the public, should not become a private monopoly, but should rather be taken over and worked by the Government or the municipalities. At that time the service which was given by the National Company in Glasgow was, it was considered, not only inefficient, but excessive in cost. The Corporation, therefore, felt that something should be done to check the creation of a monopoly and to give the citizens an efficient and cheap telephone service. They approached the Government at the time with the view of getting them to make the telephones a national institution, and to establish a telephone exchange in Glasgow. That the then Government refused to do, and the Corporation had, they considered, no alternative but to apply to the Postmaster-General for a licence, and after several years' correspondence a licence was granted. The Corporation telephone system had been in operation for five years, and had met all financial liabilities. It would be admitted, even by those who did not approve of municipal telephones, that the system had been a great boon to the city. It provided an efficient and cheap telephone and caused the National Co. at once to improve its service and reduce its rates. Prior to the competition of the Corporation the National Co. charged £25 for a telephone which they supplied at present for £10. They had even introduced a telephone at the remarkable low figure of 25s., although it was admitted by everyone that it was impossible in a city like Glasgow to give a telephone at that rate without sustaining a considerable loss on each of such telephones supplied. The advantage of the competition had also been seen in the enormous increase in the number of telephones in the city, there being in Glasgow some 38,000 telephones against 7,000 when the Corporation entered the field. As it was the intention of the Government to nationalise the whole telephone system on as early a date as possible, the sub-committee, on considering the whole situation and the present position of the Corporation telephone undertaking, found themselves face to face with the necessity of adopting one of three courses—(1) to continue the telephone system up to the expiry of the licence in 1913, (2) to sell the system to the National Co., or (3) to sell the system to the Postmaster-General. As a result of the most careful consideration, the committee had decided that the last-named course was to be preferred. With regard to the continuation of the system until 1913, the committee felt that the Postmaster-General, having refused to give an undertaking to renew the licence after 1913, the Corporation should not longer continue the service. When the Corporation took a licence to 1913 they did not for a moment expect that the least difficulty would be raised in getting an extension, and that was confirmed by what the Corporation did by taking leases of premises for lengthened periods, and also by the fact that the act of Parliament under which they were permitted to borrow money gave them a period of 30 years to repay it. Under the circumstances the committee did not see any reason why they should longer continue a service which in six or seven years they had to hand over to the Postmaster-General. Another objection to the Corporation continuing to work the telephone service was that it would be necessary to apply to the Secretary for Scotland for power to borrow at least £100,000 in order to make necessary alterations on the switchboard and to carry on the system and meet the capital expenditure necessary in view of the increased number of subscribers. If the telephones were not to remain in the hands of municipalities, then it seemed to him they should be nationalised. The sub-committee did receive an offer from the National Co., but they unanimously decided not to recommend its acceptance. He was not at liberty to report the details of the company's offer. To accept the offer of the Postmaster-General would involve a capital loss of something like £12,000 to £15,000. Almost £10,000 of that sum represented expenditure incurred by the Corporation in preliminary and Parliamentary expenses. He regretted that the Chancellor of the Exchequer and the Postmaster-General had not seen their way to give the Corporation back every penny of their money, because he firmly believed that what the Corporation had done would ultimately effect a considerable saving to the Post Office in connection with the purchase by the Post Office of the National Co.'s undertaking. The question, however, which the Corporation had to consider was whether, by selling to the Post Office then, the loss would be less than it might be if such a sale were delayed until 1913. At present the Postmaster-General would acquire all the plant of the undertaking, but if the Corporation continued till 1913, the Postmaster-General would buy only such plant as was suitable for the actual requirements, at that time, of the Post Office. They must therefore keep in view the fact that if they did not now sell to the Post Office, the Postmaster-General, in 1911, when he acquired the entire National Co.'s undertaking, would put it into perfect condition, and then in 1913 might say to the Corporation that the greater portion of their plant was not suitable for the actual requirements of the Post Office at that date, and that, therefore, he was not going to acquire it. While he was strongly of opinion that the Corporation ought to get every penny of its money back from the Post Office he thought that the offer now made by the Government might be regarded as a reasonable one. If it had not been for the great interest taken in the matter by the members of Parliament for the city and the districts adjacent, the Government would not have offered the sum they had. He thought it was better that the Corporation should acquiesce in the Government policy of nationalising the telephone and part with their undertaking now than go on fighting in a condition of doubt for the next six or seven years. If they had not succeeded in perpetuating telephony as a municipal enterprise in Glasgow, they had at least contributed their share towards developing and extending an invention which was becoming more and more an absolute necessity for the commercial and social requirements of the people.

Mr. W. F. Anderson opposed the sale and gave details of the history and development of the municipal telephone system. The Corporation had, he said, secured a rebate of 50 per cent. on the charges, they had the £10 telephone for £5, while in Govan and Clydebank they got a £25 telephone for £5. Was it right, he asked, that the loss of £15,000 should be borne by the citizens of Glasgow and no part contributed by the people who got a £25 telephone for £5. He referred to the competition which the Corporation had to contend against. In order to kill the Corporation system the National Co. were losing £40,000 per annum in their Glasgow area. The moment the Corporation sold their system, the National Telephone service for 25s. would go by the board, as well as the £5 restricted service, and it was generally believed that either the Government or the National Co. would subsequently change the unmeasured rate of £5 per annum for a measured rate which would bring the charge in many cases up to £30 or £40 per annum. He moved that the minutes be referred back.

Mr. W. F. Russell seconded the amendment, and said that there was a meeting of the directors of the National Co. in London that forenoon, and he (Mr. Russell) was authorised to state that the company, if the Corporation made them an offer of their undertaking, would take it over and guarantee the Corporation should not lose a penny by the transaction. The company would gaurantee to keep to the present rate of subscription for two years.

Several other members having addressed the Council, the motion to sell the undertaking to the Post Office was carried by 45 votes to 13.

It is reported that, as a result of the above agreement between the Post Office and Glasgow Corporation, negotiations have been started for the transfer of the remaining municipal systems at Hull, Portsmouth, Brighton and Swansea.

Newark.—The Electric Lighting committee have opened negotiations with the National Electric Construction Co., Edmundson's Electricity Corpn. and the Derbyshire & Notts. Electric Power Co. in regard to the supply of electricity in the district.

Obituary.—The death is announced of Mr. Francis J. C. May, C.E., for 15 years borough engineer and surveyor at Brighton. Deceased, who superintended the construction of the Brighton tramways, relinquished his appointment in March, 1905.

The death is also announced of Mr. Wm. A. Bryson, M.I.E.E., F.R.S.E., who was superintendent of the electrical departments at the last two international exhibitions in Edinburgh, and who was subsequently for a few years electrical engineer and manager of the Leith Burgh electricity works. Prior to his Leith appointment Mr. Bryson was for some years a consulting engineer in Glasgow. The work of designing and erecting the electricity supply station at Leith and the execution of the other details of the scheme devolved on Mr. Bryson. He resigned in 1901, but remained in Leith as a consulting engineer. Recently he devoted a good deal of his time to the improvement of steam motor vehicles.

Overhead Transmission Lines.—The Durham Collieries Electric Power Co. intend erecting overhead transmission lines from their power station at Philadelphia (Co. Durham) for the supply of electric power to various collieries in the neighbourhood, and Houghton-le-Spring Urban and Rural Councils, the Hetton-le-Hole Urban Council and the N.E. Railway Co. have consented to the erection of the overhead line, subject to proper precautions being taken. The consulting engineers (Messrs. D. Balfour & Sons) have carried out the negotiations in regard to wayleaves, &c.

Oxford-street Lighting.—On reconsideration of the question of lighting Oxford street (probably the finest and most important business thoroughfare in London) the Lighting committee of Marylebone Council recommended the adoption of electric lighting.

The committee were assisted in arriving at this conclusion by a report of their consulting engineer (Mr. Arthur Wright), and the committee advised the erection of 81 flame arc lamps in Oxford-street, from the Marble Arch to Tottenham Court-road, at an estimated capital cost of £2,500, and an annual charge for current and maintenance of £1,675.

The recommendation was adopted by the Council last week.

Presentation.—The manager and staff of Salford Corporation tramways have presented a silver fern bowl to Mr. Wm. Billington on his marriage.

Roumania.—In reporting upon the trade for the year 1905 of Constantza, Mr. Vice-Consul Pogson states that the electric lighting of the quays at this port is good, but that switch lamps and apparatus for lighting and power for use on board vessels are as yet unknown. Mr. Pogson considers that it would be an advantage to the shipping trade if attention could be directed to the absence of these minor but useful facilities.

South Africa.—The municipal electrical engineers of Cape Town and Durban (Mr. W. F. Long and Mr. John Roberts) to whom (as we stated in our issue for June 8) the question of the improvement of the East London electricity and tramway undertakings was to be submitted, approve in nearly every particular the proposals of the borough electrical engineer (Mr. J. Mordey Lambe).

In their report they state that the operation of the present plant is unsatisfactory and expensive, and that considerable capital expenditure is necessary to enable the municipality to supply current at the lowest price. The Council have agreed to the general principle involved in the report, and it is expected that the capital required to put this into operation will exceed £45,000.

A bill is to be introduced in the Natal Legislative Assembly to authorise Pietermaritzburg Council to borrow £23,198 for the expansion of their electricity undertaking, and £45,360 for extensions to the tramways.

South Lancashire Tramways.—The South Lancashire Tramways Co. have commenced to run cars on their new extension from the Leigh boundary to Lowton St. Mary's station of the G.C. railway. The work of extending the lines from Boothstown through Worsley to Winton to link up with the Manchester and Salford tramways is expected to be completed next month, thus making a tramway connection between Manchester and Liverpool by way of Tyldesley.

Southend-on-Sea.—The Council have asked the borough electrical engineer and tramways manager to reconsider the question of his resignation.

Spain.—The "Bulletin" of the French Chamber of Commerce at Barcelona states that funds for the construction of an electric tramway from Casa Gomis (Barcelona) and Tarrasa are being raised locally, and that the preliminary works have been commenced.

A company to supply electric power to Ribades and Villalba and energy for an electric tramway connecting those districts with Lugo has been formed at Madrid under the title of the Hidroelectrica del Tanceda.

Stretford.—The Electricity and Tramways committee propose to lay additional feeder and distributing cables to meet the increasing demands for electricity for power and lighting.

Sunderland District Tramways.—The recent extension of the above tramways from Hetton-le-Hole to Easington-lane makes 14½ miles of the system fully open, extending from Sunderland, via Ryhope, Philadelphia and Houghton-le-Spring on to Hetton-le-Hole, with branches to Fence Houses and Penshaw station. Power is being taken from the Durham Collieries Electric Power Co.'s station at Philedelphia. The engineers are Messrs. D. Balfour & Son, of Newcastle.

Sweden.—Mr. Consul Duff, of Gothenburg, in a report just issued states that :—

The organisation during 1905 of the Sydsvenska Elektriska Aktiebolaget (South of Sweden Electric Co., Ltd.), is an event of considerable importance to industry. The company has been formed with a view of purchasing the waterfalls of the river Lagan, and to supply power and lighting not only to Halmstad but also to Helsingborg, Landscrona, Malmö and other places. The community of Halmstad owns an extensive tract of land adjoining the harbour, and anticipates great advantage from obtaining electric power at a low rate for present industrial enterprises and such as will spring up in the immediate future. This company intends to improve the falls so that they may furnish about 14,000 H.P., and later on to introduce further improvements so as to obtain about 30,000 H.P.; and it is intended to supply this power so cheaply as to exclude competition from any other source of power at present available.

Helsingborg Corporation has undertaken to subscribe £25,000 on behalf of the city to the company.

Switzerland.—The "Feuille Fédérale Suisse" for June 27 contains the text of concessions to M. Othmar Kluser, Brigue, for the construction of a narrow gauge electric railway (partly funicular) between Stalden and Saas Fée, at an estimated cost of 2,900,000fr. (£116,000); to Messrs. C. Niess and L. Flesch, of Lausanne, and M. F. Buchs, of Ormont-dessus, for the construction of a narrow gauge electric railway between Ormont-dessus and Gstaad, at an estimated cost of 2,000,000fr. (£80,000); and to Messrs. Haag & Grenlich, of Bienne, for construction of a similar railway from Grindelwald to Mer-de-Glace, the cost being put at 2,300,000fr. (£92,000).

Venezuela.—The approaching electrification of the tramways in Caracas, in which British enterprise and capital are largely concerned, forms the subject of an instructive report by Mr. Acting Vice-Consul Haggard just issued. The right to construct and operate electric tramways in this city for a period of 99 years has been secured by a group of British capitalists, with Mr. E. Wallace as manager of the undertaking. This enterprise has purchased the interests of the three small companies in the existing animal worked lines, and the work of electrification and extension is, we understand, about to be commenced. The overhead trolley system has been adopted for about 12 miles of the track, and the line will be built to a 3 ft. 6 in. gauge with 90 lb. rails. Current is to be taken from the mains of the Native Electric Power Co., which has established a waterpower generating station about 12 miles from the city.

Following upon this tramway enterprise, the conversion of the existing telephone service to the central battery system may shortly be undertaken by the Venezuela Telephone & Electrical Appliances Co. (Ltd.), of London, who own the service. This company's principal exchange is in Caracas, and this is connected up by trunk lines with the principal towns and villages in the centre of the Republic of Venezuela. The alteration and extension of the service when taken in hand will involve an expenditure of about £25,000.

Mr. Haggard refers to the unfortunate dispute between the Government of Venezuela and the Compagnie Français des Telegraphs regarding the submarine telegraph cable service and to the interruption of business which this altercation has caused. Mr. Haggard expresses the hope that arrangements will eventually be come to which will remove the isolation which the merchants of Caracas suffer from this interruption of telegraphic communication with the outer world.

Watford.—At the Council meeting last week Mr. H. F. Colebrook, the Council's consulting and resident electrical engineer, tendered his resignation, in accordance with the terms of his agreement. The resignation takes effect on Oct. 1.

West Ham.—At Tuesday's meeting of the Corporation the electrical engineer (Mr. A. H. Seabrook) reported that he hoped to be able to give a supply of current to Silvertown by the end of September.

An additional feeder is to be laid at a cost of £1,150 and an additional h.t. distributor at an estimated cost of £491.

The borough engineer has been directed to undertake the construction of the permanent way and the tramways manager the overhead equipment for the line connecting up the Leyton tramway system with that of West Ham.

The cost of the works executed in connection with contract No. 2 of the Corporation tramways was £40,960, and the original contract was £27,650. There were additional works to the amount of £12,079, and extras of £2,310.

In order to encourage economy in coal consumption the Council have adopted Mr. Seabrook's suggestion that if the coal cost per unit sold reaches 0·30d. for the year ending March 31, 1907, the shift engineers and boiler house employés are to be given a bonus of £50 to be divided between them according to their rate of wages, and a bonus of £5 to the resident engineer; and for every further 0·01d. below 0·30d. an additional bonus of £10 and £1 respectively.

Will.—The late Mr. William Stratford Andrews, of Kincraig, Sevenoaks, a director of the Western, River Plate, Indo-European, West Indian & Panama and the London-Platino Brazilian Telegraph Cos., and in the early days secretary to the British & Irish Magnetic Telegraph Co., manager and secretary of the United Kingdom Telegraph Co. and managing director of the Indo-European Telegraph Co., who died on May 4 last, aged 74, left estate of the gross value of £76,223, including £73,478 net personalty.

Wimbledon.—The Council have agreed to supply Malden Council with electricity in bulk at 2d. per unit with pro rata increase in the event of the price of coal going above a certain figure. Malden Council are to repay the instalments of sinking fund and interest on loans for laying cables and are to take a supply for a term of years, but with the option of terminating the agreement at the end of 10 years on six months' notice, and repaying the outstanding balance of loans and interest due. The 2d. per unit is subject to revision at end of 10 years and afterwards at five year periods.

An unopposed inquiry was held last week into the application of the Council for sanction to borrow £500 for erecting 20 additional arc lamps.

York.—The Tramways committee have reopened negotiations with the local tramway company for the purchase by the Corporation of the tramways.

Outings.—Ferranti Limited held their annual outing on Saturday at Llandudno. Breakfast was partaken of at the Grosvenor Hotel, and afterwards the party were photographed. A drive round the Great Orme's Head and a sea trip down the Menai Straits were organised, and as the weather was all that could be desired, the outing proved a most enjoyable one.

Favoured with fine weather the employés of Messrs. Stegmann & Co., of Clapham Junction, London, spent an enjoyable day at Brighton on Saturday. Dinner was served at the Queen's Hotel.

The staff and employés of Ealing Corporation electricity department had their third annual outing on 30th ult., when about 40 travelled to Westerham, Kent. At the dinner the chief electrical engineer (Mr. J. Douglas Knight) presided, and, in proposing the toast of "The Ealing Electricity Undertaking," said that when the balance sheet for the past financial year was presented it would be found that they would hold the record for lowest generation cost in the whole history of the undertaking, showing that the new plant recently installed was of the right sort.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Eastbourne.—At last week's Council meeting the Electricity committee submitted, and the Council adopted, the annual report of the borough electrical engineer (Mr. J. K. Brydges).

The revenue for the year ended March last was £16,849 from private lighting, £489 from power consumers and £1,822 from public lighting. After meeting working costs and capital charges there was a net profit of £1,301, of which £1,000 has been placed to depreciation, making the latter £7,000, or 4 per cent. on capital expended.

Glasgow.—For the year ended May 31 the gross revenue of the tramways department was £825,684, against £764,790 in 1905; and the expenditure was £456,268 (including £233,013 for traffic and £82,448 for general expenses, £113,532 for repairs and £27,275 for power), against £387,167.

£159,887 has been set aside for renewals and depreciation, leaving £209,529 to meet rent of Govan lines (£5,089), rent of Paisley District tramways (£4,627), interest (£54,787), sinking fund (£48,327), income tax (£12,423), parliamentary expenses (£2,838), and £25,000 voted to the Common Good, leaving a net balance of £56,418, which has been appropriated by voting £10,000 to special depreciation, £10,000 to additional payment to Common Good, and the balance (£36,418) to general reserve. Last year there was a net balance of £93,298 after meeting all charges. The working expenses last year were £69,101 more than in the preceding year. £68,500 was set aside last year for special depreciation; this year only £10,000 is set aside, but £10,000 additional has been paid to the Common Good, making in all £35,000, and £36,418 is carried to reserve in place of £24,798.

Halifax.—The annual report of the tramways manager (Mr. F. Spencer) states that the route mileage of the municipal tramways is over 37 miles.

19,866,230 passengers were carried. The total revenue was £80,925 (11·55d. per car-mile), against £74,521. The carriage of passengers' luggage and haulage of Post Office mail waggons resulted in a revenue of £144, against £111. The parcels traffic receipts had increased from £244 to £759.

Hammersmith (London).—The capital expenditure of the electricity department for the year ended March 31 was £260,669. 18s. 11d., an increase of £49,675. 10s. 3d. during the year.

The net income from the sale of current for private lighting was £30,508. 18s. 4d., from public lighting £4,398. 18s. 2d., and meter rents and miscellaneous receipts made a total of £37,013. 1s. 9d. Working expenses were £21,034 14s. 11d., including £9,100. 13s. 10d. for cost of generation, £1,947. 17s. 3d. for repairs and maintenance, £2,942. 10s. 10d. for distribution, £1,873. 5s. 7d. for public lighting and £2,337. 16s. 2d. for management expenses. After paying interest and redemption of loan charges (£13,166. 0s. 6d.), and writing off £180. 18s. 3d. for bad debts, the net profit was £2,631, 8s. 1d., against £5,282. 16s. 2d. in the previous year. 4,356,342 units were generated; 3,149,353 units were sold to private consumers and 494,793 were supplied to public lamps. The total maximum supply demanded was 3,297 kw.

In the report of the engineer and manager (Mr. G. G. Bell) it is stated that the reduced charges in operation during the last six months of the year (reducing the average price obtained for current sold to private consumers to 2·33d., compared with 2·94d. per unit in the previous year) were responsible for a decrease in the revenue of over £8,100. The capital expenditure during the year (£49,675) was chiefly spent on new turbines, boilers and auxiliary plant. The cost of coal per unit sold was 0·36d., against 0·40d. in 1904-5. £3,000 was voted out of accumulated profit in relief of rates, and the balance of accumulated profits is £8,083. 11s. 6d.

Application is to be made to the Board of Trade to permit the maximum power to be supplied to the new substations to be increased from 75 to 150kw.

Hereford.—The total receipts of the electricity department for the year ended March were £3,023 4s. 4d., including £2,724. 11s. 1d. net from the sale of current.

The working expenses were £1,332. 1s. 3d.; interest absorbed £632. 18s. 11d. and sinking fund £1,050, leaving a net profit of £8. 4s. 2d., compared with £2. 6s. 4d. in the previous year.

The Chairman of the Electric Lighting committee, in moving the adoption of the accounts at the last Council meeting, said that their engineer (Mr. Keir) had informed them that unless they put down additional plant they would be unable to deal with the coming demand. The committee requested the Council to convene a special meeting to receive a report dealing with the matter.

Hornsey.—The output of the electricity department for the past year was 571,890 units, against 469,219 in the previous year. The equivalent of 51,040 8 c.p. lamps for private lighting and power is connected. Works costs were 1·318d. per unit and total working expenses 1·810d. per unit sold. The cost of coal was 0·54d. per unit sold.

Hove.—During the year ended March 31 the capital expenditure of the Council on the Aldrington electric lighting scheme was £3,326. 12s. 5d, bringing the total to £7,102. 10s. 4d.

Supply of current commenced on Aug. 31, 1905, and at March 31 the profit was £80. 8s. 1d.

King's Lynn.—For the year ended March 31 the profit on the electricity department was £535. 7s. 11d., after paying £1,273. 7s. 2d. interest and £1,814 sinking fund. The profit has been allocated to reduction of suspense account.

Paisley.—At the Council meeting on Tuesday the Electricity committee stated that it was expected that the accounts of the electricity undertaking would show a profit of about £1,800 for the year ended May 15. They proposed to place £1,300 to renewals and £500 to depreciation.

Portsmouth.—At March 31 the capital expenditure of the electricity department was £295,036. 1s. 3d., an increase of £19,216. 16s. 1d. on the year.

The total annual income was £51,761. 4s. 4d., including £44,410. 2s. 10d. net from the sale of current for private lighting, £5,403. 3s. 9d. from public lighting, £272. 10s. for current supplied under contract and £163. 12s. for current supplied through slot meters. Meter and motor rents and miscellaneous receipts accounted for the balance. The total expenses (including £15,655. 15s. 6d. for cost of generation, £1,656. 6s. 4d. for distribution, £1,607. 15s. for public lamps maintenance, £1,426. 0s. 5d. for rent, rates and taxes, and £2,491. 9s. 10d. for management expenses) were £23,131. 3s. 2d. Interest and repayment of instalment of principal absorbed £16,806. 3s. 10d., £3,996. 13s. 6d. was contributed to capital outlay, £3,500 to relief of rates, £1,000 to insurance fund and the balance (£3,327. 3s. 8d.) to reserve. 3,841,850 units of electrical energy were generated, 551,510 units were supplied to the public lamps (264 arcs and 395 incandescents), 2,534,872 units to private consumers by meter, and 2,998 by contract. The total maximum supply demanded was 2,580 kw.

The income of the tramways department for the past year was £51,025. 3s. 8d. Traffic expenses were £14,204. 14s. 5d, general expenses £4,379. 8s. 7d., repairs and maintenance £5,703. 12s. 6d., and power for traction and lighting of cars (1,338,710 units at 2d. per unit, less discount, &c.) cost £10,826. 7s. 9d. Interest absorbed £6,087. 16s. 1d, income tax £353. 3s. 10d., and sinking fund charges £5,189. 9d. The balance (£4,126. 11s. 2d.) has been carried to depreciation and renewals fund. The expenditure on renewal of permanent way was £4,485. 16s. 10d., and the balance forward of the tramways depreciation and renewals fund account is £528, against £887. 5s. 8d. last year. Capital expenditure is £199,031. 6s. 6d., an increase of £101. 14s. 8d. during the year. 9,420,013 passengers were carried, and 1,156,783 car-miles run; the receipts per car-mile were 10·20d.

St. Pancras (London).—For the year ended March 31 the capital expenditure on electricity supply was £17,879 (principally on extension of mains), bringing the total expenditure to £498,296, of which £54,802 has been repaid.

The year's income was £72,086, an increase of £3,627 on previous year, and after meeting all working expenses, paying interest, and repayment of loan charges the net profit was £9,441, compared with £13,098 and £20,583 in the two previous years. The reserve fund now amounts to £40,891. Against this, and in accordance with the L.C.C.'s sanction of electricity loans, there had been charged the net cost of replacement of plant during the year at King's-road station, amounting to £6,897, also the cost of opposition to electrical bills in Parliament (£2,480) and other sums for law and parliamentary costs, making a total of £9,783 for the year. The Electricity committee, in view of the desirability of providing a working balance for electricity purposes, have provisionally decided that the new profit (£9,527) be disposed of by placing £5,000 to relief of rates and the balance to form the nucleus of a working balance.

Salford.—During the year ended March 31 10,907,123 units of electrical energy were sold, an increase of 1,900,000 over the previous year.

There were 140 new consumers. The income was £75,839; gross profit was £49,071.

Southwark (London).—During year ended March 31 the reduction in price of electricity supply reduced the revenue from private consumers by about £330 for lighting and £170 for power, while public lighting benefited to the extent of £410 due to increase in the number of units supplied Repairs during the year showed an increase of £165, rates and taxes £294 and cost of management £100. Interest required £2,461. 16s. 6d. and instalments of loans repaid came to £2,197.

Surbiton.—For the past year the deficit on the electric lighting department was £741.

Wakefield.—The annual report of the borough electrical engineer (Mr. H. A. Neville) states that the gross income for the year ended March was £9,088 and the expenditure £4,239.

After paying £3,788 for interest and sinking fund, the net profit is £1,060. Of this £949 has been repaid to the general district fund, leaving £111 to be transferred to reserve, which now amounts to £3,877. The capital expended is £70,435. A feature of the year was the increased demand for power.

Wolverhampton.—The Council on Monday adopted the recommendation of the Electricity committee to make additions to the generating plant at a cost of £4,756.

The total income of the tramways department for the past year was £41,905, and working expenses £24,227. Out of the balance (£17,627) £5,364 has been contributed to renewals fund, instalment of interest and repayment of loans required £11,333, loss on motor omnibus account was £179, and the net profit is shown as £1,012. Working cost was 6·131d., or 0.422d. per mile less than in the previous year. A working arrangement for through running from Bilston, Willenhall and Dudley has been made with the Wolverhampton District Electric Tramways (Ltd.), and cars commenced running in November last. The result has proved satisfactory.

The annual report of the electricity department to March 31 states that the gross profit was £13,245. Interest required £4,038, and sinking fund £6,052, leaving a net profit of £3,215.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Messrs. Preece & Cardew are authorised by the Municipal Council of *Shanghai* to receive tenders for supply and delivery (c.i.f. Shanghai) of the following plant: (*a*) Two 600 kw. steam turbo dynamos (or, alternatively, two 600 kw. steam dynamos) with condensing plant, certain pipes and valves, motor generator, switchboard, &c.; (*b*) two water-tube boilers, with feed-water heaters, superheater and chain-grate stokers, feed pump, pipes, valves, &c. Specifications and forms of tender from Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W., to whom tenders before noon of Tuesday, July 31. Further particulars are given in an advertisement.

Wigan Corporation invite tenders for liveries for inspectors, motormen and conductors. Forms of tender and particulars from the tramways' engineer and manager, Mr. Jas. Slevin, Bradford-place, Wigan. Tenders to the town clerk, Mr. Harold Jevons, by 16th inst. See an advertisement.

Dublin Corporation invite tenders for 12 months' supply of machinery oils for the Corporation electricity works. Specifications, &c., from the town clerk, Mr. H Campbell, City Hall, Dublin, where tenders must be sent by noon July 19. See also an advertisement.

Sunderland Corporation invite tenders for the supply of (*a*) two 250 kw. synchronous motor generators, 5,000—240 volts; (*b*) high-tension and low-tension switchgear for above. Specifications, &c., from the borough electrical engineer, Mr. J. F. C. Snell, M.Inst.C.E., Town Hall, Sunderland. Tenders (addressed to the chairman of Electricity and Lighting committee) to the town clerk, Mr. Fras. M. Bowey, not later than noon 27th inst.

Hackney Borough Council require tenders for section A, arc lamp pillars; B, erection of arc lamp pillars and switch pillars; C, arc lamps and accessories, and D, switch pillars. Conditions, specifications, &c., from Mr. Robert Hammond, 64, Victoria-street, Westminster, S.W. Tenders to the town clerk, Mr. W. A. Williams, Town Hall, Hackney, by 4 p.m. July 26.

Kings Norton and Northfield Council want tenders by noon 16th inst. for reconstruction of permanent way of tramways and construction of new lines and for overhead electrical equipment. Specification from Mr. A. W. Cross, 23, Valentine-road, King's Heath, or Mr. C. H. Gadsby, 20, Victoria-street, London.

London County Council want tenders by 10 a.m. July 24 for reconstructing the second portion of the Streatham depôt as a car shed for electric cars.

Stepney (London) Council want tenders by noon 23rd inst. for wiring two underground conveniences. Specifications from the Borough Engineer, 15, Great Alie-street.

Tenders are wanted by 5 p.m. 25th inst. for surface condensing plant, with electric pumps and pipework, and water-softening and purification plant for the county asylum, *Rainhill*, Lancs.

Salford Electricity committee want tenders by 9 a.m. July 23 for one year's supply of fuel to Frederick-road generating station.

Bexley District Council want tenders by noon July 23 for extension of car shed and erection of steel structure for repairing shop.

Ealing Council want tenders by noon July 20 for oils, waste and stoneware pipes for the electricity works.

Beckenham Council invite tenders for wiring houses in their district. Tenders to Clerk by 4 p.m. July 23.

TENDERS RECEIVED AND ACCEPTED.

Salford Council have accepted the following tenders:—

J. H. Holmes & Co., two sets of tramway feeder boosters, £480; British Thomson-Houston Co., Tirrill regulator, £88, less 20 per cent.; S. Dixon & Son, mechanical car accessories and overhead equipment; Tandem Smelting Synd., Magnolia metal; E. Boydell & Sons, Esther Bros., R. W. Blackwell & Co., John Hall, and Brecknell, Munro & Rogers, mechanical car accessories; L. Andrew & Co., electrical car accessories, insulating materials and wire; Wm. McGeoch & Co., electrical car accessories.

Hammersmith (London) Council received the following tenders for feeder cables for sub-stations:—

Western Electric Co. (*accepted*)	£433	8	0
British Insulated & Helsby Cables	459	19	2
W. T. Glover & Co.	458	16	0
Callender's Co.	454	10	0
W. T. Henley's Telegraph Works Co.	454	2	0
Siemens Bros. & Co.	445	15	0

West Ham Corporation have accepted the following tenders:—

British Thomson-Houston Co., switchgear for motor generators, £153. 16s. 6d.; Babcock & Wilcox, last section of pipe work (exhaust and water) for turbo generator, £102; Parmiter, Hope & Sugden, motor switches; J. T. Halsey, maintaining telephones and electric bells at Plaistow Hospital (for five years), £25 per annum.

In connection with the new power station at Durban orders have been placed with the Electric Construction Co. for a main switchboard; with the British Insulated & Helsby Cables for a 3-mile high-tension three core cable (paper insulated, lead covered and armoured) suitable for 6,600 volts pressure; and with W. T. Henley's Telegraph Works Co. for ½ mile of cable.

Colchester Council have accepted the tender of McPhail & Simpson's Dry Steam Patents Co. for the supply and erection of six flue-fired steam superheaters for £859. 4s., the company guaranteeing a saving in the coal consumption of 10 per cent. and to maintain the superheaters for two years.

Bradford Corporation have placed orders with following firms for the supply of 5,000 tons of steam coal each during the ensuing 12 months:—Edward Parkinson, Bradford; Joseph Carnelley, Bradford; Lofthouse Colliery (Ltd.), Lofthouse; and Rhodes Bros., Pontefract.

North Metropolitan Electric Supply Co. has placed an order with Messrs. Bruce Peebles & Co. for a 300 kw. 50 period motor converter, constructed under the Peebles-La Cour patents. This machine will be directly connected to the company's 10,000 volt mains without transformers.

Messrs. Hubert Davies & Spain, as contractors to the Natal Government Railway, have placed with Messrs. Bruce Peebles & Co. an order for three 300 kw. motor converters, converting 6,000 volts, 50 period, three-phase current to 550 volts d.-c.

Midland Junction (W. Australia) Council have accepted the tender of W. H. Kidston & Co. for the supply of a Babcock boiler and superheater, Bellis & Morcom engine, E.C.C. dynamo, Mumford flywheel pump and (if required) steam separator.

Carlisle Corporation have accepted the following tenders: Lancashire Dynamo & Motor Co., reversible booster, motor-driven balancer and shunt-regulating switches and resistances, at £848. 15s.; and E. Musgrave, for extension of station buildings, at £810. 6s. 5d.

Wolverhampton Corporation have placed the following contracts: Bellis & Morcom, high speed engine, £1,850; Thos. Parker (Ltd.), generator, £695; Mirrlees-Watson Co., condensing plant, £1,095 Callender's Co., cables and feeders.

Leith Parish Council have accepted the tender of H. C. Gibson's heirs for an electric light installation at the new poor house at £1,759. 2s. 7d.

Luton Council have accepted the tender of the St. Helens Cable Co. for cables as under: 4,814 yds. single-core, 15s. per yd; 55 yds. single-core fireproof, 16s.; 1,385 yds. three-core pilot and test cable, 1s.

Colchester Council have accepted the tender of T. J. Ward for extending the tramcar shed and depot at £1,030.

Croydon Corporation have accepted the tender of Babcock & Wilcox for a boiler at £1,835 and pipework at £320.

Carlisle Corporation have placed a contract for a storage battery of 250 P. 21 cells with the Electrical Power Storage Co.

Torquay Corporation have accepted the tender of Davis-Perrett (Ltd). for de-oiling plant at £315.

Eccles Council have placed an order with Mather & Platt for an engine and dynamo.

Canterbury Council have placed the contract for wiring work, &c., during the ensuing half-year with E. J. Philpott.

Finchley Council have accepted the tender of Callender's Cable & Construction Co. for cables.

The contract for the electrical plant and transmission lines for the Rand Water Board has been given to the British Westinghouse Co, An order for single-phase motors for Doornfontein (S. Africa) has been placed with the Rhodes Electrical Mfg. Co.

A contract for three-phase motors for the Simmer and Jack mine (Transvaal) has been placed with Siemens Bros. & Co.

Boiler Contracts.—We are informed that the following orders for boilers for electricity works have been placed with MM. J. & A. Niclausse, of Paris, within the last month :—

L'ouest-Parisien at Puteaux, two boilers to produce 50,000 lb. steam per hour superheated to 615°F. and fitted with economisers (5th order); L'est-Lumiere at Alfortville, four boilers to produce 70,000 lb. of steam superheated to 615°F. with economisers; Ste Lilloise D'Eclairge Electrique (Lille, Nord), eight boilers to produce 88,000 lb. steam per hour superheated to 660°F. with economisers (3rd order); Central Electrique du Nord at Wasquehal (Nord); six boilers to produce 75,000 lb. of steam per hour superheated 660°F. with economisers; Sectaur Electrique de la Rive Gauche Issy, two boilers of 22,000 lb. steam per hour superheated to 600°F. (3rd order); Ste d'Eclairage et de Chauffage par le Gaz de la ville de Reims (3rd order); two boilers to produce 1,250 lb. steam per hour superheated 525°F. to use coke dust as fuel; Ste Francaise de Tramways et de Chemins de fer Electriques de la Manche; two boilers to produce 4,500 lb. steam per hour to use coke dust as fuel; Grands Magasins du Printemps, Paris, three boilers of 12,000 lb. steam per hour, with economiser.

Gas Engine Contract.—The Indiana Steel Co. has (we are informed) given the largest single order for gas engines ever placed by one company, viz., for 8 Westinghouse twin tandem, double acting, horizontal gas engines, each of 3,000 H.P., capable of delivering 30,000 c.f. of free air per minute to the furnaces which produce the blast furnace gas which, in its turn, is also used to operate the engines.

BUSINESS NOTICES.

Messrs. Seabrook Bros., 32 and 34, Featherstone-street, City-road, London, E.C., have opened an electrical department for the sale of American electrical novelties and specialities.

Edward Wight & Ernest W. Jones, electrical and general engineers, High-street, Hornsey, have dissolved partnership. Debts by Mr. Wight.

Mr. J. W. Kirkland, manager of the South African General Electric Co., has resigned to take up a New York appointment.

Ralph Guest and Archibald Keartland, electrical engineers and contractors, 15, Arcade-chambers, Walsall, have dissolved partnership. Debts by Mr. Keartland.

The Manchester offices of the Eastern and Associated Telegraph Companies have been removed from 20, Brown-street to 44, Spring-gardens.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Gerald Algar, electrical engineer, &c., 5, Denning-road, Hampstead, London, N.W., the trustee (Mr. G. W. Chapman) has been released.

The trustee (Mr. E. S. Greg) in the bankruptcy of Robt. Herlet Scotter, C.E., formerly of Cambridge-road, Southend, and 36, Emperor's-gate, London, W., has been released.

Claims (under order for consolidation of proceedings) against W. Leslie, electrical engineer, and Alice Cheesman (now of H.M. Prison, Brixton) are to be sent by 24th inst. to Mr. H. W. Figg, 128A, Queen Victoria-street, London, E.C.

Electric Lighting Provisional Order Transfer.—Tiverton (Devon) Town Council are prepared to receive offers for the transfer of their powers under their electric lighting provisional order. Particulars from the borough electrical engineer, Mr. J. Siddalls, and offers to the town clerk, Mr. C. M. Hole, by Aug. 7.

Plant for Sale.—The New Spa & Gardens (Ltd.), Bridlington, have for disposal some electric lighting plant, consisting of a dynamo, gas engine, &c. See an advertisement.

Messrs. Paten & Co., 19, Long-causeway, Peterborough, advertise for sale a complete electric lighting plant, comprising a 10 B.H.P. Crossley gas engine, Cutting dynamo (30 amperes at 20 volts), driving belt, switchboard, &c.

Mr. A. Underwood, 3, Queen-street, London, E.C., advertises for sale two Lancashire boilers and two compound vertical engines (Browett-Lindley) coupled direct to Siemens dynamos; also two Willans & Robinson compound vertical engines coupled to dynamo.

A Century of Instrument-making.—Literature relating to the special branch of manufactures of Messrs. Elliott Bros. is always well illustrated and informing. A pamphlet just issued contains a brief retrospect of the history of the firm since its foundation in the year 1800 by William Elliott, who very early in his career as an instrument maker gained a great reputation for the excellence of his work. The business of the later firm of Elliott Bros. was carried on up to 1900 in the neighbourhood of Holborn and the Strand. It was in 1900 that the extensive "Century" works premises at Lewisham were occupied. As far back as 1864 Elliott Bros. were engaged in making electrical standards for the B.A. Committee, and it was about this time that the demand for electrical testing and signalling instruments for various classes of work commenced. Numerous absorptions of firms engaged in the same or a similar line of business helped to swell the total of the firm's operations, the latest business to be taken over in this way being that of Theiler & Sons, of Canonbury, whose reputation as telegraph instrument makers ranked high in the industry. The removal of the works to Lewisham in 1900, exactly 100 years after the business was started, gives point to the name adopted for them—"The Century Works." A description of these works precedes a well illustrated description of many of the principal items of the firm's manufactures, followed by a list of some of their numerous clients. These include all the principal railways, the telegraph companies, electric light and power companies, and a long list of local authorities.

Catalogues, &c.—Some new and attractive catalogues and price lists of A.B.P. storage batteries are newly issued, giving complete particulars of the various types of these batteries which can be supplied

The London Decorative Metal Works (Ltd.) have established themselves at 44 and 46, Eagle-street, Southampton-row, London, W.C., and have ready some excellent designs in decorative switch covers and bell pushes in classic and modern styles. Circular lists can be obtained.

We recently called attention to some well-prepared pamphlets relating to Crompton electrical plant and apparatus. A list just issued by Messrs. Crompton & Co. treats of projectors and the special class of accessories relating thereto. Other Crompton lists now available include electrical instruments for continuous-current circuits and a pocket abbreviated price list of electrical machines manufactured by this firm.

Mr. A. H. Hunt, 115-117, Cannon-street, London, E.C., is agent in this country for a number of electrical specialities and has ready several circular lists relating to these goods. These include a new list of Hellesen dry cell ignition batteries manufactured by Hellesen's Enke & V. Ludwigsen, of Copenhagen, for which firm Mr. Hunt has been appointed sole agent for Great Britain. The combined catalogue and pamphlet dealing specially with the Hellesen battery contains much information of interest to automobilists. Other lists include automobile flexible wires for high or low tension and the "Clutch" insulating tape.

We referred last week to the strong line of "Freezor" fans now offered by the General Electric Co. A booklet specially prepared for the trade, to assist in pushing these goods, can now be obtained by installation contractors and others.

Imports.—The following are official values of imports of electrical machinery, material and apparatus imported into this country during June, 1906 :—

Electrical machinery, £39,283 (decrease of £4,294); telegraph and telephone cables, £11,916; telegraph and telephone apparatus, £28,195; other electric wires and cables (rubber insulated), £2,591, (with other insulations), £4,722; other electrical goods and apparatus, £33,221. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £80,645 (increase, £17,736), and for the six months ended June 30, £580,988 (increase £79,674).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from July 4 to 10, with the ports of destination :—

Africa—Alexandria, £1,780 (including £52 telegraph material); Cape Town, £2,452 (including £1,668 telegraph material); Delagoa Bay, £425 (including £269 telegraph material); Durban, £1,591 (including £490 telegraph cable); East London, £983; Port Elizabeth, £188; Port Said, £19. *Argentina*—Buenos Aires, £2,136 (including £1,644 telegraph material); Rosario, £104. *Australasia*—Adelaide, £21; Auckland, £320; Brisbane, £108; Christchurch, £27; Fremantle, £100; Launceston, £115; Lyttelton, £175; Melbourne, £692 (including £572 telegraph material); Napier, £77; Otago, £5; Perth, £158; Sydney, £519; (including £178 telegraph material): Wanganui, £419. *Belgium*—Ostend, £60. *Brazil*—Rio Janeiro, £72 (including £16 telegraph material); Santos, £174. *Canada*—Toronto, £11. *Ceylon*—Colombo, £108. *Channel Islands*, £40. *Chili*—Valparaiso, £240. *China*—Canton, £280; Shanghai, £80. *Cyprus*, £5 (telegraph material). *France*—Boulogne, £116; Paris, £66; Marseilles, £240. *Germany*—Bremen, £50 (telegraph material). *Gibraltar*, £45 (telegraph material). *Holland*—Amsterdam, £285 (including £250 telegraph material); Rotterdam £32. *Hong Kong*, £98 (including £12 telegraph material). *India*—Bombay, £976 (including £107 telegraph material); Calcutta, £845 (including £18 telegraph material); Madras, £31 (telegraph material). *Japan*—Kobe, £289; Nagasaki, £503; Yokohama, £147. *Malta*, £322. *Mauritius*, £6. *Mexico*, Coatzacoalcos, £9. *Russia*—Batoum, £135 (telegraph material); Odessa, £52 (telegraph material). *Straits Settlements*—Penang, £803 (including £137 telegraph material); Singapore, £138. *Turkey*—Constantinople, £425 (telegraph material). *U.S.A.*—Boston, £10. *West Indies*—Trinidad, £259 (including £210 telegraph material). Total £19,366, against £18,353 in the corresponding week last year (July 5 to 11).

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

The half-yearly general meeting was held on Tuesday at the offices, under the presidency of Mr. William Shuter.

The SECRETARY (Mr. Edmund Dickens) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, your directors have much pleasure in seeing you at this half-yearly meeting and in reporting to you that the affairs of our company continue in a satisfactory condition. No Report or Accounts are presented for your consideration at this meeting, but, according to our ordinary custom, we have to announce that the interim dividend of 5 per cent. will be paid to-day. It is usual at the half-yearly meetings for the attendance to be small and for the remarks of the Chairman to be brief. We have no business to transact or resolution to propose, but I daresay you will be glad to hear what we have been doing during the first six months of this year. I am happy to be able to tell you that we have done a good deal of work, that both our factories have been running overtime, and that our ships have been employed on cable repairs, and have still some important engagements to fulfil. But although our output for the last six months has been large, I must call your attention to the fact that prices have been very closely cut, and that we have now to be contented with very small profits. This should not in any way discourage us, as, fortunately, in the golden years of our prosperity we were able to make reserves for reconstructing our works with the most modern machinery and labour-saving appliances, as well as for the renewal of our ships and bringing them up to date in efficiency and economy. This has been done without calling upon the shareholders for any increase in the capital. We are thus placed in the most favourable position for meeting competition in the future, and I may say, in conclusion, that your Directors are perfectly satisfied with the present position of the company. I think that that is all I can put before you.

Mr. CROFT proposed a vote of thanks to the Chairman and Directors for the way in which the business of the company had been conducted. He had no doubt that their success was very largely due to the loyal efforts made by the Staff to maintain the prestige of the company, and he therefore desired to include the Staff in the vote.

Mr. PHELAN seconded the motion, which was carried by acclamation.

The CHAIRMAN briefly acknowledged the compliment, and the meeting separated.

Chili Telephone Co. (Ltd.)

The seventeenth ordinary general meeting was held yesterday under the presidency of Mr. George Keith.

The SECRETARY (Mr. Edmund Petley) read the notice calling the meeting and the auditor's certificate.

The CHAIRMAN then said: Gentlemen, the accounts show a substantial and general improvement in the Company's business. The increase of 966 subscribers has been larger than in any previous year, and there has been a corresponding increase in message and sundry receipts. Altogether, the revenue in Chili amounts to \$1,090,569, showing an increase for the year of \$111,823, which compares very favourably with the increase of \$62,204 for the preceding year. The expenditure has increased with the revenue. The past winter in Chili was unusually severe, and the plant in some districts suffered severely from storms and inundations, which made the maintenance difficult and expensive. The increased demand for labour and higher cost of living have also led to a considerable increase in salaries and wages. All this has been met by the increased business of the year, with the result that the expenditure works out at 46 per cent. of the revenue—the same as last year. The financial situation has not been so satisfactory. The lower value of the currency ruling during the year has lessened the increased profits. The average rate of exchange for the year was about 15¼d., or fully 1d. less than for the previous year, and the net increase of profit in Chili comes out at £1,208 for the year. The total income from all sources amounts to £38,166. The London expenses and income tax are respectively £51 and £163 more, both due to the increased business, whilst debenture interest is £780 less, owing to the reduction of the outstanding debentures. These disbursements leave a net profit balance of £33,905, out of which an interim dividend of 3 per cent. was paid in January, and £16,119 has been transferred to reserve We now propose to pay a final dividend of 5 per cent., making 8 per cent. on the share capital, tax free, and to increase the carry forward to £2,653. On the whole, I think I may congratulate the shareholders on the result of the year's business. During the year another £10,000 of the 6 per cent. debentures has been paid off, reducing the amount still outstanding to £12,000, which means a saving to the revenue of £600 per annum. The reserve account now stands at £95,000, while investments remain the same as last year. £4,710 has been expended during the year on new construction. The trunk line system of the Company has been largely increased and extended, and several new offices have been opened in order to meet the growing requirements for telephone communication. Altogether, the construction work of the year has very considerably increased the earning capacity of the plant.

As regards the current year, the uncertainty as to the result of the general elections and the increase of paper money have had a depressing effect on sterling exchange, which now stands at about 14¾d. Nevertheless, business generally in Chili is active and prosperous, and our business continues to improve. The elections are now over, and Mr. Pedro Montt has been elected the new President. His election is in favour of good government and sound money. Our business is being ably and energetically managed in Chili, and I think we may look forward to its continued prosperity. I now move the adoption of the report and accounts.

Mr. FRANK W. JONES seconded the motion, which was carried unanimously.

Resolutions approving the dividend, re-electing the Hon. Herbert Allsopp as a director, and the retiring auditor, Mr. T. A. Welton, were then carried, and a hearty vote of thanks to the chairman and directors terminated the proceedings.

Electrical Power Storage Co. (Ltd.)

The seventeenth ordinary general meeting was held yesterday under the presidency of Mr. J. Irving Courtenay.

The SECRETARY (Mr. Malcolm Leggett) read the notice calling the meeting, and the auditors' certificate.

The CHAIRMAN then said: Gentlemen, the balance-sheet shows, after payment of debenture interest, a profit for the year of £8,603. 14s. 3d., or, with £711. 1s. 1d. from last year, £9,314. 15s. 4d. Out of this the directors have placed £1,000 to credit of the contingent fund and have written £2,500 off patents goodwill account, reducing this figure to £69,885. They recommend a similar dividend to that of the last three years (6 per cent.), which will absorb £5,389. 13s. 7d., leaving £425. 1s. 9d. to be carried forward. There has been spent on maintenance, renewal and repair of buildings, plant and tools £3,663. 3s. 6d., and £1,823. 13s. 7d. has been spent on account of new plant. The works are equipped with the most modern and labour-saving appliances for the purpose of cheapening, as far as possible, the cost of production. In addition to the above amounts, we have expended this year a somewhat heavy sum on account of exhibitions. The result of these exhibitions is not confined to the financial year just completed, for we shall doubtless derive benefit from them in the present and succeeding years. This notwithstanding, the directors have written off the whole of the expenditure incurred during the year on these items out of the revenue of the year. Had it not been for this special expenditure the profit would have been even larger than that of last year. Considering the prevailing depression in our particular branch of the electrical trade and the keenness of competition, which renders prices very low, together with the fact that we have had to face an abnormal rise in the cost of raw materials, especially lead, the result, I think you will agree, is eminently satisfactory. The year is specially noticeable for the diminution in the amount of orders placed for large or central station batteries, and no doubt the difficulty which many corporations are finding in obtaining money for such enterprises and extensions is the chief cause of this diminution. Of such business however as there has been we have certainly had our full share, and during the year we have completed batteries for Preston, Bury St. Edmunds, Dartford, Stoke Newington, Oxford and the Chelsea Electricity Supply Co., and we have at present on our books, amongst others, batteries for Marylebone, the Chelsea Electricity Supply Co., Sheerness Dockyard (Admiralty), Ilford and Birmingham. With reference to the Birmingham contract, it may be interesting to mention that our first battery was supplied to the old company, which has since been absorbed by the Corporation, in 1891, and we have had repeat orders from them on no fewer than six occasions, a fact which fully testifies to the continued excellence of our manufactures.

With regard to batteries for the propulsion of automobiles, our business is still increasing, although not as rapidly as we should like. We are continually making improvements in this class of battery, and at the present time there is no carriage which can compare with the electric carriage for town use, although for touring purposes the electric car is not so well adapted. In connection with electrically-propelled vehicles the company is giving special attention to the question of electrically-driven omnibuses. We are at the present time, in conjunction with other engineers, considering the matter, and hope before very long to have a specimen 'bus running in London. In the meantime, not having had sufficient experience in this class of vehicle, we prefer not to make any definite statement concerning them. The success of the vehicle does not depend on the cost of upkeep of the accumulator alone; if it did, from our experience with other vehicles, we can safely say that there is no reason why electrically-propelled omnibuses should not be the solution of the much-discussed question of motor vehicles for such purposes in crowded traffic.

As I have on previous occasions told you, the company keeps itself fully acquainted with, and abreast of all, the developments in its special line, and investigates all new discoveries which are brought to its notice. During the past few months many of you may have noticed extravagant statements in the daily press with reference to new methods of manufacture and discoveries in regard to storage batteries, mainly originating from the other side of the Atlantic. These have generally been connected in some way with more or less rare metals, and have been accompanied by the information that those owning or interested in the discoveries are making arrangements to purchase the whole, or the greater bulk, of the world's supply of the particular metal required. It is difficult to understand why such precautions should have been taken unless it is that these people, being convinced that they are unable to obtain a monopoly by patent rights, have endeavoured to ensure it by this means; but I think the general public must be getting somewhat tired of hearing year after year similar statements without any of the promised results being forthcoming. From our own experience we consider that there is no more probability of these new batteries developing into successful commercial articles than there has been in those which have been previously put forward. In fact, I am advised by our technical staff that nothing short of a discovery which would revolutionise the accepted theories of the chemistry of metals would be able to oust lead from the position that it occupies to-day as being the only metal from which a satisfactory commercial storage battery can be manufactured. I think the outlook is distinctly encouraging and I hope that we have seen the worst of the depression in our branch of the electrical industry. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion.

Mr. J. W. BARCLAY congratulated the Directors and his fellow-shareholders upon the satisfactory report and statement of accounts. During the past year the competition in all electrical plant had been very extreme, while at the same time the price of lead had advanced some 25 or 33 per cent. above what it was only two or three years ago. In these circumstances he had been prepared as a shareholder to find that the accounts submitted by the Directors would hardly be so satisfactory as those of last year, but even with the amount spent on the buildings at Millwall, they saw that the profits this year were no less than they were in previous years. On this account he thought that the Directors and the engineering staff were entitled to the shareholders' congratulations and thanks. With respect to what the Chairman had said as to the new accumulators which they read of from time to time in the newspapers, he thought that Mr. Courtenay's conclusion was perfectly sound, and it was confirmed by this consideration, that since Faure took out his patent — now 25 years ago, he supposed—the brains of the ablest men, not only in theory but in practice, had been devoted to trying to get some other metal which would answer the purpose practically better than lead, but they had entirely failed to make a commercial battery for practical use. No doubt the patents were all run off now, but the experience which the Company had had, and the pains and care which its officials exercised in turning out the batteries, secured the business of the public quite as effectually as if the Company had a monopoly by virtue of a patent. This should give the shareholders confidence in the future. He saw that, besides what appeared on the face of the accounts, the Company was careful in making provision for the future. They had two reserve funds, one amounting to £10,000 and the other, which was called a contingent fund, amounting to £9,000, which he was glad to see the Directors were steadily adding to. These funds had been accumulated in recent years, besides paying the dividends which the shareholders had received. There was another matter he had been very glad to hear about, that was the Directors' faith in the future of electric traction as applied to motors—either private carriages or omnibuses. If they compared the running of electrically-propelled landaulettes or private carriages, the contrast was startling. It was dangerous to prophesy, but he thought they were warranted in holding out the expectation that very possibly it was electric traction which was to prevail in the streets of London , and if so, he thought that the citizens would be very grateful for the change.

The resolution was then carried unanimously,

The re-election of Sir James Pender as a Director, and of the retiring auditors Messrs. J. Meston & Co., was then approved.

The CHAIRMAN : I desire to say that this has been a very hard year for the staff, and they have done exceedingly well. I thought it right that they should receive a vote of thanks, and I understood Mr. Barclay to conclude his remarks by moving a vote of thanks to the staff. If I might be allowed—reversing the position—to second it instead of proposing it, as I know what they have done, it would give me very great pleasure to do so. I therefore second this vote of thanks to Mr. Butler (the chief engineer) and the rest of the staff.

The resolution was carried unanimously.

A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

United River Plate Telephone Co. (Ltd.)

The twentieth ordinary general meeting was held on Tuesday, under the presidency of Mr. J. Irving Courtenay.

The SECRETARY (Mr. David Smith) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: Gentlemen, we have to record another prosperous year. The all-round growth and prosperity in Argentina that has been noticeable ever since the settlement of the Chilian boundary question, and which has been so greatly increased by the exceptionally good crops and high prices of produce during the past two years has not been without its corresponding beneficial effect upon the business of the company, more especially during the year to March 31 last. To adequately meet the growing requirements of the business and the demands of our subscribers and the public we have found it necessary to expend a large amount of capital. All of this, however, either by the direct and immediate income derived therefrom, as in the case of new exchanges or subscribers' line construction, or from the economy in working that will ensue, and the strengthening of the company's position, as in the case of subway construction, purchase of real estate and common battery installation, must be considered as securely and substantially invested. Consequent upon the prosperous conditions of things in Argentina we are paying higher wages to our employés, and in common with the employers of labour in all countries we have to contend with occasional strikes. I propose paying another visit to Buenos Ayres at the end of this month. Numerous and important additions and improvements have been carried out since my last visit, and the further exchange construction and extensions, including the opening of new exchanges at several towns and the gradual installation of the newest and most efficient types of switchboards at existing exchanges, render necessary the purchase of real estate for the new exchanges and extension of the existing buildings. We have work in progress at the present moment in towns and districts over a wide area. Subscribers have, as I have said, increased continuously, and we have had much difficulty in supplying quickly enough all sorts of telephone plant and in coping with the demand. Our capital has been increased by £50,000 by the issue of 10,000 new ordinary shares in July last year. The increase shown in the accounts in sundry creditors is accounted for by the underground cables, new common battery switchboards, and other outlays in connection with our extensions. We have added £15,000 to our reserve and a like amount to renewals of plant. On the credit side we have £93,028 additional expenditure for the year. Sundry debtors are lower, showing that the prosperity of the country enables us to collect our accounts more promptly than before. Real estate has increased by £7,192 owing to the purchase of new and the extension of existing exchange buildings. It is most desirable for telephone companies to own their own exchanges, as besides the difficulty of getting suitable premises on lease, the expense of shifting wires, boards, cables and accessories from one building to another is enormous and has to be avoided wherever possible. Our securities are £19,812 less than last year, as we have had to realise certain of our investments to meet the capital expenditure. Upon the remainder at market prices we have a satisfactory margin to the good. Receipts in the River Plate show an increase of practically £30,000, while maintenance charges and general expenses are roughly £21,000 more than before. The prices of materials for many different kinds of goods have increased during the year, while freights have also advanced. We have also done a considerable amount of work in repairing and improving some of our older trunk lines. The net profit for the year is £7,823 better than last year, and the directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year (tax free). The directors are making an immediate issue of £100,000 in ordinary shares, which will be offered to the ordinary shareholders at par. I now move the adoption of the report and accounts.

Mr. GEO. KEITH seconded the motion.

Mr. F. W. JONES offered his congratulations on the prospects of the company. These prospects were never brighter than at the present time. He thoroughly approved of the intended issue of new shares. He regarded it as one of the most favourable features of the company's business that they should require large capital commitments, when these were followed, as had always been the case with the company, by a proportionate increase of business and receipts. He also hoped any shares not applied for would be re-allotted, pro rata, to shareholders who had taken up their allotments.

Mr. GAMBLE asked why the preference shareholders should be excluded from the allotment. He knew the preference shareholders gained an enhanced value for their shares through such an issue, but he thought they should not be left out if there were any unallotted shares remaining.

Mr. ELLIS pointed out that years ago the ordinary shareholders did without any dividend, and for some time received only a small one, whereas the preference shareholders had always had their full dividend and the debenture holders their full interest. It was in these days of prosperity that the ordinary shareholders might reasonably expect to come in, at any rate for the next year or two. He suggested that the directors should have the option of any shares so unallotted, as they had managed the business of the company remarkably well.

The CHAIRMAN, in reply, said the directors did not intend to place themselves in any different position to the other shareholders. With regard to the preference shareholders—and he was one of these—he did not know why they should not share in the allotment, but the fact was that the ordinary shareholders preferred to take the shares themselves. The directors intended to dispose of any unallotted shares at a premium. He felt sure the shareholders would leave the arrangement of these matters in the discretion of the Board.

The resolution was then carried unanimously, and Mr. Geo. Keith having been re-elected a director and Messrs. Welton, Jones & Co. re-appointed auditors, a vote of thanks was passed to the local board, to the staff in London, and to the manager and staff in the Argentina, the chairman remarking that it had been an anxious and trying year for the staff there.

A very cordial vote of thanks to the chairman and directors was then unanimously agreed to, and the chairman having briefly replied, the proceedings terminated.

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—During the year ended April 30 the number of 8 c.p. lamps added was 2,405 (including motors). The receipts from sale of current show an increase of £987. 18s. 4d. over the preceding year, but the net profit has been greatly reduced owing to the embezzlement by the company's cashier of £421. 19s. 11d., of which £212. 16s. 5d. has been written off revenue. The remainder the directors have written off from the difference in exchange reserve account. Two years ago the directors thought it advisable to enter into an option which has not been exercised, and the amount paid for this option having, in consequence, been forfeited, the amount has been written off, the directors having brought forward a large amount from last year to meet this contingency. After writing £136. 15s. 2d. off as depreciation, £75 from preliminary expenses, £100 as depreciation of plant and £212. 16s. 5d. balance of amount embezzled, with £239. 0s. 10d. for the unexercised option, the balance to credit of revenue (including balance from last year) is £595. 19s. 5d., which the directors recommend shall be appropriated in paying the dividend on the 5½ per cent. cumulative preference shares for the year, leaving £45. 19s. 5d. to be carried forward. The directors are making arrangements to pay the back dividends on the preference shares. £566. 11s. 6d. was spent on new plant and meters during the year.

CRYSELCO LIMITED.—We are informed that, at the eighth ordinary general meeting on the 2nd inst., a dividend of 10 per cent. was declared, with a balance forward of £2,148. 4s. 5d. The directors reported a steady increase in business, and, notwithstanding keen competition, they had on hand, amongst others, a three years' contract for the War Office, and contracts with the Admiralty, the chief railways and many corporations.

DIRECT UNITED STATES CABLE CO. (LTD.)—The board have resolved to recommend a final dividend of 4s. per share and a bonus of 2s. 6d. per share (both tax free), payable on and after 31st inst., making with three interim dividends already paid a total distribution of 4½ per cent. for the year ended June 30 and carrying forward about £6,316. The transfer books will be closed from July 10 to 24 inclusive.

ELECTRIC CONSTRUCTION CO. (LTD.)—The directors' annual report states the profits available for distribution amount to £6,045. 8s. 2d., and recommends payment of the preference dividend, which will absorb £4,394. 12s. and leave to be carried forward £1,650. 16s. 2d. The buildings and plant have, as formerly, been thoroughly maintained out of revenue, and £5,000 has been credited to depreciation, which account now amounts to £63,000, while the general reserve fund stands at £32,000. The output of the Bushbury Works has been increased during the past year, but the intense competition that has prevailed and continues has so reduced prices that, notwithstanding strict economy and improved efficiency, the margin of profit is not sufficient to provide a dividend on the ordinary shares. Among the important contracts practically completed are the London County Council installation at Greenwich, where the generators are the largest in this country, and the installation for the Great Western Railway Co. at Park Royal to provide electric current for operating their suburban traffic. The falling off in the return from "shares in other companies" is due to a reduction of the dividend paid by the Madras Tramways owing to the failure of the monsoon in 1905, and to an outbreak of plague in the city, but the traffic is now rapidly improving.

MELDRUM BROS. (LTD.)—In view of the loss shown in the accounts for the year ended Dec. 31 (when the $5\frac{1}{2}$ per cent. preference dividend was met for the year), the directors announce that they are not justified in declaring an interim dividend on these shares for the six months ended June 30.

NATIONAL TELEPHONE CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the income accrued in respect of the business of the half-year amounted to £1,195,685. 19s. 7d., compared with £1,086,381. 4s. 3d. for the corresponding period of 1905, an increase of £109,304. 15s. 4d. Working expenses amounted to £696,193. 2s. 6d., compared with £627,314. 10s. 10d., an increase of £68,878. 11s. 8d. The net result, after deducting Post Office royalties (£113,365. 6s. 6d.), is a profit balance of £386,127. 10s. 7d., compared with £358,477. 8s. 1d., an increase of £27,650. 2s. 6d. The rentals carried forward for unexpired terms of running contracts amount to £1,106,639. 3s. 5d., compared with £1,018,882. 0s. 4d., an increase of £87,757. 3s. 1d. Out of the available balance of £293,483. 18s. 2d. the board will recommend payment for the half-year of dividends at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. on the third preference shares, 6 per cent. on the preferred stock and 5 per cent. on the deferred stock, less tax in all cases. It is proposed to transfer £120,000 to reserve, and to carry forward £10,858. 18s. 2d. £608,407. 16s. 3d. has been expended on capital account during the half-year in the erection of 24,210 additional exchange and private stations, and in the construction of underground works.

ROSARIO ELECTRIC CO. (LTD.)—At an extraordinary meeting on Friday last Mr. W. G. Western said that since the company was formed the number of customers had been doubled, and the business had reached that point when it was earning a respectable dividend on both classes of its shares. The directors, when they started work, did not build plant large enough. A new dynamo had been sent out, and they were about to send out another. Besides additional generating plant it was advisable that they should have condensing plant. Their contract with the municipality was nearly ended, and fresh tenders were invited; but, owing to the conditions imposed, the municipality had not been successful in getting a fresh contract fixed up.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

RHYMNEY VALLEY & GENERAL ELECTRIC SUPPLY CO. (LTD.) (89,413)—Reg. July 6, capital £5,000 in £1 shares, to carry on business of suppliers of electric light and power, electrical engineers and contractors, &c. First directors B. Newton, D. Phillips, D. Protheroe, J. Powell, M. A. Edwards, E. L. Watkins and J. Jenkins. Reg. office, Tenby House, Capel-street, Bargoed.

RUBEROID CO. (LTD.) (89,378)—Reg. July 4, capital £6,000 in £1 shares, to acquire the goods manufactured by the Standard Paint Co., of New York, and the Ruberoid Gesellschaft (m.b.h.), of Hamburg, and to carry on business of manufacturers of and dealers in roofing, sheathing, insulating and wrapping papers, paints, oils, varnishes, electricians, manufacturers of insulating materials and electrical compounds, &c. First directors R. L. Shainwald, G. A. Meyer, B. H. Howell and E. R. James.

STATUTORY RETURNS.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—Return to June 7 gives capital as £750,000 in 75,000 ordinary and 75,000 preference shares of £5 each, all of which have been taken up. £750,000 is considered as paid. Mortgages and charges, £425,000.

HESWALL ELECTRIC LIGHT CO. (LTD.)—Return to June 10 gives capital as £1,500 in £1 shares, of which 1,225 have been taken up and paid for in full. Mortgages and charges, nil.

MARDY ELECTRIC LIGHT CO. (LTD.)—In return to Jan. 26 (filed May 11), capital is £2,000 in £1 shares, all of which have been taken up. £2,000. 5s. has been received, including 5s. paid on one forfeited share. Mortgages and charges, £600.

MORTGAGES AND CHARGES.

EMPIRE ELECTRIC LIGHT & POWER CO. (LTD.)—A debenture, dated June 27, 1906, to secure £1,100, charged on (1) Chesham Urban District Council provisional electric lighting order, (2) Chesham electric lighting station, machinery therein and site thereof, (3) company's interest in Romford Tramways and Electric Lighting Acts and all land, buildings, plant and machinery of company in connection therewith, (4) benefit of two agreements with Halesowen Rural Council respecting the light railway order of the Council and the company's interest therein, (5) all moneys payable to company on sale or transfer of said undertakings, and the company's undertaking and other assets, including uncalled capital (subject to mortgage for £6,200), has been registered. Holders, Le Brasseur and Oakley.

JULIUS SAX & CO. (LTD.)—A memorandum of satisfaction in full of debentures dated Feb. 11, 1904, securing £1,200, has been filed.

NEWQUAY ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on July 1 of £2,500 5 per cent. debentures, part of series created June 30, 1900, to secure £4,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA (July 12).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $30\frac{1}{8}$d. per oz. Consols $87\frac{15}{16}$—$88\frac{1}{16}$ for money, 88—$88\frac{1}{8}$ for account; $2\frac{1}{2}$ per cent. annuities $86\frac{1}{2}$—87. Consols Pay Day, August 1; Stocks and Shares Continuation Day, July 25; Ticket Day, July 26; Pay Day, July 27; Mining Share Carry-over Day, July 24.

COMPANY LAW AMENDMENT.—The Departmental Committee of the Board of Trade, which was appointed in February, 1905, to inquire into amendments necessary in the acts relating to joint stock companies, have issued their report. The attention of the committee was particularly directed to the following questions: (*a*) The growing practice of issuing companies without a prospectus; (*b*) the registration outside the United Kingdom of companies carrying on business in England and appealing to English investors; (*c*) the extension of the provisions of the Companies' Act, 1900, with regard to the registration of mortgages and charges so as to include all mortgages and charges as well as those created before as since Jan. 1, 1901; (*d*) the amendment of Table A in the first schedule to the Act of 1862. The committee make a number of recommendations which will appeal to investors.

EASTERN TELEGRAPH CO. (LTD.)—This company announce that, subject to final audit, the accounts show, after making a contribution to general reserve, payment of interest on the 4 per cent. mortgage debenture stock, dividend on the $3\frac{1}{2}$ per cent. preference stock to March 31 and an interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31 last, a balance available, out of which the directors recommend payment of a final dividend of £1. 5s. per cent. and a bonus of 3 per cent., both tax free, and payable on 25th inst., making a total distribution of 7 per cent. on the ordinary stock for the year ended March 31, 1906. The transfer books of the ordinary stock will be closed from July 18 to 25 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The interest on this company's 4 per cent. mortgage debenture stock for the half-year ending July 31 inst. will be paid by warrant on Aug. 1. The register will be closed from 27th to 31st inst. inclusive.

ELECTRIC POWER COMBINE.—A new company is being formed to acquire the business of the Cleveland & Durham County Electric Power Co., and a provisional arrangement has been also come to by which the new company will acquire a controlling interest in the Northern Counties Electricity Supply Co., so that the areas of supply of the two companies may in future be under one administration.

LLANDUDNO & COLWYN BAY ELECTRIC TRACTION CO. (LTD.)—Application has been made to the High Court for the winding up of this company and in pursuance of an order of the Court, a meeting of the unsecured creditors will be held in Manchester on Saturday, to consider a scheme of arrangement. A new company, called the Llandudno & District Electric Tramway Construction Co. (Ltd.) with a capital of 100,000 in 1,000 shares of £100 each, is about to be formed by the Carnarvonshire Electric Traction Synd. (Ltd.) to complete and work the railway, and the proposal is, that the old company's undertaking should be sold to the Carnarvonshire Synd. for £3,500 in shares of the Llandudno & District Tramway Co. and £2,900 in cash, and that of the £3,500 in shares £3,000 shall be distributed ratably among the unsecured creditors in full satisfaction of their debts. To enable this to be done an arrangement has been made provisionally with the debenture holders to accept £500 in shares of the new tramway company in discharge of their debentures, and the mortgagee has also provisionally agreed to accept £2,900 in cash. Messrs. Bruce Peebles & Co, who are to complete the railway, have recommenced the work of construction, and Mr. Arthur H. Whyte Butler is the engineer of the work on behalf of the company, with Mr. Bullock representing the contractors.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend on the 7 per cent. preference shares and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30. The share transfer books will be closed from July 18 to 31 inclusive.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed July 19 a special settling day in \$2,500,000 \$500 5 per cent. first mortgage gold bonds of the *Electrical Development Co. of Ontario (Ltd.)* and have ordered same to be quoted. The committee have been asked to appoint a special settling day in and grant a quotation to 20,000 £10 (£1 paid) conversion shares of the *British Aluminium Co. (Ltd.)* and also to follow a further issue of £235,620 4 per cent. debenture stock of the *Western Telegraph Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 4	1,475	– 68	5	7,090	– 310
Airdrie	June 29	231	+ 7	26	5,693	+ 570
Anglo-Argentine	July 8	14,818	+ 1,902	27	400,424	+ 41,806
Ashton-under-Lyne Corp.	June 30	847	+ 20	14	4,871	+ 539
Ayr Corporation	,, 30	327	– 50	7	2,081	– 175
Baker St. & Waterloo Ry.	July 7	1,446	...	17	24,559	...
Barnsley	June 29	153	– 13	26	4,157	+ 26
Barrow	,, 29	288	– 10	26	6,051	+ 858
Bath Electric Trams, Ltd.	July 4	935	+ 150	27	20,198	+ 3,018
Birkenhead Corporation	,, 8	1,109	+ 88	1	1,109	+ 38
‡Birmingham Corporation	...	...	...	...	...	...
*Birmingham & Mid.	June 29	1,402	– 767	26	36,639	– 11,632
Blackburn Corporation	July 4	1,131	+ 175	¶14	15,446	+ 982
Blackpool Corporation	,, 5	1,309	– 46	13	14,269	+ 572
Blackpool and Fleetwood	,, 7	950	+ 78	1	950	– 74
Blackp'l, St. Anne's & Lytham	,, 5	566	+ 59	§35	9,855	+ 1,059
Bolton Corporation	,, 8	2,267	+ 178	14	30,679	+ 1,937
Bournemouth Corporation.	,, 4	1,676	+ 203	†14	22,384	+ 5,695
Bradford Corporation	,, 7	4,709	– 120	14	65,549	+ 2,879
Brighton Corporation	,, 8	1,109	– 71	14	18,820	– 578
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 6	5,612	+ 61	21	104,296	+ 3,253
‡Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trms.	June 9	1,247	+ 134	23	32,032	+ 6,316
Burnley Corporation	July 7	1,326	+ 172	14	17,251	+ 675
Burton Corporation	,, 8	331	+ 4	§18	4,297	– 233
Bury Corporation	,, 1	989	...	13	13,185	...
Calcutta Tramways Co.	,, 7	R45,024	+ R2,493	1	R45,024	+ R2,498
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	June 30	2,135	– 771	13	26,982	– 1,116
Cavehill	,, 29	101	+ 80	26	1,914	+ 561
Central London Railway	July 7	6,131	– 229	1	6,131	– 229
Chatham & Dist. Lt. Rys.	,, 5	731	– 115	†1	731	– 115
***City of Birm'gh'm Tram Co.**	June 29	5,512	– 416	26	137,782	– 8,684
City & South London Rly.	July 8	2,465	+ 165	1	2,465	+ 165
Colchester Corporation	,, 5	237	...	49	9,296	– 1,295
Cork Electric Trams Co.	,, 5	616	– 15	27	12,630	– 318
Croydon Corporation	,, 6	1,641	+ 49	5	8,601	+ 795
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	June 29	444	– 55	26	11,202	– 497
Dover Corporation	July 7	401	+ 55	14	3,550	+ 468
Dublin & Lucan Railway	,, 6	98	– 34	§1	98	– 34
Dublin United	,, 6	5,218	+ 659	‡1	5,218	+ 659
Dudley—Stourbridge	June 29	881	– 51	26	21,352	– 143
Dundee Corporation	July 4	1,086	+ 198	§7	7,740	+ 1,515
East Ham Council	,, 7	982	+ 52	14	13,351	+ 1,355
Exeter Corporation	,, 6	310	– 6	14	4,038	– 197
Gateshead & Dist. Trams.	June 29	1,228	+ 57	26	24,454	+ 1,154
Glasgow Corporation	July 7	17,026	+ 928	6	94,853	+ 6,221
Glossop	,, 8	148	+ 16	27	3,500	+ 326
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	June 29	265	+ 9	26	5,818	+ 263
Gt. Northern & City Rly.	July 7	1,679	+ 166	1	1,679	+ 166
Greenock & Port Glasgow	June 29	724	– 59	26	16,519	+ 340
Halifax Corporation	July 4	1,757	+ 113	14	23,708	+ 1,328
Hartlepool Tramways	June 29	362	+ 90	26	7,175	+ 651
Hastings Elec. Trams Co.	July 5	776	...	1	776	...
Huddersfield	,, 7	1,545	+ 95	14	21,694	+ 2,304
Hull Corporation	,, 7	2,332	+ 94	14	3[illegible],459	+ 789
Ilford Dist. Coun.	,, 7	551	– 12	14	7,235	+ 196
Ilkeston Dist. Council	,, 4	148	+ 21	14	1,831	+ 60
Ipswich Corporation	,, 7	478	– 41	14	6,108	– 1[illegible]0
Isle of Thanet Co.	,, 7	1,100	– 65	59	14,870	– 550
Keighley Corporation	§June 30	227	+ 16	52	7,475	...
Kidderminster & District	,, 29	134	– 12	26	2,787	– 59
Kilmarnock Corporation	July 7	169	+ 1	8	1,203	– 55
Kirkcaldy Corporation	,, 4	226	+ 8	1	226	+ 8
Lanarkshire Trams Co.	,, 5	952	+ 313	‡27	23,222	+ 5,893
Leamington	June 29	234	+ 176	26	[illegible],127	+ 2,350
Leeds Corporation	July 7	6,896	– 7,045	14	89,[illegible]83	+ 4,266
Leicester Corporation	,, 7	2,326	+ 81	1	2,326	+ 31
Leith Corporation	June 30	542	+ 204	‡7	3,014	+ 1,912
Liverpool Overhead Rly.	July 8	1,563	– 83	1	1,563	– 83
Liverpool Corporation	June 30	11,190	– 2[illegible]9	26	274,[illegible]23	+ 5,624
***London County Council**	,, 30	26,247	+ 10,0[illegible]2	13	345,859	+ 154,082
London United	July 6	7,493	+ 346	†27	159,010	+ 9,267
Lowestoft	,, 7	208	– 37	41	5,569	– 404
Maidstone Corporation	,, 5	119	– 30	14	1,647	– 208
Manchester Corporation	,, 7	14,391	+ 504	14	191,257	+ 10,509
Mersey Railway	,, 7	1,587	+ 94	1	1,587	+ 94
Merthyr	June 29	196	+ 11	26	4,918	+ 35
Metropolitan Dist. Railway	July 8	8,159	+ 745	1	8,159	+ 745
***Metropolitan Elec. Trams**	June 29	3,676	+ [illegible]	26	84,133	+ 24,740
Middleton	,, 29	393	– 49	26	8,741	+ 352
Nelson Corporation	July 7	163	+ 18	15	2,146	+ 197
Newcastle-on-Tyne Corp.	,, 7	3,794	+ 247	14	57,606	+ 2,883
Newport (Mon.)	,, 7	630	+ 29	14	8,850	+ 398
Northampton Corporation	,, 6	533	+ 31	14	6,276	+ 65
Oldham, Ashton & Hyde	June 29	585	– 27	26	14,294	+ 505
Oldham Corporation	July 8	1,831	+ 2[illegible]3	15	26,9[illegible]5	+ 2,282
Perth (N.B.) Corporation	,, 4	155	...	7	1,109	...
Perth (W. A.) Elec Trams	,, 6	1,404	+ 5	‡27	40,341	+ 2,814
Peterborough	June 29	133	– 24	26	2,972	– 2[illegible]4
Pontypridd District Coun.	July 7	170	+ 12	14	2,458	– 8
Portsmouth Corporation	,, 7	2,451	+ 23	14	28,183	– 157
Potteries	June 23	1,767	– 70	25	45,497	+ 2,272
Preston Corporation	July 4	789	+ 151	1	789	+ 151
Reading Corporation	,, 5	679	– 63	1	679	– 63
Rochdale Corporation	,, 7	1,115	+ 156	14	14,957	+ 5,[illegible]76
Rotherham Corporation	,, 5	515	+ 61	14	6,871	+ 632
Rothesay	June 29	313	+ 94	26	3,403	+ 934
Salford Corporation	July 9	4,849	+ 303	14	65,210	+ 1,496
Sheerness	June 27	60	– 23	20	1,378	– 271
Sheffield Corporation	July 8	5,493	+ 3[illegible]8	15	79,2[illegible]8	+ 5,515
Southampton Corporation	,, 4	1,067	+ 4	†14	14,[illegible]59	+ 56
Southend Corporation	,, 4	458	– 14	14	5,330	+ 341
Southport Tramways	June 29	356	– 14	26	7,523	+ 88

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
S. Staffordshire Trams.	June 29	816	+ 80	26	20,797	+ 2,802
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	July 6	1,115	+ 330	14	18,974	+ 5,168
Sunderland Corpn.	,, 8	1,557	+ 29	14	19,873	+ 1,078
Sunderland & District	,, 4	403	...	27	10,031	...
Swansea Trams	June 29	847	– 32	26	20,319	+ 4,380
Swindon Corporation	July 4	168	– 38	¶13	2,642	– 49
Taunton	June 29	46	– 10	26	1,120	– 83
Tynemouth and District	,, 29	507	– 18	26	5,736	– 143
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	July 7	908	+ 35	14	11,891	+ 879
Walsall Corporation	,, 7	528	+ 18	24	13,624	+ 967
Warrington Corporation	,, 5	415	+ 27	14	5,211	+ 519
West Ham Corporation	...	...	...	...	...	...
Weston-super-Mare	June 27	238	+ 12	26	2,142	+ 80
Wolverhampton Corpn.	July 4	851	...	1	851	...
***Wolverhampton District**	June 29	420	+ 21	26	10,531	+ 854
***Worcester**	,, 29	308	– 26	26	6,797	– 629
Wrexham	,, 29	119	+ 20	26	2,545	– 8
Yorkshire W.R. Trams	July 8	885	– 6	27	21,270	...
Yorkshire Woollen District	June 29	906	+ 188	26	22,727	+ 6,802

(a) These comparisons are with the corresponding period last year. * Partly electrical. ¶ Plus 3 days.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., July 11.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to July 11. Highest.	Business, Week to July 11. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	6¾—7	5 15 0	Ap, Oct	6$\frac{13}{16}$	6$\frac{13}{16}$
5	2/9	† Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	5$\frac{15}{16}$	5$\frac{15}{16}$
St.	6%	† Do. Permanent 6% Deb. Stock	139—141	4 5 0	—	140	..
St.	5%	† Auckland Elec. Trams 5% Deb. (red.)	102—104	4 16 3	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—4½	5 1 0	—	[illegible]	4⅜
St.	4½%	† Do. 4½ per Cent. Db. Prov. Cts.	96—99	4 11 0	—	[illegible]	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	115—118	5 1 6	—	116¼	15
St.	5%	Do. Pref. Ord. Stk	107—110	4 11 0	—	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107—110	4 11 0	—	..	..
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	103—106	4 4 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	8$\frac{5}{16}$—8$\frac{9}{16}$	4 18 0	—	..	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5½—5¾	5 4 4	—	..	..
5	8/0	Do. "B"	5—5½	5 7 0	—	..	—
St.	5%	† Do. 5 per Cent. Debs.	104—106	4 14 4	—	..	..
St.	5%	† Do. 5% 2nd Deb. (red.)	101—104	4 16 8	—	..	..
St.	5%	†Buenos Ayres Elec. Trams (1901) Ltd.	93—100	5 0 0	..	..	..
100	5½%	†Buenos Ayres Grand National 5½% Pref. Debs.	101—105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102—107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8—8½	4 15 0	—	8¼	..
5	2/6	† Do. Nos. 105,001 to 137,610	7¾—8¼	4 16 0	..	8$\frac{1}{16}$	..
10	4½%	† Do. 4½% 1st Deb. Stock (red.)	102—104	4 6 6	—	103	102½
1	0/6	Cape Electric Tram Shares	½—¾	6 13 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100—102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	96—98%	5 4 2	..	..	..
St.	5%	†Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92—93	5 7 0	..	96	93
St.	6	† Do. 6% "B" Ditto	88—93	6 9 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord. ex rights	1⅜—1$\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref. xd & rights	1⅛—1⅜	4 7 4	..	1$\frac{7}{32}$	..
100	5%	† Do. 5% Reg. Mort. Debs.	101—103	4 17 0	..	..	..
St.	5%	†Madras Elec. Trams 5% Deb. Stk.	100—103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102—104	4 6 6	—	..	..
St.	5%	†Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105—107	4 18 6	..	..	..
..	$2	†Sao Paulo Tramway, Light and Power Co. $100 Stock	14—14¾	5 12 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	97½	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	..	..
5	5/4	Calcutta Elec (1–50,000)	8⅛—8⅜	4 18 0	—	8⅜	..
50	5%	†City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48—50	5 0 0	..	..	..
..	5%	†Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92—94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	† Do. 5% Debs.	86—89	5 12 4	—	..	..
St.	6	†Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	111—114	5 5 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{13}{16}$—⅞	7 0 0	—	⅞	..
1	1/6	Rand Electric	1$\frac{1}{16}$—1$\frac{3}{16}$	..	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{7}{16}$—$\frac{9}{16}$	..	..	½	..
1	1/2¾	Do. 6% Non. Cum. Pref	⅞—1	6 0 0	..	..	..
St.	5%	† Do. 5% Deb. Stock	99—102	4 18 1	..	100½	9½
5	8/0	Rosario Elec. Co. 6% Pref. (1–12,000)	5½—5⅝	5 8 6	..	[illegible]	..
100	4½%	†Royal Elec., Montreal 4½% 1st Mort. Deb	99—102	4 8 0	Ap, Oct	—	...
..	5%	†Shawinigan Water and Power 5% Bds., Scrip	99—101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., July 11.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to July 11. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10½—11½	6 3 6	..	11⅛	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛—10⅝	4 5 3	..	10¼	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	..	—	—
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	104—106	4 4 10	..	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛—5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101—104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8—9	5 11 6	—	8⅜	..
5	3/6	Do. 7 per Cent. Pref.	7¾—8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100—103	3 17 9	—	..	..
1	2/6	Charing Cross (W. End & City) El. Sup. Co.	4—5	5 0 0	Feb, Aug	4½	..
5	2/3	Do. 4½ per Cent. Pref.	4—4½	5 2 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99—102	3 18 3	—	—	—
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	3¾—4¼	5 6 0	—	..	..
5	2/3	† Do. Do. (1903)	3¾—4¼	5 6 0	..	..	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	*† Do. 4½ per Cent. Deb. Stock (red.)	106—108	4 3 3	Jn, Dec ..	..	..
10	7/0	City of London Electric Lighting Ord.	10¾—11¼	6 6 6	Feb, Aug	11⅜	10⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¾	4 16 0	Jan, July	12⅜	..
St.	5%	*† Do. 5 per Cent. Deb. Stock (red.)	121—124	4 0 8	Jn, Dec ..	124	—
St.	4½%	† Do. 4½% 2nd Deb. Stock (red.)	99—102	4 8 3	..	100	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2 1/16—2 3/16	3 18 4	April, Oct	—	..
5	5%	Do. Do. 5% non cum. pref.	5—5½	4 10 11	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	8—9	5 11 0	—	8⅜	8 5/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼—12¼	4 18 0	Mar, Sept	..	..
St.	4½%	† Do. 4½% Deb. Stock (all paid) (red.)	107—110	4 1 10	..	107	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—104	4 6 6	..	102⅝	..
5	5/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	5 7/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101—104	4 6 6	—	..	..
5	5/0	Hove Electric Lighting Ord.	7¾—8¼	5 9 0	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98—101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10—11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98—101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101—103	3 17 6	..	..	..
3	2/4½	London Electric Supply Ord.	2—2½	4 0 0	..	..	..
5	3/0	Do. 6 per Cent. Pref.	5—5½	5 7 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—99	4 0 10	Mr, Jn, S, D	98	..
5	10%	Metropolitan Electric Sup. Ord.	8¼—9¼	5 8 6	April, Oct	8⅞	8¾
5	2/3	† Do. 4½ per Cent. Cum. Pref.	5 5/16—5 9/16	4 1 0	Jan. July	5⅜	5 5/16
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	109—113	4 1 10	Jn, Dec ..	..	..
St.	3½%	† Do. 3½ per Cent. Mrt. Db. Stock (red.)	94—96	3 13 0	—	..	..
100	4½%	† Midland Elec. Corp. for P.D. 1st Mort. Db.	98—101%	4 9 1	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11½—12½	5 8 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102—104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾—8⅛	4 18 5	Feb, Aug	..	—
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞—6¼	4 0 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100—101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1 3/32—1⅛	2 13 3	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	101—102	4 8 9	Jan, July	—	—
10	6/0	† Notting Hill Electric Ord.	13½—14½	6 4 0	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97—99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅜—6⅞	4 17 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	99—101	3 19 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½—11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7—8	4 7 0	Feb, Aug	..	..
St.	3½%	† Do. 3½ per Cent. Deb. Stock (red.)	95—97	3 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2—2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76—80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾—3¼	6 8 0	..	2⅞	..
1	0/8	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1 3/16—1 5/16	5 9 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105—106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3⅜—3⅞	6 11 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	—	4¾	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100—102	4 8 0	..	101	..
5	6/6	Westminster Elec. Sup. Ord.	10½—11½	5 13 0	Mar, Sept	11⅛	..
5	2/3	† Do. 5 per Cent. Cum. Pref.	5¼—5½	4 11 0	..	5 7/16	5⅜
5	1/4½	† Do. Issued at 7/6 premium all paid	5¼—5½	4 11 0	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90—93	4 6 0	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16—1 1/32	4 14 0	..	..	..
1	0/6	† Do. 5% Cum. Pref.	15/16—1 1/16	4 9 0	..	1	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	101—104	4 6 6	..	..	..
St.	4½%	† B'ham & Midland Trams 4½ 1st Db. Stk.	98—100	4 10 0	..	..	..
10	8½%	Bristol Tramways and Carriage Ord.	15¼—15¾	5 8 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	10—10¼	3 18 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101—103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	5½—6	5 0 0	—	5 15/16	5⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	9—9½	6 6 3	Feb, Aug	9 5/16	9 1/16
St.	5%	Do. 5 per Cent. Perpetual Debs	109—113	4 8 6	..	111½	110¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	89—92	4 19 0	..	91½	91¼
St.	4%	Central London Ordinary Stock	86—88	4 13 0	June, Dec	87	85
St.	4%	Do. 4 per Cent. Pref. Stock	99—101	3 19 0	..	..	..
St.	4%	Do. Deferred Stock	74—77	5 4 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	110—112	3 11 3	..	110½	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	91—93	4 6 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	4⅞—5⅛	4 9 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100—103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	42—44	4 6 0	Feb, Aug	42½	40¼
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114—117	4 5 3	..	..	..
St.	5%	Do. (1901)	114—117	4 5 3	..	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 8	May, Nov	..	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	13¾—14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14—15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼—3¾	10 18 4	..	3½	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100—103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15—16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11½—12	5 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	102½—104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2—2½	..	—	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	77—83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16—8 9/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—102	3 19 3	Jan, July	..	..
10	5/0	† London United Trams. 5% Cum. Pref.	7¾—8¾	5 14 0	—	8⅛	7⅞
St.	4%	† Do. 4% 1st Mort. Deb. Stock	94—97	4 2 6	—	95½	95¼
St.	..	Mersey Con. Ord. Stock	4—6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8—11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—½	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	13/16—15/16	5 9 0	—	..	..
St.	4½%	† Do. 4½% Deb. Stock	100—102	4 8 3	—	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾—7¼	5 5 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½—8½	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100—103	4 7 3	—	..	..
100	5%	† Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	90—93	5 7 6	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	94—95	5 4 0	—	..	..
St.	3½%	Waterloo and City Ord.	100—103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3—3½	..	—	..	..
St.	4½%	† Do. 4½% 1st Debs.	93—95	4 14 9	..	..	..

Shre.	Last Dividend	Name.	Price Wed., July 11.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to July 11. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	7½d.	Aron El. Met. 6% Cm. Pf.	1 7/16—1 9/16	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	3¾—4	4 14 0	..	3 15/16	3⅞
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
1	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	6 0 0	July, Feb	6 3/16	..
1	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	102—105	4 5 6	..	103½	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96—98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1⅛—1⅜	..	..	1 3/16	—
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	77—83	4 16 6	..	78	77¾
1	1/0	Brush Electrical Engineering	⅝—⅞	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½—2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97—99	4 11 0	Mar, Sept	..	—
St.	4½%	† Do. Perpetual 2nd Deb. Stock	82—84	5 7 2	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½—11½	4 10 6	Jan, July	10⅞	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5⅝—5⅞	4 5 0	Jan, July	5 13/16	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Debs. (rd.)	107½—109½	4 2 6	Nov, May	..	..
1	9½d.	Castner-Kellner Alkali Co.	1 1/32—1 5/32	5 4 6	..	1 1/16	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	99—102	4 8 0	—	100¼	..
1	1/4½	† Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	1 7/32	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1 11/16—1 13/16	3 17 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94%—97%	5 3 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1 1/16—1 3/16	5 12 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept	1 3/16	..
St.	4½%	† Do. 4½% Deb. Stock	103—106	4 5 0	..	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅜—1⅝	4 18 0	Feb, Aug	1 9/16	..
5	2/6	Do. (£5 paid)	2½—3	4 3 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	85—87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90—95	5 5 0	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¾—4¼	3 4 6	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4½—5	6 0 0	..	4¾	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—106	4 5 0	—	..	..
2	1/7½	Electric Construction Co.	⅜—⅝	11 4 0	July	7/16	..
2	2/2⅖	Do. 7 per Cent. Cum. Pref	2—2½	5 12 0	July	2⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	88—91	4 8 0	Jan, July	..	..
10	5/0	† General Electric (1900) 5% Cum. Pref.	9—9½	5 5 3	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93—97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12—13	5 15 0	Feb, Aug	12 11/16	—
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	..	—
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107—109	4 2 6	..	107	..
St.	12/6	Do. Do. Scrip (all paid)	107—109	4 2 6	..	..	..
10	5/0	† India Rubber, Gutta Percha, &c., Wrks.	17—18	2 17 2	Feb, Aug	17 23/32	17⅛
100	..	Do. 4% Debs. Red.	100—102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾—12¼	4 1 8	Mar, Sept	..	—
1	1/2⅜	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	31/32	15/16
1	7½d.	Do. 6% Cum. Pref.	15/16—1 1/16	5 13 6	..	..	..
St.	4½%	† Do. 4½% Perp. Deb. Stock	96—99	4 11 0	..	..	..
12	14/0	Telegraph Construction & Mainten'ce.	32½—34½	6 1 6	Mar, July	34	33¾
100	4%	† Do. 4 per Cent. Deb. Bonds, 1909	100—102	3 18 3	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16—2 9/16	5 15 0	..	2½	2 7/16
1	1/0	Do. 5% Non-Cum. Preference	1 1/16—1 3/16	4 4 0	..	1¼	..
St.	5%	Do. 5% Non-Cum. Preferred	113—117	4 5 4	..	114½	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103—105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105—107	4 4 6	..	106	..
5	—	Willans and Robinson Ord.	1—1½	—	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	—	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	78—83	4 16 6	May Nov	..	..
		TELEGRAPHS.					
10	—	Amazon Telegraph	8—8½	..	Jn, Dec	8¼	8 3/16
100	5%	† Do. 5% Debs. (red.)	80—85	5 17 8	..	81¼	81½
St.	26/0	Anglo-American	65—67	4 17 0	F, My, Ag, N	65¼	..
St.	60/0	Do. Preferred	112½—113½	5 7 0	F, My, Ag, N	112⅞	111¾
St.	10/0	Do. Deferred	22⅞—23⅛	2 7 0	F, My Ag, N	23 11/16	22 1/16
St.	4%	† Commercial Cable 4 per Cent. Deb. Stk	97½—99½	4 0 6	Jn Ap, Jy, O	99	98
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	..	—
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅝—3⅞	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½—9	5 11 0	April, Oct	..	—
50	4½%	† Do. 4½ per Cent. Deb.	98%—101%	3 19 0	Jan, July	..	..
20	4/0	Direct United States Cable	15½—16	4 13 9	Ja, Ap, Jy, O	15 13/16	15½
100	4½%	† Direct West India Cable 4½% Rg. Db. (rd.)	99½—101½	4 8 9	Ju, Dec ..	..	..
St.	26/0	Eastern Ordinary	141—144	4 17 2	Ja, Ap, Jy, O	143¼	142½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90—92	3 16 0	Ja Ap, Jy, O	91⅜	90⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107—109	3 13 4	May, Nov	..	..
10	6/6	Eastern Extension	14—14½	4 16 6	Ja, Ap, Jy, O	14⅜	14 1/16
St.	4%	Do. 4 per Cent. Deb. Stock	105½—107½	3 14 4	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	100—102	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) ex coupon 67	39½—41½	5 18 0	Jan, July	40⅛	..
100	4½%	† Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½—101½	4 8 9	June, Dec	..	..
25	52/6	Indo-European	57½—59½	5 6 3	May, Nov	58¾	58⅝
100	4%	Mackay Companies Common	72 3/16—74 1/16	5 12 0	Jan, July	—	..
100	4%	Do. Preference	74 3/16—75 5/16	5 6 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛—1⅜	..	..	..	..
100	4%	† Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½—10	5 0 0	..	..	—
5	—	West Coast of America	⅝—⅞	..	—	..	..
100	4%	† Do. 4 per Cent. Debs.	99—102	3 17 0	Jan, July	..	..
10	—	West India and Panama	⅜—½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6—7	3 11 4	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	† Do. 5 per Cent. Debs.	99—102	4 18 0	Jan, July	..	..
10	3/0	† Western Telegraph	14¼—14¾	4 15 0	Mr, Ju, O, D	14⅜	14⅛
100	5%	Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	..
St.	4%	† Do. 4% Deb. Stock (red.)	102—105	3 16 2	..	104½	..
		TELEPHONES					
—	4%	† Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	94—96	4 3 4	..	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101—103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	7⅛—8⅛	4 18 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	0/6	Do. 1% Pref.	⅞—1	5 0 0	..	..	..
St.	5%	National Co. Pref. Stock	110—112	5 7 0	—	111½	111¼
St.	5%	Do. Def. Stock	108—110	4 12 6	—	109	108½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11—13	4 13 6	Feb, Aug	12¼	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10—12	5 0 0	Feb, Aug	11¼	11⅛
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅝—5⅞	4 6 0	Feb, Aug	5⅞	[illegible]
St.	3½%	† Do. Deb. Stock 3½ per Cent. (red.)	96½—98½	3 11 0	June, Dec	97¾	..
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	103—104	3 17 0	—	104	103
1	0/9⅗	Oriental	1 1/16—1 3/16	4 8 6	April, Oct	1⅛	1 1/16
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¼—1⅜	4 7 0	—	..	..
St.	4%	† Do. 4% Red. Deb. Stock	97—99	4 1 0	..	..	..
St.	4½%	† Telephone Co. of Egypt 4½% Db. Stk. Rd.	100—103	4 7 0	..	..	..
5	3/0	United River Plate	7—7½	5 6 8	July	7 1/16	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼—5½	4 2 0	June, Dec	..	..
St.	5%	*† Do. 5 per Cent. Deb. Stock (red.)	108—111	4 10 0	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	† Elec. & Gen. Investment 6% Cum. Pref.	4½—5	6 0 0	—	..	..
10	5/0	Globe Telegraph and Trust	10⅞—11⅜	4 10 0	Ja Ap, Jy O	11 1/16	10 15/16
10	3/0	Do. 6 per Cent. Pref	14⅝—14⅞	4 0 6	Ja Ap, Jy, O	14 11/16	14⅝
10	6%	Submarine Cables Trust (Cert.)	127—130	4 12 8	April, Oct	129½	128½

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE report of the Commission appointed by the German Gas and Water Companies to inquire into the question of electrolysis by earth currents, reveals a very unsatisfactory state of things. As will be seen by the abstract which we give elsewhere, a great deal of electrolytic corrosion is taking place, and owing to the want of official regulations on the subject, the conditions vary enormously. In many cases the pipes are highly positive to the rails. Thus, at Leipzig and at Erfurt, potential differences of 8 volts and 5 volts respectively are recorded, and in many cases the fall of pressure along rails and pipes seems to be excessive. In the two cases where there is no appreciable corrosion—namely, in Hamburg and in Freiburg—the conditions are much the same as those obtaining in this country, and it is thus satisfactory to find support given to the Board of Trade regulations which have done so much to give us immunity from electrolytic troubles, and around which there has been so much controversy before Parliamentary Committees.

THE answers given by Mr. McKENNA in the House of Commons in reply to questions by Sir BENJAMIN STONE as to the carrying out of tests at the National Physical Laboratory are not altogether reassuring. Although Mr. McKENNA may be technically correct in saying that the avoidance of competition with private practitioners was not one of the recommendations of the Treasury Committee of 1898, there is no doubt that this Committee were decidedly averse to any such competition. It is, however, stated in the reply that the desirability of not interfering with work which can be satisfactorily done outside the Laboratory had always been borne in mind by the Executive Committee, but there had been considerable difficulty in laying down a precise definition of the work that might properly be undertaken by the Laboratory.

NEVERTHELESS, there are many who feel with good reason that the Executive Committee of the Laboratory have not always considered the question of competition in the fair way that might have been expected. Undoubtedly the function of the Laboratory should be the carrying out of work which, although of great importance from the industrial and scientific point of view, is unremunerative and therefore beyond the resources of the private practitioner. The non-recognition of this point of view is probably due to the unsatisfactory financial position of the Laboratory. It is noticeable that, according to the memorial to the Chancellor of the Exchequer for an increased grant presented last year by members of the House of Commons, the number of tests carried out during the year by the National Physical Laboratory was 28,183, bringing in a sum of £5,943, as compared with 18,951 tests, producing an income of £2,016 at the Reichsanstalt; but the annual grant is only £5,500 for the former, as compared with £16,000 for the German institution. A satisfactory policy cannot be expected unless the Laboratory is made independent of receipts for work done. As to the nature of this work, Mr. McKENNA is referring the question to the Royal Society, and we therefore hope that the work of the Laboratory may be satisfactorily defined. We cannot help feeling, however, that a matter of this kind is not of much interest to the Royal Society, and that it would have been much better to refer the whole question also to such bodies as the Institution of Electrical Engineers and the Institute of Chemistry, whose membership includes many private practitioners affected by the policy to be ultimately pursued.

By no means daunted, but rather encouraged, by the fate of their Electric Supply Bill, the London County Council have decided to draw up a new scheme, the preliminary expenses of which have been fixed at £1,500 as a maximum. Sir Melvill Beachcroft ventured to move an amendment at the meeting of the Council to the effect that a cheap supply of electricity for London is obtainable at private risk under conditions that will safeguard public interests, thus rendering a speculative enterprise involving the Council in great financial responsibilities unnecessary; but the amendment was lost by 67 votes to 32. Meanwhile, there has been a general withdrawal of Bills for giving power on a large scale. That of the Administrative County of London and District Electric Power Co. is the one exception. This Bill is to be read a second time next week, when it will presumably be buried by the supporters of the London County Council.

There have been many rumours during the last few weeks of great developments on the Rand. Although details are still lacking, we understand on good authority that the Allgemeine Elektricitäts Gesellschaft have made terms with the British South Africa Co. for the erection of a very large generating station for the supply of power. It is stated that the A.E.G. has taken up debentures to the extent of £625,000, and is to supply a large proportion of the plant, though a good deal of the heavy machinery will go from this country. The first part of the scheme, it appears, will be confined to Vereeniging, or some other part of the Rand where coal is available; mystery, however, still surrounds the utilisation of the Victoria Falls, though, doubtless, this will be dispelled as soon as the maze of financial negotiations can be left behind.

We are glad to note that Mr. J. E. Newman, in continuation of the work begun by the late Prof. Lemström, is carrying out experiments near Bristol on the application of electricity to agriculture. Nearly 20 acres of wheat and barley are being subjected daily to electrical discharge, and the results appear to be promising. When the harvest is in, and the results fully determined, we hope to give some details of Mr. Newman's interesting experiments.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	**Jan. 18, 1904**
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906

Wireless Telegraphy.—A Reuter telegram from Melbourne states that the Marconi Company has established wireless telegraphy between Queenscliff (Victoria) and Devonport (Tasmania) across the Bass Strait, congratulatory messages having passed between Lord Northcote, the Governor-General of Australia, and Sir Gerald Strickland, Governor of Tasmania.

Lectures on Meteorological Subjects.—Following their practice of last year, the Council of the Royal Meteorological Society have again appointed Mr. William Marriott to act in co-operation with scientific societies, &c., in various parts of the country, by giving lectures, illustrated by lantern slides, on subjects connected with meteorology. The society are also willing to make arrangements for lending selections from their valuable collection of photographs, drawings and diagrams, and various instruments used for meteorological observations for exhibition at gatherings of local scientific societies or similar occasions. Full particulars can be obtained from the Assistant Secretary, 70, Victoria-street, Westminster.

Earthquakes and Electric Supply Mains.—A correspondent has written to us calling attention to a statement which appeared a short time ago in the daily Press to the effect that Sir Norman Lockyer had attributed the great destruction of property by fire in San Francisco to the breaking of the electric light mains by the earthquake, and crediting him with the remarkable suggestion "that directions be posted up in all electric generating stations in this country to switch off the current in the event of earthquakes." Our correspondent very rightly points out that although the earthquake did sever the mains in many cases with no worse result than plunging several districts in darkness, it also severed the gas mains, and it was the gas escaping into the houses which led to many of the explosions and fires.

Obituary.—We regret to record the death, by his own hand, at the age of 43, of Prof. Drude. A native of Brunswick, he early showed promise as a physicist when a student at Göttingen. A series of Papers from his pen appeared in *Wiedemann's Annalen* in 1896-9, in which he applied the electromagnetic theory of Maxwell as developed by Herz to the problems of light. These researches were afterwards embodied in his work on "Physics of the Ether," and his text book on optics deservedly ranks as a standard work on the subject. In 1900 he succeeded Wiedemann in the editorship of the *Annalen der Physik*, and last year he was appointed professor of physics in Berlin on the occasion of Prof. Warburg becoming President of the Reichsanstalt. His decease is a serious loss to the University of Berlin and to physical science in general.

The British Association.—The following Papers and discussions relating to physics have been arranged for Section A (Mathematics and Physical Science) of the British Association at the forthcoming meeting at York.

"The Evolution of the Elements," by Prof. Soddy. "The Nature of the Radiation from Incandescent Mantles," by J. Swinburne, on which subject Dr. H. Rubens, of Charlottenburg, will also speak. "The Internal Structure of the Earth as Indicated by the Phenomena of Radio-activity," by the Hon. R. J. Strutt, on which Prof. J. Milne will also speak. "Osmotic Pressure," by the Earl of Berkeley. "Chemical and Electrical Changes Induced by Ultra-violet Light," by Sir Wm. Ramsay and J. F. Spencer. "Photography of Thin Liquid Films," by H. Stansfield. "Photographic Records of a String's Vibrations and Responsive Motions in the Air," by Prof. E. H. Barton and J. Penzer. "The Production of a Conducting Glass," by C. E. S. Phillips. "Entoptic Vision," by Prof. W. F. Barrett. A number of mathematical Papers are also down for reading.

A Thermo-electric Method of Measuring Small Alternating Currents.—J. K. A. Wertheim-Salomonsen describes in the *Physikalische Zeitschrift* a method of measuring small alternating currents which is an improvement on the thermo-electric method originally proposed by Klemencic, in which the current to be measured heats a series of thermo-junctions connected to a galvanometer. In order to get over the difficulties introduced by possible asymmetry of the waves and variations in the contact resistance of the junctions, the author connects up a group of iron-constantan wires in Wheatstone's bridge form and accurately balances the resistances of the two branches which contain an equal number of junctions. Alternate junctions are made with plates with large cooling surface and fine wires to make the difference of temperature as much as possible. It is found that the deflection of the galvanometer is proportional to the square of the current and currents of the order of 2×10^{-5} amperes can be measured.

Electric Mining Locomotives.—A recent number of the *Engineering and Mining Journal* has an article descriptive of the latest developments in electric mine haulage. The usual modern American mining locomotive weighs from five to seven tons, and is provided with a reel carrying about 600 ft. of flexible insulated cable. In the main entries and parts of the mine where there is plenty of headroom, the locomotive works with an overhead trolley in the usual manner, but in shallow parts of the mine the trolley pole is lowered and the end of the cable attached to the trolley wire. The locomotive can then proceed to the working face, paying out its cable as it goes. On picking up its load, the cable is rewound on the reel, which is now positively driven from the locomotive axle by a chain. For heavy work in mines of considerable length, locomotives weighing from 20 to 25 tons are required. It is found that with a fairly heavy rail a four-wheeled 20-ton locomotive is quite practicable, but in the majority of cases a pair of locomotives in tandem is preferable, the four motors being of course controlled by a single controller.

An Electromagnetic Thermostat.—An American patent has recently been issued to Prof. Elihu Thomson for a method of utilising the change in the magnetic permeability of certain alloys for the purpose of temperature indication and regulation. A solenoid, energised by current from a battery, serves to set up a magnetic flux through the core which is made of a sensitive alloy, so that with constant excitation of the winding the magnetic flux through the core will undergo a substantial change when the temperature of the core reaches the critical temperature of the alloy. These changes in magnetic flux are used to change the position of the armature, thus opening or closing the local circuit through a motor which in turn performs such operative acts as are necessary to secure any desired temperature regulation. It is stated that a satisfactory alloy is obtained by using substantially 75 per cent. copper, 24 per cent. of an alloy of manganese and aluminum combined in their atomic proportions, and 1 per cent. of lead, as this gives an alloy the permeability of which changes at approximately 60°C.

The Irish International Exhibition, 1907.—Some considerable progress has already been made with the preparations for the International Exhibition, which is to be held in the summer of 1907 in the Herbert Park, Ballsbridge, Dublin. The buildings are well advanced, especially the Central Hall and Power and Machinery Section. The area of the machinery building is 90,000 sq. ft., and several other large buildings are to be erected. The Power Section will include the generating plant for the supply of light and power to the buildings and grounds. Provision has been made for a large display by electrical engineering firms, and it is to be hoped that British firms will respond heartily to the opportunities offered. An official statement as to the progress of the arrangements was made by Mr. J. Shanks, chief executive officer, at a luncheon, which was given to Press representatives and others on Tuesday last. This statement shows the progress effected in regard to the enterprise to July 17th. Other literature that is now ready contains particulars of the inception of the exhibition, and some interesting notes concerning the district where the show is to be held.

A Two-car Train Control System.—According to the *Street Railway Journal*, a somewhat novel arrangement of train control is being adopted at Columbus, Ohio. Two-car trains are used, but only one is provided with a multiple unit control equipment. The rear car has ordinary direct acting drum type series parallel controllers and the motor circuits of the two cars are connected by seven-wire flexible cable connections. Each car is equipped with two motors, but the forward car of the train is provided with a General Electric four motor multiple unit equipment. The wiring of the multiple unit controller is identical with that of an ordinary four-motor equipment, with the exception that the leads for the two motors on the rear car are taken in a multiple "'bus line" extending the full length of the car, and terminating in receptacles at each end. On the rear car, wires leading from the receptacles at each end are taken to the motor leads, but no other change is made from the usual plain controller wiring. It is thus possible to drive either car singly from either end or drive the whole as a two-car train from one of the multiple unit master controllers. The chief advantage of the employment of the two different kinds of controllers is that the extra expense of installing a multiple unit controller on the rear car is avoided.

Electrical Installation at the Royal Victoria Infirmary, Newcastle.—The electrical equipment of the newly opened infirmary at Newcastle is a good example of a complete hospital installation. The whole of the wiring is run in screwed steel tubing of which there is over 100,000 ft. in the building, all fixed out of sight. The fuses are all symmetrically arranged on distributing boards, of which some 65 are placed at various parts of the building. A special arrangement of emergency lights for the operating rooms has been provided on McGilvary's patent system in which an emergency light supplied by accumulators is automatically switched on in the event of the ordinary supply failing during an operation. The lifts, fans, kitchen, laundry and dispensary machinery are all electrically driven from an entirely separate circuit at 480 volts. A very complete telephone service has been installed and a system of gongs is provided which all ring simultaneously in various parts of the building upon which certain code signals can be sounded if a particular person is urgently wanted. There is a full equipment of electro-medical appliances which are supplied for the most part from a motor generator giving a lower voltage than the supply mains, but in some cases the batteries for the emergency lighting of the operating rooms are used for this purpose. Other electric items include a lamp signalling arrangement in the out-patients' department, by which the doctors can summon the patients when they are ready to see them, a complete bell installation and a system of electric clocks. Messrs. Dolby & Williamson were the consulting engineers, and the work was carried out by Messrs. Falconar, Cross & Co., of Newcastle.

Imperial Cables.—The experience gained during the working of the "all-British" Pacific Cable has not deterred the Chambers of Commerce of the Empire (whose sixth annual congress was held in London last week) from passing the following resolution, on the motion of the Montreal Board of Trade :—

> That the Imperial Government be asked to devise means whereby cable and telegraph news to and from all parts of the British Empire shall be furnished entirely through Imperial channels.

The Chamber of Commerce of Georgetown, Demerara, also proposed a resolution, which was approved, as follows :—

> That, having regard to the constant interruption of the cable communication with and between our West Indian Colonies, and to the extreme importance of an all-British cable, the Imperial Government be asked to assist the Colonies in providing an all-British and reliable means of cable communication through Canada to the West Indian Colonies.

As these "constant interruptions" are due to volcanic causes, it is difficult to understand how an all-British cable would bring about any change in the position. Except for these volcanic troubles there is very seldom any difficulty in maintaining communication with the existing cables.

According to a report in the *Standard*, Sir Sandford Fleming is responsible for a statement that—

> The Empire cables to complete the globe girdle would cost about £5,000,000. As to who should bear the cost is matter for negotiation, and, as to the return to be expected, ordinary messages would be transmitted at low rates during 12 hours out of the 24, and would yield a revenue considerably more than sufficient to cover all working expenses. The cables would be at liberty during a number of hours every day to transmit regularly free Press messages.

A Torsion Meter for use on Turbine-driven Steamships.—A Paper on "Turbine Machinery," by S. A. Everett, published in the *Proceedings* of the South Wales Institute of Engineers, describes a form of instrument due to Messrs. Denny & Johnson, which is being used on board turbine steamers to measure the power transmitted from the turbines to the propellers by observing the torsional deflections of previously calibrated portions of the main shafts. A light gunmetal wheel is fixed to each extremity of the length of shaft whose torsion is to be measured, and a small permanent magnet with a V-shaped projecting pole is carried by the periphery of each wheel. Beneath the magnets and concentric with the wheels and shaft are two fixed segmental inductors, each of which carries a number of separate windings equally spaced in a row concentric with the shaft and each on its own soft iron core. The whole is mounted on a gunmetal stand with levelling screws. One end of each coil is connected to one of a series of contact studs to which connection can be made through a dial switch. Included in each of the circuits is a variable resistance, by which the strength of the current may be adjusted, and one of the windings of a differentially wound telephone receiver. Thus at each revolution of the shaft, supposing no power were being transmitted, a current impulse would be induced in the end or zero winding of each inductor simultaneously, and these passing in opposite directions through the telephone windings would neutralise each other, provided that the resistances were correctly adjusted. When, however, the shaft transmits power, the zero winding of the inductor nearer the turbine is excited in advance of the other by the amount of the torsion of the shaft and a loud ticking sound is heard. One of the contact arms is then moved from stud to stud until silence is again produced, when the reading of the scale opposite the contact arm indicates the torsional deflection of the shaft. In another form of the instrument two single inductor windings are used, one of which can be adjusted as to its position in a segmental guide by a micrometer screw. The apparatus has been extensively used in trials of turbine steamers and an average accuracy of 99 per cent. has been obtained.

The Signalling System of the New York Central Railway.—The new block signalling to be installed on the electrified portion of the New York Central, which is described in the *Street Railway Journal*, presents some points of interest. The system adopted is entirely electric. Alternating current is used for track circuits in connection with reactance bonds, permitting the passage of the continuous propulsion current freely through both of the running rails, while preventing the flow of the alternating current which is used in signalling. Power will be obtained from the main generating station through transformers in the sub-stations which will deliver current at 3,000 volts 25 cycles into the signal transmission line, and motor generators, which can be driven off a battery, are to be provided in event of a failure of the main supply. For the operation of signal circuits, signal motors, indicators, and signal lighting, the 3,000 volt current is stepped down 50 volts through transformers placed on signal bridges or transmission line poles. For track circuit operation the voltage depends on the length of track circuits, and varies from 1½ volts for circuits of 200 ft. to 8 volts for circuits of 5,000 ft. The reduction from 50 volts to the track voltage is made by a transformer provided with four taps, which will permit of one type of transformer being used on all track circuits. The blocks vary in length from 1,200 ft. to 3,200 ft., and a distant signal is provided for each home signal. There are three types of track circuits. Where they are 500 ft. or less in length, and where the drop in potential in the length of the track circuits is not greater than 50 volts, one rail of the track is given up for signalling purposes. There being no continuous current on the signal rail, it is not necessary to use any reactance bonds. On all track circuits over 500 ft. in length the two-rail system is used, and both track rails are employed for the return of the continuous power current. On all of these circuits it is necessary to use the reactance bonds, by which the connection is made around the insulated rail joints, permitting the continuous current used in operating to pass, while impeding the alternating current used for track circuit work. On track circuits between 500 ft. and 1,600 ft. in length the two-rail system is also used, and the reactance bonds consist of a copper bar 1 in. in cross section and 30 ft. long, coiled in eight turns around an iron core and enclosed in watertight cast-iron cases. The track relay is of the induction-motor type with two field coils. One coil is energised by the 50 volt signal-operating current which gives the greater part of the energy required to magnetise the fields and armature. The other coil is energised by the current from the track rails, and this current need only be strong enough to give sufficient magnetism to rotate the armature. Especially hard carbon is used for the fixed point of the contact. The point and signal motors are worked by continuous current at 150 volts, furnished from storage batteries charged by motor-generators from the 3,000 volt signal transmission line.

Lightning Arresters.—Amongst the Papers read at the Milwaukee Convention of the American Institute of Electrical Engineers were three Papers dealing with the subject of lightning arresters. One, by Mr. F. Osgood, related to actual experiences with the use of the multigap type with and without series resistances on a 33,000 volt circuit. These experiences would seem to indicate that it is the resistance in series with the gap which causes the greater obstruction to the lightning discharges, rather than an increase in the number of the gaps themselves. It is expected that much trouble will be eliminated by placing a resistance in shunt with a portion of the gaps. It seems advisable, also, to change the arrangement of the high-potential coils of the transformers from the present delta connection to a star formation, and to ground the neutral points. The second Paper, by Mr. Wirt, outlined some features of the shunt resistance type of arrester. The theory of the operation of this arrester is that the cylinders are charged up electrostatically, with sufficient voltage so that the gaps are broken down in succession, passing the charge along from cylinder to cylinder and discharging the whole series practically instantaneously. At first the arresters were installed without any resistance, but shunt resistances were added. Laboratory tests have shown that the low-voltage, moderate-current discharges go through the series gaps and resistances, and the large-current, high-voltage discharges go through all of the gaps. The proper adjustment of series and shunt gaps must be determined by actual service tests. The character of the metal used has much to do with the amount of dynamic current that will pass through the arrester after the static discharge. With the best alloy a reduction of 10 per cent. to the number of gaps could be made compared to the number required when ordinary brass rods were used for the cylinders with the same dynamic current. There is reason to believe that considerable effect is exerted by the electrostatic capacity of the entire transmission system—not only from lines to ground, but also from line to line, as shown by the discharges through multiplex arresters from line to line without any discharge to earth. At all times during the operation of a system there is a condenser effect, and the line voltages resulting therefrom are apt to be greatly above the voltage of the generator. The lightning disturbance charges up the system electrostatically and the excessive aggregate voltage causes a discharge to pass. This discharge may occur on the lines outside a station, making a short-circuit and causing a surge of dynamic current which in turn breaks down apparatus at the station; so that, although there would appear to be only a remote connection between the high voltage manifestation in the apparatus and the short-circuit on the line, one is really a consequence of the other; or the discharge may take place from line to ground, thereby setting up high static stresses between line and line in the station, or anywhere else in the system, and giving rise to high-voltage oscillations. From the above considerations it is apparent that an arrester must be able to take disturbances of both high and low frequency and of considerable current capacity as well. The third Paper was by Prof. E. E. F. Creighton and treated with methods of testing arresters and dielectrics. In testing arc-extinguishing quality the first requisite is sufficient power to sustain an arc over the simple multigaps used. The second is a ballistic wattmeter to measure the energy lost per stroke. The third requisite is a suitable set of resistances to use in parallel or series with the multigaps. The fourth requisite is a synchronous switch. This synchronous switch consists of a rotating insulating arm carrying a conductor which sets off the static spark at any desired point of the E.M.F. wave. This arm is carried by either the generator shaft or an auxiliary synchronous motor. By this means the discharge which follows the static spark has been studied. Starting with the zero value of the E.M.F. no current follows the spark. With twelve gaps in series on a 2,400 volt circuit it is possible to increase the E.M.F. wave to a considerable percentage of the maximum value before the line current begins to follow the spark.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, July 24th.
Iron and Steel Institute.
10:30 a.m. Summer Meeting, in conjunction with the American Institute of Mining Engineers, at 25, Great George-street, Westminster, London. Visits to works will be made in the afternoon.

WEDNESDAY, July 25th.
Iron and Steel Institute.
10:30 a.m. Summer Meeting continued. Visits to works will be made in the afternoon.

THURSDAY, July 26th.
Iron and Steel Institute.
10:30 a.m. Summer Meeting concluded. Visits to works will be made in the afternoon.

FRIDAY, July 27th.
Iron and Steel Institute.
7 for 7:15 p.m. Annual Dinner at the Guildhall, London.

SOME CAUSES OF ERROR IN PHOTOMETRY.

BY LANCELOT W. WILD.

Few photometrists properly appreciate the importance in photometry of the elimination of angularity errors. Such errors are in many forms of photometer very much greater than is generally supposed, and are not by any means entirely overcome by making a double balance and the employment of a comparison lamp.

In general the art of photometry may be said to consist in judging the illumination of two contiguous surfaces, each being lighted from a separate source. A perfect screen may be defined as one which appears equally illuminated at no matter what angle it is viewed, the illumination being also exactly proportional to the cosine of the angle from the perpendicular at which the light rays strike its surface. It is hardly necessary, however, to say that such perfect screens do not exist outside the domain of mathematics.

Variation of Illumination with Angle of View.—That the apparent illumination of a screen varies slightly with the angle of view is no doubt well known. That this variation depends greatly upon the nature of the surface is also well known. As to the effect upon photometer screens, however, there is little information available. The following test, carried out on a Bunsen disc, will, however, serve to illustrate the magnitude of the errors that are likely to occur.

A Bunsen disc was set up between two incandescent lamps. The disc was then viewed at various angles and one of the lights shifted till balance of illumination was obtained. The apparent candle-power of the moving lamp at the various angles of view was found to be as follows:—

Angle of view.	Candle-power.
20 degrees from perpendicular	9·0
30 ,, ,, ,,	9·4
40 ,, ,, ,,	9·7
50 ,, ,, ,,	9·9
60 ,, ,, ,,	10·0
70 ,, ,, ,,	9·5

It would appear from these tests that, in the case of this particular screen, the best angle of view is at about 50 to 60 deg. For very accurate work it is advisable to fix the angle of view fairly accurately. This can be done in two ways, first by using a couple of plumb lines in the centre of the field of view, or better still, by viewing the disc through a longish tube.

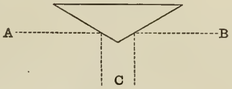

FIG. 1.

Errors Due to Side-play of Carriage.—There are several forms of photometer screen in general use in which the two surfaces to be illuminated are inclined in opposite directions, the light rays from the lamps falling upon them at a considerable angle from the perpendicular. The following are well-known examples. The Ritchie wedge, the Trotter screen, the Whitman flicker screen, and the Simmance-Abady flicker photometer. In the first three of these the rays commonly strike the surfaces at an angle of 60 deg. from the perpendicular, the surfaces being inclined horizontally. In the Simmance-Abady photometer the light strikes at an angle of 50 or 55 deg. from the perpendicular, and the surfaces are inclined vertically.

Fig. 1 shows diagrammatically a Ritchie wedge. The lights are at A and B, and the eye of the observer at C. The wedge is generally mounted upon a carriage which can be moved along some form of bar or rails. As the motion of the carriage must be easy, it is impossible entirely to prevent horizontal side-play occurring between the carriage and bar. Now, suppose that the carriage is displaced slightly and is turned through a horizontal angle of, say, 1 deg. The illumination of one surface will be increased and the other reduced. The amount of change taking place on each surface will be proportional to the difference between the cosines of the angles at which the rays strike the surfaces. If, under normal conditions, the rays strike the surfaces at 60 deg. from the perpendicular, then a deflection of the carriage of 1 deg. will increase the illumination of one surface by 3 per cent. and reduce that of the other by 3 per cent., making a total error of 6 per cent. There are very few photometers in use in which the carriage cannot be deflected through this small angle of 1 deg., so the errors involved are perhaps more often greater than less than 6 per cent.

In the case of the Simmance-Abady photometer, the two surfaces being inclined vertically instead of horizontally, there is no error due to side-play between carriage and bar. There will be, however, a considerable error if the wheels of the carriage are not quite true or if the bar is not dead straight. In the tilting form of Simmance-Abady photometer there is a considerable error brought in if the photometer is tilted slightly by inadvertence whilst re-winding the clockwork motor. The tilting scale cannot be easily read closer than to 1 deg., and this displacement will produce an error in the measurement of 5 per cent. This would be 6 per cent. if the rays were to strike the surfaces at 60 deg. from the perpendicular, as in other forms of photometer, instead of striking at about 50 or 55 deg.

When the two surfaces of the screen are parallel and perpendicular to the light rays, as in the Bunsen, Joly and Lummer-Brodhun photometers, side-play between the carriage and bar involves no measurable error, as the two surfaces to be viewed are at all times parallel, and any tilting of the carriage reduces the illumination of both surfaces to the same degree.

Errors Due to Incorrect Alignment of Lights.—Again taking the Ritchie wedge as an example, supposing that one of the lights is displaced horizontally and at right angles to the photometric axis by ½ in., the distance from light to screen being, say, 30 in. This will cause the light rays to impinge upon the screen at an angle of 59 or 61 deg. instead of 60 deg., and will produce an error of 3 per cent. in the measurement of candle-power. If both lights are out of alignment by this amount, the total error involved may amount to 6 per cent. With a Simmance-Abady photometer horizontal displacement is of no moment, but vertical displacement is of great consequence. A displacement vertically of ½ in. in 30 in. in the case of the Simmance-Abady flicker photometer will produce an error of about 2½ per cent., and if both lights are out of alignment as much as 5 per cent.

A displacement of ½ in. either vertically or horizontally is by no means abnormal, when ordinary incandescent lamps with irregular filaments are dealt with. Even if arrangements are made for moving the lamps in all directions with a view to bringing them into exact alignment it is very difficult to judge sufficiently exactly the true photometric centre of the filament.

With a photometer screen so arranged that the rays shall fall perpendicularly upon the surfaces to be viewed, the error due to a want of alignment is quite negligible, a displacement of one light by ½ in. in 30 in. producing an error of only 0·02 per cent., this being the difference between cosine 0° and cosine 1°.

There are to the writer's knowledge but two forms of flicker photometer on the market—namely, the Simmance-Abady photometer made by Messrs. Alexander Wright & Co. and the Whitman flicker photometer made by Messrs. Everett & Edgcumbe. On account of their angularity errors neither of these photometers are sufficiently accurate for laboratory work of the highest class, and the writer would very much prefer to work with a simple Bunsen disc, even when the colour difference between the two lights is as great as between a Welsbach burner and a flame arc lamp. As, however, the use of some form of flicker photometer is advisable where the colour difference is appreciable, the writer some time ago started to investigate the question of angularity errors, and arrived at the following general principles as being desirable in any form of photometry:—

General Principles for the Avoidance of Angularity Error.—The two surfaces to be viewed must be absolutely parallel, so that side play between carriage and bar may affect the illumination of both surfaces in the same direction and to the same degree.

Both surfaces must be normally perpendicular to the light rays falling upon them, so that should either light be out of true alignment the effect upon the illumination shall be negligible.

The surfaces must be viewed through a tube, so that the angle of view cannot become changed to any appreciable extent. A telescope answers the purpose very well.

Bearing these general principles in mind, the writer found that it was not a very difficult matter to produce a flicker photometer that was quite free from angularity errors.

Description of Flicker Photometer free from Angular Errors.—The form of flicker photometer which the writer can confidently recommend for work of the very highest class consists of a special form of Bunsen disc revolved by an electric motor and viewed by the agency of a mirror and telescope. Fig. 2 shows the disc, which is cut out of ordinary white blotting paper and has about half of its surface treated with white paraffin wax, so that half the disc is opaque and reflecting and the other half translucent and diffusing. The disc is revolved on its centre by means of a small 2 volt motor. A small portion of the upper part of the disc is viewed through a mirror and telescope. The arrangement of mirror and telescope is shown in Fig. 3. The object of using a telescope instead of a simple lens is that if no diaphragm is used the eye finds it very difficult to keep in focus on the disc, which, when revolving, shows no detail. As arranged, an image of a portion of the revolving disc is formed, in the air so to speak, inside the diaphragm. The eye-piece is adjusted till the diaphragm appears in focus and thus the eye is automatically focussed upon the revolving disc. Keeping the disc in absolute focus increases the sensitiveness of the photometer and at the same time very greatly reduces the fatigue to the eye.

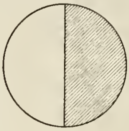

Fig. 2.

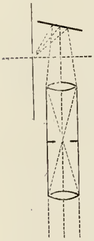

Fig. 3.

A couple of these photometers have been in general use at the Westminster Electrical Testing Laboratory for the past three months and have given entire satisfaction. Their sensitiveness on lights of the same colour is at least as good and probably better than that of any other of the usual forms of photometer. On lights differing as to colour the sensitiveness of course falls off slightly on account of the high speed of rotation required to eliminate colour flicker. The photometers have been tried tilted as much as 10 per cent. out of truth and with one or both lights as much as 6 in. out of alignment, and, within the limits of experimental error (about ½ per cent.), no angularity error has been found.

The writer will be pleased to show these photometers to anyone interested in accurate photometry.

RECENT RESEARCHES ON ELECTRICAL DISCHARGE.

Spark Discharges.—In a posthumous work by T. Schwedoff,* the relation between potential and spark length is treated by the "ballistic" method of ionic shock, in which the gas is supposed to be ionised independently of any special ionising agent by the electrons which happen to fall through the difference of potential necessary to impart to them sufficient kinetic energy to split up neutral atoms into ions. The electron is treated like a ball of lead falling through a resisting medium of density δ. The electron experiences a frictional resistance, f, depending upon its velocity, u, in a manner indicated by the Newtonian equation

$$f = pu^2\delta,$$

where p is the resistance for unit speed and density. The author arrives at the following differential equation representing the relation between the field h and the spark length l:—

$$\frac{dh}{dl} = -\frac{1}{h_0\lambda}h^2e^{-l/c},$$

where λ is an unknown length, and $c = m/2p$, m being the mass of an electron. Since the expression is always negative, the field curve descends, and since d^2h/dl^2 is always positive, the curve is convex towards the axis of abscissæ. Further, if l is infinite dh/dl is zero. Hence the curve tends towards parallelism with the axis of abscissæ, and the same field strength suffices to break through any thickness. The author puts these results in words as follows: "Since the spark discharge, according to the [ballistic] theory, is produced by the simultaneous action of the potential and kinetic energies [of the electron], one of these forms of energy must increase while the other diminishes. Like a falling lead ball, an electron in the electric field acquires a momentum proportional to the driving force. If the height of the fall, or, in this case, the thickness of gas pierced is sufficiently great, a feeble field suffices to impart considerable energy to the electron. But the force must be very great when the thickness is small—*i.e.*, when the space necessary to acquire a sufficient momentum is not available. But, on the other hand, if the electrodes are placed far apart, the speed does not increase indefinitely. For, as we know, a body falling in a resisting medium ends by acquiring a constant speed, and that occurs when the resistance equals the driving force. Hence, at very great gap distances the electric force required will asymptotically approach a finite value."

If, however, the gap is very small, the electrons do not acquire sufficient momentum to take any perceptible part in the ionisation. As the width of the gap approaches zero, the field necessary for discharge rises rapidly. When the gap is measured by centimetres, the field curve seems to approach the axis of ordinates asymptotically, which would mean that the field is infinite for infinitesimal gaps, but on examining Earhart's curves plotted per microns, it is seen that the maximum field is about 6,400 electrostatic units (192 volts per micron), and this field suffices to split up the atoms into ions without the assistance of any impact.

The curve connecting gap and P.D. is, of course, quite different from the gap field curve. It begins at the origin of co-ordinates, bends towards the axis of abscissæ to about 10 microns, and then makes practically a straight line, in accordance with the equation

$$v = \frac{h_0 l}{1 + \frac{c}{\lambda}\left(1 - e^{-l/c}\right)}$$

This formula is well sustained by all recent measurements.

All the above work supposes that the discharge takes place in a sensibly uniform field, as between large plane surfaces or large spheres. On the other hand, J. Algermissen* has studied the P.D. – gap curves with small spheres and large gaps, and found that the curve, instead of being rectilinear, bends towards the axis of abscissæ—*i.e.*, that the necessary P.D. is comparatively less for large than for small gaps, and that the bending increases as the spheres get smaller. The bending is very perceptible when the diameter of the sphere is 1 cm. Gaps were used up to 6 cm.

The same author† has determined the sparking potentials for very high frequencies of the order of a million per second, obtained from a condenser fed with an induction coil. He calculated the P.D.'s from the dimensions of the circuit, since the Braun tube fails for such high frequencies. He formulates his conclusions as follows :—

1. While with 10^6 reversals per second the ratio of gap length to maximum potential differs but slightly from that for static discharges, especially with large spheres, the maximum potential for a given gap is larger at higher frequencies, and the difference increases with the frequency. (The greatest difference shown in the curves is about 12 per cent.)

2. With frequencies well above a million reversals per second the curve becomes a straight line, except for extremely small gaps, but this straight line does not pass through the origin. Hence the relation between the maximum P.D., P, and the gap-length, F, may be represented by

$$P = a + bF,$$

where a and b are constants depending upon the frequency and the radius of the spheres.

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* *Annalen der Physik.*, No. 5, pp. 918-934, 1906.

* *Annalen der Physik*, No. 5, pp. 1,007-1,015, 1906.

† *Ibid*, pp. 1,016-1,029.

3. While with static charges the curves for the various sizes of spheres are very different, the difference is less at high frequencies.

Experiments with strong ultra-violet light showed but a slight influence at frequencies of 10^7 and under, but a very marked influence (over 50 per cent.) at frequencies of 10^8 reversals per second. This explains why the effect of ultra-violet light on spark-gaps is best observed at very high frequencies. Another effect of ultra-violet light is to make the curve pass very approximately through the origin. This means that a in the above equation becomes zero.

Resistance of Sparks.—John Koch* brings some further evidence in support of the formula characteristic of continuous condenser discharges—

$$V = a + \frac{b}{i},$$

where V is the P.D., i the current, and a and b are functions of the spark-length. This formula allows of a determination of the apparent resistance of the spark-gap R, being V divided by the current i, so that

$$R = \frac{a}{i} + \frac{b}{i^2}$$

The energy developed by the spark in a time, dt, may be expressed by

$$df = Vidt,$$

which was confirmed experimentally by Heydweiller†. But this may also be written

$$df = Ri^2dt,$$

which accounts for some enormous changes of R with slight changes of energy. With oscillating discharges these changes are much reduced.

Calculating R from Thomson's formula for the periodicity, Heydweiller found R = 26 ohms in 1891. Lindemann in 1903 found the value 1 to 3 ohms from the mean consumption of energy. In both cases the resistance in the rest of the circuit was under 20 ohms, and the spark was a short alternate-current arc. Lindemann's formula was

$$E_F = E\frac{x}{x + w},$$

where E_F is the energy consumed in the spark, E the total energy expended, x the mean resistance of the spark and w the resistance in the rest of the circuit. For a spark-gap of 2 mm. and a resistance, w, of 885,000 ohms, Koch calculated a minimum spark resistance of 69,000 ohms. Somewhat similar figures were obtained experimentally by Heydweiller, who found, with a 2 mm. gap and $w = 855{,}000$ ohms, $E_F = 0{\cdot}038$ joule, and $E = 0{\cdot}402$ joule, which gives, by Lindemann's formula,

$$x = 89{,}000 \text{ ohms}.$$

The author concludes: "I must therefore most decidedly adhere to my former statement that the apparent spark resistance is very large in the case of continuous discharges through high resistances, and is of quite a different order of magnitude from the resistance to oscillating discharges through small resistances."

E. E. F.

ELECTRIC BLASTING APPARATUS, WITH SPECIAL REFERENCE TO ITS USE IN COAL MINES.‡

BY W. MAURICE.

(*Concluded from page 491.*)

THE DANGERS OF ELECTRIC BLASTING.

It is claimed, and justly so, that the greater danger involved in the industry of mining—namely, liability to explosion of gas, or coal-dust or a combination of the two, is minimised by the use of electrical means of firing shots. The advantages, from the safety point of view, of electric shot firing have been recognised in every important mining centre in Europe. It has been the rule in Dortmund since 1900 that shots in coal and ripping shall only be fired electrically (or by approved safety fuse), and where the simultaneous ignition of more than one shot is required the electrical method only is permissible. In Austrian, Hungarian and Belgian fiery mines an electric or other approved system is also compulsory.

It does not fall directly within the scope of these articles to discuss the risks of blasting in combustible or explosive atmospheres because these risks are almost entirely referable to the nature of the explosive used. In the view of the writer a sound general impression as to the relative safety of different classes of explosives is indicated in Mr. Axel Larsen's translation* recently published of the well-known researches of M. Bichel, the inventor of Carbonite. Quoting from the eminently practical volume referred to, the strength or "mining power" of explosives is proved to be directly proportional to the quantity of heat and rate of detonation. How far it is influenced by the various quantities of gaseous products, and their composition *at the moment of detonation*, still remains an open question. As to danger in the presence of firedamp, gunpowder, blasting gelatine, Kieselguhr dynamite and gelatine dynamite must be considered very unsafe. The nitrate of ammonia compounds are all sufficiently, the Carbonite varieties pre-eminently, safe. To the various phenomena affecting safety must be added the length and duration of flame. In the case of gunpowder the latter are alone decisive, other elements of danger being absent. The dynamites, on the other hand, exhibit all the undesirable factors. Ammonium nitrate compounds give a longer flame and higher temperature and pressure than the carbonites, hence the greater safety of the latter. There is reason to believe besides that the temperature of the fumes at the moment of explosion also carries weight.

In general safety explosives should show a minimum rate of detonation and a minimum of length and duration of flame at a given pressure; none of these should exceed certain limits, as the detrimental effect of one of them cannot be counterbalanced by the others, however favourable. Thus it is the long contact between flame and gas-mixture which is fatal to gunpowder in spite of its low calorific value. To "detonate" gunpowder even with a detonator is impossible, accelerated combustion, at the best, taking place. The heated gases remain too long in contact with the inflammable gas mixture, and thus, even at low temperatures, ignition is unavoidable.

Explosives containing high percentage of nitro-glycerine detonate very quickly—so quickly that the gas mixture in the (testing) gallery cannot recede in time and is struck by the long flame; although this contact is instantaneous, ignition takes place in consequence of the high temperature.

Passing from these general to the particular dangers of electric blasting, it will be noticed that while the former lie to a certain extent beyond human control, the latter are almost invariably the result of ignorance or thoughtlessness. (One example cited below will, however, show that "accidents will happen" even under the most unexpected circumstances. A considerable number of accidents have arisen owing to want of knowledge as to the extremely sensitive nature and violent properties of fulminate of mercury, which is the essential component of a detonator.

There is an instance recorded of an official shot firer in a mine who withdrew the electric fuse from a detonator cap and then proceeded to poke out "the stuff in the end of the tube" by the aid of a pin. The "stuff" of course exploded, and the official bemoans the loss of one eye or three fingers.

Another accident occurred in the following manner at a colliery where electric shot-firing had recently been introduced:—A number of underground officials were together in their "cabin," engaged in writing their reports. One of them was testing electric detonators through a dry cell and galvanometer circuit. The latter instrument had three terminals, one common, the other two attached respectively to low and high resistance coils. A certain "cap," just tested, gave no deflection on the galvanometer needle, and was therefore inferred to be a bad one. An onlooker essayed to repeat the test, and, assuming that the detonator really was faulty, applied, as he thought, the same test as before. Unfortunately for him he completed the circuit through the low instead of the high resistance galvanometer coils and the detonator "went off." The man lost two fingers. Another operator tested a detonator through a low resistance galvanometer, and, cautious in his way, used a dry cell supposed to be almost exhausted.

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* *Annalen der Physik.*, No. 8, pp. 601–605, 1906.

† *Annalen der Physik.*, No. 19, p. 649, 1906.

‡ From a forthcoming book to be published by "The Electrician" Printing and Publishing Co. All rights are reserved.

* "New Methods of Testing Explosives," by Axel Larsen. Griffin, 1905.

He, too, neglected the important precaution of placing the detonator in an iron tube or otherwise out of harm's way before testing, and as its "bridge" chanced to be somewhat weaker than usual it exploded, and a piece of the copper capsule became embedded in his eye.

Detonator accidents have several times occured owing to a miss-fire charge leaving the mine unknown to the authorities and exploding on private premises, or being found and exploded by persons innocent of their danger.

A considerable number of accidents arising out of thoughtless treatment of detonators have been the subject of official investigation. Many of the rules cited in the section on "Official Regulations" are the direct outcome of actual fatalities.

Those mishaps in which a charge of explosives plays a part are necessarily more serious in their consequences.

Want of space, however, forbids reference to more than one or two accidents of this class. One unexpected fatality occurred some years ago in a stone drift branching at right angles off a main haulage road. In the head end, distant, perhaps, 80 ft. or 100 ft., a shot-firer joined the fuse wires to his firing line, and proceeded to pay out the latter towards the main road at the same time that the workmen were engaged in removing their tools from the working face. On the arrival of the official at the junction of the roads the portion of firing line remaining uncoiled was passed over a set of bare iron electric signal wires. In this act, either the two free ends of the cable, or possibly a bare end of one and an uninsulated place in the other in some way completed the circuit through the signalling battery, and as a consequence the charge exploded, and caused the death of one of the workmen remaining in the vicinity of the shot.

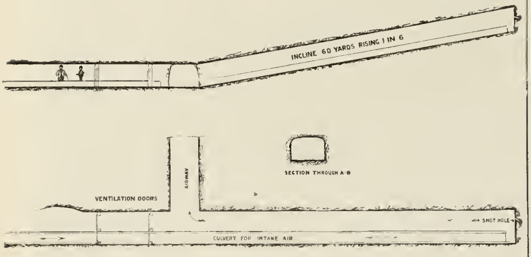

Fig. 23.

Some eight years ago an accident of an almost incredible nature happened in a north country colliery.

It is instanced as evidence of the necessity for extreme caution in those engaged in shot firing. In Fig. 23 will be seen a plan and sections through a heading or tunnel driven in the rock. Two men, father and son, having connected the line wire with a charge, in the head end, placed themselves for safety behind the second ventilation door as shown. The young man, standing with his back to the door, fired the shot and, according to the father's statement, the door opened at the moment he heard the sound of the explosion and his son rolled over dead.

At least 20 serious accidents have arisen through misunderstanding between a shot firer and a fellow workmen. A charge for some reason misses fire. One man goes to seek the cause of failure whilst the other waits by the machine. Some signals will be exchanged and misunderstood and the operator starts to work his machine. The shot unexpectedly goes off and an accident is the result.

Several cases of premature ignition have been caused by the use of a defectively insulated shot firing cable. The latter is necessarily damaged in daily use by falling fragments of stone or coal. Both wires of a twin cable may lose their insulation at the same point and come in contact, thus short-circuiting the line. A charge having failed to explode, the line, if suspected, is examined, the exploder being meanwhile left in circuit. The "short" is found and removed, and the shot exploded in doing so.

Other detonator accidents of more or less common occurrence arise through workmen stemming detonating charges too forcibly, or pulling miss-fire detonator wires out of stemmed holes. Serious accidents have also resulted from workmen having driven pick-points into detonators, whilst in the act of cutting down coal containing a charge that has missed fire.

A word or two may be said concerning reputed hang-fires of electric detonator fuses. The writer has produced the effect of delayed ignition artificially, but as yet he has no conclusive evidence of this phenomenon having occurred in actual blasting operations.

The following records may, however, prove useful for reference :—On the authority of Mr. Harold Bonser,[*] two shot-holes were charged with roburite, and the chargeman, as he thought, fired them simultaneously. He detached the cable, removed the magneto electric exploder, and placed the handle in his pocket. His assistant and another workman then went to examine the place, and to ascertain if the shots had done any work. They halted on the way, about 60 ft. from where the shots had been fired ; they were about to proceed on their way when, to their amazement, one of the shots went off, and only two simple circumstances saved their lives—the halt mentioned, and the fact that it was a breaking-down shot. Mr. J. L. Hedley,[†] speaking on the above case, remarked that he had two cases under his notice where it was said that the detonator hung fire, and that the shot had gone off afterwards, in one case killing a man, and in the other injuring one.

Another instance of an electric detonator fuse hanging fire is recorded by Mr. John Gerrard, in the *Transactions* of the Manchester Geological Society.[‡] A correspondent in *Mining Engineering* related the following incident in the issue of November 13, 1897 :—A competent person was engaged in firing a shot in the coal by means of a battery and cable. He had got all things properly connected, and he tried to fire the shot, but it would not go, so he disconnected the cable from the battery, held it in his hand for a second or two, and then put it down, when to his surprise the shot went off.[||]

A case has also been reported of a charge exploding fully three seconds after the removal of the exploder (an Obach dry cell), but the evidence is inconclusive.

It is, however, no doubt possible for an electric fuse to hang fire momentarily through some defect in the circuit, and not necessarily in the fuse itself. It is well known that a shot will sometimes explode after prolonged turning of the exploder handle, whereas in general less than half a turn will suffice. The delay might be caused by increased resistance in the circuit through broken wires, bad joints, or grease or dirt on spring contacts and terminals, permitting the passage of only just sufficient electrical energy to warm the fuse bridge. The latter has then to be kept heated during several seconds before the temperature rises to the point of ignition of the priming. The same effect would be produced if the exploder were under-powered, owing, for instance, to loss of magnetism. Or delayed ignition might be caused by defects in the fuse, such as badly-mixed, damp, or insufficient priming.

A curious and, it is believed, unexplained accident occurred in the Midland mines inspection district some years ago.

A charge in rock roof failed to fire, and somehow or other passed unnoticed until about a fortnight afterwards, when it is said to have exploded spontaneously and brought down the rock. Other examples illustrative of the dangers with which electric blasting is fraught in the hands of inexperienced operators might be cited to an almost indefinite extent. It is, therefore, not a matter for surprise that blasting in mines has now to be carried on through a bewildering maze of rules and regulations, all of which, unfortunately, have in the past been justified by experience.

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[*] *Trans.* Inst. M.E., Vol. IX., p. 215.

[†] *Ibid.*, p. 220.

[‡] 1893, Vol. XXII., p. 154.

[||] Vol. I., p. 420.

ELECTRO GALVANISING.

The importance of detecting flaws in boiler tubes at an early stage, that is, before any machining or fitting is done on them, was first recognised by the English Admiralty. In this work it was found that electro-zincing greatly facilitates the process of inspection, showing up defects and flaws which could not otherwise be detected. Electro-galvanising is now extensively used, and is superseding hot galvanising for many purposes, having recently made rapid strides in America and Germany. The Thames Iron Works, Shipbuilding & Engineering Co. (Ltd.), of Canning Town, have for a number of years been operating a large electro zincing plant for galvanising a variety of work, principally tubes to Admiralty specification. The plant is illustrated in Fig. 1, which is a general view showing two tanks. The one on the right is 26 ft. long, 6 ft. 6 in. wide and 9 ft. deep, in which pipes of all dimensions can be electro-zinced; the second tank is 20 ft. long 6 ft. 6 in. broad and 5 ft. deep, and is fitted with special arrangements for depositing zinc internally and externally on economiser tubes. The boiler tubes for Admiralty work after being flashed with zinc for the purpose of showing up flaws, are then returned to the galvanising bath, and zinc deposited to a thickness corresponding to 1¼ oz. per square foot. Condenser and economiser tubes are protected with zinc inside and outside. The apparatus employed for this purpose is used in conjunction with the Cowper-Coles regenerative process, which is distinctive from ordinary electro-zincing, inasmuch as the zinc is replenished by means of zinc dust, which is a by-product from the zinc distillation furnaces, instead of by rolled zinc anodes. This is effected by having a filter bed composed of zinc dust and coke arranged in a separate tank, through which the solution is continuously passed by means of a centrifugal pump, the anodes being of lead. When zinc anodes are employed it is found that only a small portion goes into solution, the greater part crumbling away; the adoption of a filter bed prevents the waste that would otherwise take place, as the zinc is caught by the filter and gradually dissolved, and the solution kept free from particles in suspension, which have a very detrimental effect on the deposited zinc. Fig. 2 shows the compound electrode used in this process.

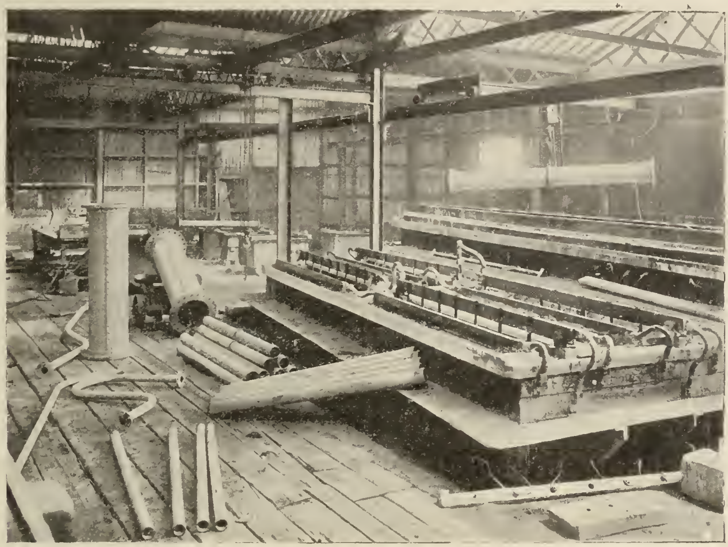

Fig. 1.

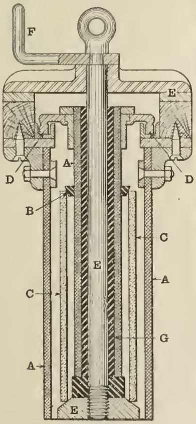

Fig. 2.—Sectional Elevation of Compound Electrode.

A, External and Internal Anodes; C, Tube to be Zinced; B, Insulating Cone; D, Mercury Contact for Internal Anode; E, Negative Connection for Tube; F, Crank Handle for Rotating Tube; G, Insulating Material.

REPORT OF THE COMMISSION OF THE GERMAN GAS AND WATER COMPANIES FOR THE INVESTIGATION OF EARTH CURRENTS.

The work of the Commission has been continued on the same lines as in former years. In the years 1904-1905 work was done by Herr Besig in the towns of Elberfeld, Strassburg, Dresden and Hamburg, and in 1905 1906 he has continued his investigations and measurements in the towns of Freiburg, Erfurt, Stuttgart, Leipzig, Leignitz and Danzig. The present report contains the results of the work done in these last years, together with short details in each particular case, and tables showing the general local conditions. Herr Besig conducted the whole of the work, and the fact that the errors of observation, which are due to the employment of several observers under varying conditions, are in this way as far as possible eliminated, makes the results of considerable interest. It is intended to conclude certain outstanding work in Solingen, St. Gallen and Frankfurt; and experiments will also be made in a town, which has not yet been selected, where the usual gas and water pipes are to be found, but where there is no electrical installation of any kind. As soon as this work is finished, the whole of the reports will be printed in one volume, and will then be accessible to anyone taking an interest in the matter.

The main results are embodied in two tables, which include results obtained in all the above-mentioned towns, with the exception of Elberfeld. The first table gives particulars of the various tramway systems, including the total length of track, sectional area of the rails, number of power stations, maximum current used, and details

Results of Measurements in Rails and Pipes.

	Town and population.	P.D. between pipes and rails.				Fall in volts per kilometre along				Current in pipes.		P.D. between return conductors.	Total fall of volts in network.	
		Pipe +		Pipe −		Rails.		Pipes.					Rails.	Pipes.
		Max. volts.	Mean volts.	Max. volts.	Mean volts.	Max. volts.	Mean volts.	Max. volts.	Mean volts.	Max. amps.	Mean amps.	Mean volts.	Mean volts.	Mean volts.
1	Strasburg i. E. (163,000)	2·8	2·2	11·5	4·0	..	3·3	..	0·3	1·0	0·7	about 4·0	about 8·0	about 1·5
2	Dresden (533,000)	3.3	2·6	3·2	1·8	..	5·6	..	1·8	6·0	4·5	about 5·0	about 8·0	about 3·5
3	Hamburg (747,000)....	0·8	0·4	1·6	0 8	..	..	..	< 0·1	..	< 0·1	0·7	1·5	< 0·5
4	Freiburg i. B. (68,000)	2·0	1·0	2·0	0·6	2·2	1·3	0·7	0·4	..	< 1 0	1·2	2·0	< 1·0
5	Erfurt (90,000)	5·0	3·5	1·8	1·2	5·8	3·3	1·4	0·9	6·8	4·0	4·1	7·0	2·0
6	Stuttgart (196,000)	..	..	3·5	1·5	2 9	1·6	24·0	14·0	1·2	0·8	1·8	2·0	2·0
7	Leipzig (494,000) ..(*a*)	8 0	5·5	2·3	1·2	10·0	8·3	2·2	1·8	1·6	1·3	3·0	8·5	4·0
	(*b*)	1·4	1·1			7·0	6·0					4·0	5·5	
8	Liegnitz (57,0000)	4 0	2·5	1·9	0·8	8·5	5·0	9·2	5·0	3·3	2·5	6·0	6·5	3·0
9	Danzig (159,000)......	2 6	2·0	6·0	2·5	4·9	3·2	5 8	3·5	7·2	5·0	0·7	6·5	3·5

of the arrangement of the return system of conductors. Under this last head is included information as to whether the return conductors are insulated or not, as to whether boosters are used, and as to the size, number and length of the return cables The second table, which we reproduce, gives the results of the electrical measurements, as taken on the various networks, together with remarks as to effects observed on the gas and water pipes.

The effects observed on the networks are noted as follows: In Strassburg there was marked corrosion on gas and water pipes, made of iron, in the danger area and in unfavourable soil. In Dresden frequent corrosion in lead pipes which cross the rails in the danger area. In Hamburg, after the introduction of insulated return conductors, no further corrosion was noticeable; nor was there any corrosion in Freiburg. In Erfurt very marked corrosion in gas and water pipes, made of iron, in the dangerous areas. In Stuttgart corrosion in the water pipes was very irregularly distributed, but was particularly noticeable in the neighbourhood of uninsulated return conductors. In Leipzig, up to the present, very slight evidence of corrosion is visible, but lead pipes have latterly been frequently attacked in the danger zone. In Leignitz signs of corroson in lead and iron pipes are beginning to be noticed in the danger area, and the same remark applies to Danzig.

Passing to the particular cases which have been examined during the past year, the report states that in Freiburg the state of affairs was found on the whole satisfactory; the bonding was in good condition, some new return conductors had been laid in place of older and insufficient ones, and the soil was found to be unfavourable to corrosion. A marked effect was noted in the water pipes at a time when the tramway station was shut down, and this was attributed to the bare middle conductor on the lighting network. One of the oldest German tramways is that in Erfurt. Much was here of a very unsatisfactory nature, but lately improvements, especially in the matter of the installation and insulation of return canductors, have taken place. Still the results have shown no improvement. A curious incident took place when the water pipes were joined up last January to a new reservoir, whereby the water pressure was increased by four atmospheres. This increased pressure produced breakages in the water pipes in 10 places, all of which were found to be included in the danger zone, and all showing marked signs of electrolytic corrosion of the iron. The case in Stuttgart is of interest, owing to the fact that the uninsulated return conductors are specially bonded to the middle conductor of the lighting network, and both are laid in the same trenches. As will be seen from the table, the fall in volts along the pipework is very great, and the corrosion is said to be correspondingly great. The fact that it is not much greater is ascribed to the method which is employed in making the joints on valves, hydrants, &c., by which means a large fall in volts takes place through the insulating packing. Still the corrosion increases from year to year, and this is somewhat remarkable, seeing that in consequence of the connection of the rails to the middle conductor of the lighting network the water pipes are negative to the rails over the whole of the pipe network till close to the power stations. Damp earth is probably in this case a contributory cause, and in Stuttgart there are also two separate sets of water pipes, which run close to one another through all the streets. In Leipzig, there are two tramway companies; the one pursues the policy of good bonding and insulated returns, while the other maintains insufficient bonding and bare returns. Consequently the efforts of the one are neutralised by the apathy of the other. The area over which the pipes are positive to the rails is unusually large; and this possibly accounts for the fact that corrosion has so far been on a small scale; but this probably means that the whole of the pipe network is being slowly eaten away. In Danzig the state of affairs was found to be very unsatisfactory; the rails themselves were strongly corroded, the area in which the pipes were positive to the rails was very great, the bonding was unsatisfactory, and discontinuities of various kinds were noticed owing to defective connection between the rails over swing bridges. Improvements are being made on this system, and although corrosion is evident, it is kept in check by the nature of the soil, which is mostly dry sand. For these experiments, the bond tester supplied by Hartmann and Braun was used throughout, and is considered by the Commission as being the only instrument which combines simplicity and accuracy.

Experiments are also being made with a view to the determination of the maximum allowable fall of potential in the rails and also the maximum that should be observed between the rails and pipes, looking at the matter from the electro-chemical point of view. It is evident that much depends on the local conditions, and on the nature of the soil in particular, and this matter is now in the hands of experts, who have offered their services for the purpose. A preliminary communication on the subject from the pen of Prof. Haber, of Carlsruhe, is printed as an appendix to the present report, and it is hoped that the methods indicated by him may be put in practice in some of the towns which remain to be visited. In particular it is hoped to derive information from the study of the conditions which prevail in the place—yet to be selected—where no electrical installation exists, and where earth currents and corrosions can be examined without external disturbing influences.

SYNCHRONOUS CONVERTERS v. MOTOR GENERATORS.*

BY CLARENCE P. FOWLER.

Although synchronous converters have in the past been largely employed as the connecting link between alternating-current and direct-current networks, yet doubt seems to exist in the minds of some engineers as to whether or not this class of apparatus is as suitable (under some conditions) for the conversion of current as the motor-generator—consisting of an alternating-current motor direct connected to a direct-current generator.

In order that comparison may be made on a common plane, the induction motor-generator set will be assumed to be of the synchronous type. This machine, like the synchronous converter, has the advantage of phase control by variation of field excitation, and this generally tends to improve the power factor of the system to which it may be connected.

The synchronous motor armature will be assumed to be wound for the direct application of the working voltage of the system, namely, 6,600 volts, and will therefore be of the revolving field type.

Efficiency.—In comparing the efficiencies, combined efficiencies will be considered. These will depend upon the total losses of conversion from high-tension alternating current to direct current, which would include the losses in transformers plus losses in converter in one case and total losses in the motor and the generator in the other. Under these conditions the synchronous converter shows quite a percentage gain in efficiency at full load over the motor-generator, the efficiency in favour of the converter becoming more marked at lighter loads, due to the relatively lower copper and iron losses of the latter machine. This better efficiency on the part of the rotary convertor at fractional loads has quite a marked effect in improving the "all-day" efficiency of the plant using this type of machine.

The comparative efficiencies are clearly demonstrated by references to Figs. 1 and 2, Fig. 1 showing the combined efficiency curves for a 500 kw. 575 volt 60 cycle synchronous converter and the equivalent motor-generator, and Fig. 2 giving a similar set of curves for a 500 kw. 575 volt 25 cycle synchronous converter and the corresponding motor-generator set. It is notable in comparing the curves of Fig. 1 with those of Fig. 2 that in the case of the converter designed for the lower frequency the efficiency is somewhat higher than that of the 60 cycle machine, while the motor-generators for the two frequencies are practically equally efficient.

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* Abstracted from the *Electrical World*.

Floor Space and Cost.—Again, taking the two machines of Figs. 1 and 2 as a basis for comparison, the cost per kilowatt of the 500 kw. 60 cycle, 575 volt converter and lowering transformers would be $15·50, while that of the motor-generator for the same output, frequency and direct voltage would be $19. For 25 cycles the relative costs would be $16 for rotary and lowering transformers, while for motor-generator the cost would be $20. As regards the floor space occupied, the motor-generator has the advantage over the synchronous converter with its lowering transformers, although this objection vanishes and actually turns in favour of the rotary if the transformers be mounted on a superstructure such as a gallery, as is found in some of the more modern installations.

Inherent Regulation and Voltage Control.—With the synchronous converter, any voltage disturbances which occur on the alternating current system are obviously reproduced on the direct-current side, which could not occur with the motor-generator set provided the impressed alternating voltage does not drop to the point at which the motor falls out of step, and, it might be added, that some engineers' specifications are now calling for synchronous motors which shall not fall out of step when the impressed voltage falls as much as 15 per cent. under full-load conditions on the direct-current side of the machine.

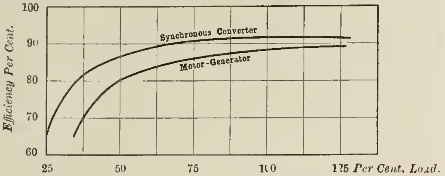

FIG. 1.—EFFICIENCY CURVES OF 60 CYCLE MACHINES.

For railway service, where voltage regulation is not as exacting as with lighting, it is usual with converters to depend upon automatic compounding by the aid of a series field winding in conjunction with an amount of reactance inserted between the rotary and its source of supply. With the closer regulation necessary in the operation of rotaries for lighting purposes, it is usual to have some device such as the induction regulator, which can be controlled by hand and which permits of variations of the applied alternating voltage over a wide range in a gradual manner.

With the motor-generator, however, the direct voltage bears no fixed ratio to the alternating voltage, and the former can, therefore, be gradually varied over a wide range by simple shunt field control of the direct-current generator. This method of control presents considerable advantages in simplicity over the one just cited for synchronous converters.

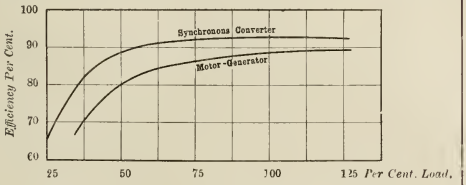

FIG. 2.—EFFICIENCY CURVES OF 25 CYCLE MACHINES.

Overload Capacity.—Owing to the neutralising effect of the alternating and direct currents in the converter armatures, there results a low copper loss for this type of machine, and, since the heating is reduced, the output may be increased as compared with the same armature forming part of a continuous-current generator. This low copper loss on the part of the converter becomes more marked as the number of the phases increases, as might be expected, owing to the greater distribution of the leading in taps on the alternating-current side of the armature, as well as to the increase of the average length of time when an alternating-current tap to armature winding will have the same angular position as the brushes resting on the commutator, thereby reducing the effective length of the path through which current must flow before finding an outlet on the direct-current side.

Table I.—*Relative Armature Heatings for Same Load.*

	D.-C. Gen.	Three-phase converter.	Two-phase converter.	Six-phase converter.
(H)	1·00	0·555	0·37	0·26

Table I. gives the relative heating (H) of the same armature used as an ordinary direct-current generator, and also when the same machine is used respectively as two, three and six-phase converters at unity power factor, the heating of the direct-current generator being taken as unity.

Table II.—*Relative Ratings for Same Heating.*

D.-C. Gen.	Three-phase Converter.	Two-phase Converter.	Six-phase Converter.
1·00	1 34	1·64	1·96

The heating being proportional to the square of the current and as the output is proportional directly to the current, for the same heating the relative rating by armature heating can be obtained by multiplying the rating of the direct-current generator by $1/\sqrt{H}$ from which is derived Table II., in which the rating of the direct-current generator is taken again as unity.

It is seen, therefore, that for a given amount of copper and iron the converter is quite superior in output to the generator and especially to the motor generator.

Further, the amount of load that may be carried by the converter is not dependent upon the mechanical torque, as there is no transference of mechanical power from the alternating current to the direct current side as would be the case with the motor-generator set, the maximum load on the former type of machine being limited by the heating of the armature conductors.

Methods of Starting.—The synchronous converter and the motor generator set are about on a par as far as starting characteristics go, neither being self-starting without considerable disturbance to the system, and in order that they may be started each requires some form of auxiliary starting device, such as a motor, or provision must be made for starting from the direct-current end, which requires some initial source of direct current when the sub-station is to be started up after having been completely shut down.

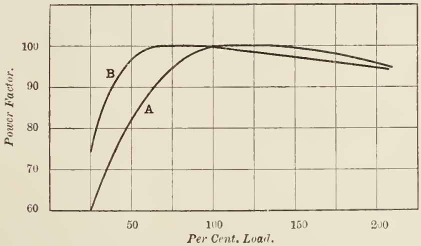

FIG. 3.—EFFECT ON POWER FACTOR OF ADJUSTMENT OF SERIES FIELD CIRCUIT OF SYNCHRONOUS CONVERTER.

Hunting.—The tendency on the part of the rotating members of synchronous apparatus to alternately speed up and slow down is found to some extent with both types of machines. In the case of synchronous converters, anti hunting devices in the shape of heavy copper grids have been effectively applied without undue eddy-current loss. With motors wound for the direct reception of high voltages with few slots, the use of such expedients becomes prohibitive, owing to the excessive eddy-current losses The tendency to hunting increases with the higher frequencies.

Power Factor.—The synchronous converter has no appreciable torque upon its shaft, and, with constant field strength, the power factor is practically independent of the load on the direct-current end.

As before stated, it is usual in railway practice with converters to use series coils with reactance inserted in the alternating-current leads. When the amount of the reactance is properly chosen, and care is exercised in adjusting the current in the series field coils by the use of a shunt resistance, the power factor may be held quite high over a wide range of load at constant potential. Thus it is possible to obtain the results shown by the curves of Fig. 3 which give the relation between the power factor and the load with the same reactance inserted, but the series field coils in curve A are shunted to give 100 per cent. power factor at full load, whereas with curve B the series field coils are shunted to give 100 per cent. at three-quarter load. Keeping the power factor constantly high at partial load as in curve B means decreased heating of converter at light load and is an important factor where loads are fluctuating as in railway service.

In the case of the synchronous motor-generator set the state of affairs is different because of the mechanical transference of power from the motor side to the generator side. This is the well-known case of the simple synchronous motor working against a resisting torque, and under such conditions there is a critical load for each field strength which brings the current into phase with the impressed E.M.F., so that for stability of power factor under varying loads on the direct-current generator it would mean considerable adjustment of the motor field to eliminate the wattless component of the current at all times.

Furthermore, if the synchronous motor is excited from the direct-current generator which it drives (which is usually the case), and if this latter machine is over compounded, then under fluctuating loads, an added complication will exist of varying the field on the motor, which will have the effect of producing a rather unstable power factor.

Frequency.—With the motor-generator set, each of the two machines of which it is composed may be designed for its intended purpose, the only condition common to both being the speed, and this is determined by the number of the motor poles, which is not, however, hampered by any consideration of the direct-current generator to which it is connected, and the motor may be designed for operation without any difficulty on circuits of frequencies now largely in commercial use.

As regards the converter, however, quite different conditions exist, since the electrical independence of the alternating current and direct-current sides is lost and the best design naturally resolves itself into a compromise of the features of the component types. At a frequency of 25 cycles per second, the converter shows an excellent performance.

The aggregate output of railway converters, however, designed to operate on 60 cycles per second is now quite large, although manufacturers formerly hesitated to build them. Generally speaking, their behaviour is rather unsatisfactory for the following reasons:—

They have a tendency to hunt, owing to the limited distance between poles, which renders it difficult to design a machine having high armature reaction, which property is conducive to stability of operation. Direct-current generators as ordinarily constructed do not commutate well when operating at speeds which produce frequencies higher than 25 cycles per second, owing to the large number of current reversals per second and the attendant difficulties in commutating. With the high commutator speed necessary with 60 cycle converters there is found to be considerable difficulty in keeping the brushes in intimate contact with the commutator surface—resulting in the necessity for increased brush tension with the somewhat abnormal resultant wear of both the brushes and the commutator.

Due to the relatively short commutator arc between positive and negative brush-holders, the arc of commutation is very limited, so that the machine becomes very sensitive to slight changes in the position of the neutral point, and frequently this condition becomes so aggravated as to cause the machine "to flash over," as might result from the shifting of the magnetic lines of force across the polar arc as a result of hunting troubles. With the crowded brush-holders it becomes much more difficult to replace brushes under operating conditions (should this be found necessary) than would be the case were more space available, such as is the case with the low-frequency type of converters.

Several improvements in detail of design have been applied to 60 cycle 575 volt converters to alleviate some of the above troubles, with varying degrees of success, such as specially designed brush-holders with moving parts of small inertia, which will readily accommodate the brush surface to the swiftly-moving commutator. Also with multiple-wound armatures a large number of balancing rings have been found necessary to equalise the potential generated in the individual armature circuits.

Reversibility.—Although synchronous converters, primarily designed to convert alternating current to direct current, are not best suited to operate as "inverted converters," or for converting direct current to alternating current, owing to their relatively high armature reaction, yet they may be sometimes called upon to temporarily handle this class of service, and, when so operating, the speed of the machine as a direct-current motor is no longer fixed by the frequency of the supply circuit, but depends upon the field strength.

When supplying alternating current of low power factor the field may become so demagnetised as to cause the armature to reach a destructive speed if it is not equipped with a speed-limiting device. A separate direct-connected exciter with under saturated field, whose voltage is very sensitive to changes of speed, may be employed for maintaining the speed at its normal value.

With the motor-generator set, which has two separate fields, obviously any reactions on the alternating end do not in any way affect the strength of field on the direct current end. It is due to this fact that when converting from direct current to alternating current the motor-generator speed is considerably more stable than that of the converter.

Summing up the situation, it would seem that each type of converting apparatus has a field of its own where it can be most advantageously employed. All things considered the converter is advantageous for use in an urban system for supplying power to lamps and motors from a large central station at a moderate frequency, the motor generator showing its superiority when operating from a system having a relatively poor regulation, as in the case of lighting circuits from a long transmission line, and also for furnishing a desirable method of obtaining a direct current for railway service from 60 cycle systems.

THE ELECTRO-CHEMICAL PROBLEM OF THE FIXATION OF NITROGEN.*

BY PROF. PHILIPPE A. GUYE.

(*Concluded from page 502.*)

We may finally call attention to a characteristic feature common to all the methods which have been studied. Whatever may be the method which is adopted, whether with direct current or with alternating current, or with rapid electric oscillations in air in motion, or whether the electric discharges are displaced in space, the arc, in order to be lighted, requires a higher voltage than that which is sufficient to maintain it in a state of stability after it has once been established. It is, therefore, necessary to instal between the source of electrical energy and the arc chamber either a considerable resistance with direct current or one or several induction coils with alternating currents or oscillatory discharges. From a practical point of view, this means that in the arc only a fraction of the nominal capacity of the dynamo can be utilised. With alternating currents, for example, there will always be a considerable phase difference, measured by a power factor which has often a rather unfavourable value. Estimates of installations must take this point into account, since it amounts to an increase in the cost of dynamos, and, therefore, in the cost of electrical energy.

The extended and expensive researches of recent years have, therefore, very greatly simplified the understanding of this problem which formerly was so mysterious. It may be interesting to state what has been accomplished in practice. In respect of the cost, the sources of information are much less numerous than in those which concern calcium carbide and, consequently, cyanamide. The problem of the fixation of nitrogen as nitric acid presents many different features. Nevertheless, several important publications relative to experiments carried out in Norway, on a very considerable scale, furnish very interesting information as regards fixing the cost price of electrochemical nitric nitrogen.

This cost price appears to depend in the first place upon factors easy enough to determine. In reality it is simply a question of provoking a partial oxidation of the atmospheric nitrogen by submitting the air to the action of electric energy and then combining the oxides of nitrogen thus formed with water and oxygen in order to obtain them in the form of nitric acid; by neutralisation with lime we could get, if wanted, calcium nitrate; in Norway, they use an excess of lime and produce a basic calcium nitrate containing about 75 per cent. $(NO_3)_2Ca$ (12 to 14 per cent. N), with about 2 per cent. CaO in excess. It is rare to find a chemical process so simple; the only expenses to be considered are, on the one hand, electric power and, on the other hand, current manufacturing expenses. Finally—an occurrence practically unique in the industrial world—the cost of the raw material is zero, if it is simply a question of preparing nitric acid, and is almost negligible when nitrate of calcium is produced.

Let us examine these different elements one by one.

Electric Energy.—The most favourable results as yet published indicate a production of 900 kilos. HNO_3 per kilowatt-year, measured at the arcs (Eyde and Birkeland). (All the yields are calculated as nitric acid of 100 per cent. HNO_3.) Prof. Haber has calculated a theoretical yield of 1,800 kilos. per kilowatt-year. According to Prof. Witt the quantity of nitric acid obtained at Notodden during last summer amounted to between 500 and 600 kilos. per kilowatt-year. In one of their patents the Badische Anilin und Soda Fabrik mentions that they obtained 650 kilos. At the Société d'Etudes Electrochimiques at Geneva, with extremely simple and cheap apparatus, we have obtained a yield of about 400 kilos. of nitric acid.

It seems then that we may take a production of 500 kilos. HNO_3 per kilowatt-year as being a fair average. This production may be greater or less according to the degree of simplicity of the apparatus employed. Without doubt, the yield will be certainly increased in the future; in reality we are only in the introductory stages of this industry.

Recovery of the Oxides of Nitrogen.—The process of recovery which has been, up to the present, adopted by different experimenters is based on the absorption of these oxides by water. Prof. Witt states that approximately 95 per cent. of the nitrogen oxides thus formed at Notodden are recovered.

In reality the recovery is not so simple as it might appear at first sight, for the chemical mechanism of the fixation of nitrogen oxides by the elements of water is extremely complex.

The author then gives some particulars of the plant at Notodden. Here water is used for the absorption of the nitrogen oxides, though experiments by the Société d'Etudes Electrochimiques have shown that sulphuric acid has a greater power of absorption. A detailed estimate of the costs gives £8. 3s. 5d. as the price per ton of nitric acid, including depreciation and interest at 5 per cent. Similarly calcium nitrate comes out at £10. 14s. 5d. (including packing and transport), or nitrogen at 1s. per kilogramme. Since the value of nitrogen in Chili nitrate is 1s. 3d. per kilogramme, successful competition should be possible.

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* Paper read before the Society of Chemical Industry May 21, 1906. Slightly condensed from the *Journal* of the Society, issued June 30, 1906.

FUTURE PROSPECTS.

If we attempt to compare the characteristic features of the two principal methods of electrochemical fixation of nitrogen, which occupy at the present moment the attention of manufacturers and economists alike, we observe in the first place that the yield per unit of electric energy is superior in the cyanamide process.

Yield in Nitrogen per Kilowatt-year.—With one kilowatt-year electric power we obtain 2 tons carbide = 400 kg fixed nitrogen.* With the same power we obtain 0·5 ton HNO_3 = 111 kg. fixed nitrogen. Nevertheless, the cost price per kilogramme of fixed nitrogen is no higher in the electrochemical nitric acid process (without taking into account an agricultural coefficient for cyanamide):—

Cost Price per Kilogramme Fixed Nitrogen.—By the cyanamide process, carbide at 140fr. a ton = 1·35fr.; carbide at 185fr. a ton = 1·58fr. By the electrochemical nitric acid process, as basic nitrate of calcium = 1·21fr.; as nitric acid = 1·15fr.

PROFIT PER KILOWATT INSTALLED.

(The capital invested for one kilowatt installed is almost the same for the two processes—that is, 200 to 300 fr., or £8 to £12.)

With Cyanamide.—Nitrogen sold at the price of that of ammonium sulphate: 400 × (1·55 – 1·35) = 40fr. = £1. 12s.

With Nitric Acid.—(*a*) Nitrogen sold at the price of that of Chili nitrate: 111 × (1·55 – 1·20) = 38·85fr. = £1. 11s. 1½d.

(*b*) Nitrogen sold at the price of that of nitric acid: 11 × (2·25 – 1·20) = 116·55fr. = £4. 12s. 5½d.†

The lower price of nitrogen in nitric acid is due to the fact that the yield, although smaller in the last-named process, is greatly compensated for by the extreme simplicity of the operations and also inasmuch as it is unnecessary to take the price of raw materials into account. If we consider the matter, it is really impossible to imagine more simple operations than the oxidation of atmospheric nitrogen and the subsequent absorption of the oxides of nitrogen formed. Nitric nitrogen offers in itself several important economical advantages which it is interesting to examine briefly.

To begin with: as regards agricultural needs, it is evident that calcium nitrate, closely related as it is to sodium nitrate, has before it almost unlimited prospects, which are daily increasing. It is already well known that all nitrates of alkalis or of lime are as good manures as the nitrate of soda. In the second place, electrochemical nitric nitrogen has before it an extremely brilliant opening, through its sale in the form of nitric acid, which represents in Europe alone a market of about 200,000 tons. It looks as if it were an economical error in this new industry to supply, in the first place, nitrate of calcium, as is done in Norway, instead of nitric acid. The nitric acid leaves a greater margin for profit as has already been shown. Our principal efforts ought, therefore, to be concentrated on the manufacture and sale of this acid, which would make it possible for the factories to pay off rapidly the capital invested on the initial plants, at the same time perfecting the technique of the processes. It is all the more to the interest of this industry to follow this branch, since the uses of nitric acid are continually increasing and others are to be expected as soon as its price has sunk lower. To continue, as regards the future of the two industries, we think that the development ought not to be considered as that of two rivals in the usual sense of the word.

The principal aim in the development of the nitric industry should be that of the production of nitric acid, at the same time with a view to increasing the yield. It will have consequently before it a very large future, in the manufacture of nitrate.

On the other hand, the cyanamide industry is destined, at first, to be linked with the carbide industry; considering the actual cost price of calcium carbide, it will scarcely be possible to develop this industry anywhere but in the neighbourhood of carbide works, possessing favourable economical conditions; and even then it would only employ the excess of carbide not absorbed for lighting purposes. We have already observed that the sale of carbide for lighting is much more remunerative. If all the circumstances are not especially favourable, the building of large carbide factories, destined exclusively for the manufacture of cyanamide, seems to be more or less hazardous; especially if we take into consideration the diminution in price of nitric nitrogen, which can be considered practically certain to take place in the more or less near future. Other considerations, which will be examined a little later, give further weight to this argument. Although limited in this way, I consider that the field for activity still remains very large.

Finally, I should like to add that it is all the more in the interest of these two growing industries not to consider themselves as rivals, for they can benefit by working hand in hand with a view to a better utilisation of the atmospheric elements—nitrogen and oxygen—as I have already suggested in my lecture before the Société Helvétique des Sciences Naturelles. In the cyanamide industry, the atmospheric oxygen is actually lost; whereas it might be employed with advantage in the manufacture of electrochemical nitric acid, in which the addition of this gas to the atmosphere constitutes a favourable factor in increasing the yield per unit of electric energy. Captivating as the prospects are which are open to these two young industries, it may be well to glance at several exterior factors liable to promote or retard their development. We have just indicated the importance of liquid air in this respect; it is certain that every progress realised in this branch ought to be considered as a factor favourable to the rapid extension of the processes of electrochemical fixation of nitrogen.

A question not less important concerns the production of electric energy, which is indispensable to the extension of these processes. It is certain that the first nitrogen works will make use of this energy at a low price, furnished as it will be by large hydro-electric stations; however, we must not deceive ourselves and certainly not forget that this source of energy is more limited than is generally realised. The hydraulic forces still available, and at the same time favourably situated, reach in Europe a power of several hundred thousand kilowatts—at most one million. Although it is true that they constitute a reserve sufficient to fix a quantity of nitrogen corresponding to a very large part of the present European consumption of nitrates and ammoniacal salts, still they would not be sufficient to meet the larger consumption which we may consider as a certainty in the near future.

Our attention is therefore attracted to the problem of the economical production of energy by means of motors, employing in some form or other (vapeurs, poor gases, &c.) coal power. The progress made in this branch during the last 20 years has been so considerable that we may contemplate its future with confidence.

In this respect, the important industrial researches of Dr. L. Mond seem to me to have indicated the fundamental principles by means of which electric energy will certainly be furnished in the future to the electrochemical industry in countries which do not possess hydraulic power. These methods, based on the recuperation of nitrogen, are doubly interesting in connection with the subject which is occupying our attention. It is, therefore, indispensable that we should pause here for a few moments, less in order to fix the details with which you are already acquainted, than to emphasise the immense future which awaits these processes; and here let me express my thanks to Dr. Mond, and to Mr. Emile Mond, managing director of the Power Gas Corporation, to whom I am indebted for several of the following particulars.

Dr. Mond's system consists in producing gas from gas producers under conditions which permit the recovery in the form of ammonia of the greater part of the nitrogen contained in the fuel and in utilising afterwards this gas in gas engines, which, in their turn, drive dynamos.* In the case of especially powerful producers, moist air is passed through the incandescent coal (up to 2¼ tons of water per ton of coal). This operation ought to be conducted at not too high a temperature. After the gases have been scrubbed in appropriate apparatus, from 60 to 70 per cent. of the nitrogen contained in the coal is extracted as ammonia; this represents on the average 40 kg. of ammonium sulphate per ton of coal. The system is applicable even to combustibles of very inferior quality.† The calorific power of the fuel being approximately 6,786 cal., the heating power of the gas would be 77 per cent. of that of the coal.

From the economical point of view, these most remarkable results may be interpreted by one or other of the following possibilities:—(*a*) Either the combustible gas is reckoned at the ordinary price of general production; in which case the cost price of sulphate of ammonia amounts to 4 lb. per ton (*Journal of Gas Lighting*, 1903). (*b*) Or we may deduct the profit arising from the sale of ammonium sulphate from the cost price of the motive power generated by gas engines; a fact which is distinctly in favour of the gas engine.

If we apply the preceding data to the average conditions in Europe for the production of electric energy in power stations producing several thousand horse-power by gas engines, and if we reckon at £14 per electric horse-power the cost of the outfit, the price per electric horse-power-year would amount to about £3 with fuel at 10s. a ton. The industrial Mond-gas plants which have been built in England realise conditions very similar to those which we

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* Or 280 kg. if the percentage of nitrogen is only 14 per cent.

† This figure is certainly too high; if the production of electrochemical nitric acid is realised on a large scale, the price of this product will become lower.

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* The consumption of gas is 66 cubic ft. per brake-horse-power-hour—*i.e.*, about 71 cubic ft. per electric horse-power-hour.

† Thus with coal of 62·69 per cent. C and 10·42 per cent. ash, it was possible to convert into gas 57·38 per cent. of C, whereas 5·31 per cent. remained in the ash. The gas so obtained contained (in volume):—CO, 11 per cent.; H_2, 29 per cent.; CH_4, 2 per cent.; CO_2, 16 per cent.; N_2, 42 per cent. One ton of the fuel produced 39·59 cubic metres of this gas, saturated with water at 15°C.; its calorific power was 1,317·8 calorific per cubic metre.

have just indicated. The price per horse-power (electric) is, I understand, approximately £2. 15s. a year, with fuel at 7s. a ton.

If we apply this last figure to the cost price of electrochemical nitric acid, as we have already estimated it, the latter would amount to 325fr. (£13) a ton; in which the fixed nitrogen would be 1·58fr. = 1s. 2d. the kilogramme. This is about the price of the Chili saltpetre nitrogen; it leaves, on the other hand, a very interesting margin for the production of nitric acid. If we take into consideration the enormous advantages which the chemical industry will gain in manufacturing these products in the neighbourhood of centres of consumption, we shall be able to appreciate without difficulty the very great interest attaching to the development of these methods.

Their importance is still further enhanced by the possibility of producing ammoniacal salts in enormous quantities, if we remember that the world's consumption of coal is now not far from one million million tons a year.[*] It is scarcely necessary to add that this production of ammonia will furnish the electrochemical nitric acid industry with facilities for producing ammonium nitrate at a low price. This latter, among all the nitrogenous bodies destined for agriculture, is the one which is best adapted to long-distance transport, thanks to its high percentage of nitrogen. At the same time it is the nitrogenous fertiliser par excellence.

The following table shows the percentage of nitrogen contained in the various nitrogenous bodies under consideration:—

	Nitrogen per cent.
Sodium nitrate	16·5
Ammonium sulphate	21·2
Guano	10—15
Calcium cyanamide	14—20
Calcium nitrate	17·1
Basic calcium nitrate (Norway)	13—14
Nitric acid HNO_3	22 2
Nitric acid of 95 per cent.	21·1
Ammonium nitrate	35·0

In the discussion that followed the reading of the Paper, the following, among others, took part:—

Dr. N. CARO remarked that only 800 kg. of 80 per cent. carbide is necessary to produce one ton of crude calcium cyanamide. The cost of nitrogen was put at too high a figure, and the other general expenses were also much too high. Theoretically 1,400-1,500 kg. of nitrogen could be fixed in the form of calcium cyanamide per kilowatt-year; actually the figure is 500 to 520 kg. According to Haber and Muthmann and Hofer only 380 kg. of nitrogen could be fixed by direct combustion, and actually the figure is 140 kg.

Dr. J. A. VOELCKER had not found cyanamide altogether satisfactory as there was a loss of ammonia on keeping. He was more favourably inclined to the calcium nitrate.

Mr. BINGHAM pointed out that although lime was obtainable in Norway and Sweden at 15s. per ton, this was a very special case. He also criticised the figures relating to carbide.

The AUTHOR, in his reply, stated that his figures could be justified, that the cost of carbide as given is practically that of successful works in central Europe, and that, owing to increased cost of extraction, no drop is likely to occur in the price of Chili nitrate.

[ERRATUM.—On page 501 of our last issue, about the middle of last column, for "1,850 kilos HNO_3" *read* "1,174 kilos HNO_3."]

ELECTROLYSIS OF DILUTE SOLUTIONS OF ACIDS AND ALKALIS AT LOW POTENTIALS: DISSOLVING OF PLATINUM AT THE ANODE BY A DIRECT CURRENT.[†]

BY GEORGE SENTER, PH.D.

In the course of several investigations carried out in Nernst's laboratory at Göttingen, incidental observations have led to the conclusion that when oxygen is brought into contact with a platinum electrode in acid or alkaline solution, an oxidising substance is formed in very small amount. The question has also arisen as to whether an oxidising agent is formed under certain conditions when acid or alkaline solutions are allowed to remain in contact with the air in the absence of platinum.

The first observation which bears on these points is due to Wohlwill,[‡] who found that when solutions of potassium and sodium hydroxide are treated with excess of acid and potassium iodide is added, iodine is set free. He was unable to decide whether this result was due to the catalytic action of traces of iron present even in well-purified alkalis, or whether an oxidising substance had been formed.

Wilsmore,[*] in the course of his extended observations on the potentials of concentration cells, found that after oxygen had been led through the anode solution for some time (the anode being of platinised platinum) an oxidising agent, which he regarded as hydrogen peroxide, was formed in the solution, and the oxidation potential simultaneously increased. Bose[†] confirmed Wilsmore's observation that after oxygen had been led through the anode solution for three or four days the oxidation potential of the anode slightly increased—he does not seem to have tested the solution chemically.

Bornemann,[‡] in a recent Paper, has investigated this subject very carefully. He made a series of experiments in which N/10 acids and alkalis were left in contact with oxygen or air for three months: in one series of experiments platinised platinum foil was placed in the solutions. On subsequent testing, it was found that those solutions which had stood in loosely-closed flasks with access of air as well as those which had been kept full of oxygen and tightly closed gave a slight reaction with zinc iodide and starch in acid solution; the results were practically the same whether platinum foil was present or not. None of the solutions gave any reaction with titanic acid, so that the oxidising effect was not due to hydrogen peroxide.

Still more recently, Gräfenberg[§] electrolysed dilute sulphuric acid for some time at potentials below that at which oxygen is evolved, an anode of platinum-iridium being used, and found that on removing the anode and allowing drops of the adhering liquid to fall on iodide of potassium, iodine was set free. From his results he drew the conclusion that under these conditions small quantities of an oxidising substance are formed at the anode.

About a year ago Brislee[‖] published observations which seem to show that considerable amounts of hydrogen peroxide are formed in the anode solution by passing oxygen through it for two or three weeks—a result in direct contradiction to Bornemann's observations. In this connection it should be remembered that the addition of hydrogen peroxide *lowers* the anode potential,[¶] so that its formation would not explain the gradual rise of the oxidation potential observed by Wilsmore, Bose and others.

Some time ago Prof. Nernst suggested to me the desirability of a further investigation of the changes at the anode brought about by electrolysis at low potentials and the experiments here described were made partly in Nernst's laboratory at Göttingen, and partly at the Davy-Faraday Research Laboratory in London. A large number of electrolyses with dilute acid and alkali have been carried out at potentials below that at which gaseous oxygen is evolved (−1·66 volts, taking the potential of a hydrogen electrode in normal acid as zero), and it is shown conclusively that under these circumstances very small amounts of an oxidising substance, which rapidly sets free iodine from hydriodic acid, are produced at the anode. *The substance is not hydrogen peroxide.* It is not *a priori* certain, but very probable, that the oxidising agent is the same as that observed by Wilsmore and Bose; the conditions in the present case differ in that the oxygen is generated in contact with the solution at several hundred atmospheres pressure corresponding to the potential used, instead of being passed through at atmospheric pressure. Further, in the course of the experiments the unexpected observation was made that under the above conditions small amounts of platinum are dissolved from the anode during the electrolysis of dilute sulphuric acid, although the direct current used was very small.

PRELIMINARY EXPERIMENTS.

In the first place, to clear up Wohlwill's results, a few preliminary experiments were made with the object of determining whether pure sodium hydroxide under ordinary conditions contains an oxidising agent (perhaps traces of peroxide). The simplest method of doing this seemed to be to obtain as pure a hydroxide as possible, and therefore a specimen of Merck's sodium hydroxide prepared from the metal was obtained, and a solution was also prepared by dissolving metallic sodium in distilled water in an atmosphere of hydrogen. Neither of these specimens, even after long keeping, gave a blue colour with zinc iodide and starch after acidification with dilute sulphuric acid, so that the result obtained by Wohlwill was doubtless due to impurities (nitrate, &c.). The observation of Bornemann,[**] that a N/10 solution of sodium hydroxide, after exposure to the air for three months, gives a slight blue colour under the above conditions, could not be confirmed.

METHOD EMPLOYED IN ELECTROLYSIS EXPERIMENTS.

The apparatus used in the investigation was similar to that employed by Bornemann and others in Nernst's laboratory. It consists essentially of two cylindrical tubes about 4 cm. in diameter and 50 cubic cm. capacity, joined at their lower ends by a capillary tube. In the middle of this tube is a three-way stopcock, by means of which the anode and cathode compartments can be emptied separately. Even when closed the stopcock allowed sufficient current to pass, and effectually prevented diffusion. The anode compartment is connected by means of a side tube with a smaller cylindrical tube, in which a hydrogen electrode can be placed. A battery of accumulators is closed through an adjustable resistance; from the latter any desired E.M.F. can be tapped off and applied at the terminals of the electrolytic cell. A platinised platinum electrode (3 cm. × 4 cm.) was used as cathode; the anode, of unplatinised platinum, was 170 sq. cm. in area, and was rolled round a glass frame in order to expose as large a surface as possible. The P.D. between the anode and the hydrogen electrode was determined by a compensation method against the accumulator, a sensitive galvanometer being used as a null instrument. The current passing through the electrolytic cellwas measured with a mirror galvanometer; one scale division corresponded to 4×10^{-8} ampere.

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[*] The recovery of the nitrogen, applied to only one-tenth of this consumption, within the limits of the Mond's process, would give about 1,000,000 tons nitrogen per annum—*i.e.*, four times about the actual consumption of nitrogenous bodies.

[†] A Paper read before the Faraday Society on Monday, July 2, 1906.

[‡] *Zeit. für Electrochemie.*

[*] *Zeit. für Physikal. Chem.*, 35, 298 (1900).

[†] *Zeit. für Physikal. Chem.*, 34, 701 (1900); 38, 1 (1901).

[‡] *Zeit. Anorg. Chem.*, 34, 1 (1903).

[§] *Zeit. Anorg. Chem.*, 36, 355 (1903).

[‖] *Proc. Faraday Soc.*, 1 (1905).

[¶] See Gluser, *Zeit. für Elektroch.*, 4, 374, 1898; Bose, *Zeit. Physik. Chem.* 38, 18 (1901).

[**] *Loc. cit.*, p. 26.

In carrying out an experiment the whole apparatus, including the compartment for the hydrogen electrode, was filled with the solution to be electrolysed; the electrodes were then placed in position, both stopcocks closed, and pure hydrogen passed through the small compartment sufficiently long to ensure that the potential had attained a constant value. The current was then allowed to pass through the electrolytic cell, and simultaneous readings of the anode potential and of the current strength were made at definite intervals. The potential of a platinum electrode which has been exposed to the air is approximately 0·9 volts, taking the potential of a hydrogen electrode as zero. In all cases it was found that, on making connection, a relatively large current passed through the cell. This gradually decreased, and at the same time the negative potential of the anode increased, at first rapidly, then more slowly, and finally attained a practically constant value. The applied E.M.F. was so arranged that the anode potential attained its final value at from − 1·4–1·55 volts, and this potential, as well as the current strength, remained practically constant for days. At the end of the electrolysis the anode and cathode solutions were run out separately and examined.

Electrolysis of Dilute Sulphuric Acid.

Numerous experiments were made with the normal acid by the method described above. As the course of such an electrolysis is well known, it is unnecessary to give full details of an experiment; it will be sufficient to mention that the E.M.F. attained a constant value at from 1·45 to 1·55 volts on different occasions, the average current was about 5×10^{-5} amperes, so that the average current-density at the anode was $1{\cdot}5 \times 10^{-7}$ amperes per square centimetre (counting both sides of the electrode). At the end of four or five days, in the majority of cases, the anode and cathode solutions were removed and tested separately with zinc iodide and starch as already described. The results were not absolutely concordant, but in the great majority of cases it was found that a small quantity of iodine was set free, either immediately or within five or ten minutes. Since control experiments with acid which had not been electrolysed gave no blue colour within half an hour, even if saturated with oxygen, it is clear that traces of an oxidising substance had been formed. The investigation of this substance is rendered very difficult owing to the extremely small quantities produced, even after prolonged electrolysis; the amount is always very much smaller than corresponds to the quantity of electricity which has passed through the solution. Thus, in one experiment in which 7 coulombs of electricity were passed through the acid in the course of four days, the amount of oxidising agent formed was less than one-twentieth of what would have been found if all the electric energy had gone to its production.

The oxidising action of the anode solution was only slightly diminished by passing hydrogen through it for 10 minutes before adding the zinc iodide, and boiling the solution for some time had also scarcely any effect. The nature of the substance formed will be discussed after the corresponding experiments with sodium hydroxide have been described.

Tested under exactly similar conditions, the cathode solution also liberates iodine, but only after a much longer interval and to a smaller extent than in the case of the anode solution. This result is due in all probability to the production of a small amount of hydrogen peroxide; the experiments of Traube[*] and others have shown that a certain amount of the latter substance is formed under these conditions.

After the same anode of unplatinised platinum had been in use for a considerable time it was noticed that the anode solution gave a deep reddish-brown colour on addition of the zinc iodide-starch mixture. The same colour was produced in the absence of starch, and it was ultimately found that a small quantity of platinum had been dissolved off the anode and was reacting with the zinc iodide to form the very deeply-coloured platinum iodide. This observation —that platinum in contact with normal sulphuric acid can be dissolved at the anode by a direct current at a potential below that at which oxygen is evolved in gaseous form—is further referred to below.

Electrolysis of Sodium Hydroxide Solution.

In the preparation of the solutions, Merck's sodium hydroxide, prepared from the metal, was employed. The electrolysis was carried out exactly as described for dilute sulphuric acid; in the majority of experiments the normal solution was used. The values of the anode potential and current-density were approximately the same as in the experiments with dilute acid, and the electrolysis was usually continued for five or six days.

In order to find out whether an oxidising substance was produced in this case, 5 cubic cm. of the electrolysed anode solution was mixed with 10 cubic cm. of N/1 sulphuric acid and a few drops of the zinc iodide-starch mixture added. In all cases in which the electrolysis had been in progress for three or four days the solution prepared as above turned blue within 10 minutes, whereas in blank experiments no change was observed in 24 hours. Even after being kept for three weeks in a stoppered Erlenmeyer flask the oxidising power of the solution was not appreciably lessened, nor did boiling for 10 minutes produce any effect. In no case did zinc iodide alone produce a red colour after acidification, so that platinum is apparently not dissolved at the anode in contact with alkali.

Nature of the Oxidising Agent.

The question as to what produces the oxidising action described above must now be discussed. It might be suggested that the effects are due to the traces of dissolved platinum, to hydrogen peroxide or to dissolved oxygen or ozone, and these possibilities will be considered separately. That the results obtained are not brought about by platinum dissolved from the anode seems clear from the observation that electrolysed alkaline solutions, which contain no dissolved metal, have a strong oxidising action. It has further been noticed that some acid solutions containing a relatively considerable amount of dissolved platinum only gave a blue colour after a long interval, whereas others containing no more of the metal turned blue immediately; there is thus no apparent connection between the oxidising power of the solution and the amount of platinum it contains.

As regards hydrogen peroxide, it has been shown by Traube, Bornemann and others that, although this substance is formed at the cathode during electrolysis, there is no evidence of its formation at the anode. I have been able to prove by comparative experiments that the oxidising action in question is not due to this substance. To a solution of N/2 sulphuric acid containing 2×10^{-6} grammes hydrogen peroxide per litre a few drops of the zinc iodide-starch mixture were added, and at the same time a little of the same reagent was added to some of the electrolysed sodium hydroxide solution to which sufficient sulphuric acid had been added to make the mixture half-normal with respect to the latter. It was found that whereas the latter mixture became blue within five minutes, the hydrogen peroxide solution was not appreciably coloured at the end of half-an-hour. On testing with titanic acid in long tubes of clear glass, the hydrogen peroxide solution showed a distinctly yellow colour, whereas the electrolysed solution remained quite colourless. Corresponding results were obtained with electrolysed sulphuric acid solutions.

With reference to the possible formation of ozone, it has been shown by Gräfenberg,[*] and by Luther and Inglis,[†] that a platinum electrode saturated with this gas shows an oxidising potential of 1·66 volts against a normal hydrogen electrode. Since, in the experiments here described, the potential in no case exceeded − 1·54 volts, it is scarcely probable that ozone would be formed in appreciable amount. It might further be supposed that ozone would be driven off by boiling, or by passing hydrogen through the solution, although there is some evidence to show that, at least in sulphuric acid solution, it forms an oxidising substance which is not destroyed under the above conditions.[‡]

As already mentioned, Gräfenberg considered that a special oxidising agent is formed at the anode by electrolysis of dilute acids, but his experiments do not seem conclusive, as the effects might be due to dissolved oxygen. He obtained the best results by taking the anode from the electrolysed solution and allowing the adhering acid to drop on to iodide of potassium starch paper, when a blue colour was immediately produced. It cannot be doubted, however, that that part of the solution in contact with the electrode becomes supersaturated with oxygen which itself sets free iodine from hydriodic acid. The experiments described in the present Paper show, however, that the results are not due to dissolved oxygen.

It seems, therefore, to be proved that a special oxidising agent is formed at the anode under the conditions described. So far this substance has been obtained only in very small concentration, so that it has not been possible to determine its nature. Owing to the irregular character of the results, it is not easy to determine whether it continues to increase in amount with the duration of the electrolysis, but there are indications that it reaches its greatest concentration after three or four days' electrolysis.

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[*] Compare Bornemann, *loc. cit.*

[*] *Loc. cit.*

[†] *Zeit. Physik. Chem.* 43, 203 (1903).

[‡] Compare Jahn, *Zeit. Anorg. Chem.* 48 (1906).

Dissolving of Platinum from the Anode in Dilute Acid.

The experiments with dilute sulphuric acid described above were made with a very pure sample, but in order to make certain that the action on the platinum was not due to an impurity, a number of electrolyses were also carried out with a specially pure, redistilled acid kindly given me by Dr. Scott; the results were exactly similar to those obtained with the former acid.

After a large number of electrolyses had been made with one platinum anode, some experiments were carried out with another electrode of the same size, and it was found that at first less platinum went into solution, but a considerable amount of the oxidising substance was produced; after being in use for some time, however, it was more readily acted upon, like the first electrode. The solvent action thus seems to depend upon the condition of the platinum surface; after having been used for a number of experiments, it is more easily dissolved than a fresh anode.

The amounts of platinum found were in all cases exceedingly small, and could only be detected with certainty by the iodide test. In one case in which the latter gave a very deep colour the solution was tested with sulphuretted hydrogen, and it was found that a just appreciable darkening was produced. Comparison experiments with solution of platinic chloride of known strength showed that after electrolysis for four or five days the whole anode solution only contained from $\frac{1}{20}$ to $\frac{1}{4}$ mg. of the metal—amounts which could only be detected by a very sensitive reaction. In very dilute solutions, the brownish pink colour of the iodide is only developed on standing for a few minutes.

It was shown by Warren de la Rue[*] that platinum is acted upon under the influence of alternating currents, and this point has recently been accurately investigated in Nernst's laboratory by Ruer,[†] but at the time the observations described above were made there was no record that the metal is acted on by a direct current alone. Ruer, for example, could detect no loss of weight at the anode when 66 per cent. sulphuric acid was electrolysed between platinum electrodes with currents from 0·05 to 2·5 amperes. A few months ago, however, Tafel[‡] pointed out that small quantities of platinum are dissolved by dilute sulphuric acid at an oxidation potential of 1·7–1·8 volts, and a current density of 0·007 amperes per square centimetre; as in the experiments described above he was only able to detect it by the potassium iodide test. The results here given show that, with a current density about ($1{\cdot}5 \times 10^{-7}$ amperes per square centimetre) $\frac{1}{50000}$th of that employed by Tafel the same effect is produced, and when these facts are considered in connection with the relatively enormous currents employed by Ruer it is clear that the solvent action on platinum is not in any sense proportional to the current density. A corresponding result has been obtained by Haber[§] for the action of hydrochloric acid on platinum anodes during electrolysis—he finds that the solvent action is promoted by increasing the strength of the acid and decreasing the current density.

The present observations are of importance in connection with the careful experiments of Ruer[§] with alternating currents, referred to above. He finds that platinum anodes are not affected either by direct or alternating currents acting separately, whilst they are dissolved when the currents act simultaneously. In explanation of this behaviour, he suggests that a direct current induces the formation of a layer of a platinum superoxide insoluble in sulphuric acid, this superoxide being reduced by the hydrogen generated by the alternating current to an oxide soluble in the acid. This hypothesis seems no longer quite satisfactory in view of the proof now advanced that traces of an oxide soluble in sulphuric acid are formed by a direct current, but it seems possible that under the very different experimental conditions employed by Ruer a different oxide of platinum is formed, and this may explain the disproportion between the effects of small and large current densities.

Summary and Conclusion.

When dilute solutions of sulphuric acid and of sodium hydroxide are subjected to electrolysis at a potential of 1·4—1·55 volts, and a current density of $1 - 2 \times 10^{-7}$ amperes per square centimetre, an oxidising substance is formed in very small amount at the anode.

The substance in question is very stable, especially in alkaline solution, and is not destroyed by boiling; it is not hydrogen peroxide.

Under the conditions of the experiments with dilute acid, small amounts of platinum were dissolved from the anode; the amount of action seems to depend upon the length of time the electrode has been in use.

The bearing of the results on Ruer's experiments and conclusions with regard to the solvent action of simultaneous alternating and direct currents on platinum anodes are considered.

It seems probable from the results given that when a small electric current is passed through an electrolytic cell, the greater part of the evolved oxygen is occluded by the platinum or diffuses out into the liquid, but the anode at the same time becomes superficially oxidised. When in contact with sulphuric acid the oxide dissolves, but it seems to be insoluble in alkalis, as no platinum can be detected in the latter after electrolysis. As to the part played by the oxidising agent very little can be said until a means has been found of obtaining it in greater concentration. As suggested by Coehn, it may be of importance in connection with the ultimate potential of the anode, or, on the other hand, may be produced by side reactions, and thus not play an essential part in the conditions of equilibrium at the anode.

In conclusion, I take this opportunity of expressing my indebtedness to Prof. Nernst for his kind advice and assistance while I had the privilege of working in his laboratory at Göttengen. I wish further to acknowledge the facilities for the prosecution of this work which I have enjoyed at the Davy-Faraday Research Laboratory.

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[*] Pt. 99, *Annalen*, 46, 439 (1839).

[†] *Zeit. Physik. Chem.* 44, 81 (1903); *Zeit. Elektrochem.* 11, 661 (1905). Compare also Brochet and Petit (*Compt. Rend.* 140, 655 (1905).)

[‡] *Zeit. Physik. Chem.* 52, 349 (1905). [§] *Zeit. Anorg. Chem.* 16.

[§] *Loc. cit.*

ANNUAL REPORT OF THE ELECTRICAL INSPECTOR OF FACTORIES.

We give below an abstract of the Report by Mr. Ram, H.M. Electrical Inspector of Factories, which has just been issued:—

Mr. Ram first discusses at some length the importance of keeping down the capital cost of generating stations and supply systems, so that they may be remunerative, and he remarks that he has observed a tendency to cut down expenditure on capital and attendance to a point involving personal danger. The report then proceeds as follows:—

ACCIDENTS REPORTED DURING 1905.

I.—Accidents at Electrical Stations of Electricity Supply Companies or Local Authorities.

Description.	Non-fatal.	Fatal.
(a) Non-electrical Accidents.		
At engines, pumps and generators	22	—
At boilers and steam plant	28	1
At coal handling plant	15	1
Falls	51	3
Struck by falling bodies	19	1
Miscellaneous	32—167	1—7
(b) Electrical Accidents.		
At switchboards wheu engaged in ordinary routine work. Mostly due to faulty design of apparatus	12	—
Cleaning, repairing, &c., at "live" switchboards	8	—
Cleaning, repairing or other handling of switchboards supposed to have been made "dead":—		
(*a*) Skilled persons	—	2
(*b*) Unskilled persons	—	—
Adjusting brushes	3	1
Miscellaneous	9—32	——3

The mechanical accidents are again such as are to be expected in view of the nature of the work carried on. Those under the first heading are mainly due to the cleaning of machinery in motion, and to the apparently unavoidable practice of engine drivers and others feeling bearings, &c., of machinery to ascertain if they are running cool, where the failure to remove a hand at the right moment involves its being crushed, often with the loss of one or more fingers. Under the second heading three were due to the bursting of gauge glasses on boilers, three to fingers being trapped in the gearing of mechanical stokers, three to burns owing to back draught at boiler furnaces, four to scalds from steam, including a fatal one due to a boiler being blown down while the blow-down valve of an adjacent one in which a man was working was not closed.

Under the third heading four accidents, including a fatal one, were due to coal trimmers being struck by crane grabs.

Falls were again the most numerous of the mechanical accidents, and were due, as I have pointed out in former reports, frequently to the absence of proper fencing in dangerous places, such as along the edges of boiler flues, economisers, coal bunkers, &c., and to the use of loose planks and ladders where properly railed and fixed gangways and ladders should be provided.

The electrical accidents reported are again not numerous, but mostly severe. Of those under the first heading the inju[illegible] were all burns. Nine were due to arcing of [illegible] these from mistakes on the part of the injur[illegible] and six to bad design or faulty apparatus, and [illegible]ficient working space in front of a high-pressure board. one owing caused by the arcing of fuses, one being an oil fuse.

Two [illegible] when working on or close to live conductors are only to be [illegible]ected, and can only be prevented by avoiding the practice altogether. Very often such work is unnecessary, as it could be done at a time when the pressure could be cut off, and in other cases might be made unnecessary by having the board arranged in sections, any one of which could be made dead when required. One of these accidents occurred to a man when examining a live transformer at 6,000 volts from which he had removed ex[illegible] protecting screen. He received severe injuries, including the loss of the fingers of his right hand. Another case shows the danger of the very the [illegible] practice of locating fuses for small instrument transformers in commo[illegible] places where they cannot be got at without danger of coming into contact with exposed conductors at high pressure.

The two accidents under the next heading were both fatal. In one case the victim, though doubtless knowing that if tho apparatus he was at work upon was in order there should have been no danger, was clearly aware that there was some risk in the operation he intended to perform, as he provided a rubber mat to stand on. He did not, however, taking the additional precaution of putting on the rubber gloves which were provided. The apparatus happened to be faulty. He inadvertently stepped over the edge of the mat on to iron floor plating and paid the penalty with his life. The operation was one in which indiarubber gloves could have been used without inconvenience. Indiarubber boots would have been equally efficacious. Incidentally, this case draws attention to the danger of the working floor in front of a switchboard being constructed of metal plates, even though normally covered with indiarubber mats.

In the other case, a misunderstanding arose over a telephone message between a sub-station and a generating station. The switchman at the generating station understood the message to signify that all was clear at the sub-station, whereas it should have been the reverse, as persons were working at the sub-station switchboard. The current at a pressure of 6,000 volts was consequently switched on before those in the sub-station were ready. One man in operating an isolating switch by hand received a fatal shock. Whether the mistake was made at the generating or sub-station end of the telephone, or how it arose, was not satisfactorily cleared up. Although in this case the man had to climb up in order to reach the switch, the accident emphasises the danger of a practice commonly met with of placing sectional or isolating switches, working at very high pressures, where they can be readily touched or operated by hand. They are intended to be operated by means of a hook at the end of a long insulating pole. There is often no reason whatever why the switches should not be placed out of reach, say 8 ft. from the floor, where they cannot be accidentally touched and so that they cannot be worked except by the insulating pole.

The fatality under the heading "adjusting brushes" was again due to neglect of the elementary precaution of wearing indiarubber gloves, in this case when adjusting the brushes of a rectifier working at high pressure. The victim was thoroughly conversant with the danger, having been employed as a shift engineer at the station for some years. The fatal shock was received between his hand, which touched a live metal part of the key he was using, and his body, which was pressing against the earthed metal of the machine. The operation was one which could have been readily effected with gloves on. Rubber boots in this case would not have prevented the accident. The form of key used was no doubt a contributory factor to the accident. It was a kind of box spanner with metal end and insulating handle, which however was tapered towards the metal. There was no guard disc of insulating material to prevent the hand slipping on to the metal end.

One of the miscellaneous accidents was due to the employment of an unskilled person in a dangerous situation. Two others are instructive as showing the fallacy of an argument, sometimes advanced, to the effect that, although certain precautions are admittedly necessary in the case of electrical installations in factories, they are not necessary in similar circumstances in electrical generating stations, because the persons employed in the latter are skilled persons, and know how to avoid danger. The accidents referred to occurred in the generating station of a municipal electrical supply undertaking at the works distribution boards, and were due to short circuits being made between fuse terminals. The fuses consisted of bare wire fixed in screw terminals, the opposite poles being placed only a few inches apart, thereby inviting a short circuit when the fuse wires have to be replaced. The simple expedient of providing a fillet of insulating material between the two poles projecting beyond the terminals, or a switch by which the pressure could first be cut off, would obviate such accidents. In the first case, the short circuit was made by an "improver," and in the second, which occurred a few minutes afterwards, by the shift engineer, who was severely burned about the face, hands and arms. This crude, unreliable and out-of-date type of fuse and dangerous arrangement of the same is very commonly met with and continues to be supplied to new installations.

II.—ACCIDENTS AT PRIVATE ELECTRICAL GENERATING STATIONS.

(a) Non-electrical.

Description.	Non-fatal.	Fatal.
At engines, pumps and generators	8	—
At boilers and steam plant	3	—
At coal-handling plant	—	—
Falls	11	—
Struck by falling bodies	3	—
Miscellaneous	10—35	—

(b) Electrical.

Description.	Non-fatal.	Fatal.
At switchboard, when engaged in ordinary routine work. Mostly due to faulty design of apparatus	2	—
Cleaning, repairing, &c., at "live" switchboards	7	—
Cleaning, repairing, or other handling of switchboards supposed to have been made "dead":—		
(a) Skilled persons	—	—
(b) Unskilled persons	—	—
Adjusting brushes	4	—
Miscellaneous	5—18	—

The mechanical accidents at private generating stations are of a similar nature to those occurring in the stations for public supply, and call for no special remarks.

The electrical accidents at these stations are also not of particular interest. Some appear to have been due to stupidity or ignorance on the part of the injured person. Those due to working on live conductors are often inexcusable in this class of station, as any such work can generally be undertaken after factory hours, when the pressure can be cut off.

III.—REPORTED ELECTRICAL ACCIDENTS IN FACTORIES, ENGINEERING WORKS, &c.

No.	Description.	Non-fatal.	Fatal.
1	(a) Arcing of switches	18	—
	(b) Arcing of fuses	7	—
2	Arcing at fuses, when replacing fuse wires	9	—
3	Unprotected conductors, switches, terminals, fuses, &c.	6	2
4	Faulty apparatus (other than switches)	22	—
5	Working on live conductors:—		
	(a) Skilled persons	17	—
	(b) Unskilled persons	7	—
6	Flashing at motor brushes when adjusting	4	—
7	Electric travelling cranes:—		
	(a) Unprotected electrical apparatus in driving-cage	—	—
	(b) Faulty apparatus	6	—
	(c) Carelessness	3	1
8	Miscellaneous accidents in testing electrical apparatus in course of manufacture	8	—
9	Miscellaneous	11—118	1—4

These accidents have increased by over one-third compared with the previous year, but such increase is perhaps to be expected, owing to the extended use of the current to which I have already alluded. They are of a similar nature to those occurring in previous years, and the observations which I have made in my previous reports are equally applicable.

Those due to arcing of switches, causing often severe burns to the hands and face of the operator, are generally due to faulty design or construction and often to the absence of protection. Those from the arcing of fuses are due to the use of unprotected bare wire fuses generally fixed immediately above the switch controlling the circuit. If there is anything amiss or any fault upon the circuit, the fuses will generally "blow" at the moment of switching on the current; that is to say, when the operator is standing close by. The arrangement is best described as a trap. The operator walks up to it, turns on the switch and receives the full benefit of the explosion of molten metal and the heat of the arc on his hand or in his face, and the performance is called an *accident!*

Accidents due to the arcing of fuses when replacing fuse wires I have already referred to under accidents in electrical stations. They are of a wholly preventable nature due to the use of antiquated methods. Besides the probability of short-circuiting the terminals when renewing the fuse wires, owing to the absence of a dividing partition of insulating material or of switches for cutting off the pressure, there is a similar danger of arcing in renewing a fuse even on a single pole board when no switches are provided. A fuse may blow from a short circuit on the line, which remains unremedied. In attempting to renew the fuse a flash occurs, burning the operator. Again, in the absence of switches there is a similar danger, even though there be no fault on the line, as the ordinary working current of the circuit might be quite sufficient to cause a bad flash when attempting to complete the circuit by means of a new fuse wire. Bare metal fuses are best not used at all, but if used should be protected so that when they come into operation in ordinary working the fused metal cannot be scattered. They should also be single-pole and be protected by switches, so that all pressure may be cut off when it is necessary to renew the fusible metal.

The accidents under the next heading "unprotected conductors, switches, &c.," are of a preventable nature. The absence of protection is often due to the cutting of prices, switches without covers being cheaper than those with covers, and bare wires or wires with poor insulation being cheaper than if well insulated and cased in. They are also sometimes due to the very prevalent but erroneous belief that low pressures are safe under any conditions. One of the fatal accidents was due to a man touching a bare motor switch. To reach the switch he leaned over an iron railing and was therefore making "earth." The system was three-phase and the pressure 220 volts per phase, consequently the actual pressure received by the victim to earth probably did not exceed 130 volts. He was unable to release himself. Another man seeing that he was in difficulties ran to his assistance, but could not drag him away owing to receiving a severe shock himself. He then pulled out the fuses at the distribution board. The man was then found to be dead. He was probably receiving a shock for a full minute before the pressure was cut off. The proper position for working this switch was on the other side of the railing, but there the danger was equally great, as the floor consisted of iron plating. The switch was, therefore, placed in the most dangerous position possible, the excuse being that a pressure of 220 volts was thought to be harmless. The other fatal accident under this heading was from shock to earth from a three-phase system at 440 volts per phase, and therefore probably 250 volts only to earth. A labourer was working on a roof over which bare wires passed. He was warned not to touch the wires, but accidently did so with his face, and was killed apparently instantaneously. Of the non-fatal accidents under this heading four were due to the absence of proper protection of wires.

Most of the accidents under "faulty apparatus" occurred with portable appliances. Nine were due to shocks or burns received from portable lamps. The burns in these cases are due to short circuits at the lamps or at the flexible conductors at the point where they enter the lamp fitting, and where the insulating material on the wires is likely to be worn away by the edge of the fitting. Six were due to short circuits at the plug connectors of portable lamps from a similar cause. The burns in these accidents were in many cases severe, due to the circuits being too heavily fused, and therefore allowing much larger currents to flow than would have been the case on light fuses. Two others were due to similar faults on portable drills. One was due to a faulty automatic low-voltage cutout on a motor circuit.

Seventeen accidents occurred to "skilled" persons when working on "live" conductors, mostly at switchboards. In 16 cases short-circuits were made with the accompanying injuries of burns. As the whole of these persons may be assumed to have known of the danger, being described as "electricians" or "wiremen," the accidents serve to emphasise the folly of working on "live" conductors. Probably in nearly all of the cases the work could have been carried out after factory hours in safety. Seven similar accidents occurred to unskilled persons. These persons being described as "labourers" were presumably working under the direction of others who failed to give proper supervision.

The fatal crane accident was caused by shock from coming into contact with the trolley wires. The system was three-phase at 440 volts pressure per phase. The shock was apparently received to "earth," and the actual pressure experienced would probably therefore not exceed 250 volts. The victim was a labourer engaged in sweeping the wall behind the trolley wires from which the pressure was supposed to have been cut off. The evidence as to how the wires came to be alive at the time was very conflicting and inconclusive.

The small number, eight, of accidents in testing electrical apparatus in course of manufacture indicates the care with which in general such operations are carried on.

The fatal case under the heading "Miscellaneous" was a mechanical accident due to an electrical cause. It occurred in a printing works. A printing machine at work came to a standstill through the fuse, which was located in another room, blowing and cutting off the supply of current to the motor. The man in charge of the machine sent a message to the electrical attendant, and in the meantime proceeded to make some adjustment or alteration within the machine. The electrical attendant duly arrived and replaced the fuse. The motor at once started up and the machine man was caught in the machinery, receiving injuries from which he subsequently died. The accident would not have happened had the machine man remembered to turn off the switch before leaving the working platform, neither would it have happened if the electrical attendant had personally looked to see if all switches on the particular circuit had been turned off before replacing the fuse. It would also have been prevented if an automatic no-voltage cutout had been used. Such a cutout is in general applied as an adjunct to the motor starter. In fact, such cutouts were actually in use at these works in other cases, but some, being found unreliable, were abandoned. It is a question whether such cutouts should not be made compulsory in all cases. They are in very general use, and there is no reason why they should not be made to work satisfactorily. They are provided, as a rule, for the purpose of preventing damage to the motor from excessive current in case of being switched on with all the resistances cut out, but incidentally they would be of use in preventing such accidents as that described. In a former report I recorded a similar fatal accident in connection with an electric crane.

During the year I investigated the circumstances of two fatal electric shock accidents not reportable under the Factory Act. One, at the request of the Board of Trade, at a generating station, used solely for traction purposes. This was caused by a man coming in contact with the tail ends of cables connecting with transformers at 11,000 volts. There was a passage way at the tranformers about 2 ft. wide, and the high pressure terminals of the transformers were placed on the side next the passage, in itself an undesirable practice, while the cables overhung the passage way at about the height of a man's face. The cable ends were taped up with insulating material, but not sufficiently to render them safe to touch. Such an arrangement can only be described as a trap. The other case occurred from a shock to earth from a 220 volt alternating supply in the cellar of a house. A wireman was engaged in wiring for an additional light in the cellar, the floor of which was merely earth trodden hard and slightly damp. The man started the work by connecting the end of the insulated coil of wire to the distribution fuse board, so that the whole length of wire was charged. He then took his pliers to cut the wire to the required length. As soon as the pliers cut into the wire he consequently received a shock to earth, which proved fatal. This accident again shows the danger of alternating currents of low pressure when a shock through the body to earth is experienced.

Two other fatal accidents, not reportable under the Factory Act, also bear testimony to this. (Vide list of fatalities at end of this report.)

One occurred to a man when engaged in winding a public clock. The striking portion of the clock was operated by alternating electric current at 200 volts pressure, taken from the public mains, and the arrangement was such that the whole works of the clock became electrically charged at intervals, hence the "accident."

The other is worthy of attention, as the conditions are such as might occur anywhere, even in domestic installations. It occurred in a blacksmith's shop attached to a colliery. The victim was carrying a portable lamp, partly constructed of metal. There was a leakage in the lampholder, by which the metal he had hold of became charged. The current was alternating, four-wire 440 volts three-phase, so that he actually received 250 volts to earth. The ground was in some measure conducting. He therefore received a shock through his body from his hands to his feet. He called out to his mate, but was unable to let go of the lamp and was killed. The circumstances were therefore very similar to those described in the case of the man cutting a live wire with his pliers. This accident might happen to anyone carrying a portable lamp, when standing on damp ground or other conducting floor, should the lamp happen to be leaky. The danger arises from not being able to release one's hold of the lamp. With probably several yards of slack flexible wire attached, the connection cannot be broken by a sudden pull or jerk and the victim is speedily overcome. One of the accidents in Table III., under the heading "faulty apparatus," was of similar nature, although unattended by fatal consequences. The man was on a platform 20 ft. from the ground, when he received a shock from a hand lamp, but fortunately for him he fell off the platform, and therefore broke the connection, and escaped with nothing worse than bruises. A portable lamp intended for use in places where the person holding it is in contact with earth, such as damp ground, metal plates or inside steam boilers or metal tanks, should be specially insulated and constructed so that no metal part which might become accidentally charged by leakage in the lamp holder or elsewhere can be touched, or alternatively all the metal which can be touched should be connected to earth by means of a metal flexible armouring of the conductors. In the latter case the fixed end of the flexible armouring should be permanently fixed and earthed, otherwise the danger might be increased.

With one exception, I am not aware of any serious fires on premises under the Factory Act caused electrically during the year. It does not follow, however, that there were none, as they would not be reportable unless personal injuries resulted. The exception referred to occurred at a generating station for public supply. The works were totally destroyed, but as no one was injured the fire was not reportable. The completeness of the destruction was not to be wondered at, the whole building and floor being constructed of wood, and the latter soaked with oil. I had pointed out the inflammable nature of the premises a year before, and made certain recommendations in regard thereto, but nothing less than reconstruction would have been entirely satisfactory.

The report concludes with some instances of bad design on high-tension systems, the question of regulations dealing with the use of electricity at medium pressure in factories, and the following tables of electrical fatalities. The table of fatalities on mains of electric supply undertakings, given in the report, contains no entries :—

ELECTRICAL FATALITIES IN 1905.—(a) *Reported under the Factory Act.*

Date.	Place.	Voltage of system.	System.
April......	London	2,000	Rectified alt.
May	Gateshead	440*	Alt. three-phase
June......	Airdrie	220†	Alt. three-phase
Nov.......	London	2,500	Alt. single-phase
Nov.......	Edinburgh............................	440*	Alt. three-phase
Dec.......	Glasgow	6,500	Alt. three-phase
(b) MINING.—*Reportable to H.M. Inspectors of Mines. (Probably incomplete.)*			
January .	No. 2 Tytrist Colliery	(?)	(?)
October .	Lady Victoria Pit......................	500	(?)
Nov.......	Ince Hall Colliery......................	550	Continuous
Nov.......	Pelton Hall Colliery..................	400*	Alt. three-phase
(c) RAILWAYS AND TRAMWAYS.—(*Reportable to Board of Trade.*)			
February	N.E. Railway, near Monkseaton ..	600	Continuous
March ...	N.E. Railway, Manors Station ...	600	Continuous
July	Metropolitan Railway, Neasden...	11,000	Alt. three-phase
August...	Met. Dist. Railway, Whitechapel	11,000	Alt. three-phase
August...	Hastings..................................	6,600	Alt. three-phase
(d) MISCELLANEOUS.—*On Private Consumer's Premises. (Reportable to Board of Trade (?).)*			
January .	Leeds	200	Alternating
June......	London—Kennington	220	Alternating
October .	London—Brixton‡	220	Alternating

* Probable voltage of shock 250.
† Probable voltage of shock 130.
‡ Death was due to fall following shock.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Steam Turbines and Turbo-compressors: Their Design and Construction." By Frank Foster, (Manchester: The Scientific Publishing Co.) 10s. 6d. net.

"The Electrical Nature of Matter and Radio-activity." By Harry C. Jones. (London: Archibald Constable & Co.) 7s. 6d. net.

"Working Hints for Suction Gas Producers." By A. Flurscheim. (London: "The Gas and Oil Engine Record.") 1s. net.

"Stromverteilungssysteme und Berechnung elektrischer Leitungen." By Phil. Häfner. No. 9 of "Repetitorien der Elektrotechnik." Edited by A. Königswerther. (Hanover: Dr. Max Jänecke.) 8m.

"Règles Normales de l'Association des Électriciens Allemands (Verband Deutscher Elektrotechniker) pour la Comparaison, et l'Essai des Machines et Transformateurs Électriques; Suivies des Commentaires de G. Dettmar." Translated by Prof. F. Loppé and A. Thouvenot. (Paris: H. Dunod & E. Pinat.) 2fr. 50c.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. No. 3, 1905. (Berlin: Julius Springer.) 7m.

"Elektrolytische Alkalichloridzerlegung mit flüssigen Metallkathoden." By Dr. R. Lucion. Vol. XXIII. of "Monographien über angewandte Elektrochemie." (Halle a.S: Wilhelm Knapp.) 9m.

PHYSICAL SOCIETY.

At a meeting of the Physical Society on Friday, June 22nd, Prof. J. Perry, F.R.S., President, in the chair, a Paper on

"The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo"

was read by Mr. A. A. Campbell Swinton. It has been shown by Edison, Fleming and others that the passage of the electric discharge in vacuo is much facilitated by heating the cathode. More recently it has been shown that the passage of the discharge is still further facilitated by coating the heated cathode with oxides of the alkaline metals. It is generally held that the efficacy of the hot oxides in this direction is due to their giving off negatively-charged ions or corpuscles. The author therefore decided to ascertain whether similar effects could be obtained by painting the cathode with radium, and, as radium gives off corpuscles when cold, it was anticipated that it might not be necessary to heat the cathode. Using a continuous current up to 400 volts pressure, this was found not to be the case, the radium having no appreciable effect in producing a visible discharge. When the radium-coated cathode was heated to redness the radium was found to have a very marked action in facilitating the production of a luminous discharge. Experiments were made which proved that the mere presence of radium in the tube was insufficient to produce the effect, and, furthermore, it was found that the tube would only allow visible discharges to pass in the direction that made the radium-treated electrode the cathode, the tube acting as a unidirectional valve in the same way as do tubes with cathodes coated with oxides. Experiments were also made without any heating of the cathode, but using alternating currents of higher voltages than were available in continuous current. It was found that using an untreated electrode it required from 800 to 900 volts to get a visible discharge to pass; whereas, using a radium-treated electro, a visible discharge could be got to pass with from 700 to 800 volts. The exact voltages required in each case were variable, but it was always found that a visible discharge could be got to pass, using the radium-treated electrode, with about 100 volts less than when the untreated electrode was employed. The phenomena with continuous currents, as described in the Paper, were illustrated experimentally.

A Paper on

"The Effect of the Electric Spark on the Actinity of Metals"

was read by Mr. T. A. Vaughton. It has been pointed out by several observers that some metals, such as aluminium, cadmium, zinc, magnesium, &c., although not radioactive in the ordinary sense of the word, yet have the power of affecting a photographic plate. The electric spark has a remarkable influence on this "actinity," in some cases causing an increase, and in others apparently diminishing it. The alteration is not merely momentary but remains for months. It is, however, quite superficial, and may be removed by slightly rubbing the surface of the metal with emery-paper. In the case of aluminium sparked with gold the direction of the current does not make much difference in the actinity of the sparked plate, but in the case of other couples the difference is very marked. For example, if a cadmium strip is sparked with antimony, the cadmium being connected with the positive terminal, the cadmium becomes very active photographically, not only on the spot sparked, but all over its surface. If, however, the cadmium is connected with the negative terminal and sparked with a positive terminal of antimony, the cadmium remains very slightly more active than if not sparked at all. In order to compare the effect of the spark on the "actinity" of various metals, plates of the following 15 elements were prepared:—Magnesium, aluminium, iron, cobalt, nickel, copper, zinc, silver, cadmium, tin, antimony, platinum, gold, lead and bismuth. Each plate was sparked with a terminal of each of the 15 metals in the order of their atomic weights. After sparking, the plate was placed on a sensitive bromide plate and left in the darkness for a month. It was found that in the case of Al, Ni, Mg and Sn the sparked spots were more active than the rest of the plate; but with Zn, Cd, Pb and Bi the spots are not so active as the rest of the plate—probably resulting from an opaque film of oxide produced at the sparking point. The penetrating power of the rays emitted from sparked metals varies considerably, and is investigated in the Paper. The author points out that it is interesting to note that most of the greatest increases in actinity, caused by sparking, are produced in sparking together two metals, the sum of whose atomic weights approaches that of a radio-active element, thus suggesting a synthesis of these elements.

A Paper on

"The Dielectric Strength of Thin Liquid Films"

was read by Dr. P. E. Shaw. The range of voltage used in the experiments is from 25 to 400, and the corresponding spark-lengths vary from about 0·15 μ to 6 μ ($\mu = 0{\cdot}001$ mm.) for the insulating liquids used. The apparatus employed for measuring length is the micrometer designed by the author for measuring gauges (*Proc. Roy. Soc.*, April, 1906). On each micrometer screw a cap is fitted—one cap terminates in a disc of iridio-platinum and the other in a sphere or portion of a sphere of iridio-platinum. Discharge occurs between the two iridio-platinum surfaces, a drop of the insulating liquid being placed between them. Voltage is registered by a voltmeter, and is obtained by passing an electric-lighting current through a liquid resistance and taking whatever fraction of the voltage is required. Two circuits are used, one of very low voltage, say $\frac{1}{40}$ volt, to determine the contact position for the surfaces, and the other to give the high voltage required for sparking. The substances used were olive oil, castor oil, linseed oil, rape oil, turpentine, fusel oil, oil of resin, cod-liver oil, neat's-foot oil, paraffin, transformer oil, the homologous series C_5H_{12}, C_6H_{14}, C_7H_{16}, C_8H_{18}, and armacell, ohmaline, and Sterling varnishes. The best insulators are paraffin and transformer oil, though for these, as for all commercial oils, great care was taken to remove water and acid by prolonged heating to 110°C., and treating with potassium carbonate. Generally speaking, the curves connecting voltage and spark-length are roughly straight to the origin, the gradient varying between 110 volts per micron and 70 volts per micron. Distinct local variations in gradient are found in one or two cases—*e.g.*, castor oil, olive oil, and paraffin. The air curve is cut by the oil-curves at voltage 300; for less voltage air has greater dielectric strength, but at that voltage air suddenly weakens, and for greater voltages all oils are stronger. No simple connection can be traced between specific inductive capacity and dielectric strength.

Mr. A. RUSSELL considered the method of research a valuable one. He doubted, however, whether the results obtained would be much help in determining the relative values of the "dielectric strengths" of thin films of insulating materials. The numbers given in the Paper only refer to thin films between iridio-platinum electrodes. Hobbs has shown that for small distances the sparking potentials are practically independent of the nature of the gas between the electrodes. They depend mainly upon the metal of which the electrodes are made. At these microscopic distances, owing to the corpuscles, the electrostatic field between them was far from uniform. The disruptive voltage for a film of air one micron thick, if it could be subjected to a uniform electrostatic stress, would only be about 3·8 volts. When liquids were introduced between the electrodes, it was extremely difficult to determine the maximum electric intensity at the instant of discharge, as they had a different dielectric coefficient from air, and so there would be refraction of the Faraday tubes.

Dr. SHAW, in reply to Mr. Russell, said that the air-curve mentioned was that for iridio-platinum, and was obtained by a distinct set of experiments on air. The gradient was steeper than any found by Hobbs in his recent work. As regards the use of the term "dielectric strength," Dr. Shaw used it in its common sense as a general term implying strength to resist discharge, and no numerical value was given to it in the Paper.

A Paper on

"The Effect of Electrical Oscillations on Iron in a Magnetic Field"

was read by Dr. W. H. Eccles at the same meeting; this we hope to give in abstract in our next issue.

A 40,000 Volt Transmission System.—According to the *Elektrotechnischer Anzeiger* the first European power transmission system to employ a pressure as high as 40,000 volts is that in Italy, from Gromo, on the river Serio, to Nembro, a distance of about 20 miles. Provision is now made for transmitting 2,000 H.P. and for extensions to double this amount. The present power house contains three 1,000 H.P. Brown-Boveri three-phase alternators for 4,000 volts, 50 cycles, driven at 500 revs. per min. by Escher-Wyss turbines with horizontal shafts, one of which is intended as a stand by. The alternators are of the revolving field type with the rotors complete with poles and pole shoes formed of single steel castings. Two six-pole 25 kw. exciters are provided, driven by separate turbines at 800 revs. per min. Each alternator is connected through tubular fuses, but without any intermediate switch to its own step-up 40,000 volt oil-insulated water-cooled three-core type transformer, so that all paralleling on to the 'bus bars is done on the high-tension side. Thus each group, consisting of alternator and transformer together, is treated as a complete independent unit. The instrument transformers for the ammeters, voltmeters and synchronising apparatus are connected to the 4,000 volt side of the power transformers. Three single-pole isolating switches are, of course, provided between each main switch and the 'bus bars. The main machine oil switches are hand-operated and fitted with maximum time-limit relays, worked from the 4,000 volt side of the main transformers. A similar switch is used for the single feeder circuit, but, of course, in this case the instrument transformers are worked by the 40,000 volts. Separate sets of multi-gap arresters protect each outgoing line.

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ELECTRICAL ACCIDENTS.

The annual report of Mr. G. S. RAM, H.M. electrical inspector of factories to the Home Office, extracts from which we give elsewhere in this issue, draws attention to some risks which are quite unnecessary from the electrical point of view. Quite a number of accidents, although perhaps due finally to carelessness, would never have happened if the apparatus employed had not been so faulty in design as to be nothing less than a trap. Thus, when the operator receives the full benefit of an explosion of molten metal in his face because an unprotected fuse is placed just by the switch controlling the circuit, the incident can scarcely be described as an accident. Experiences of this kind are unpleasant enough on a low-tension board, but when high-tension circuits are concerned, faulty design may easily lead to fatal results. As an example, Mr. RAM describes a passage way which he discovered in the switchboard area of a generating station. On each side was a row of vertical brick cells facing each other, and containing isolating switches working at 10,000 volts. The switches and connections were of bare metal, and were not in any way protected from the passage. When in the "on" position they were 8 in. or 9 in. back from the front of the brickwork; but when the switches were "off," their blades, which might still be alive, projected some 8 in. into the passage way beyond the brickwork, on one side about the height of a man's knee, and on the other at about the elevation of his nose. The safe width of the passage way was, therefore, reduced to about 2 ft., and along this the attendant was expected to make his way and pull or push with a pole at any isolating switch required. As Mr. RAM remarks, although many engineers have a proper regard for danger to their employés, examples of this kind show that even important stations are designed by persons having no consideration whatever for the safety of those who will subsequently have to work in them.

In the case of a large sub-station in which the attendants had lost confidence in the switchboard owing to defective working, Mr. RAM had an interesting experience, which is best described in his own words: "While I was there a telephone message was received from the generating station to the effect

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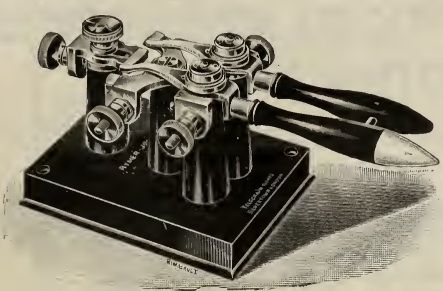

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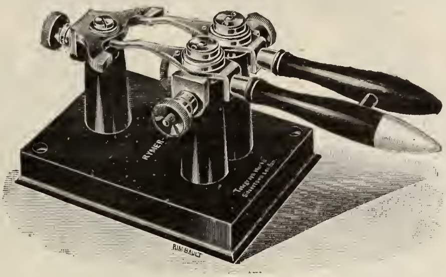

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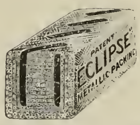

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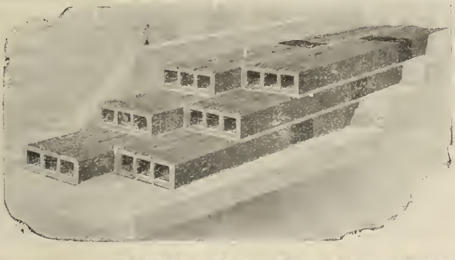

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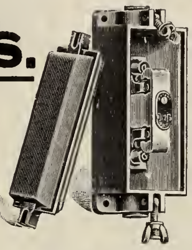

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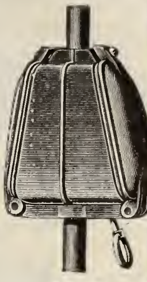

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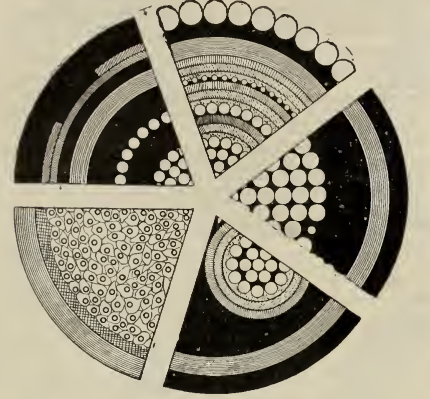

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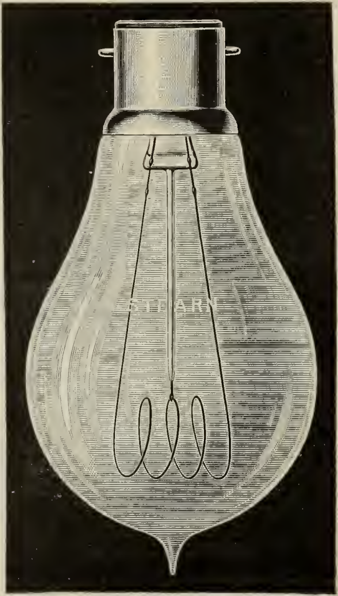

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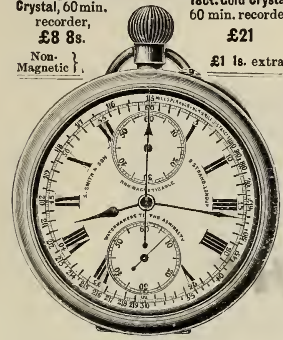

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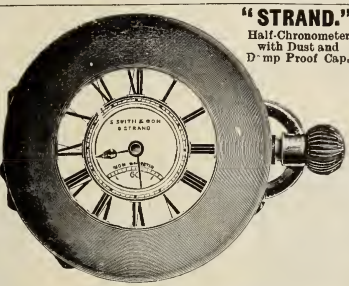

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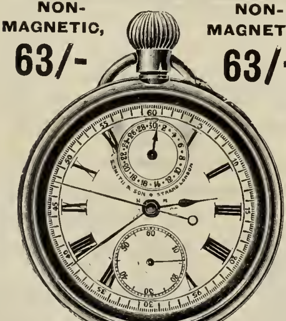
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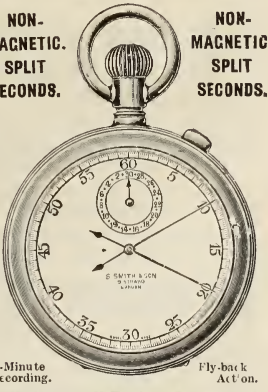

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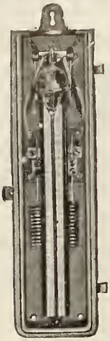

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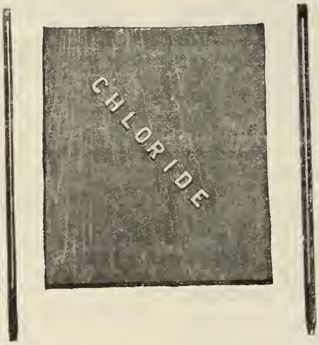

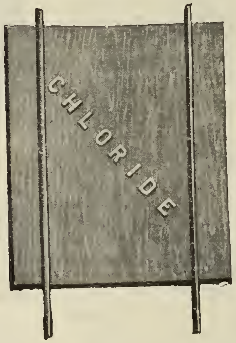

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that another feeder was about to be switched on. The switchboard attendant promptly got behind an iron column, and the engineer and the consulting engineer, who were present, hid behind a motor generator, and, following their example, I did the same, just as if we were in a slate quarry when a shot was about to be fired. Such an undignified exhibition, founded on previous experience, afforded an instructive object-lesson on the merits of that type of switchboard. Previous experience had shown that persons were not safe, even at a considerable distance away, from an occasional bombardment by pottery ware and flaming oil from the fuses."

Another point that is brought out by the report is the fact that quite a number of accidents still occur on low-pressure circuits. For example, a man was killed by touching a bare switch while leaning over an iron rail, the system being three-phase with 220 volts per phase, so that the pressure received by the victim to earth probably did not exceed 130 volts. As another instance, a man was engaged in wiring an additional light in a cellar, of which the floor was merely earth trodden hard and slightly damp. He started the work by connecting a coil of wire to a fuse board so that the whole length of wire was alive, and then cut the required length off in the cellar with a pair of pliers, receiving a fatal shock from the alternate current supply at 220 volts. Other cases of the same kind occurred with portable fittings where the ground was damp.

Having regard to the popular alarm caused by accidents on low pressure circuits, it is unfortunate that the simple precautions necessary to avoid shock are not always adopted in damp situations. It is not enough to rely upon the fact that electric shocks of a certain kind are not, as a rule, dangerous. It is necessary to bear in mind the exception and to guard against it. Whether a shock is dangerous or not depends, to a large extent, upon the health of the individual; and the extent of the shock depends enormously upon the dampness of the victim. These points are now generally well known, and yet the remedies are not infrequently disregarded.

Security from low pressure shocks must be left very much in the hands of the electrical contractor, unless the authorised undertakers can be induced, as they should be, to be more exacting in their rules and inspections than at present. Danger from high pressure shocks is rather a different matter. There can be no excuse for such things as unguarded high pressure terminals in narrow passages with floors wet from a driving rain, as described in the report. The cutting of prices without very definite specifications may be responsible for a good deal; but these wholly unnecessary dangers are not a good return for a low price, and they may result, as we are warned by Mr. Ram, in the introduction of a set of stringent regulations which would otherwise be unnecessary.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electrical Engineering in Theory and Practice. By G. D. Aspinall Parr. (London: Macmillan & Co.) 12s. net.

The inclusion in one octavo volume of less than 500 pages of the whole subject of electrical engineering is of course an impossibility, and even the sense of proportion and at the same time completeness which the author has manifested in the book before us scarcely justifies him in the use of so ambitious and comprehensive a title for a work which may almost be said to stop short on the threshold of electrical engineering proper. Of the making of text books for the long-suffering electrical student there is no end, but we are bound to say that amongst the mass of such productions as we have met with we have seldom seen an educational work in which the sequence of subject matter has been so logical and the proportion between theoretical and practical considerations so well balanced. The tyranny of examinations is, of course, felt to some extent, and each chapter concludes with a collection of questions which have been set in actual examinations relating to subjects dealt with. Beyond this, however, the "cram book" element is happily absent. Another good point is the exclusion of the redundant historical matter, which, although in itself often of the utmost interest, is so often given undue prominence in works of a similar nature at the expense of the direct tendencies of modern developments. The ground covered may almost be said to stop short of electrical engineering proper, as so many important branches are left untouched, but a future volume is promised treating further of the generation and distribution of both continuous and alternating currents, and what may be called the heavier branches of electrical engineering. The early chapters on fundamental principles are concise and well arranged. The idea of magnetism and magnetic lines of force is, in contradistinction to most text-books, made familiar to the student before purely electrical phenomena are introduced. The preliminary chapter on "statical" electricity is commendably short and not so insistent on the reiteration of "pith ball" experiments as works of the older school. This enables the all-important conception of the electric current to be instilled into the mind of the student at an early stage. A certain amount of general mechanics is also included. Having then introduced the idea of electrical resistance, a long chapter elaborates the subject and describes up-to-date apparatus for its measurement, both in the laboratory and for practical fault localisation. Some notes on insulators are also included.

The succeeding chapter is entitled "Electro-magnetism," and discusses the production of magnetic lines of force and magnetic induction, permeability and hysteresis. In connection with this part of the subject the note No. 3 at the foot of p. 150 is a little misleading. The note first states that an induction of $B = 2{,}500$ is sometimes taken as a standard for comparison of hysteresis, but proceeds to give particulars of a specially good brand of "non-ageing" iron which has the very low hysteresis loss of 480 ergs per cubic centimetre per cycle at $B = 4{,}000$. This material is stated in the same note to be unaffected by temperature up to 160° F., but the nature of the "ageing" effect of temperature common to ordinary brands of iron is not explained. The subjects of electrostatic and electromagnetic induction are grouped into one chapter where first condensers and later induction coils and the like are considered. It is rather a pity that the word "induction" has to do duty for such a variety of different conceptions in electrical text books, for only in the preceding chapter, the student was familiarised with the idea of magnetic "induction" as a certain number of lines of force per square centimeter. The next three chapters are devoted to electrical and magnetic instruments, electric incandescent lamps and electric arc lamps, and are thoroughly practical and up to date. A large quantity of well-chosen examples of typical apparatus is described and illustrated, the instruments to which attention is directed being those intended for every-day practical work rather than the refinements of the laboratory.

The incandescent lamp section contains a short description of the manufacture of the carbon filament lamp, besides notes on metallic filament, Nernst and mercury vapour lamps. A few types of ordinary and "flame" are lamps are described, with their accessories, and brief mention is made of the so-called "electrolytic" arc lamp and the magnetite lamp. The last chapter, entitled "The Production of Electromotive Force," is devoted principally to primary and secondary batteries. The whole book is well got up, and contains upwards of 280 excellent illustrations.

Notes on Electro-chemistry. By F. G. Wiechmann, Ph.D. (New York: The McGraw Publishing Co.) 1906. $2.

We do not quite know what place this book is supposed to take in the educational world. It is quite a nice little production, but the subject matter is more than covered in several other books on the subject which we might mention. In his preface the author says that the book is intended to serve as a general introduction to the study of electro-chemistry and to aid in securing a proper understanding and appreciation of the work along individual lines. A general survey of the theoretical considerations certainly is given, but we doubt whether it helps those who read it to work along special or individual lines.

The book commences with a study of the General Principle of Science—Matter and Energy—Forms of Energy, &c. Chapter II. treats of Electrical Energy, commencing with the theories of electricity and radio-activity. The last chapter deals in 46 pages with practically the whole subject of electro-chemistry, touching—but only touching—upon electro-deposition from solutions, chlorine and the alkalis, electrolysis of fused salts, electrothermic processes, electro-organic processes, &c.

Chapter IV. on Electrolytic Dissociation is well written and goes over the ionic theory in an interesting manner. The author also does not neglect to refer to the work of Kahlenberg and the criticisms of Reychler, the latter of whom considers the theory of dissociation of salts in solution to be in direct opposition to thermo-chemical deductions and data. The book has been carefully written, but we hardly think that it supplies a want, and it is far too expensive.

EFFECTS OF SELF-INDUCTION IN AN IRON CYLINDER.*

BY ERNEST WILSON.

If a solid cylindrical conductor be divided into imaginary concentric tubular conductors, the ordinary self and mutual induction theory shows that when the conductor is subjected to an alternating P.D., the interior shells carry electric currents of smaller density than the exterior ones, and the currents suffer a phase displacement greater the nearer the centre of the cylinder. The theory shows that the permeability and conductivity of the material play an important part, the effects above mentioned being increased in magnitude with increasing permeability and conductivity. When, however, the material of the conductor has variable permeability the problem becomes more complicated, and it is the object of this Paper to examine more closely what goes on in an iron cylinder when electric currents are reversed in it, and maintained steady after reversal. A second part of this research will deal with alternating currents of varying frequency and wave form.

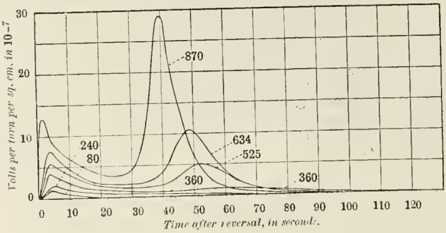

FIG. 1.—COIL 1.

The cylinder employed is of mild steel and has a diameter and length each equal to 10 in. (25·4 cm.). It is provided with holes drilled in a plane containing its axis of figure in such a manner that exploring coils can be threaded to enclose certain portions of that plane. The exploring coils are three in number. They are each 2 in. wide in a direction parallel with the axis of figure and midway between the ends of the cylinder. Their depths in a radial direction are 1, 2 and 2 in., and their average radii are 0·5, 2 and 4 in. respectively. These coils are referred to as coils Nos. 1, 2 and 3, No. 1 being near the centre of the cylinder. The cylinder has been already described,† but for the purpose of the present research has had a hole ¼ in. diameter drilled through it coinciding with the axis of figure. At each end of the cylinder are two massive gun-metal projections, which in the present research serve to conduct the electric current into the cylinder. The conductors attached to these projections are connected to a reversing switch so constructed that at its mid-position it short-circuits the circuit of the cylinder and its conductors, which were arranged in the form of a circle about 6 ft. diameter. The electric current was supplied by storage cells through an adjustable resistance and the shunt of an amperemeter. The P.D. of the cells and the adjustable resistance were such that on reversing the current in the cylinder its value in the main circuit remained constant. In fact, the reversal of the main current was practically instantaneous. The epoch of reversal was noted on a seconds clock and at two second intervals after reversal the deflections of the dead-beat galvanometers in circuit with the exploring coils were noted. The deflections have been reduced to volts per turn per square centimetre of the coils from which they were obtained, and plotted in terms of the time. Figs. 1, 2 and 3 give the results obtained from coils Nos. 1, 2 and 3 respectively, and each curve is numbered to correspond with the total amperes reversed when it was observed. The curves have been integrated in order to find the maximum average value of the induction density B for the respective coils. The average values are set out in Table I.

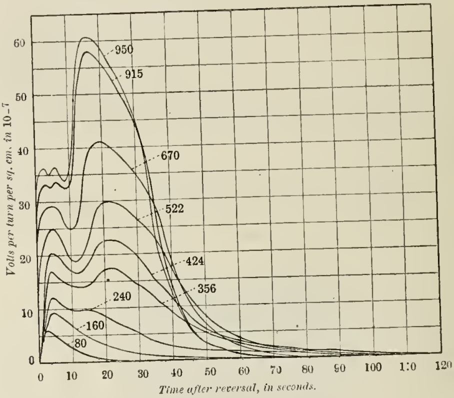

FIG. 2.—COIL 2.

Current Density.—If the current density over the cross-section of the cylinder was constant, the force H would vary as the radius. If the values of B for coil No. 3 in Table I. be plotted in terms of the total currents reversed in the cylinder, it will be found that the resulting curve resembles the BH curve of a piece of mild steel. If the values of B for coils Nos. 2 and 1 be plotted in terms of the total current multiplied respectively by 0·5 and 0·125 (to correspond with their radii) it will be seen that, although similar, the three curves do not lie on one another. To make them do so the coefficients with which to multiply the total currents are 0·75 and 0·28 respectively. This suggests that under steady conditions the current density is greater near the centre of the cylinder than near the surface. The average relative densities appear to be: (1) over the area of the cylinder within the average radius of coil No. 1, 0·56; (2) over the annulus between the average radii of coils Nos. 1 and 2 0·36; (3) over the annulus between the average radii of coils Nos. 2 and 3, 0·21. A total current of 950 amperes corresponds to an average force H of about 6 C.G.S. units for coil No. 3, and the BH curve for mild steel is well represented by the results of the experiments. The relation between the average value of H for each of the coils and the total current is given in Table I.

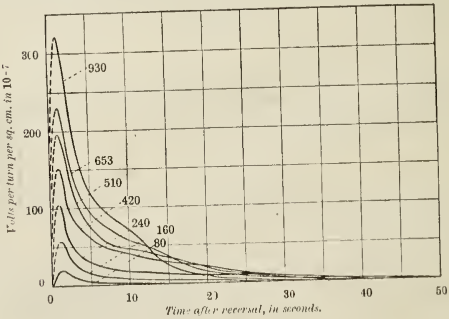

FIG. 3.—COIL 3.

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* Paper read before the Royal Society, June 7th, communicated by Sir W. H. Preece, F.R.S.

† Roy. Soc. *Proc.*, Vol. LXIX., p. 440.

Table I.

Total current in cylinder.	Coil No. 1.		Coil No. 2.		Coil No. 3.	
	Av. H.	Max. av. B.	Av. H.	Max. av. B.	Av. H.	Max. av. B.
950	1·68	2,640	4·5	8,950	6·0	9,640
670	1·18	1,620	3·15	7,300	4·2	8,200
522	0·924	1,040	2·48	6,000	3·3	7,080
424	0·75	660	2·01	4,610	2·68	6,210
356	0·627	540	1·69	3,560	2·25	5,420
240	0·426	200	1·14	1,840	1·52	3,420
210	0·372	..	0·998	1,350	1·33	2,520
160	0·283	100	0·758	773	1·01	1,400
123	0·218	68	0·583	473	0·777	739
80	0·141	40	0·379	247	0·505	415
45	0·079	..	0·213	136	0·284	180

Comparison of E.M.F. Curves.—The E,M.F. curves are given in Figs. 1, 2, 3, to which reference will be made. Coil No. 3 experiences its maximum rate of change at once, although after reversal of about 400 amperes there is slight evidence of a second maximum at about 20 seconds after reversal. After about 400 amperes it will be seen that as the total current increases the curves cross one another at shorter intervals, indicating that the effects penetrate more rapidly after the maximum average induction density has passed the value at which maximum permeability occurs.

Coil No. 2 shows the effect of a second maximum more markedly. When the total current in the cylinder is small there is no second maximum. At about 200 amperes the second maximum shows signs of being developed, and with larger currents its development is such as to make it the most important feature of the curves. As in the case of coil No. 3 the E.M.F. curves cross one another at earlier intervals after about 420 amperes has been reached. Coil No 1 shows similar effects, but its E.M.F.'s have a still later maximum for a given current. Moreover, the time between the first and second maxima is greater than in the case of coil No. 2. These results are in keeping with what has already been observed in the case of the reversal of currents in a copper coil surrounding cylinders of 4 in. and 12 in. diameter,[*] and in the present cylinder when rotated in a magnetic field.[†] It is difficult to say exactly how long the effects take to die away owing to the ultimate want of sensibility of the instruments, but a comparison of the times taken to practically die away is of interest. In Table II. are given the times taken to reverse the magnetism at the centre of 4 in. and 12 in. diameter cylinders when the currents in their magnetising coils are instantaneously reversed, and then maintained steady. The times in these two cases roughly vary as the square of the diameters of the cylinders. The results obtained in the present experiments are also included in Table II.

Upon integrating the E.M.F. curves it was found that the average magnetic flux, for total currents up to about 240 amperes, was reversed in sign for coil No. 2 after coil No. 1. For currents greater than 240 amperes the curves cross the axis of time in the order 3, 2, 1. In all cases, however, the total interior average currents, as obtained from the magnetic hysteris loops, reversed in the order 3, 2, 1.

Table II.

4 in. magnet.		12 in. magnet.		10 in. cylinder.			
Duration in secs.	Max. H.	Duration in secs.	Max. H.	Duration in seconds.			Total current in cylinder.
				Coil No. 1	Coil No. 2	Coil No. 3	
40	1·7	360	1·2	..	20	..	45
45	3·0	420	2·4	20	28	15	80
33	4·96	180	6·0	30	48	30	160
10	16·0	80	11·0	58	80	50	210
5	37·0	50	24·0	75	100	..	240
..	..	..	..	116	112	60	356
..	..	..	..	120	120	50	424
..	..	..	..	190	90	..	522
..	..	..	..	90	75	40	670
..	..	..	..	90	65	30	950

Application of Results to other Sections.—Comparing two cylinders whose diameters are as $1 : n$, the value of H at similar radii will be the same when the total currents are as $1 : n$. Considering unit length of the two cylinders, the total magnetic induction up to similar radii varies as n, and the electric resistance of similarly placed longitudinal paths varies as $1/n^2$. Therefore to induce n times the current in those paths the E.M.F.'s must vary as $1/n$. If the time varies as n^2 the E.M.F.'s will vary as $1/n$, thereby giving rise to the same value of the magnetic force H at similar radii.

A Paper recently published[*] dealt with the self-induction of bullheaded railway rails, weighing 70 lb. per yard. It was there shown how greatly the self-induction varies with the frequency for a given current, and with the current for a given frequency. The head of one of these rails is roughly equivalent to a cylinder of 2 in. diameter. A current of 100 amperes in such a cylinder corresponds to 500 amperes in our 10 in. cylinder if the forces at similar radii are to be the same. We infer roughly that an alternating current of 8 seconds periodic time and approximately rectilinear wave-form would permit of practically the whole section being made use of as regards conduction for a small fraction of the time of each half period. The frequencies employed in practice are of the order 25 periods per second, and are enormous by comparison. In railway work an inverted channel rail would obviously be more suited from the standpoint of electric conduction of alternating currents. A current of about 0·5 ampere in an iron wire of 0·1 in. diameter would give rise to a force of about 0·2 near the surface. Changes of magnetism in our 10 in. cylinder were observed 20 seconds after reversal of about 50 amperes. A frequency of 250 would allow of the full section of the wire being made use of during a small fraction of the time of each half period with 0·5 ampere, but not with a current of 5 amperes.

In conclusion, I wish to thank Mr. A. E. O'Dell for his patience and care in working out results, and Mr. H. W. Franks for his assistance in the experimental part of the Paper.

THE MEASUREMENT OF X-RAYS AND OF RAYS FROM RADIO-ACTIVE BODIES.

A recent number of the *Archives of the Roentgen Ray* is especially devoted to the measurement of Roentgen rays and the α, β and γ rays from the radio-active elements. In the main the matter is discussed from the medical aspect, the contributors to the discussion being all leaders in radio-therapeutics. As is pointed out in an editorial, the first question is: What phenomena exactly should be taken as the basis of measurement? Should it be the physiological action or the heat effect, the total output of energy, or some mechanical action, as by some variety of light mill; or should it be the ionising action of the rays or some chemical colour reaction? Moreover, in measuring the radiations from radium and the like, should the α, β or γ rays be taken as the basis of measurement? Again, in the case of the Roentgen tube, the measurement of quality must be distinguished from that of quantity; perhaps, for medical purposes, one of these measurements might suffice, but possibly both may be necessary. That some standard method of measurement, some accurate way of gauging the dose, is urgently wanted is proclaimed by every contributor to the discussion, and is evident to every layman who knows how widely extended and efficacious is the application of the rays to lupus, epithelioma and a host of skin diseases.

The article by Dr. H. Bordier, of Lyons, comprises an excellent summary of the principal methods that have been used in gauging doses. He divides the methods enumerated into two groups—methods for measuring the quality of the rays and methods for measuring the quantity. His remarks are abstracted below:—

Qualitative Methods are needed to enable the practitioner to estimate the degree of penetration of the radiations into the tissues. The principal instruments used in qualitative measurements are the following:—

1. *The Electroscope of Hurmuzesku.*—This instrument acts by measuring the distance at which the electroscope is discharged by the rays. The procedure is, however, better adapted for the laboratory than for clinical use.

2. *The Spintermeter of Béclère* measures the length of the spark-gap which is equivalent to the interior resistance of the focus-tube. This enables us to judge of the degree of penetration of the rays and is a useful and practical instrument.

3. *Benoist's method* uses a silver disc 0·11 mm. in thickness as the standard of comparison. The penetration of the rays is measured by the thickness of aluminium which gives the same intensity of shadow on the fluorescent screen.

4. *The milliammeter*, when placed in circuit with the focus-tube, gives a measure of the current passing through the tube, and thus indirectly of the resistance of the tube.

5. *The radiometer of Courtade* is also an instrument for qualitative measurement. In this method the degree of fluorescence of a screen of barium platino-cyanide under the influence of the X-rays is compared with that produced by a specimen of radium of known activity. The instrument consists of a lead shield in which are two similar apertures, each covered with a fluorescent screen. The radium, which serves as a standard of fluorescence, is placed behind one aperture. The degree of fluorescence on the second screen is

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[*] *Phil. Trans.*, A, Vol. CLXXXVI. (1895), pp. 93-121; also *Journ.* Inst. Elec. Eng., Part 116, Vol. XXIV., p. 194.

[†] Roy. Soc. *Proc.*, Vol. LXIX., p. 435, and Vol. LXX., p. 359.

[*] *The Electrician*, Vol. LVI., p. 757.

equalised with that of the standard by altering the distance of the focus-tube or other radio-active body to be measured. The distance will be a measure of the output of the tube and of the quality of the radiations.

This method is open to the objection that the intensity of fluorescence of all the platino-cyanides is subject to great variation when exposed for a prolonged period to the radiations of radium or to the X-rays.

6. *The Method of Contremoulins.*—This method, which was antecedent to Courtade's, is based on the same principle. Instead of radium, the standard fluorescent screen is illuminated by an acetylene light. This method is open to the same objections as the former.

Quantitative Methods.

1. *Holzknecht's Chromoradiometer.*—In this instrument the reagent is contained in a little capsule with a celluloid cover. The reagent, the composition of which has been kept secret, is probably a mixture of various salts fused together, the mixture having the property of changing colour under the action of the X-rays. The colour changes under the influence of the rays from a dirty yellow to a green tint, which becomes gradually deeper as the quantity of the rays is increased. Accompanying the instrument is a scale of colours graduated from a greenish-yellow to a deep green, which serves as a standard of comparison to judge the colour of the capsule after irradiation, but for several reasons the indications are apt to be unreliable.

2. *Freund's Method* appears to be a means of measurement of very great promise. The reagent is a 2 per cent. solution of iodoform in chloroform. The iodoform, CHI_3, is decomposed by the X-rays, setting free iodine which gives a claret colour to the solution. Unfortunately the reagent is equally sensitive to the action of light; hence the solution is not stable, and this fact has prevented the method from being brought into general use.

3. *Sabouraud and Noiré's Radiometer* is the method which appears to be in most general use—at least, in France. The reagent, platino-cyanide of barium, is spread on a little disc of paper. This salt turns brown under the action of the X-rays—a reaction first pointed out by M. Villar, who showed that under the influence of increasing doses of the rays the platino-cyanide passed from bright green to brown, while at the same time the fluorescence gradually decreased. Sabouraud and Noiré issue with their pastilles a standard colour corresponding to the tint which the pastilles assume after being exposed to a given dose of X-rays.

4. *Kohler's Method.*—This method was introduced by Dr. Kohler of Wiesbaden, who attempted to measure the quantity of the X-rays by the variation of temperature in the focus tube. This was indicated by means of a thermometer placed in a depression in the wall of the tube. We hardly need discuss this method, as it is difficult to understand how the elevation of temperature can possibly measure the dose of rays absorbed by tissues at a varying distance from the tube. Moreover, it has not been proved that the quantity of X-rays is in any way proportional to the temperature of the tube.

5. *Kienbock's Quantimeter* is based on the action of the rays on a specially prepared photographic paper. A small piece of sensitised paper, enclosed in a black envelope, is placed on the tissue to be irradiated. After exposure to the rays, it is washed, developed and fixed with hyposulphite in the usual manner. The tint of the paper is then compared with a scale of tints corresponding to progressive doses of X-rays. If the paper has not attained the tint corresponding to the prescribed dose, the irradiation must be continued. The method thus is hardly a practicable one.

6. *The Guilleminot-Courtade Method* depends on the principle of the radiometer of Courtade, which we have already alluded to as a measure of the quality of the X-rays. Guilleminot takes for his standard a sample of radium whose radio-activity is 50,000. He places his focus tube at such a distance from the platino-cyanide screen as to procure an equal illumination on the part exposed to the focus tube and that exposed to the radium.

7. *Contremoulin's Radiophotometer.*—This is a photographic totaliser, and, consequently, of no great practical use in radiotherapy. It was designed more especially for radiographic work, in order to be able to control the development of the radiographic plates.

For this purpose the author makes use of two scales, each consisting of layers of electrically deposited silver of gradually increasing thickness—one of these increasing in arithmetical and the other in geometrical proportion. These scales are used as screens placed in front of a plate of the same sensitiveness as the radiographic plate. The two test plates are then developed under identical conditions, until the required depth of colour appears. The impressions are then fixed both together under the same conditions. The time of exposure to the X-rays, together with the time of development, is noted for further reference.

Dr. Bordier himself finally proposes a method based on the dehydration of the platino-cyanides. The platino-cyanide of barium has been chosen on account of the facility with which it changes to a brown colour. On irradiation its original bright green colour passes into a clear yellow. As the quantity of the rays is increased, this is succeeded by a deeper tint of sulphur yellow, and subsequently a gamboge colour, followed by a deep maroon. This is the final colour, at which also the fluorescence, which has been gradually diminishing, finally disappears entirely.

The Bordier chromoradiometer differs from its predecessors in several details. The barium platino-cyanide, suspended in a thin layer of collodion, is placed on the skin itself, or at all events in the same plane as the part to be irradiated. The pastilles are square, with a diameter of 6·5 mm. The back of the square is adhesive to facilitate its attachment to the skin.

In another article Dr. H. Lewis Jones focusses attention on the utility in clinical work of current-measuring instruments. He advocates the use of the milliammeter, and says that the advantages of an apparatus giving continuous indications throughout the whole time of an exposure by the simple movement of a pointer on a dial are so manifest that it is much to be desired that further investigations may teach us how to employ the milliammeter for exact work.

The questions to be settled before the milliammeter can be accepted as reliable for X-ray measurements are the following: (1) Does X-ray production bear a direct relationship to the magnitude of the current through the tube? This question is of prime importance, and has not yet been fully answered. (2) What difference may be expected to exist between the amount of X-ray production within the tube and the amount actually emitted and available for use outside? (3) Can the milliammeter be trusted to give a measure of that part of the current through the tube which is concerned in the production of the X-rays, and of that part only? (4) How may the readings be interpreted to suit different distances of the radiant point from the service irradiated? The first of these questions has been attacked by several experimenters. D'Arsonval, using the photographic method, has expressed the view that the effect is proportionate to the current, and has shown photographs in support of his case.

Wertheim Salomonson considers that the X-ray production is a function of the watts expended in the tube, rather than of the current traversing it. If his view be the correct one, the situation is complicated by the fact that energy is consumed and wasted in heating the anticathode, and therefore any calculation of the watts expended in an X-ray tube must be corrected for this loss before it can be taken as a measure of X-ray production. It is conceivable that the energy wasted in the form of heat may leave the actual X-ray production at a figure roughly proportional to the current, though in reality proportional (with correction for heat loss) to the watts.

An experiment which throws light upon this subject is that of connecting two X-ray tubes in series, the one having a high and the other a low resistance. In such a case the current through the two tubes is the same, but the watts absorbed by the high-resisting tube are greater than those absorbed by the low tube. If the X-ray production be a matter of current only, the two tubes should be alike in fluorescence in their action upon the screen and in their action upon the photographic plate. If, on the other hand, the X-ray production depends upon the watts expended, then the higher tube should always give out the most X-rays.

This point is engaging the author's attention at the present moment, and experiments so far made appear to indicate that the higher tube does give out more X-rays than the lower one, excited with the same current. Definite measurements of the point have not yet been completed.

In all experiments which measure the current through the tube it must be borne in mind that a tube of low vacuum may carry a large current without any production of X-rays at all, and therefore it is necessary to postulate that the tube shall be of a proper degree of vacuum. But it is the case that a tube may be just on the border line, and may give out a few X-rays, though far less than the amount which might be expected from the current traversing it, and it is probable that this behaviour of tubes of low vacuum has had much to do with the adverse criticisms which have been written against the milliammeter method of measurement.

It has been suggested by the writer in another place that tubes with a resistance less than that of 2 in. of equivalent spark are not fit for use when measurements are to be made, if, indeed, they are fit for any use at all in X-ray work; and a word may here be added on the importance of a proper disposition of point and plate at the discharges of the coil if the equivalent spark-gap is to be of any use. When a point and a plate are used, the point should always be positive and the plate negative, and uniformity in this respect is much to be desired

The second point for consideration is that of the difference between the total radiation and the fraction which appears outside the tube. This difference is one which the milliammeter cannot possibly indicate, and we are unaware of its magnitude. The method of measurement by the pastilles of Holtzknecht, Sabouraud and Noiré takes this factor into consideration. Differences in the thickness of the glass wall of the tube might make some corrections necessary before arriving at the X-ray emission from the measurement of current, but probably the corrections would not be very large with tubes of average character.

A more important element in this connection is the different proportion of rays absorbed by the wall of the tube when the rays are soft or hard respectively. For very soft tubes the X-ray production may be absorbed entirely by the glass of the tube, as has been shown by W. Seitz, with a tube having an aluminium window. He found that a tube which was too low to emit X-rays under ordinary circumstances gave out abundance of easily-absorbed rays, which were able to penetrate the aluminium, though completely absorbed by the glass wall of the tube.

The third question may probably be answered in the affirmative, for the indications given by the glow-light oscillograph of Gehrcke show that the current can be rendered unidirectional by the use of a Villard valve tube, and that the discharges through an X-ray tube are of the nature of very short impulses or rushes of current, which are probably of uniform efficiency in starting the cathodal stream, and therefore the X-rays. The ordinary dead-beat milliammeter is capable of indicating the average current correctly, when that current is made up of a series of isolated impulses separated by intervals, provided that the impulses are uniform in strength and recur at sufficiently frequent intervals.

The fourth question is one for which an answer can readily be found, for it only involves a measurement of the distance from anticathode to skin surface. Certainly the Holzknecht pastille was convenient, because it was placed upon the surface of the patient, and therefore obviated the need for any measurement of the distance between the radiant point and the surface exposed to the rays. A more difficult procedure is that rendered necessary by the comparative insensitiveness of the pastilles of platino-cyanide of barium, for they have to be fixed at a point intermediate between the tube and the patient, involving measurements more difficult to make than those of the simple distance from the anticathode to the surface of the patient or the photographic plate.

CORRESPONDENCE.

OBSERVATIONS ON THE MERCURY ARC AND SOME RESULTANT PROBLEMS IN PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have just seen in *The Electrician* for May 11, 1906, the account of a Paper by Mr. Bastian on his interesting mercury vapour lamp. In this Paper Mr. Bastian refers to measurements of luminous intensity made at the Laboratoire Central d'Electricité. Allow me, therefore, to mention some curious phenomena of hetero-chromatic photometry presented by the measurement of candle-power of mercury arcs in comparison with ordinary incandescent electric lamps.

The tube of the lamp having been placed at right angles to the axis of the bench was at the moment of balance at a distance of 1 86 metres from the photometric screen (and not from the standard, as has been stated in error). The apparatus employed was of the "Lummer-Brodhun contrast" type, and the standard was an incandescent electric lamp of a well-known make. The calculation of candle-power gave 14 decimal candles. But when the mercury lamp was placed at a distance of 21·50 metres from the screen of the photometer the measurement was 25 decimal candles.

This result, which at first sight appears abnormal, was considered at the laboratory to be a consequence of the well-known Purkinje phenomenon. Mr. Bastian thinks that, in addition to this phenomenon, two other causes might have affected the results. First of all, he calls attention to the dimensions of the luminous source, which cannot be considered as a point. Speaking from memory, the luminous tube was not longer than 20 cm., and 1 cm. in diameter. The maximum angle of the luminous beam falling on the photometric screen was therefore twice the angle whose tangent is $\frac{10}{186}$, or about 6°–10′.

The illumination produced by a source of light of these dimensions can easily be calculated, taking into account the obliquity of the rays, and making only the hypothesis that the radiation follows the cosine law through an angle of emission of 3 deg. around the normal. The error made in the calculation of illumination by applying purely and simply the law of the inverse square of the distance is less than $\frac{2}{1000}$, which is negligible in the case we are considering.

Mr. Bastian also thinks that differences in the transparency of the air for the different radiations could explain the result given above. Between the first and second experiments the thickness of the air traversed varied from 1 metre to 8·6 metres on the side of the incandescent lamp, and from 1·86 to 21·50 metres on the side of the mercury lamp. It would, therefore, be necessary to admit that the loss of yellow and red radiations for an increased thickness of 7·6 metres of air was considerably more than the loss of the green radiation for 19·6 metres. It seems difficult to admit that ordinary air could have such an absorbent action on the usual luminous sources. On the contrary, it is generally agreed that the air in the neighbourhood of the earth is more transparent for yellow and red radiations than for radiations of shorter wave-length, and the yellow colour of the light from lighthouses at a great distance seems to bear this out.

The following experiment which was made at the time of the tests shows that the physiological phenomenon of the eye known under the name of Purkinje is capable of causing abnormal results in the measurements which we are discussing.

In making photometric measurements with short distances it had been noticed that systematically different results were obtained for the equilibrium position of the photometer according to whether the eyepiece of the apparatus was observed with the eye normally open, or, on the other hand, with the eyelid lowered, so that the luminous field of the photometer was observed with the eye almost closed. A disc of cardboard pierced with a small pin hole was therefore placed in front of the eyepiece of the photometer and measurements were made with this cardboard in place as a diaphragm. With a distance of 1·9 metres between the lamp and the photometer screen, measurements were obtained giving a candle-power of 17 decimal candles, or even 22 candles according to the dimensions of the diaphragm. It seems, therefore, that these variations depend upon the physiological sensibility of the eye, which differs according to the colour and quantity of the light received by the retina.

With the smallest diaphragm the sensation of the difference of colour is very small, but the sensibility of the eye for measurement is much diminished.

I would add that these experiments were made by two observers, and, although their results differed systematically, they were nearly always proportional.—Yours, &c.,

F. Laporte,
Sous Directeur du Laboratoire Central d'Electricité.

THE GLASGOW CORPORATION TELEPHONE SALE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The remarks in the two editorial notes on p. 488 of *The Electrician* do not do full justice to the "difficult position" in which the Glasgow Corporation have been with regard to their telephone system, nor do they touch at all on the real reasons for the sale of the system.

There seems to be an impression that the Corporation would willingly continue in the telephone business could they be assured of a renewal of the licence in 1913. Perhaps they would, but it is extremely unlikely, for the simple reason that the system has been a failure—technically and financially, and as a growing telephone business. The service has been so inferior, owing to the adoption of the obsolete call-wire method of working, that the Corporation system has been unable to compete with the National Telephone Co., which for a long time past has done all the telephone development of the Glasgow area; the capital expenditure and working expenses have been so much greater than was anticipated that all expectation of making the system a commercial success has long ago disappeared.

For some time the Corporation system has virtually ceased to grow. To put the service on a modern basis, so as to enable the business to develop, would require the expenditure of a large capital sum, and to cover the resulting increase in fixed charges would require an advance in the rates charged for the service. These facts have been apparent for at least two years, but the Glasgow Telephone committee, already committed to a very much larger capital expenditure than that anticipated, and confronted by a relatively decaying business, have shrunk from the further difficulties that a costly reconstruction of the system would involve.

The failure of the biggest experiment in municipal telephony is due to errors in design, errors in organisation, errors in estimates, errors in rates—in short, to generally erroneous ideas on all the main features of the telephone business. The cumulative effect of these errors has created such a "difficult position" that nothing worse could happen to the Glasgow Corporation than to be compelled to carry on the telephone business. The sale is a lucky escape from an impossible situation.—Yours, &c., HERBERT LAWS WEBB.

35, Old Queen-street, Westminster, S.W.,
July 17.

PARLIAMENTARY INTELLIGENCE.

NATIONAL PHYSICAL LABORATORY TESTS.

The following two questions were asked in the House of Commons last week by Sir BENJAMIN STONE: (1) To ask the Secretary to the Treasury whether he is aware that commercial, mechanical and physical tests such as the determination of the tensile and compressive strength of structural materials, the determination of the electrical conductivity of materials, the determination of melting points of solids and liquids, the determination of the calorific value of fuels and the photomicrographical examination of metals and alloys are being undertaken at the National Physical Laboratory, or are included in the circular of charges of the laboratory; that, under the heading of testing of materials of construction, they offer to test shafts, joints, ropes and chains; and, if so, whether such competition with private practitioners will be stopped, in view of the recommendations of the Treasury Committee in 1898, that it would neither be necessary nor desirable to compete with or interfere with the testing of materials of various kinds as now carried out in private or other laboratories.

(2) To ask the Secretary to the Treasury, whether commercial tests of any kind (with the exception of the standardisation of instruments) have been or are being undertaken for private firms or individuals or public companies at the National Physical Laboratory; and whether the full and complete results of all such tests (with the exception of the standardisation of instruments), which may have been undertaken for private firms or individuals or public companies, have been published.

In a printed answer to the first question Mr. M'KENNA said that the National Physical Laboratory was established as a public institution for standardising and verifying instruments, for testing materials, and for the determination of physical constants. The mechanical and physical tests referred to in the question formed part of the work of such an institution and were contemplated when it was founded. The last sentence of the question was not one of the recommendations of the Report of 1898, but was taken from clause 9 and should be read in connection with the rest of the Report, which clearly contemplated such tests. The Committee had always borne in mind the desirability of not interfering with work which was or could be satisfactorily done outside the laboratory; but there was considerable difficulty in laying down a precise definition of the classes of work which might properly be undertaken by the laboratory. He was, however, in communication with the Royal Society on the subject, with the view of ascertaining whether the existing regulations required amendment.

Replying to the second question, Mr. M'KENNA said that mechanical and physical tests were undertaken for private firms at the National Physical Laboratory. The general practice had been in cases in which the results appeared likely to be of scientific interest to ask permission to publish before undertaking the work; and in no case had permission been refused. The point should be considered in connection with the other matters referred to in the answer to the preceding question.

LONDON ELECTRIC POWER BILLS.

Since the presentation of the report of the Committee which dealt with the London County Council Electric Power Bill, the following bills relating to electric power supply in London have been withdrawn: Charing Cross, West End and City Electricity Supply, City of London Electric Lighting, West End Electric Undertakers Association, South Metropolitan Electric Light and Power, Shoreditch and Stepney Electricity and the London Electric Supply Corporation. This still leaves the Administrative County of London and District Electric Power Bill waiting for second reading in the House of Commons, which has been officially set down for Monday next, July 23.

LANCASHIRE ELECTRIC POWER BILL.

On Thursday and Friday last week, a Committee of the House of Lords considered this Bill, which was unopposed in the House of Commons. The circumstances of the promotion are somewhat interesting. In 1900 the Lancashire Electric Power Co. was given the whole of the County of Lancashire, south of the River Ribble, for the purposes of electric supply, such supply, however, being restricted to authorised distributors, a condition which has frequently been held responsible for the comparatively little progress made with the scheme up-to-date. This year, the company sought to extend the sphere of its operations in order to enable it to supply railways, canals, &c., and persons requiring a supply of electrical energy for power purposes. There was a limitation that the consent of the authorised distributor was essential in all cases, subject to an appeal to the Board of Trade should the company think that any consent was unreasonably withheld. These proposals brought about a storm of opposition and no less than 64 local authorities petitioned against the bill. In fact, so severe was the opposition that the bill was actually blocked in the House of Commons, and was not allowed to go through the necessary stages to bring it before a committee. In order to prevent the bill being absolutely lost for the session, a conference was held with the local authorities, and the terms upon which it was agreed to withdraw opposition were that the company should only be allowed to supply direct to railway companies, the local authorities admitting that this was a class of business which they themselves could not cater for. Thus all reference to canals, &c., and power users was struck out of the bill (which eventually passed the House of Commons unopposed), the company agreeing not to supply in the area of an authorised distributor without consent, and this clause was extended to all districts for which provisional electric lighting orders were granted up to the year 1908. In this way the local authorities have an absolute veto in the matter.

Before the House of Lords Committee there was one opponent—viz., the Rochdale Canal Co.—whose petition asked that the Power Co. should, at any rate, be compelled to give this Canal Co. a supply in common with the railway companies, with whom there was competition as regards goods carriage.

The Hon. J. D. FITZGERALD, K.C., on behalf of the Canal Co., said that there were 25 miles of the canal in Lancashire and 15 miles in Yorkshire. In Yorkshire, under the terms of the Yorkshire Power Co.'s Act of 1901, the Canal Co. could obtain a supply of electrical energy direct, whereas in Lancashire, which contained the most important section of the canal, the supply could only be obtained from the various authorised distributors, who numbered eight, unless they consented to Power Co. giving the supply, which, of course, they could not. It was notorious, he said, that the canals of this country were in a very backward condition, and it was now the policy of Parliament to assist them wherever possible; but the bill was giving a preference to his competitors, and to this he had the strongest possible objection. The alteration in the bill in this respect had been made without the knowledge of the Rochdale Canal Co., otherwise they would have opposed in the House of Commons.

Mr. F. E. GRIPPER, managing director of the Lancashire Electric Power Co., said that whilst the company had been compelled to modify the bill as it now appeared before the Committee, yet he was of the opinion that the supply to canals would be of too small a character to justify the company anticipating a large revenue from that source. It was a supply that could be dealt with more effectively by the various supply authorities en route. The cost to the Power Co. of laying the necessary mains to supply the whole length of the canal would be so great that they would have to ask for a guaranteed minimum consumption of such an amount that it would be prohibitive from the Canal Co.'s point of view.

Mr. FITZGERALD, in addressing the Committee for the Rochdale Canal Co., said that the bill had been altered only in consequence of the unfair and improper pressure brought to bear upon the Power Co. by the local authorities. It had been the original wish of the company to supply canals, and the evidence now given was hardly consistent with the bill as deposited.

A number of local authorities were represented by counsel to petition against any alteration in the bill, the plea being that it would be breaking a bargain entered into between the local authorities and the Power Co. upon the strength of which the bill was allowed to go forward. In fact, it was hinted that if the alteration asked for were made, the bill would be again blocked in the House of Commons, when the Lords' amendments were considered, and in all probability lost for the session. Amongst the towns thus appearing were Rochdale, Burnley, Blackburn and Accrington.

Mr. RAM, K.C., for the promoters, supported the views expressed by the local authorities, admitting that the company was "between the devil and the deep sea."

Several questions were put by the Committee as to why a differentiation should be made between railways and canals, but Mr. RAM urged that the bill would assuredly be blocked in the House of Commons if it were altered. He said that it was open to the company to supply canals if the local authorities gave consent.

The Committee, after deliberation, decided to send the bill forward without amendment.

EDINBURGH CORPORATION BILL.

A House of Lords Committee considered this bill last week. Included in the bill is the proposal to construct a short length of electric tramway practically in the centre of the existing cable system, which is run by a company under a lease from the Corporation. The Corporation sought to bring the new tramways within the lease, but the company objected unless it were worked on the cable system. The effect of introducing a short length of line worked on a different system, it was argued, would be to constitute it a separate undertaking, which, by its very nature, could not be remunerative. In the end the Committee sanctioned the construction of the line, which, if it be worked on the cable system, is to be brought within the terms of the company's lease as provided therein, but if worked electrically then it is to remain outside the lease, and the company will not be bound to work it.

CORPORATION OF LONDON (BLACKFRIARS AND OTHER BRIDGES) BILL.

When this bill came up for third reading in the House of Lords on Monday, Lord WELBY moved that a clause be inserted giving protection to the Metropolitan Water Board and the gas companies against damage to their pipes by electrolytic action in consequence of the use of electric traction upon the tramways which it is proposed to run over the widened bridge.

After some discussion, in which it was indicated that the Government preferred to leave this matter in the hands of the Board of Trade, the motion was withdrawn and the bill passed.

WIRELESS TELEGRAPHY BILL.

The amendments made in the House of Lords to the Wireless Telegraphy Bill, 1906, came up for consideration in the House of Commons on Friday last week. As originally introduced into the House of Commons the bill extended the control of the Government over the wireless telegraph industry, as provided for in the Act of 1904, from 1906 until 1912—viz., six years. In this form the bill passed the House of Commons, but in the House of Lords the Earl of Granard, on behalf of the Government, agreed to reduce the period to three years—viz., 1909. Since then considerable discussion has taken place regarding the necessity for any extension of the Government control whatever, and statements have been issued both by Lloyds and by the Marconi Co. (See *The Electrician*, June 15, p. 343.)

On Friday, in the House of Commons, Lord BALCARRES suggested that the bill should be placed within the scope of the Expiring Laws Continuance Bill. In this way it would be continued from year to year at the discretion of Parliament. His reason for this was that the bill practically conferred a monopoly upon the Marconi Co., and during the next three years very great developments might be anticipated.

Mr. HENNIKER-HEATON said the Marconi Co. would be placed in a better position if the bill were rejected; in fact, he had authority for saying that the company would rather welcome the defeat of the bill.

Mr. SYDNEY BUXTON (the Postmaster-General) said that the bill merely continued the policy of the late Government. It was the intention to give free play to all systems of wireless telegraphy, and should anything arise within the period of three years to warrant the introduction of an amending bill this could be done. The only object of the bill was to give the Postmaster-General some control.

The bill was then agreed to with the period of three years inserted.

MISCELLANEOUS.

The Unopposed Committee of the House of Commons passed the following bills on Thursday last week: Folkestone, Sandgate and Hythe Tramways, Southport and Lytham Tramroads (Extension of Time), County of Durham Electric Supply and the Newcastle-on-Tyne Electric Supply. They have all been passed by the House of Lords, and their objects were stated in our columns at the time.

The Cumberland Electricity and Power Gas Bill and the Folkestone and District Electricity Supply Bill were passed a third time in the House of Commons on Monday. The Metropolitan Electric Supply Bill was read a second time.

The Shropshire, Worcestershire and Staffordshire Electric Power Bill is now proceeding unopposed.

The following bills were read a third time in the House of Lords on Monday: London United Tramways, Twickenham and Teddington Electric Supply, London County Council (General Powers) and Corporation of London (Blackfriars and other Bridges).

The South Wales Electrical Power Distribution Bill was read a third time in the House of Commons on Thursday last week.

The Derbyshire and Nottinghamshire Electric Power Bill and the Ascot and District Gas (Electric Lighting) Bill were read a third time in the House of Lords on Friday.

The Unopposed Committee of the House of Lords considered and passed the following bills on Tuesday: St. Pancras Electricity, Hackney Electricity, North-West London Railway and the Watford and Edgware Railway. They have all passed through the House of Commons and were then dealt with in these columns.

LEGAL INTELLIGENCE.

Sartorius v. Northey.

This case came before the Lord Chief Justice and a special jury on Wednesday. Plaintiff (Major-General Harry Sartorius, V.C., C.B.) sought to recover from defendant (Mr. Percy Northey, electrical engineer) £3,563 as damages for loss sustained through the alleged negligence of defendant in making a valuation of the electric carriages, plant and other assets of the Antivibrator Co. (Ltd.) Plaintiff, having been applied to for an advance of £4,000 to the company, employed defendant to make a valuation to satisfy himself as to the security, and on the faith of defendant's valuation (at £5,964) plaintiff advanced the money, but on the company going into liquidation the property was only valued at £963.

Defendant denied any negligence.

The jury found for defendant, with costs. Judgment accordingly.

Ellis v. Bridge & Co.

At Winchester Assizes, before Mr. Justice A. T. Lawrence and a special jury, last week, the second trial of this action took place. Plaintiff, on the advice of his doctor, underwent a course of Röntgen-ray treatment, defendants agreeing to administer it to plaintiff, charging him 2s. each application. Plaintiff was treated 10 or 11 times, but the doctor was not present, and defendants' assistant (a Mr. Keen) used, it was alleged, to leave plaintiff alone while the X-ray was being administered. Plaintiff said the machine emitted great sparks, and once or twice gave him a great shock, but being quite ignorant he made no complaint to his doctor. In the beginning of 1905 his feet began to blister and he suffered intense pain. Eventually the soles of his feet sloughed off, and he has never since been able to put his feet to the ground and walk.

Mr. CHISHOLM WILLIAMS, surgeon, and superintendent of the X-ray department of West London Hospital, said that it was evident plaintiff had been placed much too near the instrument. In cross-examination he admitted that frequently even doctors were burnt, but that 12 in. to 18 in. was the proper distance for a patient to be placed, and certainly not 2 in. or 3 in. The treatment could be used in plaintiff's ailment, but the person administering the rays should be there so as to judge what effect the rays had on the patients. He would only allow a doctor to administer the rays; but he knew that often men who were not doctors had done so in years past.

Mr. ORD (plaintiff's medical adviser) said that he had never himself administered the treatment, and he had only studied the subject from books; but he thoroughly trusted defendants, and he merely told them the parts to which it should be applied and the length of time the application should last.

For the defence it was contended that defendants were not liable for the mistake of the doctor, and evidence was given to show that it was essential that a doctor should always be present as well as the person who administered the Röntgen-ray treatment.

Mr. BRIDGE said that he used one of the earliest apparatus of Röntgen-ray machines.

The ASSISTANT (Mr. Keen) said that he told Mr. Ord that he administered the treatment only under medical directions, and that he was quite certain that plaintiff's feet were never nearer than 12 in. from the instrument.

Expert testimony was given to the effect that everything had been conducted properly, and the doctors who had examined plaintiff as late as the beginning of the present month stated that it was a bad case of locomotor ataxy, and that the terrible state of plaintiff's feet was due only to the X-ray treatment being too frequent, and not because plaintiff was placed too close to the instrument.

The jury returned a verdict for defendants, and judgment was entered in accordance with the finding.

Auto-Controller and Switch Co. v. John Barker & Sons.

At Manchester Assizes on Wednesday Mr. Justice Bray concluded the hearing of this action for the recovery of the value of a motor and controller supplied by plaintiffs to work an electric lift.

Defendants last year supplied a Reddish firm with a lift, which was to be fitted with an efficient controller. In August Mr. Bush, a partner in plaintiff company, inspected the lift after it had been installed and he recommended that as it was not working satisfactorily the controller be replaced by one of plaintiffs' manufacture. The action was in respect of this second controller (which defendants said was inefficient) and also for a motor and controller installed at Leeds. Plaintiffs said they gave no guarantee with their new controller, but it did its work efficiently, and the inefficiency complained of was due to a misadjustment of the valve and to the controller having been subjected to excessive current and improper handling on the part of defendants' servants.

After hearing a mass of technical evidence, the Judge held that there was no proof of plaintiff's controller being inefficient, and gave judgment for them for £138. 13s. 7d. and costs.

Fuller v. Bernstein.

At Shoreditch (London) County Court last week plaintiff sued for the recovery of £6. 3s. 2d., paid for electrical fittings which it was alleged defendants had no authority to sell.

PLAINTIFF said he took a shop at Ilford from defendant, and agreed to pay £11 for electrical fittings, an arc lamp, &c. Subsequently he received a demand from Ilford Council for a quarter's hiring of the fittings, and he was then informed that defendant had no right to sell the fittings. The amount he claimed was inaccurate, as he gave a bill for £10, which he met. He wrote to defendant pointing out the claim made by the Council, and read a reply that if the bill were sent to him (defendant) he would put everything right with the Council. Plaintiff declined to pay the rent until something definite was done, and defendant thereupon signed a warrant of execution for the recovery of the amount and it had to be paid.

Mr. HERBERT KING, chief clerk at Ilford Electricity department, said the previous tenant to plaintiff (Mr. Sidney Read) signed a hire purchase agreement in conjunction with defendant for the electric fittings and arc lamp. The cost of the installation was £6. 3s. 2d. Defendant had no right to have sold the fittings as they were the property of the Council until the hiring instalments had been paid, and could not be moved without their permission.

DEFENDANT said that he told plaintiff at the time of the purchase that the goods did not quite belong to him, but that at any time he desired to move he would complete the purchase so that they could be taken away. That he had actually done regarding the arc lamp, which he settled for on June 22. It was agreed that any bills that came in from the Council should be sent to him (defendant) and he would settle, and he was willing to do so only plaintiff never would let him have them.

His HONOUR: But what I would like to know is how you came to dispose of a quantity of fittings which had been obtained on hire?

DEFENDANT: By arrangement with an official of the Council. It was agreed that I should be allowed to dispose of them, but all the same they would not have been my property until fully paid for.

His HONOUR: Then is it not obvious to you that you were professing to sell what did not belong to you?

Defendant asked for an adjournment to prove the arrangement with the Council.

His HONOUR: No adjournment could possibly do any good. If you attempt to sell goods which have been obtained on the hire system it is illegal and no arrangement can be come to legally to allow you to do so. There will be judgment for plaintiff for the amount claimed with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The District Council of Annfield Plain require the services of a competent person to report on the question of electricity supply for the district. Particulars from the clerk to the Council, Mr. T. L. Watchman, until July 21. See also an advertisement.

Acton District Council require an experienced general clerk and commercial assistant in their electricity department. Salary £100, rising by annual increments of £10 to £130 per annum. Form of application, &c., from the resident electrical engineer (Mr J. Martin Blair), 130, Churchfield-road, Acton, W. Applications to the clerk to the Council (Mr. Wm. Hodson), 242, High-street, Acton, W., by July 30. See an advertisement.

The Council of the University of Leeds invite applications for the appointment of assistant lecturer and demonstrator in electrical engineering, to date from Sept 1. Salary £175. Applications by Aug. 1 to the Registrar, from whom particulars can be obtained. See also an advertisement.

A daughtsman, accustomed to high and low-tension switchgear, is required by Ferranti Limited, Hollinwood, Lancs. See an advertisement.

A vacancy occurs for a premium pupil at Whitby District Council's electricity works. Particulars from the electrical engineer, Mr. L. H. King See an advertisement.

An engineer and clerk of works is wanted for addition to electric power station and to act as clerk of works during construction. See an advertisement.

There are vacancies at Portsmouth and Malta Dockyards for thoroughly good men for the following positions: Three switchboard attendants and two jointers at Portsmouth; two station supervisors, one mains and distribution supervisor and one jointer at Malta. Particulars from the Electrical Engineer, H.M. Dockyard, Portsmouth, on or before July 21.

An assistant lecturer and demonstrator in electrical engineering is required at the University of Birmingham. Stipend £150 per annum. Applications to the secretary, Mr. Geo. H. Morley, by July 20.

An assistant, to teach electrical engineering and practical mathematics, is wanted at Darlington Technical College. Commencing salary £120.

Exeter Council require a depot foreman with experience in electric-traction equipment and rolling stock. Salary £2. 2s. per week. Applications by 28th inst.

Heston and Isleworth Council have appointed Mr. P. E. Rycroft (of Islington) resident electrical engineer. The three candidates selected for interview by the Council were P. E. Rycroft, J. G. Doran (Bermondsey) and A. P. MacAlister (Battersea).

Mr. H. W. Laing, of the Cambridge Motor Omnibus Co., has been appointed general manager of the Blackpool, St. Anne's, and Lytham Tramways Co., in succession to Mr. Guthrie, deceased. Mr. Laing was originally connected with the Bury, Rochdale, and Oldham Tramway Co., and was subsequently at Paisley and Cambridge.

Mr. G. R. Blackburn, assistant electrical engineer in the Bradford tramways department, has been appointed rolling-stock superintendent of the Manchester tramways at £300 per annum.

Mr. F. H. Edwards, A.M.I.E.E., of Gunnorsbury, W., has been appointed station engineer in the electricity department of Woolwich Council.

American Exports to the U.K.—Exports from New York to the United Kingdom during 1905 included electrical instruments and appliances to the value of £322,000, and electrical machinery £117,700.

Ashton-under-Lyne.—The Council have applied for sanction to a loan of £17,000 for electricity supply extensions.

Australasia.—A profit of £13,900 (against £13,600 in previous year) was made by Melbourne Corporation electricity department to the year ended February.

The Australian General Electric Co. have supplied to the Duke & Main Leads Consols Co., Maryborough (Victoria), electric pumping plant. Current is supplied by a continuous-current dynamo, coupled by a Belliss engine to a c.c. motor which operates a three-stage centrifugal pump, capable of lifting 1,200,000 gallons of water in 24 hours.

The Federal Government have decided to defer the adoption of the toll system of telephone charges until the Postmaster-General (Mr. A. Chapman) returns from Europe.

Mr. T. Rooke, city electrical engineer, has submitted a modified scheme for an extension of the Sydney electric supply mains to Camperdown. It is proposed to lay a h.t. underground cable into the University grounds, and an overhead cable from thence to Camperdown, with transformers at various sub-stations. The initial cost is estimated at £1,000, and the annual revenue at £450. The Electric Light committee have approved the scheme.

Our Australian correspondent states that P. Boll & Co., who supplied the plant for Kerang electricity supply, have put before Echuca Council a similar scheme.

The "Australian Mining Standard" says St. Kilda Council proposes to take current for lighting from the power station of the new St. Kilda–Brighton tramway. Moorabbinshire Council have asked the Government to extend the tramway from Middle Brighton to Mordialloc and Cheltenham, two favourite summer resorts.

At the recent meeting of the Taswall (Tasmania) Coal Co. the chairman (Mr. D. Ritchie) said the company's new electric haulage plant was nearing completion, and would enable the face to be worked some distance further.

Midland Junction (W.A.) Council recently decided to carry out an extension of their electric lighting plant, and it has been decided to raise a loan of £3,500 at 4½ per cent. for the purpose. Particulars of a contract for the supply of plant are given in another column.

Broken Hill (N.S.W.) Council are to put down additional plant to provide electric current for street lighting. It is intended at the outset to light a portion of the town by 75 arc lamps and to impose a special rate of 4d. in the £ on the area so lighted.

Barnes.—The Council last week decided to convert the remaining gas lamps (about 40) to electric lamps at a cost of about £4 per lamp.

Bray.—The Council have referred to a special committee the question of the sale of the electricity supply works to a company.

Brighton.—The Lighting committee have taken premises in North-street for conversion into showrooms for exhibiting electric light fittings, motors, &c.

Cardiff.—The relative advantages of holding an electrical exhibition or of fitting up a showroom for exhibiting fittings, motors, &c., is to be reported upon by the borough electrical engineer and manager, Mr. Arthur Ellis.

Chili.—The "Diario Officiel" for June 5 contains the text of the laws authorising Don Rafael Edwards to construct an overhead trolley electric tramway in Talca and Don Antonio Cagliastri to erect electricity works at Taltal.

Coventry.—On Tuesday the Council adopted a recommendation of the Electric Lighting committee to supply and erect additional arc lamps and posts at a cost of £800.

The committee had considered the question of lighting the streets by electric light and gas, and they considered the proposal would be more economical.

The Chairman (Mr. HILL) said a deputation had been to Leicester where gas was used, and they were impressed with the superiority of the electric light.

Customs Duties.—It has been decided that electric coin-in-the-slot meters are, under the Australian Commonwealth tariff, free of duty, being classified as "electrical materials." Telegraphic codes are also admitted free, as "books, printed, &c."

Devonport.—The contract between the Council and the Devonport & District Tramways Co. for the supply of electric current having terminated by efflux of time, and as the negotiations for renewal have proved futile, the question of the price to be paid by the company for electrical energy will probably be referred to arbitration.

Dundee.—The rails of the Perth road tramway route are to be renewed at a cost of £4,400.

Electrical Association of Victoria.—At the recent meeting of this Association it was decided to abolish the classification of Associates, as the division into Members and Associates has been found unsatisfactory. The present Associates become Members.

Excess Passengers on Tramcars.—West Ham Tramways committee have sent a deputation to the Home Office to urge that the licensing of municipal tramways should be transferred from the police to the local authority, but in the event of this not being conceded, they ask that no objection be raised by the police in licensing tramway cars to such limited number of passengers to stand inside as is sanctioned by the Board of Trade.

Electric Lighting Notices.—Companies and others who propose to apply for provisional electric lighting orders have to give local authorities notice of their intention by July 1. Notices have been given in the following cases:—

Aspull.—Lancashire Electric Power Co.
Beverley.—Foote & Milne.
Bodmin.—Foote & Milne and Western Electricity Corpn.
Brentwood.—Electrical Works Development Co.
Burgess Hill and *Portslade.*—Mutual Electricity Supply Co.
Chertsey.—Camberley Electric Supply, Foote & Milne and Mutual Electricity Supply Co.
Chippenham and *Honiton.*—Western Electrical Corpn.
Cirencester.—Seymour Williams & Co.
Dalkey.—Irish Electrical Agency.
Egham.—Foote & Milne, Mutual Electricity Supply Co. and Egham Electric Supply Synd.
Friern Barnet.—A company.
Hemel Hempstead.—Empire Electric Light & Power Co., and Mutual Electricity Supply Co.
Herne Bay.—Three companies.
Holbeach.—Mutual Electricity Supply Co.
Huntingdon.—Electrical Works Development Co.
Ledbury.—Foote and Milne.
Littlehampton.—Mutual Electricity Supply Co. and another company.
Romford.—Mutual Electricity Supply Co.
Runcorn.—Crompton & Co.
St. Albans.—St. Albans & District Electric Supply Co. (to authorise transfer of existing order to North Metropolitan Electrical Power Distribution Co.).
St. Mellons.—Rhymney Valley & General Electric Supply Co.
Sevenoaks.—Mutual Electricity Supply Co.
Standish.—Tahourdins and Hitchrofts (for a company).
Stroud.—Mutual Electricity Supply Co.
Thornhill.—Electrical Distribution of Yorkshire (Ltd.)
Truro.—Foote & Milne.
Wath.—Electrical Distribution of Yorkshire.
Wellington (*Somerset*).—A company.
Windsor (*Rural*).—Foote & Milne and Camberley Electric Supply Co.
Wrotham (*Kent*).—Mutual Electricity Supply Co.

Exeter.—The Electric Lighting committee recommend that the charge for electric current for power be reduced to 2d. per unit to consumers of not less than 2,000 units per half-year.

Fatalities.—At Cwmneol Colliery, Cwmaman, on Wednesday, two men (named Williams and Hunter) who were engaged in fitting up an engine, received fatal electric shocks as the result of an accidental contact between a fly-wheel, which was being raised by chains, and an insulated conductor, the insulation of which had been cut by the flywheel.

Fulham (London).—The use of electric arc lamps in the public baths has resulted in a saving of 30 per cent. in the lighting bill, and the capital cost of the lamps will be practically saved during the first year of use.

Cables are to be extended, at an estimated cost of £196, to meet an increased demand from the London & District Motor 'Bus Co. for current for power and lighting.

Gravesend.—The Council have decided to supply electricity for outside arc lamps at 3d. per unit. The electricity department is to undertake the supply of lamps and brackets and carbons and maintain the lamps, with the exception of globes, for 1d. per unit, in addition to the ordinary charge (*i.e.*, a total of 4d. per unit); or consumers will have the option of supply through an hour meter, charging 1d. per lamp per hour.

Halifax.—The Council are recommended to extend the tramways from Pellon to Mount Tabor (about 2½ miles) at a cost of £10,750.

Heston and Isleworth.—The Council have authorised the Lighting committee to enter into an arrangement with Brentford Guardians for a supply of electric current to the workhouse infirmary and union offices at 3d. per unit.

Application has been made for sanction to a loan of £4,550 for laying a feeder from the electricity works to the premises of the Guardians, and for adding a panel to the switchboard.

The Council have also applied for sanction to loans of £2,000 for laying additional electric cables, and of £1,000 for house services and meters.

Highgate Tramway Accident.—Islington Works committee have prepared a report on this accident, in which they recommend that the attention of the L.C.C. should be drawn to the necessity for widening Archway-road, Holloway-road, Junction-road, and Highgate Hill at the point where these thoroughfares converge on the tramway terminus.

Huddersfield.—To encourage the use of electricity for power and heating, the Corporation, on Wednesday, sanctioned a revised scale of charges for electric current, with discounts ranging from 2 per cent. to 30 per cent., according to the amount of energy consumed for power.

Ilford.—The management of the tramways has been placed in the hands of the electrical engineer (Mr. A. H. Shaw), whose salary has been increased from £450 to £475, with a further increase of £25 next year. Mr. Shaw has also received a gratuity of £25 for services rendered since Mr. Spurr's resignation.

Inquest.—The adjourned inquest into the deaths of four of the victims of the recent tramcar accident at Swindon was concluded on Thursday last.

Mr. Medcalf, traffic manager, said his attention had been called to the fact that the magnetic brake on the car came on with a jerk, but he thought that was due to there being more than the normal clearance between the thrust block and the rocking lever, and he did not think it rendered the car unsafe.

Mr. E. M. Lacey, consulting engineer, calculated that the car was travelling at a speed of 25 miles an hour when it overturned, and at that speed the car would turn over at a curve whether it contained 200 passengers or none. There were indications that the magnetic brake was holding when the car overturned. The Westinghouse brake was recognised as one of the best brakes, and he had used it on gradients as steep as 1 in 8.

Mr. Aug. Trube, manager of the tramcar department of the Westinghouse Brake Co., said the magnetic brake fitted to the car was used extensively, and had been applied to 150 cars for Birmingham. The noise and jerks, of which complaint was made, were due to excess of clearance between the thrust blocks and the rocking lever, but that would not affect the efficiency of the brake. He thought it was an error on the part of the driver to believe that the brakes failed to act. Constant jumping would make no difference to the brake in a day's working.

The jury returned a verdict of accidental death. They exonerated the driver, but considered that the electrical engineer was lacking in judgment in not sending the car to the shed. They considered that the brakes were not in perfect working condition when the car left the top of the hill, and that there had been general slackness on the part of the Tramways committee and Corporation officials in not enforcing their bye-laws.

Islington (London).—The Lighting committee have provisionally decided to charge consumers of 50,000 units of electricity per annum for lighting at 3d. per unit.

Italy.—The "Gazetta Ufficiale" for July 10 contains a copy of a law authorising the construction of an electric railway between Spezia and Pegazzano.

Japan.—The Imperial Government has sanctioned the construction of an electric railway in the city of Moji, and its extension to Hakata is under consideration.

Light Railways.—The Light Railway Commissioners have signified their intention to grant an order authorising the construction of tramways between Aldershot, Farnborough and Ash. The tramways will run through Queen's-avenue, which passes through the military camp, and connects Aldershot with Farnborough. The promoters propose to carry the tramways through North Camp for the conveyance of the troops to the Ash ranges. Messrs. J. Browne-Martin, Arthur Greenwood, H. C. Walker and R. A. Smith are the promoters, and arrangements have been made with the National Electric Construction Co. for financing the scheme.

The Light Railway Commissioners have refused to grant an order for the construction of the Gainsborough and district light railway.

London County Council.—On Tuesday the Parliamentary committee brought up their report on the L.C.C. (Electric Supply) Bill, 1906.

Supply of Electricity in Bulk.—The Highways committee's report on this subject, after referring to the Council's bill of this session and to the report of the Select Committee of the House of Commons on the Council's bill (given in *The Electrician* for July 6), emphasises the urgency of the question, and urges that the Council should come to an early decision. The committee are of opinion that the Council should lose no time in preparing a scheme to be laid before Parliament dealing with the supply of electricity in bulk in London and the surrounding districts.

Sir Melvill Beachcroft asked if the Highways committee were to reproduce in effect the rejected bill of last session. The proposed expenditure was essentially speculative, for they would be dealing with ratepayers' money in a matter in which only private enterprise with a large amount of push could be successful. Personally he declined to be responsible for a gigantic enterprise for supplying electrical power throughout not only London but 280 square miles outside London, unless he understood what other undertakings the Council were going in for.

Colonel Rotton and Mr. E. Collins protested against the proposal.

Mr. A. F. Buxton contended that no business man would look at such a speculative undertaking.

Mr. E. Barnes could not agree that it was impossible for the Council to make a success of the proposed undertaking. He gave St. Pancras as an instance of a successful municipal electricity supply scheme.

Mr. B. Straus, M.P., was in favour of the proposal and argued that they should not sanction the creation of unnecessary monopolies.

Mr. Cleland, M.P., thought the scheme would provide a cheap supply of electricity, a vital necessity to the future commercial prosperity of London.

Mr. McKinnon Wood said that throughout all the searching evidence of the last session nothing was said about it being an unprofitable business. Parliament had for some time recognised that the supply of electricity was a proper matter for municipal enterprise.

On a division, the suspension of the standing orders (as recommended by the Highways committee, to enable them to prepare a bill to be submitted to the next Session of Parliament) was carried by 75 votes to 33, and an amendment that "This Council, being of opinion that a cheap supply of electricity for London and the neighbouring districts can be obtained at private risk under conditions which will safeguard public interests, is not prepared in the next session to introduce a bill which will compel the Council to undertake a speculative enterprise involving enormous financial responsibilities" was lost by 67 votes to 32.

Lourenco Marques.—The imports of electric and telegraphic material imported into Lourenço Marques from the United Kingdom in 1905 represented 11¾ tons, value £1,469, out of a total value of these imports of £1,669. The value of these goods in transit through Lourenço Marques for the Transvaal was £32,309, the weight of electric and telegraphic material from the U.K. passing through in this way being 615 tons out of a total of 859 tons. Germany supplied the remainder of these imports.

Lowestoft.—The Council's electricity department will in future undertake the hire and maintenance of arc lamps for private consumers, and the electrical engineer (Mr. Bruce) has been instructed to draw up a scheme.

Manchester.—The arbitration proceedings in connection with the conditions of service of the tramway employés of Manchester Corporation took place on Monday.

Mr. G. R. Askwith was the arbitrator, and the chief point was the men's demand that Sunday labour should be paid at time and a-half. The case for the men was put by Mr. G. T. Jackson, secretary of the Tramway Men's Union, and Mr. J. M. M'Elroy gave evidence on behalf of the Tramways committee. The arbitrator reserved his decision.

Motor 'Buses as Tramway Feeders.—Stoke Newington (London) Council have decided to support the proposal of Islington Council to request London County Council to apply next session for powers to run motor omnibuses as feeders to its tramway system generally and for providing temporary services during the construction or re-construction of permanent way.

Municipal Telephony.—Before proceeding further with their application for sanction to a loan of £7,000 for extending the municipal telephone system, Swansea Telephone committee have decided to again approach the Postmaster-General to request more favourable terms than the £17,000 offered for the Swansea system.

It is reported that the negotiations between Brighton Corporation and the Postmaster-General for the sale of the municipal telephone undertaking are making slow progress. It is stated that the representatives of the Post Office have pointed out to the Corporation that they have already parted with a portion of their undertaking to Hove in the form of the underground ducts. The Postmaster-General's advisers estimate the value of the Hove portion at between £3,000 and £4,000, and they propose to deduct this sum from their valuation of the Brighton system. This valuation is stated to be considerably below what the advocates of the municipal system had anticipated.

Obituary.—The death is announced of Mr. Hy. Towner, secretary of the Eastbourne Electric Light Co. until the electricity undertaking was acquired by the Corporation.

Mr. Jas. Davis, head of Jas. Davis & Co., electrical engineers, &c., Tyrrell-street, Bradford, died on July 11, aged 58.

Major Ricarde-Seaver, who died a few days ago, at one time bestowed much of his time and attention on the notorious "Keeley motor," and was responsible for some delay in the exposure of that imposture.

The death occurred suddenly on Wednesday of Mr. John Fyfe, who built the rows of shops and houses comprising "Electric-avenue," Brixton, London. He also provided in that thoroughfare one of the earliest successful examples of outside arc lighting on a large scale. Other notable examples of arc lighting on the Fyfe-Main system include the "Daily Telegraph" offices in Fleet-street, London.

Ossett.—The L.G. Board have refused to sanction a loan of £3,500 for electricity works on the grounds that there was no evidence at the local inquiry of a real demand for electric current and that the scheme would be unremunerative for some years.

Overhead Telegraph Wires.—At Kingston (Surrey) County Court on Friday the dispute between the Postmaster-General and Kingston Corporation in respect of the applications of the Post Office to construct overhead telegraph lines was entered for hearing, but it was announced that a settlement had been arrived at out of court.

The terms of the arrangement made between the parties and adopted by his honour Judge Russell are that the Postmaster-General, in erecting certain overhead telephone wires with posts in certain specified streets in the borough, binds himself to place such wires underground when the number of wires along any portion of route exceed 32, retaining only such posts as may be necessary for distribution purposes.

At Woolwich Police Court on Wednesday, Mr. Rose sat as arbitrator to determine a difference between the Postmaster-General and Woolwich Council as to the placing of telegraphic lines in certain thoroughfares.

The TOWN CLERK (Mr. A. B. Byrceson) said the point at issue was as to whether there should be overhead or underground lines.

Mr. R. NOYES, assistant solicitor to the Post Office, submitted that the objection of the Council was not reasonable. The Council had not given any help to the Postmaster-General in his desire to meet the requirements of the public. The underground system would be expensive, and the district was an outlying one.

After hearing expert evidence, Mr. ROSE reserved his decision.

Pernambuco (Brazil).—Negotiations have been opened with a British syndicate by the Companhia Ferro Carril de Pernambuco, who own the local tramways (about 14½ miles in length), for the sale of their undertaking. The traction is at present by mules, but the British syndicate propose to convert the system to electric traction, and to give a supply of electricity for lighting and power in the city and suburbs. It is stated that the British syndicate also propose to acquire the Brazilian street railways, the Companhia Trilhos Urbanos de Recife a Olinda e Beberibe and other undertakings.

Printers' Exhibition.—There is being held at the Agricultural Hall, London, N., until July 31, an instructive exhibition of machinery, plant, apparatus and accessories relating to the printing and allied trades. There are a number of exhibits at this exhibition which are of general interest. Photo process engraving and some of the apparatus used in this work is shown, and the fact that much of the machinery is electric-motor driven (this work being of specialist character), the exhibition has an added interest for many of our readers.

Provisional Order Revocation.—The Board of Trade have revoked the Liversedge Electric Lighting Order, 1900.

Smethwick.—The Tramway committee are considering the Empire Electric Light and Power Co.'s application for consent to the construction of a tramway through the Council's area from Hales Owen to Birmingham.

Spain.—The "Madrid Gazette" of July 13 states that the Sociedad Tranvia del Este de Madrid has obtained a concession for an electric tramway in Madrid.

Spanish Telegraphs.—In consequence of the recent change of Ministry, Don Martin Rosales has been appointed Director-General de Comunicaciones (Director-General Spanish Posts and Telegraphs), vice Don Federico Laviña.

Stirling.—A special sub-committee of three has been appointed to report upon a proposal by a company to obtain powers to reconstruct and extend the existing tramways.

Stoke Newington (London).—The Council have sanctioned the borrowing of £1,000 (part of a proposed loan of £5,000) for extending the electric light mains. The Council has already passed estimates aggregating £1,036 for main extensions.

The Great Wheel at Earl's Court.—One of the most conspicuous of London's landmarks, the "Great Big Wheel," is, we understand, about to become a thing of the past. The wheel at Earl's Court has, for a number of years past, afforded mild excitement for a large number of persons bold enough to entrust themselves to its humours, and, with its thousands of electric lights, has proved, it is said, a good advertising medium, although but an indifferent investment. Waning popularity is the cause assigned for its early transfer to the old metal merchant. Its demolition will prove a considerable engineering feat.

Warrington.—In future the charge for electric current supplied for power is to be 2d. per unit for the first 1,000 units per quarter, and 1d. for all units in excess.

West Bromwich.—An unopposed inquiry was held on Wednesday into the application of the Council to borrow £5,150 for extensions of the electricity undertaking.

Woolwich.—The Council have granted increases of salary as under:—

Mr. G. W. Keats (acting electrical engineer), from £200 to £250; Mr. S. H. Penning (distributing engineer), from £150 to £180; Mr. S. P. Ives (acting installation engineer), from £109. 4s. to £140; Mr. Speight, Mr. Clare and Mr. Eley (charge engineers), from £120 to £140 each; Mr. W. Bunce (junior charge engineer) from £91 to £120.

The Council have decided to engage an expert to report upon the present condition of the electricity undertaking.

Workhouse Lighting.—The cost of lighting and cooking by gas for 1901-2 at the North Infirmary of the St. Pancras Guardians was £755. 10s. 4d., while by electricity in 1904-5 the cost was £700. 2s. 2d.

Ald. HENNESSEY stated at the last meeting of the Guardians that the wards and building were much better lighted and ventilated since electricity had been introduced, and a considerable saving had been effected in the bill for cleaning, decoration, &c. At the South Infirmary the cost of lighting by gas for 1900 was £483. 18s. 3d., and by electricity and gas for 1905 £398. 14s. 9d. Considerable saving had also been effected in the cost of cleaning and decorating since the installation of electric light.

A copy of the report is to be sent to the L.G. Board in connection with an application that electric light be installed throughout the buildings under the control of the guardians.

Worsley (Lancs.)—The Lancashire Electric Power Co. have been asked to submit terms for supplying electricity in bulk or for taking a transfer of the Council's provisional order 1901.

X-Ray Treatment in Children's Ailments.—It is stated that owing to the success which the Metropolitan Asylums Board has met in the application of X-rays to the treatment of children suffering from ringworm, the period of detention has been greatly reduced, and the Board has been enabled to discontinue the use of one of the two institutions reserved for such cases.

Outings.—The annual holiday of the employés of Simplex Conduits (Ltd.) took place on Saturday. The party, numbering 200, left Birmingham for Tewkesbury, accompanied by the managing director, Mr. L. M. Waterhouse, and the heads of the various departments and branch offices. Keenly contested sports were followed by luncheon in a large marquee on the river bank, the sports prizes being presented by Mrs. Waterhouse. After a few brief speeches, in which the stewards (Messrs. Randall and Spiller) were thanked for the excellent arrangements made, the afternoon was spent in boating and river trips on a specially chartered steamer. The party arrived safely back at Birmingham after a very enjoyable outing.

The annual outing of the staff and employés of the Western Electric Co. took place on the 7th inst., when about 160 travelled by train from North Woolwich to Clacton-on-Sea.

Mr. A. Williamson, works manager, occupied the chair, supported by Messrs. H. and E. Kingsbury and Mr. Tervet. Mr. J. E. Kingsbury was unable to be present owing to his duties as chairman of the Reception committee of the Institution of Electrical Engineers in connection with the visit of the kindred electrical institutions.

The President, in replying to the toast of "The Firm," said he had an important announcement to make. The firm had worked out a pension scheme, and set aside £80,000 for a start. There would be a yearly addition of £30,000—sufficient, they believed, to benefit the whole of the company's employés at their various branches—every man, woman and child in any way dependent upon them, and none would be called upon to contribute a penny.

The first annual outing of the staff and employés of Harrow Electric Light Co. took place at Reading on 11th inst.

Marriage.—Mr. A. E. McKenzie, resident engineer at the Stuart-street electricity works of Manchester Corporation, was married at St. Mary's Church, Liscard, on July 11, to Miss Louie White, daughter of the late Mr. Richard White, civil engineer, of Widnes. The presents included a silver tray from the staff of Manchester Corporation electricity department, the presentation being made by Mr. S. L. Pearce, city electrical engineer.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The revenue of the Tramways department for the past year was £70,507, compared with £70,430 in 1904-5.

Brighton.—The total income of the Corporation tramways for the year ended March 31 was £51,620. 3s. 3d., the traffic revenue being £50,148. 15s. 1d.

Working expenses were £36,219. 7s. 9d., and included £14,270. 9s. 9d. for traffic expenses, £11,701. 11s. 10d. for power (2·394d. per car-mile), £6,259. 11s. 11d. for repairs and renewals, £830. 2s. 3d. for rent, rates and taxes and £3,157. 12s. for management and general expenses. Interest and income tax absorbed £8,759. 4s. 4d., and sinking fund £5,026. 1s. 6d., and after taking into account the deficit of £321. 11s. 11d. from 1905, the credit balance is £1,615. 9s. 8d. Capital expenditure is £274,916. 11s. 6d., an increase of £1,702. 19s. 8d. during the year. 11,026,811 passengers were carried and 1,172,933 car-miles run. The average traffic revenue per car-mile was 10·26d., the total revenue being 10·56d. The percentage of working expenses to receipts being 70·16.

An interesting report by the engineer and manager (Mr. Wm. Marsh) upon the year's working accompanies the accounts and gives interesting statistics.

Bury (Lancs.)—The traffic receipts of the municipal tramways for the year ended March were £39,752. 3s. and the total receipts were £39,968. 14s. 8d., or 9·072d. per car-mile.

Total working expenses were £20,401. 14s. 5d. (5·187d. per car-mile), power expenses being £5,627. 15s. (1·834d. per car-mile), and the balance was £19,567. 0s. 3d. After paying interest, sinking fund charges, &c., the net profit was £9,127. 11s. 7d. This has been apportioned among the various portions (Salford, Radcliffe, Heywood and Bury sections) of the undertaking, the net profit for the Bury section being £3,348. 6s. 4d., of which £500 has been applied in relief of rates and the balance transferred to reserve. 1,057,391 car-miles were run and 8,266,537 passengers carried. The total capital expenditure is £220,750. 15s. 2d., an increase of £5,077. 11s.

Cleckheaton.—The deficit on the past year's working of the electricity undertaking was £95.

Dundee.—The gross receipts of the tramways department for the past year were £50,154. 1s. 9d., and the working expenses (including £5,337. 10s. 2d. for maintenance of line) £31,112. 6s. 1d., leaving £19,041. 15s. 8d.

After paying capital charges and renewal fund, the net profit (£241. 15s. 3d.) has been carried to reserve. The traffic receipts totalled £49,347. 9s. 8d. and other receipts £716. 12s. The passengers carried numbered 13,086,396 and the car-miles run 1,005,911, increases of 1,444,871 passengers and 72,905 car-miles respectively.

Ealing.—For the year ended March 31 the total income of the electricity department was £24,969, and the net profit £2,317.

Edinburgh.—By seven votes to three the Electric Lighting committee decided on Tuesday to dispose of the balance profit (£16,361) on the past year's working of the electric lighting undertaking by placing £10,000 to reserve and £5,000 to reduction of capital debt. The balance of £1,361 will be left to the Council for disposal.

The committee recommend the Council to have lighted with electricity common stairs, the houses entering from which have an electric installation, at 20s. per 5 c.p. lamp per annum, including maintenance.

Finchley.—The profit on the electricity undertaking for the past year was £107, compared with £227 in the preceding year.

Gillingham.—The revenue of the electricity department for the year ended March was £10,885 (an increase of £1,836), working expenses were £5,110, purchase of new boiler required £927, Parliamentary expenses £357, and capital charges £5,013, leaving a deficiency of £522. 913,096 units were sold, the average price received for private lighting being 3·7d. per unit. The power load has increased from seven motors (21½ H.P.) at the beginning of the year to 33 motors (120 H.P.).

Huddersfield.—The traffic revenue of the tramways department for the year ended March 31 was £71,730. 14s. 2d., and with sundry revenue the total income was £74,495. 5s. 6d.

The total working expenses were £39,837. 13s. 5d., leaving a gross profit of £34,657. 12s. 1d. Interest absorbed £13,900 and sinking fund £9,788. £12,101. 15s. 5d. has been voted to reserve and renewals fund, leaving a net deficiency of £1,131. 18s. 13,993,449 passengers were carried and 1,750,650 car-miles were run. 3,305,889 units of electrical energy were consumed (1·89d. per car-mile), and the power expenses were 1·29d. per car-mile. The percentage of working expenses to receipts was 53·48, and the average traffic revenue per car-mile 9·83d., the total revenue being 10·21d.

Nottingham.—The capital expended on the electricity supply undertaking at March 31 was £435,522. 15s. 6d., an increase of £18,250. 17s. 1d., but these figures include £118,113. 10s. 5d. and £173. 7s. 8d. respectively spent for tramway purposes.

The total annual income was £80,247. 11s. 1d., including £76,846. 3s. from sale of current, £1,596. 17s. 11d. for public lighting and £1,291. 9s. 8d. for meter rentals. Expenses were £38,569. 17s. 6d. The gross profit was £41,677. 13s. 7d. After paying interest and sinking fund, &c., £10,000 was contributed in aid of rates and the balance (£3,514. 3s. 8d.) transferred to reserve. Interest on investments (£741. 2s. 5d.) has also been transferred to reserve, bringing this account up to £29,936. 17s. 4d. 9,792,495 units were generated; 172,062 were supplied to the public lamps and 8,880,500 were sold by meter. The total maximum supply demanded was 5,615 kw

The capital expended on the tramways was £558,922. 17s. 10d., an increase of £645. 10s. 3d. on the year. The total income was £129,748. 3s. 4d. and total expenses £77,530. 18s. 10d., and comprised traffic expenses (£31,757. 18s. 1d.), maintenance and renewals (£10,289. 5s. 1d.), salaries, rent, rates and taxes, &c. (£11,864. 15s. 4d.) and arc lighting tramway routes (£2,002. 6s. 1d.) Gross profit was £52,217. 4s. 6d., and after providing for interest and sinking fund charges, contributing £15,000 to relief of rates and £900 to defray part cost of purchase of motor omnibuses, the balance (£4,276. 15s. 5d.) has been carried to reserve.

Salford.—The net income of the electricity department for the year ended March 31 was £76,250. 1s. 6d., including £30,429. 5s. for current sold to private consumers, £1,682 for public lighting, £42,525. 11s. 7d. for traction and £1,767. 4s. for motor hire.

The annual expenses were £27,972. 14s. 10d. The gross profit was £48,277. 6s. 8d. Adding interest on investments, &c., the disposable balance was £49,076. 1s. 11d. After paying interest and repayment of loan charges (£34,185. 2s. 4d.) and transferring £4,890. 19s. 7d. to depreciation and renewals fund (including £1,500 for motors) the net profit (£10,000) has been transferred to district fund account. 12,264,969 units were generated; 1,647,427 were sold for private and 183,626 for public lighting, 2,271,975 for power and 6,804,095 for traction. The maximum load was 4,375 kw. and the load factor 28·5 per cent. There are 1,084 consumers, with the equivalent of 143,992 8 c.p. lamps connected, with motors of the aggregate of 6,054 H.P., including 234 motors of an aggregate of 1,886½ H.P. on hire. The total capital expended to March 31 was £564,253. 7s. 10d., an increase of £21,600. 9s. 3d. (including £15,954 on mains) during the year.

In the report of the borough electrical engineer (Mr. C. D. Taite) it is stated that a decided improvement in the steam economy of the engines has taken place owing to the provision of new valve rings on the high-pressure piston valves, and that Salford continues to hold the record for low coal costs among stations using only coal for steam raising. A water softener and purifier is being installed in the boiler house. The coal consumption per unit sold was 4·42 lb., against 4·65 lb. for 1905. The mains department has been kept busy during the year owing to the accession of many large consumers, several new and extensions of existing feeders having been laid. There was a net increase of 140 consumers, the new lamp connections being equal to 18,298 8 c.p. and the motor connections to 3,237 H.P. The motor hiring department has made good progress, consumers with motors on hire having increased from 100 to 150, and the revenue from £1,250 to £1,731. Mr. Taite calls attention to the necessity for increasing the depreciation and reserve fund. The capital expenditure (£92 per kilowatt installed), in spite of the high load factor of 28·5 per cent. (claimed to be the highest of any municipal station), involves an average charge per unit sold of 0·735d. out of a total cost per unit of 1·317d. Until this heavy capital expenditure is materially reduced, it is impossible (continues Mr. Taite) to supply electricity at anything like the low prices quoted by newer concerns, who have been able to purchase their plant at lower rates. The works costs were 0·436d. per unit sold, and the total working costs 0.582d., which, it is claimed, constitute a record for municipal working.

Shoreditch (London).—For the year ended March 31 the electricity supply accounts show a reduction of £3,476 (0·28d. per unit) in expenditure (excluding loan charges), compared with the previous year.

The net profit, after paying interest and providing for redemption of debt, however, was only £705, owing to reduction in charges for current sanctioned in July, and to the alteration in the system of calculating the maximum demand quarterly instead of half-yearly. The sale of current to consumers for private lighting and power increased from 2,533,544 units in 1904-5 to 2,753,461, the average price obtained being 2·55d. per unit. The surplus has been carried to appropriation account to meet the yearly instalment of cost of change of pressure, the result on that account being that there is an adverse balance of £922 to carry forward.

Southend.—It was reported to the Council on Tuesday that there was a deficit of £1,003 on the past year's working of the electricity department.

Wolverhampton.—The total income of the electricity department for the year ended March was £24,722. 10s 3d., including £22,354. 18s. 8d. from sale of current by meter, and £1,466. 1s. 5d. for public lighting.

Working expenses came to £11,322. 6s. 5d. The gross profit was £13,245. 3s. 10d., and after paying dividends on stock and sinking fund instalments the net profit was £3,215. 18s. 6d 3,758,264 units of electrical energy were generated, and 3,374,104 were sold, including 1,539,728 to private consumers for lighting and 1,516,324 to the tramways committee. The maximum supply demanded was 1,674 kw., and the equivalent of 85,126 32-watt lamps is connected to the mains. The Electricity committee state that the new showrooms are having a beneficial effect in stimulating demand for electricity for lighting, heating and power, and it is largely due to this cause, coupled with systematic canvassing, that the committee have found it necessary to make arrangements for installing additional plant to meet the anticipated demand of the forthcoming winter. The cost of equipping the new show rooms and stores has been charged to reserve.

TRADE NOTES AND NOTICES.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

TENDERS INVITED.

Leeds Electricity committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, &c. Specifications from the manager of the electricity department (Mr. Harold Dickinson), 1, Whitehall-road, and tenders to the town clerk, Town Hall, Leeds, by 10 a.m., Aug. 15. See also an advertisement.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of the ports set out in an advertisement on another page. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Sunderland Corporation invite tenders for the supply of (*a*) two 250 kw. synchronous motor generators, 5,000—240 volts; (*b*) high-tension and low-tension switchgear for above. Tenders to the chairman of Electricity and Lighting committee not later than noon 27th inst.

Hackney Borough Council require tenders for section A, arc lamp pillars; B, erection of arc lamp pillars and switch pillars; C, arc lamps and accessories, and D, switch pillars. Tenders to the town clerk, Mr. W. A. Williams, Town Hall, Hackney, by 4 p.m. July 26.

Hackney (London) Council also want tenders by 4 p.m. July 27 for alterations to the town hall electric lighting installation.

London County Council want tenders by 10 a.m. July 24 for reconstructing the second portion of the Streatham depôt as a car shed for electric cars.

London County Council also want tenders by 10 a.m. July 26 for cast-iron fire-alarm indicators.

Mr. F. G. Beeching, West London District Schools, *Ashford*, will receive tenders until 6 p.m. Aug. 2 for two 50 kw. steam dynamos, boosters, electric motor, additions to switchboard, cable, &c.

Newport (Mon.) Electricity and Tramways committee require tenders by 27th inst. for 12 months' supply of general stores.

Metropolitan Asylums Board want tenders by 10 a.m. July 25 for an electric lighting installation for the Downs School, *Sutton*.

Stoke-on-Trent Electricity committee want tenders by Aug 4 for water-tube boiler. Specification from the Borough Electrical Engineer.

The Deputy Postmaster-General, *Brisbane*, Queensland, will receive tenders until noon, Aug. 27, for supply of 21¼ tons, 200 lb. H.D. copper wire and 4,700 copper tapes and 4,700 copper binders for same, 600 McIntyre sleeves, 5,350 Acme insulators and 2,386 bolts for arms. Specifications, &c., from the Comptrollers of Stores, Brisbane, Sydney, Melbourne and Adelaide.

Messrs. Preece & Cardew are authorised by the Municipal Council of *Shanghai* to receive tenders for supply and delivery (c.i.f. Shanghai) of the following plant: (*a*) Two 600 kw. steam turbo dynamos (or, alternatively, two 600 kw. steam dynamos) with condensing plant, certain pipes and valves, motor generator, switchboard, &c.; (*b*) two water-tube boilers, with feed-water heaters, superheater and chain-grate stokers, feed pump, pipes, valves, &c. Tenders to Messrs. Preece & Cardew, 8, Queen Anne's-gate, Westminster, S.W., before noon of July 31.

The Commercial Branch of the Board of Trade learns from the acting British Consul at *Rotterdam* that tenders will be received by the Colonial Office at the Hague up to July 26 for (contract Q12) 8,200 iron telegraph poles (light) and (contract R12) 700 iron telegraph poles (heavy). Particulars from Mr. M. Nijhoff, the Hague, at a cost of 1 florin (1s. 8d.) for each contract.

TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by London County Council for supply of cables, troughing, feeder pillars, &c., in connection with the reconstruction of the first section of the northern tramways:—

High-tension Cables, &c.

Western Electric Co.*	£35,726	19	6	St. Helen's Cable Co.	£36,660	10	0
Kabelfabrik A.-G. (Vienna)	43,439	10	0	British Insulated & Helsby Cables ..	36,222	6	7
Lahmeyer Elec. Co.	40,095	10	0	Johnson & Phillips	36,102	16	2
W. T. Glover & Co.	37,330	18	9	Siemens Bros. & Co.	36,078	2	10
Callender's Co.	37,239	12	6	W. T. Henley's Co.	36,050	0	0

Low-tension Cables, Feeder Pillars, &c.

W. T. Henley's Co.*	£23,628	16	3	Johnson & Phillips	£23,913	12	1
Lahmeyer Elec. Co.	26,022	12	6	British Insulated & Helsby Cables ..	23,748	7	11
W. T. Glover & Co.	24,879	9	5				
Callender's Co.	24,715	17	3				
St. Helens Cable Co.	24,622	2	6	Kabelfabrik A.-G. (Vienna) (incomplete tender)	22,238	12	6
Siemens Bros. & Co.	24,139	19	6				
Western Electric Co.	24,003	11	0				

* Recommended for acceptance. W. T. Henley's Co. may sub-let to J. E. Spagnoletti & Co. the manufacture of the feeder pillars.

Marylebone (London) Electricity committee has provisionally accepted the following tenders:—

C. A. Parsons & Co., fifth 2,000 kw. turbine set, £9,740; Babcock & Wilcox, two additional boilers, £7,894; Lancashire Dynamo Co., duplicate balancing booster and switchboard, £2,307; St. Helens Cable Co., cables (2,500 yds. of 1·5 sq. in. paper-insulated plain lead-covered cable), £2,769. 17s. 9d.; braiding and compounding same, £85. 1s. 6d.; 300 yds. of 0·5 ditto, £115. 18s. 2d.; braiding and compounding same, £5. 9s. 1d.; 5,200 yds. of 7/16 cable, £183. 3s. 8d.; braiding and compounding same, £23. 12s. 8d.; 4,500 yds. 7/20 five-core pilot cable, £332. 7s. 8d. (and braiding and compounding same, £25. 11s. 4d.), £3,541. 4s. 10d.; Walter Macfarlane & Co., supply and erection of standard pillars for lighting Oxford-street, 35 pillars at £21. 4s. 6d. each, five pillars at £24. 1s. 6d. each, six pillars at £21. 14s. each, and erecting pillars and fixing brackets and carriers, £120. 8s. 9d., total of £1,113. 17s. 9d.; Albion Clay Co., earthenware ducts, 10½d. per yard.

Stepney (London) Council have received the following tenders :—

Arc Lamps and Columns.

	£	s.	d.		£	s.	d.
Improved Electric Supplies (*accepted*)	£1,327	4	0	Johnson & Phillips..	£1,382	0	6
Brit. Elec. Equip. Co.	1,652	11	3	Reason Mfg. Co.	1,358	10	0
				W. Lucy & Co.	1,351	4	6

Three other tenders were informal.

For 72 boiler tubes the tender of the British Mannesmann Tube Co. was accepted, at 1s. 2d. per foot, total £75. 12s. ; Stewarts & Lloyds tendered at 1s. 10d. (£118. 16s.) and Babcock & Wilcox at 1s. 3d. (£81. 4s.)

Bermondsey (London) Council have received the following tenders for arc lamp lowering gear :—

	£	s.	d.		£	s.	d.
Johnson & Phillips (*accepted*)..........	£451	3	0	N.W. Elec. Appliances	£645	15	0
R. Easton & Son	1,701	10	0	Marples, Leach & Co.	640	15	0
Crompton & Co.......	753	15	0	Reason Mfg. Co.......	558	16	0
Gilbert Arc Lamp Co. £586 and	727	2	0	London Elec. Firm ..	524	12	0
General Electric Co...	695	12	6	Veritys Limited......	509	16	8
				Prestwich & Burt	504	3	2
				Improv'd Elec. Supplies	313	15	0

Poplar (London) Council have now decided upon the tenders for coal-conveying plant at the generating station. The lists of tenders and amended tenders received were given in our issues of June 1 and June 29. Upon the advice of the borough electrical engineer (Mr. J. H. Bowden) the Council have accepted the tender of Babcock & Wilcox at £2,158.

Bermondsey Council have accepted the tender of C. Franklin for Welsh coal (Bwllfa) at 20s. 2d. per ton, delivered at works.

Shoreditch (London) Council have received the following tenders for arc lamp carbons (13 mm. × 9″, 18 mm. × 11″, 12 mm. × 10″ and 18 mm. × 10″) for 12 months :—

Sloan Electrical Co. (*accepted*), **19s. 4d., 45s. 2d., 19s. 7d.** and **41s. 1d.** per 1,000 respectively ; General Electric Co., 24s., 53s. 6d., 25s. and 48s. 6d. ; Crompton & Co., 20s. 2d., 47s. 4d., 20s. 6d. and 43s. 1d. ; Johnson & Phillips, 19s. 8d., 45s. 10d., 20s. and 41s. 8d.

Beckenham Council have accepted the offer of the Underfeed Stoker Co. to supply on trial for six months one of their mechanical stokers (to be fixed at the company's expense and to be removed at the end of the period without charge to the Council) if so desired. In the event of purchase by the Council the first stoker to be £187 and two similar stokers to be provided at £125 each.

The tender of the General Electric Co. for motor generators and switchboards at the L.C.C. School of Building at £646. 10s. has been accepted. The Electric Construction Co. tendered at £665, the Westminster Engineering Co. at £718 and Witting, Eborall & Co. at £812.

Briton Ferry Council have accepted the tender of Callender's Co. for supplying and laying distributing cables. The South Wales Electrical Power Distribution Co. will supply the Council with electricity in bulk.

Fulham (London) Council has accepted the tender of S. A. Curzon for wiring the destructor house at £63. 5s. and the boiler house at £20. 5s.

Stalybridge, Hyde, Mossley & Dukinfield Joint Electricity and Tramways Board have accepted the tender of the British Westinghouse Co. for the supply of additional steam plant.

West Ham Corporation has accepted the tender of S. Hammond & Co. for re-arranging the internal telephones and the provision of additional telephones at The Grove.

The Brynamman & District Electric Supply Co. have placed a contract for the extension of the cables to Gwaun-cae-Gurwen with J. B. Saunders & Co.

London County Council have placed a contract with R. W. Blackwell & Co. for an extension of the Camberwell Green and Lordship-lane tramways (South London system) at a sum not exceeding £3,500.

Bolton Tramways committee have placed an order with the British Thomson-Houston Co. for 10 tramcars.

Bradford Corporation have accepted the tender of the Bradford Electrical Engineering Co. for wiring the Hanson secondary school.

Portsmouth Council have accepted the tender of W. H. Sabine & Co. for wiring the Victoria Park band stand.

Rugby Council have accepted the tender of Foster & Dicksell for electric fire-alarm installation.

Croydon Council have accepted the tender of the British Westinghouse Co. for 10 tramcars at £521. 10s. each.

Loughborough Council have accepted the tender of T. H. Simpson for an electric lighting installation at the town hall at £115. 13s. 8d.

Radcliffe Council have placed an order with the Lancashire Dynamo & Motor Co. for the supply of electric motors to be let out on hire.

In addition to the Hammersmith contract for the alteration of the street lighting lamps from rectified to alternating current (referred to on another column) the Universal Electrical Mfg. Co. have carried out a number of other important orders for central station and consulting engineers. The company manufacture a variety of electrical goods, including switchboards, switches, fuses, switch-fuses and switch work of every description ; D.P., enclosed, water-tight or dust-proof switches ; house fuse boxes, arc lamp gear, lamp post brackets (for arc, incandescent or Nernst lamps), house service boxes ; house service and main cable disconnecting boxes, dynamo brush-holders, feeder pillars, &c. The company also make a speciality of carrying out work to special requirements, and are prepared to undertake any special contracts of this class.

BUSINESS NOTICES.

On and after July 23 the head office, works, stores and test room of the Union Electric Co. (Ltd.) will be Park-street, Southwark, London, S.E., where the company have secured new and greatly enlarged premises, constructed on modern lines, with exceedingly good light, and provided with good lifting apparatus, enabling them to carry on business with additional promptitude. The Union Co.'s new telephone number will be 2970 Hop, and the telegraphic address as hitherto, "Abeam London." The use of the A.B.C. Code (5th edition) is retained for cablegrams.

Mr. F. Charles Raphael's new business address is 156, Temple-chambers, Temple-avenue, London, E.C.

Mr. Haydn T. Harrison informs us that he has severed his connection with the Reason Manufacturing Co., and that he retains his offices at 11, Victoria-street, London, S.W., where he will carry on business as previously.

John G. Addinell, Cecil A. Chamberlain and Harry B. Syer, trading as the A.C. Electrical Co., Saracen-buildings, Snow-hill, London, E.C., have dissolved partnership. Debts by Mr. Addinell, who continues.

The Aron Electricity Meter (Ltd.) have removed to their new premises, 80A, Salusbury-road, Kilburn, London, N.W.

The business carried on by Mr. W. A. Stevens, in the name of Stevens & Barker, Maidstone, has been taken over by W. A. Stevens (Ltd.), which has a capital of £10,000. Mr. Stevens is governing director and chairman of the new company, the other directors being Messrs. C. L. Stevens, H. C. Clark and A. R. Reed.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of the creditors of Alex. C. M. Jenkins, 140, Leadenhall-street, E.C., took place on Wednesday. Unsecured liabilities were estimated at £9,000 with no assets.

Debtor attributed his position to the failure of the Otto Electrical Mfg. Co. (1905), Ltd. In May, 1905, he obtained an option to take over the concern for £10,000 cash and £15,000 in shares. He paid a deposit of £500 and provided the money for promotion expenses, amounting to about £5,000, out of a loan of £10,000 obtained from a friend. As vendor he was to have £20,000 cash and the balance in shares, the capital of the company being agreed at £75,000. He intended to pay out of the £20,000 cash consideration the £10,000 to the old company, and he further undertook to provide £20,000 for working capital. The company never went to allotment, as the public only subscribed about £1,200 and the minimum required before proceeding to allotment was £20,000. He consequently lost the whole of the money he had invested in the company, and was, in addition, held liable for debts of the company to the amount of about £300. The company went into liquidation, and Mr. Fletcher, George-street, Mansion House, London, was appointed liquidator.

The Mersey Electric Supply Co. (Ltd.) is to be wound up voluntarily with Mr. J. G. Hodgson, 41, North John-street, Liverpool, as liquidator.

A meeting to receive an account of the winding up of Pullin & Shore (Ltd.) will be held on Aug. 15 at 13, Yorkshire-street, Rochdale.

The Electro-Medical Supply Co. (Ltd.) is being wound up voluntarily, with Mr. H. C. Howard, 70A, Basinghall-street, London, E.C., as liquidator.

A receiving order has been made against Albert Barker and Wm. Clough (trading as the Electrocycle Co.), Woodbine-street, Bradford.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co., have received instructions from the liquidator of the City & Suburban Electric Carriage Co., 1903 (Ltd.) (in voluntary liquidation) to sell by auction (if not previously sold privately) on the premises on Tuesday, July 31, and Wednesday, Aug. 1, 1906, the modern freehold works, 157A, Manor-street, Clapham, London, S.W.; also (in lots) the stock of new motors and parts, machinery utensils, &c., comprising a large quantity of carriage motors, gearing, frames, springs, meters, wheels, controllers and other parts used in the manufacture of electric vehicles; also the machine-shop repair plant. Further particulars and catalogues from Messrs. W. B. Peat & Co., C.A., 11, Ironmonger-lane, London, E.C., or from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. An advertisement gives further information.

Street Lighting.—The Universal Electrical Mfg. Co., 14, Station-parade, Queen's-road, Peckham, have just completed the alteration of the Hammersmith Borough Council's street lighting lamps (some 170 in number) from rectified to alternating current. The actual alterations to the lamps, including supplying all necessary switchboards, choking coils, substitutional resistances, additional domes, &c., have been carried out by the company ; the re-fixing and alteration of the circuits have been done by the Council's own workmen under the supervision of the chief assistant engineer (Mr. F. Hill). It reflects credit on both parties that not a single lamp was out any evening during the reconstruction. The complete change-over was undertaken owing to the high cost of upkeep of the rectifiers (which had been in use some years) and to the loss in the rectifiers, and it is estimated that, under the conditions of working at Hammersmith, the whole cost of the alterations will be repaid in about 12 months' working.

Siemens Bros. & Co.'s Woolwich Works.—The name of Siemens is so closely allied with every phase of the development of the electrical industry in all parts of the world, that particulars relating to the extensive range of works premises at Woolwich, where Siemens machinery, plant, apparatus and material has been manufactured for nearly half a century, are interesting and welcome. The company have prepared a very fully-illustrated description of their Woolwich works, established in 1864 and covering at the present time about 15 acres of land. As our readers are aware, the dynamo and motor branch of the firm's business was transferred to Stafford last year, and has been taken over by a new undertaking called Siemens Bros. Dynamo Works (Ltd.). The extension of the company's operations in connection with cable and instrument work necessitated this change, and the fine works at Woolwich are left free to handle orders of any magnitude in connection with cables, instruments, batteries and the lighter kinds of machinery. The book before us contains a brief account of some of the extensive orders which have been executed by the firm, and gives an excellent idea of the extent of the company's field of work, which ranges from submarine telegraph cables to the smallest instruments of precision, from the heaviest type of electric light and power cables to wet and dry batteries, and may, in fact, be said to comprehend the whole range of electrical manufactures. The particulars regarding the company's power house, testing rooms, cable tanks, braiding and other shops, are of especial interest. While the booklet of 40 quarto pages contains much that is well known to those whose association with the industry is of long standing, it is also full of matter that will interest the younger members of the industry.

Insulated Staples.—Messrs. Mosses & Mitchell, 68-71, Chiswell-street, London, E.C., have ready a neatly-printed card list of prices and particulars of the "Blake" improved insulated staple, specially designed for wiring low-voltage circuits (telephone, telegraph, annunciator and bell work). These staples are made with a standard square shoulder, having good driving qualities, and the arch of the staple is protected by insulating vulcanised fibre, in which material Messrs. Mosses & Mitchell are specialists. The covering on the wire is thus prevented from coming into contact with the metal of the staple, and is so threaded that the insulating material cannot come off in driving. In connection with their principal manufacture of vulcanised fibre Messrs. Mosses & Mitchell have a full descriptive pamphlet ready, which can be obtained on application.

Catalogues.—Crompton & Co. have just issued an excellent list of small motors for continuous-current circuits and several standard machines of the various types are illustrated. An "Introduction" to the pamphlet is instructive reading.

John Spencer (Ltd.), Wednesbury, have issued the 23rd edition of their price list. A great variety of iron and steel tubes and fittings, arc lamp posts and pillars, tramway and telephone poles, high-pressure steam mains for electric light and power installations, &c., is included in the list.

A. Reyrolle & Co., of Hebburn-on-Tyne, are about to issue a new list of standard designs of special combination house-service fuseboards. The list gives prices and dimensions of these boards and other particulars.

A new list of Mordey fuses is issued by Ernest F. Moy (Ltd.).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from July 11 to 17, with the ports of destination :—

Africa—Alexandria, £15; Beira, £168 (including £146 telegraph material); Cape Town, £342 (including £250 telegraph cable); Chinde, £18; Delagoa Bay, £328 (and 10 tons iron telegraph poles); Durban, £387; East London, £1,035; Port Elizabeth, £8. *Argentina*—Buenos Aires, £609 (including £457 telegraph material). *Australasia*—Adelaide, £380; Auckland, £467; Brisbane, £290; Christchurch, £9; Lyttelton, £174; Melbourne, £32; Otago, £44; Perth, £613; Sydney, £436; Wellington, £1,004 (telegraph material). *Belgium*—Brussels, £40; Ghent, £10; Ostend, £30. *Brazil*—Santos, £19. *Burma*—Rangoon, £123. *Canada*—Halifax, £23. *Ceylon*—Colombo, £15. *China*—Hankow, £1,044; Shanghai, £12,037 (including £9,251 telegraph material). *Denmark*—Copenhagen, £72. *France*—Boulogne, £80. *Germany*—Bremen, £125; Hamburg, £22. *Gibraltar*, £296. *Holland*—Amsterdam, £176 (including £100 telegraph material); Rotterdam £50 (telegraph material). *Hong Kong*, £79. *India*—Bombay, £900; Calcutta, £916 (including £153 telegraph material); Madras, £6. *Japan*—Kobe, £110; Moji, £62; Tokyo, £446 (including £363 telegraph material); Yokohama, £1,645. *Malta*, £89. *Mauritius*, £79. *Portugal*—Lisbon £46; Oporto £8. *Russia*—Kurch, £1,505; St. Petersburg, £710 (including £160 telegraph material). *Siam*—Bangkok, £65. *Straits Settlements*—Penang, £149 (including £25 telegraph material); Singapore, £395 (including £307 telegraph material). *Sweden*—Gothenburg, £250; Stockholm, £300 (telegraph material). *U.S.A.*—Boston, £23. *Uruguay*—Monte Video, £21 (including £13 telegraph material). Total £28,325, against £23,435 in the corresponding week last year (July 12 to 18).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

June 5, 1906.

4,951A PAULET. Electricity meters. (Date applied for, June 6, 1905, comprised in No. 4,951, Feb. 28, 1906.)*
12,974 ALLEN. Storage battery.
12,998 FAIRWEATHER. (Benjamin Electric Mfg. Co., U.S.) Wireless lamp clusters.*
13,000 DEFRIES. Operating gear for groups of switches or rheostats.
13,002 BROWN, BOVERI & CIE. Co-axial steam turbines. (Date applied for, June 5, 1905.)*†
13,023 DE HEMPTINNE. Oxidising liquids with aid of electric discharges.
13,029 WINTON & ANDERSON. Sliding gear transmission.*
13,032 CRIPPS. Electric heating and cooking apparatus.
13,034 WEBSTER. Electrical control of electric vehicles and other installations where load is very variable.
13,058 KINGSBURY. (Western Electric Co., U.S.) Switchboard cord reel.
13,059 KUHLO. Insulated conductors.*

June 6, 1906.

13,065, 13,066, 13,067 and 13,068 SHUSTER & AST. Electromagnetic clutches.*
13,069 SCHUSTER & AST. Winding of electromagnetic clutches.*
13,078 WALKER. Conductors on field magnets of alternate-current generators.
13,085 VERITYS LIMITED & WORSLEY. Hoisting gear for arc lamps.*
13,117 MEDDINGS. Electrical device for recording the breaking of a fire prevention sprinkler. (Date applied for, Jan. 18, 1906.)*†
13,127 COWPER-COLES. Electrolytic refining of copper.

June 7, 1906.

13,167 HISLOP. Tramway trolley poles and the like.*
13,172 DRUSEIDT. Reflector mountings for incandescent lamps and the like.*
13,180 MELHUISH. Switches.
13,185 LAKE. (Submarine Signal Co., U.S.) Submarine signalling apparatus.*
13,189 SOCIÉTÉ ELECTRO-MÉTALLURGIQUE FRANÇAISE. Manufacture of decarburised cast iron. (Date applied for, Aug. 5, 1905.)*†
13,201 GRIMM. Guard for mouth-piece of telephonic transmitters. (Date applied for, Aug. 5, 1905.)*†
13,207 WISE. (Squier, U.S.) Incandescent lamp.
13,212 A.-G. BROWN, BOVERI & CO. Steam turbines. (Date applied for, June 7, 1905.)*†
13,220 B.T.-H. Co. (G.E. Co., U.S.) Speed-changing gear for self-propelled vehicles.
13,221 B.T.-H. Co. (G.E. Co., U.S.) Switches.
13,222 B.T.-H. Co. (G.E. Co., U.S.) Devices for controlling electric circuits.

June 8, 1906.

13,268 TUCKFIELD & GARLAND. Turbine.
13,285 B.T.-H. Co. (G.E. Co., U.S.) Control of alternate-current motors of the induction type.
13,286 B.T.-H. Co. (G.E. Co., U.S.) Systems of distribution employing vapour rectifiers and the like.
13,287 B.T.-H. Co. (G.E. Co., U.S.) Systems of operating electric vehicles.

June 9, 1906.

13,304 CROWTHER. Joining and bonding rails for electric traction.
13,311 HEYS. (Turner, U.S.) Telephone dictating machine or apparatus.
13,312 AITKEN. Telephone exchange systems.*
13,313 SMITH, SMITH & SMITH. Controlling gear for electrically-driven pumps.*
13,316 FRAMPTON. Hand brakes for vehicles.
13,331 MILLER. Safety gates for vehicles, applicable also to elevators.*
13,332 B.T.-H. Co. (G.E. Co., U.S.) Electric motor generators.
13,336 CAREW-GIBSON. Switches and cut-outs.
13,337 NEUDÖRFFER. Switches.*

June 11, 1906.

13,358 PEACE. Tramway trolley swivelling heads.
13,368 MCINDOE. Starting switches for electric motors.
13,370 KENNEDY. Electric transmission of power on road vehicles.
13,373 SCHNEIDER. Prevention of sparking in current interrupters.*
13,381 HUG. Electric light brackets.*
13,391 SMITH. Electric cooking stove.*
13,402 DU VERGE. Feeder and distribution cable disconnecting boxes and feeder pillar panels.

13,413 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric apparatus.

13,414 B.T.-H. Co. & Hopps. Power transmission mechanism.

13,415 B.T.-H. Co. (G.E. Co., U.S.) Switches and operating mechanism therefor.

13,427 Lincoln. Variable-speed electric motors. (Date applied for, June 27, 1905.)*†

13,432 Paier-Monriva. Switch for grooved street railway or tramway rails.*

June 12, 1906.

10,802a Cowper-Coles. Electrolytic deposition of metals. (Date applied for, May 8, 1906.)

13,442 Moseley. Batteries.

13,448 Hopkinson & Thring. Transmission dynamometers.

13,450 Collie. Trolley poles.

13,467 Langer & Wollrauch. Alarm or signal bells.

13,485 Courteen. Impulse wheels in combination with steam generators.

13,490 Larsen & Hardie. Frictional change-speed power transmission mechanism.*

13,491 Nathusius. Telephone receiver.*

13,502 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current dynamo-electric machines.

13,506 Otis. End sills for cars. (Date applied for, Oct. 2, 1905.)*†

13,508 Siemens Bros. & Co. & Kloss. Alternating-current motors.*

June 13, 1906.

13,517 Brook & Hirst. Electromagnetically controlled switches and circuit breakers.

13,542 Knight. Automatic electrical clock.

13,548 Shorey. Rail joint.

13,552 Cotis. Arc lamps.*

SPECIFICATIONS PUBLISHED.

1905 Specifications.

4,164 Tanner & Claremont. Automatic signalling apparatus.

4,237 Schwartz. Electric fuses.

4,867 Bastian & Calvert. Electrodes for pulsating current vapour electric apparatus.

10,120 Schiele. Electroplating of metals.

10,959 Hertzberg, Snyder, Griffin & Bernhard. Electrical measuring instruments.

11,537 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems.

11,600 Berry. Dynamo electric machines.

11,627 B.T.-H. Co. (G.E. Co., U.S.) Electric distribution by rectified alternating current.

11,821 Braun. Automatically equalising the load in alternating-current circuits.

11,899 Sykes. Electrical relays for railway track circuits and telegraph purposes.

11,970 B.T.-H. Co. & Wedmore. Switches.

11,970a B.T.-H. Co. & Wedmore. Electric couplings. (Date applied for, June 7, 1905.)

12,087 Lucas. Operating mercury vapour lamps.

12,171 Edmunds & Dawson. Cables or conductors.

12,253 Kelley. Accumulator plates for the storage of electricity.

12,399 Moores. Magneto-electric dumb-bell.

12,507 B.T.-H Co., Lloyd & Kingwell. Prepayment mechanism for electric meters.

12,601 Sankey. Steam turbines.

12,682 Graham & Davis. Telephone apparatus for diving and like purposes.

12,792 Allgemeine Elektricitäts Ges. Dynamo-electric machines. (Date applied for, Sept. 17, 1904.)

12,880 Betts. Conductors.

12,937 Goldsborough. Turbines.

13,228 Sawrey. Telephone or like transmitters.

13,380 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric control.

13,709 Case. Systems of motor control. (Date applied for, July 2, 1904.)

13,779 Stidolph. Appliance for adjusting trolley wheel to overhead wires.

14,167 Maclean. Making resistances for electric curling tongs.

14,715 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric rectifiers.

14,860 Eversfield. Regulating the tension of power transmitting belts.

15,070 Warwick Machinery Co. (G.E. Co., U.S.) Turbines.

15,279 Jackson. Battery holders for automobiles and other purposes.

15,498 Hamilton & Ferranti Limited. Counting trains for meters and the like.

15,770 B.T.-H. Co. (G.E. Co., U.S.) Insulation of conductors.

16,083 Robinson. Transmitting indications corresponding to a transmitter handle.

16,303 B.T.-H. Co. (G.E. Co., U.S.) Alternating current motors.

16,304 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.

16,324 Turner. Electrically-controlled circuit breaker.

16,427 Kerr. Compound steam turbines.

17,314 Kennedy. Rheostats. (Date applied for, Nov. 12, 1904.

17,751 Mason. Rail joints for railways, tramways and the like.

17,897 Electric Ignition Co. & Hall. Electrical generator system for automobiles.

18,673 Millauro. Bracket for a light on the head with electrical fittings.

18,852 Niblett. Automatic adjusting apparatus and lubricating axle for trolley heads.

19,035 B.T.-H. Co. (G.E. Co., U.S.) Insulating material.

19,036 B.T.-H. Co. (G.E. Co., U.S.) Multi-rate electric measuring apparatus.

21,583 Bolton. Automatic starting resistance for electrical motors.

22,317 Miller. Small induction coils worked from street electric light mains.

20,547 Kitsee. Transmission of alternating and pulsating electric currents.

22,578 McLaren. Trolley-heads employed upon electric vehicles.

23,085 Deutsche Telephonwerke R. Stock & Co. Connections for telephone offices with separated plug-service and group calling. (Date applied for, Nov. 10, 1904.)

23,556 Royce. Electric ignition for multiple cylinder engines.

24,621 Gianoli. Magneto-electric generators. (Date applied for, 12/2/04.)

25,236 Allgemeine Elektricitäts-Ges. Nernst lamps. (Date applied for, Dec. 5, 1904.)

25,600 Munro. Contact-breakers and ignition devices for explosion engines. (Date applied for, Dec. 8, 1904.)

26,109 Thomas & Phillips. Electric lighting of miners' safety lamps.

26,348 Ohnesorge. Connections for branch telephone stations. (Date applied for, Dec. 17, 1904.)

26,629 De Kando. Connections for two or more three-phase electric moters.

26,876 Boult. (Stebbins.) Secondary or storage batteries.

26,897 Fynn. Single-phase commutator motors. (Date applied for, March 25, 1905.)

1906 Specifications.

701 Soc. Anon. d'Electricité et d'Automobiles Mors. Brakes. (Date applied for, May 17, 1905.)

707 Thomas. Alternating-current vapour electric apparatus. (Date applied for, Jan. 27, 1905.)

939 Midgley & Reed. Controlling device for electric motors driving sewing machines, small lathes, &c.

1,091 White. Magneto ignition apparatus.

1,099 Eisemann. Controlling the contact lever of electrical igniting apparatus.

2,383 Ingram. Safety guards of tramway cars and motor vehicles.

2,452 Hall. Telephone system. (Date applied for, Feb. 8, 1905.)

2,603 Kilburn. (Phönix Elektrotechnische Ges.) Metallic vapour arc lamps.

3,430 Hammond. Electrical muscular exercising machines. (Date applied for, May 23, 1905.)

4,343 Carbone. Arc lamps. (Date applied for, Feb. 27, 1905.)

4,720 Pevear. Switches and controlling mechanism therefor. (Date applied for, Feb. 27, 1905.)

5,092 Holmes. Electric lamp-heating apparatus.

5,853 Tingley. Ventilation of dynamo-electric machines. (Date applied for, March 17, 1905.)

6,435 France. Brakes for tramcars.

6,559 Hewitt. Vapour electric apparatus for converting or interrupting electric currents. (Date applied for, March 29, 1905.

6,614 Stewart. Circuit breakers. (Date applied for, March 20, 1905.)

7,292 Soc. anon. des Manufactures de Glaces et Produits Chimiques de St. Gobain, Chauny et Cirey. Condensers for wireless telegraphy. (Date applied for, April 6, 1905.)

7,332 Mitchell & Gunn. Device for supporting electric cables, pipes, &c.

8,357 Junggren. Turbines. (Date applied for, April 18, 1905.)

8,402 Cooper. Controlling systems for electric motors. (Date applied for, April 10, 1905.)

8,526 E.A.-G vorm. W. Lahmeyer & Co. Dynamo-electrical machines. (Date applied for, April 11, 1905.)

9,164 Petersson. Electric furnaces. (Date applied for, April 18, 1905.)

9,769 Westinghouse. Turbines. (Date applied for, May 2, 1905.)

11,181 Siemens Bros. & Co. (Siemens & Halske A.-G.) Electromagnetic automatic interrupter.

COMPANIES' MEETINGS AND REPORTS.

National Telephone Co. (Ltd.)

The 38th ordinary general meeting was held yesterday at Hamilton House, Victoria Embankment, Mr. George Franklin (chairman of the board) presiding.

The SECRETARY (Mr. Albert Anns) read the notice calling the meeting and the report of the auditors.

The CHAIRMAN, in moving the adoption of the report, referred to the loss that the company had sustained through the retirement, as chairman, of Sir Henry Fowler, M.P., and said that he had been elected as his successor. Dealing with the income of the past half-year, he stated that it had increased by £109,304 to £1,195,685. This was derived from 386,623 stations, of which 24,210 had been added during the period under review. Upwards of £113,000 had been paid in royalties, making the total sum paid to the Post Office £2,130,000, for no service rendered. The net income came to £1,082,320, against £985,791 in the corresponding period of 1905. The ratio of the working expenses had risen from 63·63 to 64·32 per cent., and no doubt the stockholders would want an explanation of that increase. The answer was that during the last few years the board had been compelled to adopt cheaper tariffs, both in London and the provincial towns, the result of which had been to bring down somewhat the revenue per line year after year. The average income per station for last year was £6. 5s. 11d., as compared with £6. 12s. 3d. in 1904 and £6 17s. 4d. in 1903. Under the heading of rentals carried forward for unexpired terms they had £1,018,000, so that they started the current half-year with a very large sum coming in. Referring to the capital account he stated that the total expenditure upon the undertaking has been £11,895,602, which, divided over the whole of their stations, gave the cost per station for London and the provinces £30. 15s. 4d. There had been a lot of statements made from time to time that the company's capital included a considerable amount of "water." He was tempted sometimes to test such statements in the light of solid facts, and there was one instance in his mind which, he thought, might show the shareholders that there was not so much ground for such statements as was sometimes thought. He saw from the printed records of the Glasgow Corporation that at the end of last month they had 12,821 telephone stations working on their municipal system, and that on those stations £362,000 had been spent. That made the cost per station £28. 5s., a sum not very dissimilar from the capital cost per station of this company. Here, then, they had a Corporation starting in later days with all the advantages of experience gained by this company, and yet having an expenditure of £28. 5s. per station. It was a pleasure to the board to hear of the proposed sale of the Glasgow municipal telephone system to the Post Office, for two reasons. First, it must surely mean an end to the senseless competition in which they had been engaged, because it had been demonstrated again and again that the telephone business, from its nature and essence, must be a monopoly, carried on by whomsoever they wished. The second reason why they were pleased was that it showed the opinion that the Government had as to the proper treatment of their licensees. This company, as well as the Glasgow Corporation, were licensees of the Post Office, and it was absolutely unthinkable that any Government would attempt to mete out different treatment to the different licensees of the Post Office. As to the company's reserve of £2,065,943, the directors looked upon it as an insurance against ultimate shrinkage in the capital. Previous to last year they were always confronted with great uncertainty arising out of their limited tenure. Although that uncertainty had been removed by the agreement confirmed by the House of Commons in August of last year, there still remained a considerable amount of uncertainty as to what was to happen with regard to the ascertainment of the price to be paid. There was an obligation on the Postmaster-General to purchase the company's plant on the termination of their licence. The price to be paid, however, might have to be determined by arbitration, and it was in view of this contingency that the directors felt it necessary to strengthen the reserve from time to time in order to ensure the repayment of the capital. He mentioned, in conclusion, that the shareholders now numbered 11,107, and the debenture stockholders 4,492, while the staff had increased during the past 12 months from 14,647 to 16,719 at the present time.

Mr. S. H. SANDS (vice-president) seconded the motion.

Mr. LEA SMITH expressed his complete satisfaction with the report of the chairman's statement, and said that he thought it was simply marvellous that the company had done so much during its existence in view of the difficulties against which it had had to contend.

Mr. JACKSON associated himself with the previous speaker's remarks as to the satisfactory results obtained by the company, but added that the joint opinion of counsel with regard to the rights of the stockholders in the event of liquidation was about as unsatisfactory as it could be, and he wished to move an amendment that, instead of transferring the proposed sum of £120,000 to reserve, it should be a once distributed among the deferred stockholders.

The CHAIRMAN said that that would be out of order, and he observed, in reply to the general discussion, that the question of the third preference stockholders participating in any surplus funds would not arise for another 5½ years. The board would use their influence to see that the funds were distributed under the direction of the Court when the proper time came. The directors would not raise any capital during the remainder of their license unless it would be reproductive, and they could see their way to get it back at the end of 1911.

The resolution was unanimously carried.

The retiring directors, the Chairman, Sir Cuthbert Quilter, Mr. W. A. Smith, were re-elected; and the auditors, Messrs. Welton, Jones & Co., were also reappointed.

Votes of thanks to the board and the staff terminated the proceedings.

Electric Construction Co. (Ltd.)

The thirteenth annual general meeting was held yesterday, Mr. JAMES W. BARCLAY, presiding.

The SECRETARY (Mr. David Willock) read the notice convening the meeting, and the auditors' report.

The CHAIRMAN said: Gentlemen, the accounts show £6,045. 8s. 2d. of profits available for distribution, after maintenance of works and plant, and providing £5,000 for depreciation, and your Directors recommend payment of dividend on the preference shares, which will absorb £4,394. 12s., and a balance of £1,650. 16s. 2d. will be left to carry forward. This disappointing outcome of the year's business is due to causes beyond the control of either the Directors or the management. When I addressed you last year I told you that the competition among manufacturers of electrical machinery had been intense, and still continued, but that there was more business about, which I hoped would lead to better prices and profits. Our business has increased, but unfortunately there has been no increase of prices or profits, and although our officers have done their best towards economy in production combined with efficiency, the margin of profit we have been able to secure is not sufficient to pay a dividend on the ordinary shares. We refused to reduce prices till forced to do so by emptying workshops, and we have endeavoured to advance prices as called for by the higher cost of raw materials, but our efforts have been in vain. We are not alone in this unfortunate position, for a survey of the annual accounts of others engaged in the same business discloses an absence of profits which must be no less disappointing to them than it has been in our own case. This discouraging result does not arise from any falling off in the demand for electrical plant or to foreign competition, but is caused solely by the excessive expansion in this country of factories for the manufacture of electrical plant. Some three or four years ago great preparations were made for increasing the supply of electrical machinery for which it was foreseen a great demand would arise, and although the expectation has been to some extent justified, the demand has not come in sufficient volume to provide employment for all the factories. The struggle among the new or extended works to fill their workshops has been so keen that prices for electric installations have been reduced to the point of no profits, and this you will fully realise when I inform you that the price of electrical machinery has in the last three years been reduced by more than one-third, and that in spite of a considerable advance in the price of raw materials during the last 12 months. The cause of the unprofitable result of our business is therefore clear enough, and no doubt you would like to know how long the present state of matters is to go on. I wish I could tell you. The demand for electrical plant will, no doubt, grow, but I cannot entertain a hope of better profits until competition is reduced. The plain fact is there are too many of us for the work to be done, and the future is a question of the survival of the fittest. In this point of view I think we are as favourably equipped for a struggle as any of our competitors, and your Directors and officers must, undiscouraged, continue their efforts towards greater economy in production and increased efficiency, so as to maintain the high position the Company has hitherto held in the manufacture of electrical plant. I will now briefly refer to some of the items in the accounts. First, as to the financial position. Last year we had on the debit side of our balance-sheet a loan of £7,500. That was repaid and this year we have no loan. The contingent liability referred to in the note on the credit side of the accounts merely means that we have taken part payment for plant supplied to the Madras Tramways Co. by their acceptance, in respect whereof we have, of course, a contingent liability until it is paid. You will no doubt have observed a falling off in the return from shares in other companies. This is due to a reduction in the dividend of the Madras Tramways Co., caused by a falling off of the receipts in consequence of a bad monsoon last year and an outbreak of plague in the city of Madras. The interest on the outlay in the construction of the extensions has been charged to revenue account, although as yet there has been practically no return for this expenditure. I am, however, pleased to inform you that since the beginning of June, when a part of the extensions was opened for traffic, the increased receipts are very encouraging, and give good ground for anticipating a satisfactory return from this property, not only ultimately but in the not distant future. The Electrical Power Storage Co. (Ltd.), under the management of our colleague, Mr. Courtenay, continues to do very well, for, notwithstanding the depression and severe competition that has prevailed during the year, its previous dividend of 6 per cent. is maintained, and, in the circumstances, that, I think, is the best proof of the strong position held by that company in its special business—the manufacture of batteries for the storage of electricity. The prospects of this business are, I think, very encouraging, for no one doubts the superiority for passenger traffic in London of electric traction provided by storage batteries, or that electric traction will ultimately hold the field, provided its cost is not prohibitive, as at present is asserted by some. This question has not yet been practically determined, but I am sanguine that under judicious management the advantages of electric traction will justify all the additional cost that electric traction may involve. As I mentioned last year, we had intended to offer a part of our large holding in the Company to our shareholders, not because we were dissatisfied with the return, but because we could do with part of the money in our own immediate business; but the feeling in the financial world against everything electric has been so strong, without, as I think, adequate justification, that we did not think it expedient to offer the shares. I believe a reaction is not far distant, for nothing that has happened seems to justify the recent distrust, and, when confidence does return, we intend to offer a part of our large holding in that Company at a price which we believe will yield a good and permanent return to investors. I do not think that any of the other items call for special notice. I now move the adoption of the report and accounts.

Mr. J. IRVING COURTENAY seconded the motion.

Several shareholders having asked for information concerning items in the balance-sheet and the chairman having replied, the motion for the adoption of the report and accounts was carried nem. con.

The retiring Directors (Mr. James W. Barclay and Mr. J. Irving Courtenay) were re-elected, as were also the auditors (Messrs. J. Meston & Co.), and a cordial vote of thanks to the Chairman and Directors terminated the proceedings.

CITY & SOUTH LONDON RAILWAY CO.—The directors propose a dividend for the half-year ended June 30 at the rate of 2¼ per cent., with a transfer of £1,500 to renewal fund, leaving £1,870 to be carried forward. The dividend for the corresponding half of last year was at the rate of 2 per cent., with a balance forward of £1,041.

CONSOLIDATED ELECTRICAL CO. (LTD.)—The report stated that in August last the Canonbury business was disposed of to the Consolidated Supply Co., the assignment dating from March 31, 1905. The purchase price of £19,732 (payable as to £15,000 in 6 per cent. preference shares and as to £4,732 in cash) represented the book value of the London premises, plant, machinery and stock-in-trade taken over. The Anglo-Portuguese Telephone Co.'s shares held by the company are now taken into the balance-sheet at par (£1 each) and their appreciation in price has enabled a reduction of £16,222 to be made in the item of goodwill. Several items of doubtful value included in the previous accounts have been written off out of the past year's profits. The directors have been able to pay off the whole of the arrears of dividend on the preference shares up to Nov. 30 last. A further dividend on these shares for the period from

Dec. 1, 1905, to March 31, 1906, has been paid since the close of the year, and it is intended in future to pay these dividends half-yearly on or about Jan. 1 and July 1. Of the available balance of £12,079 standing to credit of profit and loss the final dividend on the preference shares absorbed £300. The directors now recommend a dividend on the ordinary shares of 3 per cent. for the year, absorbing £3,300, leaving £8,479 to be carried forward.

DIESEL ENGINE CO. (LTD.)—The report for the year ended March 31 states that the company's operations have largely increased and prospects have much improved. The credit balance shows £11,162, plus £1,485 royalties, or £12,647 against £7,404 last year. The profit has sufficed to pay off last year's debit balance and leave a small carry-over. The value of orders booked in the year exceeded by about 50 per cent. those for the previous year, and the turnover during the same period exceeded that of the previous year by over 50 per cent. At present the turnover is limited by the speed at which it is possible to obtain delivery of engines on order.

DIRECT UNITED STATES CABLE CO. (LTD.)—The report of the directors for the six months to June 30 states that the half-year's revenue, after deducting out-payments, amounted to £56,264. 19s. 5d., compared with £49,469. 13s. 2d. for the corresponding period of 1905, a difference of £6,795. 6s. 3d. in favour of the half-year under review. Working and other expenses (including income tax, but exclusive of cost of cable maintenance) amounted to £23,924. 8s. 9d., leaving £32,340. 10s. 8d. as net profit, or with £5,848. 17s. 3d. brought forward £38,189. 7s. 11d. For the corresponding period of 1905 these expenses, &c., amounted to £22,571. 15s. 2d. Interim dividends of 3s. per share for the quarter ended Sept 30, 3s. 6d. per share for the quarter ended Dec. 31, and 4s. per share for the quarter ended March 31 (representing £31,872. 15s.) have been paid, and a final dividend of 4s. per share is now proposed, together with a bonus of 2s. 6d. per share, making 4¼ per cent. for the year, and a total distribution of £51,603. 10s. The balance (£6,316. 12s. 11d.) it is proposed to carry forward. The reserve fund has been debited with £7,143. 15s. cost of cable maintenance, and after being credited with interest on investments and profit on sale of securities, now amounts to £504,184. 7s. 4d., taking investments at cost price.

DUBLIN UNITED TRAMWAYS CO. (1896) (LTD.)—The directors' report for the half-year ended June states that, including £2,500 from last account (appropriated towards maintenance and not expended) the amount available for division is £47,503. 9s. 7d., out of which it is recommended that dividends be paid for the half-year on the 6 per cent. preference shares and at the rate of 6 per cent. (tax free) on the ordinary shares. £5,000 is placed to reserve and renewals and £2,000 towards maintenance in the current half-year. The dividends and the sums added to reserve, &c., absorb £42,100, leaving £5,403. 9s. 7d. to be carried forward.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended March 31 shows that the revenue for the period amounted to £628,319. 12s. 7d., from which are deducted £191.468. 1s. 7d. for ordinary expenses, and £46,464. 1s. for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange, and income tax payable abroad, leaving £390,387. 10s., to which is added £39,471. 11s. 10d. from the preceding half-year, making £429,859. 1s. 10d. After providing for income tax payable in England, interest on mortgage debenture stock, and for two quarterly dividends on the preference stock, absorbing £87,591 15s., there remains £342,267. 6s. 10d., out of which the directors have placed £10,000 to reserve for maintenance ships, £150,000 to general reserve and have paid an interim dividend of 1¼ per cent. on the ordinary stock amounting to £50,000. The directors now recommend a final dividend on the ordinary stock for the year ended March 31, 1906, of 1¼ per cent. and a bonus of 2 per cent. amounting together to £130,000, both payable on 26th instant (tax free) making a total distribution of 7 per cent. for the year. It is proposed to carry forward the balance of £2,267. 6s. 10d. to next account. With the view of strengthening telegraphic communication between Great Britain, South Africa and South America, it has been decided, in conjunction with the Western Telegraph Co., to lay an additional cable between Porthcurnow and St. Vincent (Cape de Verde). The vacancy occasioned by the death of the late Sir Henry C. Fischer, C.M.G., has been filled by the election of the Right Hon. W. J. Pirrie to a seat at the board.

The register of transfers will be closed from the 18th to the 25th inst. inclusive.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—Including £15,007. 6s. 7d. from last year, the net profit for the year ended March 31, after payment of interest, was £59,173. 18s. 9d. Deducting preference dividends (£24,000) and an interim 2½ per cent. on the ordinary shares (£10,000) there remains £25,173. 18s. 9d., which the directors recommend should be appropriated in paying a final ordinary dividend at the rate of 3 per cent. (making 4 per cent. for the year) (£6,000), adding £3.962. 6s. 7d. to reserve, leaving £15,211. 12s. 2d. to be carried forward. In consequence of the smaller amount of installation work during the year the trading profit shows a considerable diminution, and the directors regret that the increase of income from investments has not compensated for this deficiency. They believe, however, that an improvement in this direction is now being experienced. All the stations in which the corporation is interested are now opened and at work. The total number of equivalent 8 c.p. lamps connected at end of March, 1906 (exclusive of the Lancashire Power Co.) is 934,119, an increase on the year of 172,666. Mr. F. E. Gripper has resigned his position as chairman, but retains office as joint managing director. Mr. H. Wolfenden has been elected chairman and joint managing director.

ELECTRIC SUPPLY CORPN. (LTD.)—Fourth report of the directors just issued shows that, after providing for repairs and £1,524. 13s. 9d. for debenture interest, there is a debit balance of £294. 7s. 1d. The company has received from the guarantors £3,967. 11s. 1d., sufficient to extinguish this small debit balance, and to provide for payment of an interim dividend at the rate of 5 per cent. per annum for the six months ended June 30 last. The dividend received from the Chelmsford Electric Lighting Co., the only undertaking possessed by the Corporation which is fully established, was again at the rate of 6 per cent. per annum. The gross revenue from the installations at Dalkeith, Dollar, Jedburgh and Melrose amounted to £1,533, against £588 in 1904, and on the Totnes Electricity Supply Co. there was a loss of £210 on its first completed year's working. The gross revenue of that company, however, shows steady improvement. During the past year electricity supply has commenced at St. Andrews, Exmouth and Hitchin. The work at Falmouth and Dumbarton is progressing satisfactorily. The total number of lamps connected to the company's systems on Dec. 31 last was equivalent to 38,115 8 c.p. lamps, and 4,195 were awaiting connection. The company has applied for a provisional order for an electric tramway from Clydebank to Dumbarton, and from Dumbarton to Balloch, on the shore of Loch Lomond. This tramway may by agreement be connected up at Clydebank with the Glasgow system. Additional capital will be required for the purposes of this company.

GENERAL ELECTRIC CO. (LTD.)—For the year ended March 31 the net trading profits and income from investments, &c., amounted to £70,149. 2s. 8d., and after deducting depreciation and debenture interest (£25,554. 2s. 11d.) the balance is £44,594. 19s. 9d., out of which the preference dividend has been paid, absorbing £12,500, leaving £32,094. 19s. 9d. The directors recommend that this should be appropriated in paying of managing directors' and employés' bonus (£3,209. 10s.) and a 5 per cent. dividend on the ordinary shares for the year (£16,561), and by placing £12,324. 9s. 9d. to reserve, bringing the latter up to £108,577. 13s. 3d. The sales of all departments have shown an increase during the year, yet the trading profits have not benefited therefrom proportionately owing to the continued rise in price of raw materials without corresponding increase of selling prices. The slight improvement in the general trading noticeable during the last few months has not affected the balance sheet under review, but has materially helped to fill the company's order books for the current year. The Witton engineering and carbon works have been increased during the year owing to progressive results and are at present in a very good condition. The machinery turned out from Witton works has gained steadily in popularity, many large contracts have been carried out, and are leading to repeat orders.

OXYCHLORIDES (LTD.)—The report for 1905 states that during the year the process and plant at Guildford have been under observation by the Royal Commission on sewage disposal, and it was in anticipation that the Commission's report would be available earlier that the shareholders' meeting had been delayed. Syndicates have been formed in Australia and in New Zealand for acquiring the company's patent rights. Those syndicates are purchasing from the company machines and dynamos, and also paying the incidental expenses.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

COWPER-COLES COPPER CORPN. (LTD.) (89,493).—Reg. July 14, capital £1,750, in 1s. shares, to acquire from Sherard Cowper-Coles & Co. (Ltd.) and others the benefit of a certain existing invention relating to the electro-deposition of metals and the patents relating thereto, and to adopt agreements with Sherard Cowper-Coles & Co. (Ltd.) and C. K. Milbourne. First directors, V. W. Yorke, C. E. Allan, S. O. Cowper-Coles, C. K. Milbourne and R. Steel. Reg. offices, 82, Victoria-street, London, S.W.

DURA MANUFACTURING CO. (LTD.) (89,475.)—Reg. July 12, capital £2,000 in £1 shares, to carry on the business of electric lighting, electrical and mechanical engineers, electricians, makers of dynamos, motors and electrical apparatus and fittings, electric and other lamps, &c.

ELECTRICAL INDUSTRIES DEVELOPMENT CO. (LTD.) (89,461.)—Reg. July 11, capital £25,000 in £1 shares (20,000 preference), to carry on in the United Kingdom and elsewhere the business of suppliers of electricity, electricians, manufacturers of wires, cables, accumulators, lamps and appliances, &c. Reg. office, 31, Walbrook, London, E.C.

FRANK SCHOFIELD (LTD.) (89,462.)—Reg. July 11, capital £50,000 in £1 shares, to adopt an agreement with F. Schofield, and to carry on in Great Britain and elsewhere the business of manufacturers and repairers of and dealers in mechanical tools, electric motors, &c.

HOLLAND HOUSE ELECTRICAL CO. (LTD.) (6,246)—Reg. in Edinburgh July 13, capital £6,000 in £3 shares, to acquire the business of the Holland House Electrical Mfg. Co. (Ltd.), and to carry on the business of manufacturers of and dealers in electrical, cast and wrought metal work, machinery, &c. Reg. office, 9, Holland-place, Glasgow.

ORIENT ELECTRIC POWER SYND. (LTD.) (89,446.) Reg. July 10, capital £5,000 in £1 shares, to carry on in India and elsewhere the business of electric power and light suppliers, electricians, electrical, metallurgical, mechanical and chemical engineers, manufacturers of electrical apparatus, &c., and to adopt an agreement with Killick, Nixon & Co. and John Fleming & Co. First directors, R. W. Hogarth, T. Wilson, L. R. W. Forrest, Sir Ernest Cable and J. F. Albright. Reg. office, Parliament-chambers, Great Smith-street, Westminster.

RIVIERA SYNDICATE (LTD.) (89,451.)—Reg. July 10, capital £5,000 in £1 shares, to carry on the business of railway and tramway constructors and owners, electricians, suppliers of electric light and power, &c. E. A. N. Morley is first director. Reg. office, 195, Palmerston-house, Old Broad-street, London, E.C.

STATUTORY RETURNS.

ELECTRIC & ORDNANCE ACCESSORIES CO. (LTD.)—In return to May 23 capital is £50,000 in £1 shares, all of which have been taken up and paid for in full. Mortgages and charges, £130,000. Since date of return the capital has been increased to £150,000, and the £100,000 new shares have been taken up subject to payment in cash.

LEWES & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Return to May 15 gives capital as £50,000 in 2,500 ordinary and 2,500 preference shares of £10 each, of which 2,507 ordinary have been taken up. £20,570 has been received. Mortgages and charges, nil.

MARKET DRAYTON ELECTRIC LIGHT & POWER CO. (LTD.)—According to return to May 8 capital is £15,000 in £10 shares, of which 1,291 have been taken up. £10 per share has been called up, and £12,910 has been received. Mortgages and charges, nil.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The capital in return to May 14 is £300,000 in 200,000 ordinary and 100,000 preference shares of £1 each, of which 179,313 ordinary and 50,000 preference have been taken up. £1 per share has been called up on 7,816 ordinary and 50,000 preference, and £57,828. 10s. has been received, including £12. 10s. paid on 50 ordinary shares forfeited. 171,497 ordinary are considered as fully paid. Mortgages and charges, £100,000.

PENARTH ELECTRIC LIGHTING CO. (LTD.)—In return to May 9 capital is £50,000 in 2,500 ordinary and 2,500 preference shares of £10 each, of which 2,500 ordinary have been taken up. £25,000 has been received. Mortgages and charges, nil.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—Return to April 25 gives capital as £60,000, in 6,000 ordinary and 6,000 preference shares of £5 each, of which 4,000 ordinary and 4,000 preference have been taken up. £5 per share has been called up, and £40,000 has been received. Mortgages and charges £20,000.

STANDARD ELECTRIC CO. (LTD.)—Return to May 21 gives capital as £10,000 in 5,000 preference and 5,000 ordinary shares of £1 each, of which 3,077 preference and 5,000 ordinary have been taken up. £1 per share has been called up on 4,175 and 10s. per share on 400 shares, and £4,202 has been received, leaving £175 in arrears. £3,700 is considered as paid, being £1 per share on 3,500 shares and 10s. per share on 400 shares. Mortgages and charges, nil.

THOMSON-DAVIS TELEPHONE SYSTEM (LTD.)—According to return to January 27 capital is £6,000 in £1 shares, of which 5,695 have been taken up. £1 per share has been called up on 842, and 7s. 6d. per share on 360. £947 has been received, leaving £30 in arrears. 4,493 shares are considered as fully paid. Mortgages and charges, nil.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The capital in return to May 17 is £650,000 in £5 shares (80,000 preference and 50,000 ordinary), all of which have been taken up and paid for in full. Mortgages and charges, £200,000.

VERITY'S LIMITED.—In return to June 15, capital is £210,000 in 200 management shares of £1 each, and 6,980 ordinary, 7,000 first preference and 7,000 second preference shares of £10 each, of which 200 management, 5,343 ordinary, 7,000 first preference and 7,000 second preference have been taken up. £1 per share has been called up on 30 management and £10 per share on 1,142 ordinary, 4,670 first preference and 7,000 second preference, and £128,150 has been received. £65,470 is considered as paid on 170 management, 4,200 ordinary and 2,330 first preference. Mortgages and charges, £40,000.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—Return to June 6 gives capital as £2,445,630 in 200,000 ordinary, 34,563 first preference and 10,000 second preference shares of £10 each, of which 88,321 ordinary, 34,536 first preference and 4,669 second preference have been taken up. £1,275,530 is considered as paid. Mortgages and charges, £80,000.

WESTERN TELEGRAPH CO. (LTD.)—In return to May 30 capital is £2,500,000 in 250,000 shares of £10 each, of which 207,930 have been taken up. £10 per share has been called up on 130,000 and £1,300,000 has been received. £779,300 is considered as paid on 77,930 shares. Mortgages and charges, £862,000.

WOODHOUSE & BAILLIE RIVIERA ELECTRICITY CO. (LTD.)—Return to March 31 gives capital as £50,000 in 16,000 first preference, 20,000 second preference and 14,000 ordinary shares of £1 each, of which 14,700 first preference, 4,000 second preference and 4,000 ordinary shares have been taken up. £1 per share has been called up on 14,700 first preference and 14,660 has been received, leaving £40 in arrears. £8,000 is considered as paid on 4,000 second preference and 4,000 ordinary. Mortgages and charges nil.

WREXHAM & DISTRICT ELECTRIC TRAMWAYS (LTD.)—In return to May 24 capital is £50,000 in 5,000 preference and 5,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on 4,700 preference and 4,697 ordinary shares, and £3 per share on three ordinary shares, and £46,989 has been received, leaving £5 in arrears. £600 is considered as paid on 300 preference and 300 ordinary. Mortgages and charges nil.

MORTGAGES AND CHARGES.

STANDARD ELECTRIC CO. (LTD.)—Issue on July 6 of £3,500 five per cent. debentures, part of series created May 25, 1906, to secure £4,000, charged on company's undertaking and property, present and future, including uncalled capital. Holder, L. D. Gunn. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA (July 19).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $30\frac{3}{16}$d. per oz. Consols $87\frac{9}{16}$—$87\frac{11}{16}$ for money, $87\frac{5}{8}$—$87\frac{3}{4}$ for account; $2\frac{1}{2}$ per cent. annuities 86—$86\frac{1}{2}$. Consols Pay Day, August 1; Stocks and Shares Continuation Day, July 25; Ticket Day, July 26; Pay Day, July 27; Mining Share Carry-over Day, July 24.

ELECTRIC POWER IN CLEVELAND AND DISTRICT.—An important joint-stock enterprise affecting the supply of electricity in Cleveland and Tees-side is in process of formation. A new company is to take over the Cleveland and Durham County Electric Power Co. (the company which has Parliamentary powers for the supply of an area of 820 square miles in the Tees district and the South and West Durham coalfields), and to secure a controlling share in the Northern Counties Electricity Supply Co., which is supplying current for power and lighting in many parts of Northumberland, Durham and North Yorkshire. It is proposed that shares in the latter company should be purchased at 25s. each, the shareholder being given the option of selling or of taking shares, to the value of the purchase price, in the new company. As will be seen from our advertisement columns, the capital of the new company (the Cleveland and Durham Electric Power (Ltd.) is £1,000,000, and the board of directors is an influential one, including Sir John D. Milburn (chairman of the Newcastle and District and of the Northern Counties Supply Companies), Mr. J. H. Armstrong (director of Newcastle-on-Tyne and the County of Durham Electric Supply Companies), Mr. Chas. Emmott (chairman of Robert Stephenson & Co., Ltd.), Mr. J. Falconer (County of London & District Electric Power), Hon. R. James (Palmer's Shipbuilding Co.) and Mr. M. Lowthian Bell (director of Bell Bros. and of Dorman, Long & Co.). Most of these gentlemen are closely identified with electric or other industrial undertakings in the district. We learn that the directors have secured the services of the engineers (Messrs. Charles H. Merz and William McLellan), who have been prominently connected with the development of the Newcastle-on-Tyne and County of Durham Supply Companies. These gentlemen estimate that the possible demand upon the company's supply amounts to upwards of 150,000,000 units per annum. The Newcastle-on-Tyne Electric Supply Co. has, we believe, made an offer to the new company by which they will work certain operating stations upon very favourable terms. The experience of the Tyneside electric concerns leads to the belief that considerable economies can be effected by this fusion of interests and centralisation of control.

The subscription list in the new company (Cleveland and Durham Electric Power, Ltd.) open to-day (Friday). The share capital is £1,000,000, divided into 70,000 5 per cent. cumulative preference, 70,000 6 per cent. participating ordinary (being entitled to a possible further participation in profits), and 60,000 deferred shares, all of £5 each. The present issue comprises the whole of the cumulative preference and participating ordinary shares. No part of the issue has been underwritten, although requests for shares to the amount of nearly £300,000 have been received. The Prospectus set out on another page of this issue gives further particulars.

CENTRAL LONDON RAILWAY CO.—A dividend is announced at the rate of 4 per cent. on the ordinary and preference stocks for the half-year ended June 30, carrying forward £32,257. A year ago the dividends were the same, with £34,800 forward.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—Warrants in payment of the dividends "on account" of the year ending Dec. 31, 1906, on this company's preference and ordinary shares have been posted.

HAVANA TELEPHONE CO.—During the week subscriptions were invited for an issue of $1,200,000 5 per cent. first mortgage debentures of this company.

METROPOLITAN RAILWAY CO.—A dividend of $1\frac{1}{2}$ per cent. per annum has been declared on the consolidated stock for the past half-year.

MONTREAL LIGHT HEAT & POWER CO.—The directors have declared a dividend for the quarter ending 31st inst. at the rate of 5 per cent.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have decided to pay an interim ordinary dividend at the rate of 5 per cent.

ROSARIO ELECTRIC CO. (LTD.)—Applications are invited for 15,000 6 per cent. cumulative second preference shares of £6 each of this company.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—The debenture stock holders last week passed a resolution appointing a committee of five (Messrs. Stanley Boulter, William Fleming, Grenfell, Ling and Collis) on behalf of the stock holders, to confer with the board in regard to the future management of the company and the satisfaction of its creditors, and also in regard to the terms and conditions of issue of any prior lien stock or preference shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted a quotation to London certificates for 11,000 $100 shares and 36,000 additional shares of the *Canadian General Electric Co. (Ltd.)* The committee have been asked to appoint a special settling day in £1 fully paid ordinary shares (Nos. 17,001 to 20,000 and 50,001 to 58,381) of *Bruce Peebles & Co. (Ltd.)*

VICKERS, SONS & MAXIM (LTD.) The following interim dividends for the half-year ended June 30 have been declared, payable Aug. 1:—$2\frac{1}{2}$ per cent. (less tax) on the preferred 5 per cent. stock and 5 per cent. preference shares; 1s. per share (tax free) on the 3,700,000 ordinary shares of £1 each.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	AGGREGATE.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 11	1,615	+ 99	6	8,705	- 212
Airdrie	,, 6	228	+ 27	27	5,921	+ 597
Anglo-Argentine	,, 15	14,427	+ 1,960	28	414,851	+ 43,766
Ashton-under-Lyne Corp	,, 7	883	+ 60	16	5,614	+ 596
	,, 14	361	- 8			
Ayr Corporation	,, 7	412	+ 38	9	2,049	- 152
	,, 14	454	- 15			
Baker St. & Waterloo Ry.	,, 14	1,440	...	2	2,886	...
Barnsley	,, 6	162	- 1	27	4,319	+ 25
Barrow	,, 6	308	- 70	27	6,359	+ 288
Bath Electric Trams, Ltd.	,, 11	995	+ 212	23	21,189	+ 3,255
Birkenhead Corporation	...	...	..	...	...	...
***Birmingham Corporation**	,, 14	1,432	+ 1,035	15	10,447	+ 5,007
Birmingham & Mid.	,, 6	10,124	+ 83	27	273,583	+ 19,617
Blackburn Corporation	,, 11	1,116	+ 44	¶15	16,563	+ 1,038
Blackpool Corporation	,, 12	1,532	- 31	14	15,601	+ 549
Blackpool and Fleetwood	,, 14	938	+ 54	2	1,828	- 20
Blackp'l, St. Anne's & Lytham	,, 12	632	+ 26	§36	10,487	+ 1,296
Bolton Corporation	,, 15	2,211	+ 92	15	32,921	+ 2,030
Bournemouth Corporation.	,, 11	1,718	+ 144	†15	24,103	+ 5,839
Bradford Corporation	,, 14	4,778	+ 6	15	70,327	+ 2,885
Brighton Corporation	,, 15	1,028	- 147	15	14,849	- 720
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 13	5,801	+ 435	22	110,097	+ 3,688
Buenos Ayres & Belgrano	,, 8	3,619	- 8	27	95,908	+ 5,515
Buenos Ayres Elec. Trms	...	..	...	...	...	...
Burnley Corporation	,, 14	1,392	+ 106	15	18,643	+ 781
Burton Corporation	,, 15	308	- 52	§15	4,605	- 335
Bury Corporation	,, 8	1,045	...	14	14,230	...
Calcutta Tramways Co.	,, 14	R44,259	+ R375	2	R89,283	+ R2,673
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 7	2,225	...	15	31,425	- 1,066
	,, 14	2,257	+ 49			
Cavehill	,, 6	105	+ 50	27	2,049	+ 611
Central London Railway	,, 14	5,896	- 168	2	12,027	- 397
Chatham & Dist. Lt. Rys.	,, 12	756	- 32	†27	17,517	- 153
City & South London Rly.	,, 15	2,454	+ 196	2	4,919	+ 361
Colchester Corporation	,, 12	248	- 4	50	10,840	+ 1,299
Cork Electric Trams Co.	,, 12	579	- 31	28	12,892	- 329
Croydon Corporation	,, 13	1,586	+ 46	6	10,188	+ 841
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	,, 6	631	+ 50	27	11,734	- 447
Dover Corporation	,, 14	527	+ 51	15	3,858	+ 514
Dublin & Lucan Railway	,, 13	133	- 9	§2	230	- 43
Dublin United	,, 18	5,587	- 234	‡2	9,931	+ 649
Dundee Corporation	,, 11	1,137	+ 231	§8	8,877	+ 1,797
East Ham Council	,, 14	970	+ 70	15	14,321	+ 1,426
Exeter Corporation	,, 13	302	- 28	15	4,349	- 425
Falkirk and District	,, 4	305	...	...	...	...
	,, 11	249	...			
Gateshead & Dist. Trams	,, 6	925	+ 66	27	25,379	+ 1,219
Glasgow Corporation	,, 14	16,958	+ 843	7	1[illegible]1,811	+ 7,064
Glossop	,, 14	141	+ 10	28	3,641	+ 336
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 6	317	+ 19	27	6,181	+ 281
Gt. Northern & City Rly.	,, 14	1,645	+ 192	2	3,824	+ 358
Greenock & Port Glasgow	,, 6	914	+ 71	27	17,433	+ 911
Halifax Corporation	,, 11	1,743	- 54	15	25,491	+ 1,277
Hartlepool Tramways	,, 6	365	+ 110	27	7,541	+ 762
Hastings Elec. Trams Co.	,, 12	874	...	2	1,650	...
Huddersfield	,, 15	1,620	+ 68	15	28,215	+ 2,372
Hull Corporation	,, 14	2,371	+ 95	15	33,830	+ 885
Ilford Dist. Coun.	,, 14	526	- 29	15	7,762	+ 168
Ilkeston Dist. Council	,, 11	142	+ 17	15	1,974	+ 77
Ipswich Corporation	,, 14	479	- 87	15	6,582	- 203
Isle of Thanet Co.	,, 14	1,124	- 159	40	15,994	- 1,109
Keighley Corporation	,, 12	170	+ 8	2	277	- 14
Kidderminster & District	,, 6	155	+ 9	27	2,943	- 50
Kilmarnock Corporation	,, 14	165	- 14	9	1,368	- 69
Kirkcaldy Corporation	,, 11	235	+ 21	2	461	+ 29
Lanarkshire Trams Co.	,, 12	875	- 193	‡28	24,097	+ 18,511
Leamington	,, 6	405	+ 358	27	[illegible],532	+ 2,708
Leeds Corporation	,, 14	6,520	- 823	15	95,695	+ 4,497
Leicester Corporation	,, 14	2,332	- 87	2	4,658	- 6
Leith Corporation	,, 7	560	+ 311	‡8	4,104	+ 2,223
Liverpool Overhead Rly.	,, 15	1,555	- 51	2	3,118	- 134
Liverpool Corporation	,, 7	12,458	+ 162	27	285,161	+ 5,790
***London County Council**	,, 7	27,227	+ 10,518	14	373,066	+ 161,600
London United	,, 13	7,511	+ 364	†28	166,621	+ 9,631
Lowestoft	,, 14	237	- 63	42	5,[illegible]6	- 468
Maidstone Corporation	,, 12	126	- 37	15	1,647	- 325
Manchester Corporation	,, 14	14,564	+ 2,357	15	205,841	+ 8,090
Mersey Railway	,, 14	1,605	+ 123	2	3,192	+ 220
Merthyr	,, 6	207	+ 19	27	5,156	+ 53
Metropolitan Dist. Railway	,, 15	8,008	+ 1,322	2	16,167	+ 2,067
***Metropolitan Elec. Trams**	,, 6	3,881	+ 2[illegible]7	27	88,014	+ 25,037
Middleton	,, 6	416	+ 17	27	9,156	+ 399
Nelson Corporation	,, 14	155	+ 3	16	2,302	+ 200
Newcastle-on-Tyne Corp.	,, 14	5,230	+ 1,493	15	62,786	+ 4,880
Newport (Mon.)	,, 14	614	- 8	15	9,524	+ 378
Northampton Corporation	,, 13	476	- 10	15	6,752	+ 35
Oldham, Ashton & Hyde	,, 6	599	+ 2	27	14,893	+ 507
Oldham Corporation	,, 15	1,814	- 8	16	28,729	+ 2,275
Perth (N.B.) Corporation	,, 10	181	...	8	1,[illegible]91	...
Perth (W. A.) Elec Trams	...	...	...	...	...	...
Peterborough	,, 6	157	- 116	27	3,129	- 400
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	,, 14	2,465	- 24	15	30,649	- 180
Potteries	,, 6	2,017	+ 239	27	47,515	+ 2,511
Preston Corporation	,, 11	823	+ 128	2	1,612	+ 279
Reading Corporation	,, 12	691	- 31	2	1,370	- 94
Rochdale Corporation	,, 14	1,103	+ 263	15	16,100	+ 5,339
Rotherham Corporation	,, 12	500	- 63	15	7,371	+ 618
Rothesay	,, 6	482	+ 163	27	8,885	+ 1,101
Salford Corporation	,, 16	4,568	- 1,587	15	69,779	- 90
Sheerness	,, 4	69	- 22	27	1,447	- 294
Sheffield Corporation	,, 15	5,215	- 1,449	16	84,463	+ 4,096
Singapore Trams	,, 7	$7,288	...	2	$14,188	...
	,, 14	$6,900	...			

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	AGGREGATE.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southampton Corporation.	July 11	1,081	- 39	†15	14,240	+ 15
Southend Corporation	...	...	...	...	...	...
Southport Tramways	,, 6	410	+ 82	27	7,933	+ 121
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	,, 18	1,064	+ 19	15	15,038	+ 5,133
Sunderland Corpn.	,, 15	1,597	+ 30	15	21,471	+ 1,10[illegible]
Sunderland & District	,, 11	500	...	28	10,531	...
Swansea Trams	,, 6	802	- 88	27	21,121	+ 4,31[illegible]
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 6	46	- 5	27	1,166	- 83
Tynemouth and District	,, 6	331	+ 2	27	6,067	- 141
Tyneside Trams Co.	...	...	...	...	...	...
Wallasey District Council	,, 14	900	+ 2	15	12,290	+ 881
Walsall Corporation ‡	...	..	...	...	...	...
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 12	2,396	+ 665	...	...	...
Weston-super-Mare	,, 4	252	+ 41	27	2,394	+ 121
Wolverhampton Corpn.	,, 11	930	...	2	1,781	...
***Worcester**	,, 6	350	- 15	27	7,146	- 641
Wrexham	,, 6	102	+ 3	27	2,647	- 4
Yorkshire W.R. Trams	,, 15	792	- 68	23	22,689	...
Yorkshire Woollen District	,, 6	947	+ 291	27	23,673	+ 7,0[illegible]3

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

SHARE.	LAST DIVIDEND	NAME.	Price Wed., July 18.	RATE PER CENT. YIELDED.	DIVIDEND DUE.	BUSINESS, WEEK TO JULY 1	
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.		High-est.	Low-est.
5	5/0	Anglo-Argentine Ord. Shs.	$6\frac{13}{16}$—$7\frac{1}{16}$	5 13 6	Ap, Oct	$7\frac{3}{32}$	6¾
5	2/9	Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	$5\frac{3}{32}$	5⅞
St.	6%	Do. Permanent 6% Deb. Stock	133 —141	4 5 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 16 3	—	103½	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	$4\frac{5}{16}$—$4\frac{9}{16}$	5 12 0	—	4½	$4\frac{7}{16}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	98 —103	4 7 4	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	116 —119	5 0 6	—	110½	..
St.	5%	Do. Pref. Ord. Stk	107 —110	4 11 0	—	..	..
10	5%	† Do. 5% Cum. Perp. Pref. Stock.	105 —103	4 13 0	—	106	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	.	—
100	4½%	† Do. Vancouver Power Debs.	101 —104	4 6 0	—	104¾	..
5	8/0	Buenos Ayres and Belgrano Ord.	$8\frac{5}{16}$—$8\frac{9}{16}$	4 18 0	—	8⅜	.
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5½—5¾	5 4 4	—	..	..
5	8/0	Do. "B"	5 —5½	5 7 0	—	.	..
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	101 —104	4 16 8	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —103	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debe.	101 —105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8 —8¼	4 15 0	—	8⅛	$8\frac{1}{16}$
5	2/6	Do. Nos. 105,001 to 137,610	7¾—8¼	4 16 0	..	8⅛	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	102 —104	4 6 6	—	..	..
1	0/6	Cape Electric Tram Shares	½—¾	6 13 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	88 —93	6 9 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord. ex rights	1⅜—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref. xd & rights	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	102 —104	4 6 6	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	105 —107	4 18 6	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	14 —143	5 12 0	..	..	.
..	5%	Do, 5% 1st Mt. $500 Dbs,	97%—99%	5 1 0	..	98½	97¼
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 6	..	..	..
5	5/3	Calcutta Elec. (1-60,000)	8 —8½	4 18 6	—	8⅜	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	85 —89	5 12 4	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	111 —114	5 5 0	..	112	111½
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{13}{16}$—⅞	7 0 0	—	..	..
1	1/6	Rand Electric	$\frac{15}{16}$—$1\frac{1}{16}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{7}{16}$—$\frac{9}{16}$	..	..	..	..
1	1/2⅖	Do. 6% Non. Cum. Pref.	⅞- 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-12,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	100¼	.

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed. July 18.	Rate % Yielded. £ s. d.	Dividend Due	Business, Week to July 18. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10½–11½	6 3 6	..	.	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅝–11⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	.	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ...	104 –106	4 4 10	..	105	..
5	6/6	Bromley (Kent) El. Lt. & Power Shares	6⅛–6⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 –9	5 11 6	—	.	..
5	8/6	Do. 7 per Cent. Pref.	7¾–8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	—	101½	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 – 5	5 0 0	Feb, Aug	..	..
5	2/6	Do. 4½ per Cent. Pref.	4 – 4½	5 2 0	Feb, Aug	4½	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 18 6	—	101	..
5	2/6	Do. City Undertaking 4½% Cm. Pref.	3⅝–4⅛	5 9 0	—	..	..
5	2/6	Do. Do. (1906)	3⅝–4⅛	5 9 0	..	..	..
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	106 –108	4 3 3	Ju, Dec ..	..	.
10	5/0	† City of London Electric Lighting Ord.	10 –10⅜	5 10 6	Feb, Aug	10 7/16	10 5/16
10	6/0	† Do. 6 per Cent. Cum. Pref.	11½–12½	4 10 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 –125	4 0 0	Jn, Dec ..	124	123½
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	99 –102	4 8 3	..	..	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2 15/16–3 1/16	3 13 4	April, Oct	.	..
5	5%	Do. Do. 5% non cum. pref.	5 –5½	4 10 11	April, Oct	.	..
10	6/0	County of London Elec. Supply Ord. ..	8 –9	5 11 0	—	8¼	8 13/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾–12¼	4 18 0	Mar, Sept	12	11½
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 –109	4 2 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs. ..	101 –104	4 6 6	..	..	..
5	6/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101 –104	4 6 6	—	..	..
5	5/0	Hove Electric Lighting Ord.	7¾–8¼	5 9 0	..	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	10 –11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	—	-
St	4%	Do. 4 per Cent. Deb. Stock (red.) ..	98 –101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	—	..	..
3	2/4⅘	London Electric Supply Ord.	2 –2½	4 0 0	—	2 1/32	..
5	6/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 – 99	4 0 10	Mr, Jn, S, D	98	..
5	10%	Metropolitan Electric Sup. Ord.	8 –9	5 10 0	April, Oct	8 15/16	8⅜
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 5/16–5 9/16	4 1 0	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	..	..
St.	6½%	Do. 6½ per Cent. Mrt. Db. Stock (red.)	94 –96	6 13 0	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	—	..	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11¼–12½	5 12 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾–7⅞	5 2 6	Feb, Aug	7⅞	—
5	5%	Do. 5 per Cent. Non. Cum. Pref. ..	5⅞–6	4 1 0	Feb, Aug	6 1/16	5⅞
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	..
1	8%	Northern Counties Elec. Sup.	1 5/32–1 3/16	2 11 0	Mar, Aug	1 5/32	..
100	4½%	Do. 4½% Deb.	101 –102	4 8 9	Jan, July	—	—
10	6/0	Notting Hill Electric Ord.	13½–14½	5 3 5	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅜–6⅞	4 17 0	March ..	..	..
St.	4%	† Do. 4% Deb. Stock	97 – 99	4 1 0	—	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	10⅞	10¾
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	95 –97	3 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord. ...	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 –80	5 0 0	—	..	..
5	4/0	South London Electric Supply Ord ...	2¾–3¼	6 8 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	..	..	..	—
1	0/8⅖	Do. 7% Cum. Pref.	1 3/16–1 5/16	5 9 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3 - 4	6 10 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4¼–4¾	5 5 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100 –102	4 8 0	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	10½–11½	5 16 0	Mar, Sept	10¾	..
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5½	5 5/16
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	† Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	—	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.) ..	101 –104	4 6 6	..	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	8½%	Bristol Tramways and Carriage Ord. ...	15¼–15¾	5 8 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	10 –10¼	3 18 0	..	—	—
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	.
10	6/0	† British Electric Traction Ord.	5⅜–5⅞	5 2 0	..	5 11/16	5½
10	6/0	Do. 6 per Cent. Cum. Pref.	8¾–9¼	6 10 0	Feb, Aug	9¼	9
St.	5%	Do. 5 per Cent. Perpetual Debs	109 –113	4 8 6	..	112	110½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	89 –92	4 19 0	..	90½	..
St.	4%	Central London Ordinary Stock	86 –88	4 13 0	June, Dec	87½	86
St.	4%	Do. 4 per Cent. Pref. Stock	99 –101	3 19 0	..	..	..
St.	4%	Do. Deferred Stock	74 –77	5 4 0	..	75	74½
100	4%	† Do. 4 per Cent. Debs.	108 –110	3 12 8	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	1¾%	City and South London Rly. Con. Ord.	43 –44	4 6 0	Feb, Aug	44	43⅛
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	120 –123	4 1 4	Feb, Aug	..	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	114 –117	4 5 3	—	116	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trms. (1896) Ltd., Ord.	13¾–14¾	4 1 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼–3¾	10 13 4	..	3¾	3½
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	—	77	..
10	1½%	Liverpool Overhead Railway Ord	7 15/16–8 1/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	.
10	5/0	London United Trams. 5% Cum. Pref.	8 –8½	5 17 4	—	8⅛	7 15/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	92 – 95	4 4 0	—	93	92
St.	..	Mersey Con. Ord. Stock	4 –6	—	—	..	..
St.	..	Do. 6 per Cent. Perp. Pref.	8 –11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	13/16–15/16	5 9 0	—	⅞	..
St.	4½%	Do. 4½% Deb. Stock	100 – 102	4 8 3	—	101½	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	1–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¾	5 5 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½–8½	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 6	—	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	92 - 94	5 6 0	—	..	..
St.	3½%	Waterloo and City Ord.	100 – 103	6 3 0	June, Dec	100	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	—	..	..
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	7/16–9/16	..	—	..	..
1	2/4⅘	Babcock & Wilcox Ord	3¾–4	4 14 0	..	3 31/32	3⅞
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6⅜–6⅞	5 18 0	July, Feb	6 9/16	6½
5	6/0	Do. 6 per Cent. Pref.	5¾–6¼	4 16 0	Jan, July	5⅞	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1½– 2	..	..	1½	1 15/32
St.	4%	Do. 4 per Cent. Mort. Deb. Stock ...	77 –83	4 16 6	..	—	..
2	1/0	Brush Electrical Engineering	⅝– ⅞	..	March ..	¾	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	10 15/16	10⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5⅞	5 13/16
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	108½	108
1	7⅞d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	1 3/32	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	—	..	..
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	..	-	—
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 6 0	..	1 1/16	—
8	1/6	Crompton and Co. (Nos. 1 to 54,000) ...	1 11/16–1 13/16	3 19 0	Jan, July	1¾	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94%– 97%	5 3 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1 11/16–1 13/16	5 12 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	7⅛–7⅜	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅜–1⅝	4 18 0	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½– 3	4 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	..	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3 – 4	8 14 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4¼– 4¾	6 6 0	..	4 11/16	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	—	.	..
2	1/7½	Electric Construction Co.	⅜– ⅝	11 4 0	July	7/16	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	2 – 2½	5 12 0	July	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. (red.)	86 – 89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref. ...	9 – 9½	5 5 3	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 – 97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 – 13	5 15 0	Feb, Aug	12½	..
5	2/3	Do. 4½ per Cent. Pref.	5¼– 5½	4 1 6	Feb, Aug	..	—
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	108½	..
St.	22/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	108¼	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17¾	..
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	—
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 15 6	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	96 –99	4 11 0	..	..	..
12	24/0	† Telegraph Construction & Mainten'ce.	32½ – 34½	6 1 6	Mar, July	34	32⅞
100	4%	Do. 4 per Cent. Deb. Bonds, 1909 ..	100 – 102	3 18 3	Jan, July	..	—
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	2⅜–2½	6 0 0	..	2½	2⅜
1	6d.	Do. 5% Non-Cum. Preference	1 1/16–1 3/16	4 4 0	..	1 1/16	..
St.	5%	Do. 5% Non-Cum. Preferred	114 – 117	4 5 4	—	115½	..
St.	4%	Do. 4% 1st Mort. Deb. Stock Red. ..	103 –105	3 16 0	..	104¼	103¾
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	..	107	..
5	-	Willans and Robinson Ord.	1 – 1½	—	Apr, Oct	1¼	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾– 3¼	—	Apr, Oct	3⅛	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	75 –83	4 16 6	May Nov	..	..
		TELEGRAPHS.					
10	—	Amazon Telegraph	8 –8½	..	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	80 –85	5 17 8	..	..	..
St.	15/0	Anglo-American	65 –67	4 17 0	F, My, Ag, N	.	..
St.	30/0	Do. Preferred	112½–113½	5 7 0	F, My, Ag, N	113⅛	112½
St.	10/0	Do. Deferred	22⅝–22⅞	2 7 6	F, My Ag, N	23 1/16	22⅝
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–98½	4 0 6	Jn Ap, Jy, O	99	98¾
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	8⅞	—
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	17 1/16	—
5	2/0	Direct Spanish Ord	6⅝–8⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	8 11/16	—
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	6 19 0	Jan, July	..	..
20	4/0	Direct United States Cable	15½–16¼	4 12 0	Ja, Ap, Jy, O	15 11/16	15¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99½–101½	4 8 9	Ju, Dec ..	..	..
St.	25/0	Eastern Ordinary	141 –144	4 17 2	Ja, Ap, Jy, O	143¾	142
St.	17/6	† Do. 6½ per Cent. Pref. Stock	189 – 191	3 7 0	Ja Ap, Jy, O	190¾	189½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	107½	107¼
10	2/6	† Eastern Extension	14 –14½	4 16 6	Ja, Ap, Jy, O	14 5/16	14
St.	4%	Do. 4 per Cent. Deb. Stock	106 –108	3 14 0	Feb, Aug	107½	107¼
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	100 –102	3 19 3	Feb, Aug	100½	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	39 - 41	6 2 0	Jan, July	..	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½–101½	4 8 9	June, Dec	..	..
25	27/6	Indo-European	57½–59½	5 6 3	May, Nov	59½	58
100	4%	Mackay Companies Common	73 7/16–74 7/16	5 8 0	Jan, July	—	..
100	4%	Do. Preference	73 7/16–74 7/16	5 8 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	1⅛–1⅜	..	..	1	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	—
5	—	West Coast of America	¾– ⅞	..	—	¾	..
100	4%	Do. 4 per Cent. Debs.	99 – 102	6 17 0	Jan, July	..	..
10	—	West India and Panama	⅜– ½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6 – 7	8 11 4	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	6/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14½	14 5/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	102 –105	3 16 2	..	..	..
		TELEPHONES					
—	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 6 4	..	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	6/0	Chili Telephone (fully paid)	7¾– 8⅛	4 18 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	6 15 8	—	—	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110 –112	5 7 0	—	111½	110½
St.	6%	Do. Def. Stock	109 –111	4 10 0	..	110¼	108¾
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	12⅛	12
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	11	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5¾– 6	4 6 4	Feb, Aug	6	5¾
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	96½–98½	3 11 0	June, Dec	98½	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 17 0	—	103½	103⅜
1	0/9⅗	Oriental	1 1/16–1 3/16	4 8 6	April, Oct	1⅛	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1½–1⅝	4 7 0	—	1 5/16	..
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	..	97½	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100 –103	4 7 0	..	..	..
5	6/0	United River Plate xd & rights	6½–7	5 14 0	July	6¾	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6¼	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.) ...	108 – 111	4 10 0	June, Dec	110	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½– 5	6 0 0	—	..	..
10	5/0	Globe Telegraph and Trust	10⅞–11⅜	4 10 0	Ja Ap, Jy, O	11 1/16	10⅞
10	6/0	Do. 6 per Cent. Pref	14⅜–14⅞	4 0 6	Ja, Ap, Jy, O	14 9/16	14⅜
10	6%	Submarine Cables Trust (Cert.)	127 – 130	4 12 3	April, Oct	..	—

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

AMONG the most recent commercial applications of electricity must be included that of electric smelting of iron ores. Notwithstanding the fact that one of our chief industries is the production of iron and steel, an electrical method is not likely to receive much attention in this country, because our iron industry is closely connected with our coal fields. The electrical production of heat is necessarily accompanied by the thermodynamic inefficiency inseparable from a heat engine wherever coal is the source of energy; thus it is cheaper to produce heat in a blast furnace directly by the combustion of coal rather than indirectly by electrical means. It is therefore unlikely that electric smelting will be used in this country except, perhaps, where purity is an essential matter; but in such a country as Canada the case is very different. Here there are large quantities of ore and a deficiency of coal, and, moreover, water power is abundant. Consequently the favourable results obtained by Dr. HAANEL in his experiments carried out for the Canadian Government may lead to considerable developments.

THAT this unfortunate globe of ours is rapidly running short of necessary commodities is now well recognised. The extent of the coal deposits has often been questioned. There may be difficulty in maintaining the supply of timber at some future date, and Sir WILLIAM CROOKES has given warnings of impending famine, which is to be averted by the fixation of nitrogen, until that in turn may become more scarce than is desirable. And now at the meeting of the Iron and Steel Institute this week Mr. R. A. HADFIELD, in his Presidential Address, tells us that only 10,000,000,000 tons of iron ore are known to exist, whereas no less than 45,000,000,000 tons of ore will have been required by the end of the present century. We fear this very unpleasant situation cannot be averted, even by the theories of a CROOKES or the experimental genius of a BIRKELAND.

ANOTHER fact brought forward by the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers is the great extent to which large gas engines worked by blast-furnace gases are being adopted in iron works. Three Papers were read, dealing with the subject as relating to Germany, Belgium and this country. Two of these Papers we reproduce at some length in the present issue, and the third Paper, which will be read with interest as indicating German practice, we hope to give shortly. Although the problem to be solved in this application of gas engines is not so difficult as that which occurs in electrical work, since parallel running is absent, electrical engineers have to thank those engaged in the iron and steel industries for the evolution of the large gas engine, from which a good deal may be expected in the future.

LAST winter, as mentioned in our issue of January 26th, Col. YORKE investigated the noisy condition of the Ealing section of the London United Tramways, and came to the conclusion that this was due partly to loose brake attachments on the cars and partly to rail corrugation and defective joints. Steps were being taken by the Tramways Company to remedy these defects, but the nuisance still continues. A further report, which we give at some length on another page, has now been presented to the Corporation of Ealing by Mr. CHARLES JONES, the borough engineer, from which we gather that the trouble is by no means at an end. It seems curious that the nuisance should be confined to Ealing, and that, according to this report, most of the noisy cars should be yellow ones. We do not suppose that the colour has any very marked effect, but nevertheless it seems from this that there may be some special local conditions at work. Be this as it may, there appears good reason for Mr. Jones to object to the remedy for defective joints adopted by the Tramway Company. To cut through the concrete bed at frequent intervals and to fill in with bituminous material, or to pack up defective joints with concrete which cannot have sufficient time to set, is a doubtful remedy and may result in a general weakening of the construction. The somewhat light section of rail—namely, 92½ lb. per yard, is proving a bad investment for the heavy traffic it has to carry, but we hope that it will not be necessary for the line to be reconstructed, which is evidently the aim of Mr. Jones.

* * *

Among the minor and somewhat obscure losses occurring in dynamos with toothed armatures is that due to the varying flux in pole shoes. Although recognised as a source of loss, no measurements of the actual loss appear to have been made hitherto, probably for the reason that any such determination is by no means an easy matter. The measurements given by Messrs. Wall & Smith on another page of the present issue are of interest. The method selected is that of the measurement of the heat produced, this being determined by electrically heating the pole-piece, so that the temperature conditions are the same when there is no variation of flux in the pole-piece as they are under running conditions. The results obtained so far are somewhat preliminary, but the authors promise further results on a more commercial scale later on.

* * *

So far nothing definite seems to have been decided as to the future of the Greenwich Observatory and the power station of the London County Council, but it appears that a Committee, consisting of Lord Rosse, Sir Benjamin Baker and Prof. Ewing are investigating the whole question. The subject is also to form one of the items in the programme of the British Association meeting next week, presumably from the unofficial point of view.

* * *

Personal.—The Società Italiana della Scienza, the president of which is Prof. Cannizzaro, have awarded their Matteucci medal for 1906 to Sir James Dewar.

Cable Interruptions.

	Date of Interruption.
Tarifa—Tangier	**Jan. 18, 1904**
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Bolama—Bissao	July 24, 1906

The British Association.—Among the Papers down for reading before the Chemical Section (Section B) at the forthcoming meeting of the British Association at York is one by Messrs. Sidney Leetham and William Cramp on "The Electrical Discharge in Air and its Commercial Application."

Memorial to Lord Armstrong.—A statue of Lord Armstrong, which has been erected in the grounds of the Natural History Museum, Barras Bridge, Newcastle-on-Tyne, was unveiled on Tuesday afternoon by His Grace the Duke of Northumberland. The statue is the work of Mr. Hamo Thorneycroft, R.A.

National Physical Laboratory.—The *Birmingham Daily Post* states that the new post of superintendent of the Department of Metallurgy and Metallurgical Chemistry which has been established in the National Physical Laboratory has been offered to and accepted by Mr. Walter Rosenhain, now with Messrs. Chance Bros., of Birmingham.

Flicker Photometers.—Messrs. Alexander Wright & Co. (Ltd.) have written to us as follows:—"With reference to Mr. L. W. Wild's description of a Flicker Photometer in your last issue, we shall be glad if you will note that this is under the Patents of Simmance & Abady, whose solicitors are communicating with Mr. Wild on the subject."

Municipal Telephony.—It will be remembered that the Postmaster-General some time back made an offer to the Brighton Corporation to purchase the municipal telephone undertaking for the sum of £41,200. This offer was declined; but at the meeting of the Corporation yesterday an increased offer of £49,000, made provisionally by the Postmaster-General was accepted.

Lighthouse Illumination.—A statement has been issued by the Trinity House Brethren refuting a suggestion that incandescent oil has superseded electric light at the Lizard or any of their electric lighthouse stations in this country. In fact, the officials of Trinity House do not consider incandescent oil superior to electric light as an illuminant during fog.

Telephones on Trains.—The New York correspondent of the *Tribune* writes that experiments are being conducted on the railways controlled by Mr. E. H. Harriman with a view to perfecting an apparatus for enabling the conductor and engine driver to communicate whilst the train is in motion. The Union Pacific line has been selected as the first to be equipped should the device prove satisfactory.

A 50,000-volt Transmission for Seville.—A scheme is in progress for supplying the town of Seville from a generating station at El Carchado, about 80 miles from the town, by means of a three-phase transmission at 50,000 volts. Three 1,500 h.p. turbines, running at 400 revs. per min., will form the first instalment of generating plant, and these will drive alternators, generating at 5,000 volts 40 cycles. In order to step up to the line voltage, seven single-phase 600 k.v.a. transformers will be provided (one as spare), and another group of transformers in the sub-station at Seville will reduce the pressure to 3,500 volts. The work is being carried out by the Spanish Oerlikon Company.

The De Dion Petrol-Electric Rail Motor Car.—Experiments have been made on the Hungarian State Railways with a single petrol-driven railway car with electric transmission, and these have been so satisfactory that the Hungarian Government have placed orders for 150 cars working on this system. The experimental car had a temporary equipment of two 20 kw. generators, each direct-driven by a four-cylinder vertical De Dion petrol engine, but a single 50 kw. set will be employed in the other cars. Two motors are used geared to different axles, and series parallel control is employed. Extensive trials were made at Arad, and with a car weighing 18·2 tons running at 38·5 miles per hour, 36·3 kw. were required. With the price of petrol prevailing in Hungary, the cost of fuel per kilometre worked out at 5 centimes. The experimental car has been put into service while the others are being got ready.

Mr. Alfred Beit's Will.—We are pleased to note that science has benefited to a considerable extent by the will of the late Mr. Alfred Beit. Among the numerous public bequests are £50,000 and 5,000 preferred shares of £2. 10s. each in De Beers Consolidated Mines (Ltd.) to the College of Technology (including mining and metallurgy) in connection with the University of London. £200,000 has also been bequeathed to the University of Johannesburg to be applied to building and equipping university buildings on the site recently given by Mr. Beit, including the construction of a tramway to connect the property with Johannesburg. If this legacy is not applied within 10 years it will lapse. For the purposes generally, in the area covered by the Cape to Cairo Railway, of railways, telegraphs (including wireless telegraphy), telephones and other methods of transmission, £1,200,000 is given to be applied under a "railway fund," the trustees for which are Messrs. Otto Beit and B. F. Hawksley and Sir J. C. Wernher.

A Combined Telegraph and Telephone Line.—According to the *Electrical World*, the Canadian Pacific Railroad has run a special copper wire between Montreal and Winnipeg, a distance of 1,430 miles, touching only Fort William and North Bay, for its telegraphone system, by means of which two messages—

one by telephone and the other by telegraph—can be transmitted over the wire at the same time. A number of tests have been made at both Montreal and Winnipeg, and the operators at each end were able to converse with those at the other and in the meantime the operators at Fort William were sending a message by telegraph over the wire to Montreal, thus proving the success of the new system. It is claimed this is the greatest distance a human voice has ever been sent over such a circuit, but the Canadian Pacific Railroad officials think the wire will work just as well at a still greater distance. The company is now stringing a similar wire between Winnipeg and the Pacific Coast terminus at Vancouver.

The Valle Maggia Single-phase Railway.—The railway which is now being equipped between Locarno and Bignasco is the second line in Switzerland to be equipped on the single-phase system, the first having been that between Seebach and Wettingen (*The Electrician*, April 20th, p. 8). The line is about 17 miles in length and is of metre gauge, the maximum gradient being 3·3 per cent. The pressure adopted on the overhead line is 5,000 volts, which is, with the exception of the 15,000 volt Seebach-Wettingen experimental line, the highest trolley pressure yet authorised by the Swiss Federal Railway authorities. The motor cars have four axles, each of which is driven by a 40 B.H.P. Oerlikon single-phase motor, and trailers are employed both for passengers and goods, the complete trains weighing about 55 tons. The Oerlikon curved bar collector, which we have described in connection with the Seebach line, is used. Power is obtained from a water-power station about 10 miles from the line, where two alternators are installed, each for an output of 350 k.v.a., and driven by turbines working with a fall of about 80 ft.

London Underground Electric Railways.—Considerable progress has now been made with the new tube railways under construction and the extensions to the existing lines. The Great Northern, Piccadilly & Brompton Railway is approaching completion and is expected to be ready for opening by the end of the present year. The large accumulator locomotives used for hauling material and construction trains have for some months been a familiar sight along the above-ground portion of the route between West Kensington and Hammersmith, and many of the station buildings are practically complete. The Charing Cross, Euston & Hampstead Railway is also in a forward condition. The tunnels are through almost entirely, the rails are laid and a large proportion of cables have been already put in. The dimensions of the tunnels and details of the track work are in all respects similar to those of the Baker Street & Waterloo line, except that the running rails are being laid in 45 ft. lengths as against the 35 ft. of the Baker Street & Waterloo. A large depot, including car-shed, stores and repair shops has been erected at Golder's Green, Hampstead, where the line emerges to the surface, and where one of the largest sub-stations is situated. Construction of the Edgware & Hampstead Railway and of the Edgware & Watford Railway, both of which are authorised and which will form extensions of the Charing Cross, Euston & Hampstead line, has not yet been commenced. The extension of the City & South London Railway to Euston is expected to be ready for traffic in about three months. The two remaining new London electric railways authorised—viz., the North-West London and the North-East London lines have not yet been commenced.

A New Petrol-Electric Automobile System.—A system of electric transmission gear for petrol-driven road vehicles, which differs somewhat from some of those which have been tried already, is described in our contemporary the *Commercial Motor*. The distinctive features of the arrangement are the use of alternating instead of continuous currents and the absence of batteries for the equalisation of the load on the engine. Briefly summarised, the system is as follows: An ordinary vertical petrol engine is directly coupled to a revolving field alternator, the rotor of which takes the place of a flywheel. Beyond this, on the same shaft, is a magnetic clutch, which serves to couple the engine shaft to a further shaft carrying the rotor of the alternating-current motor, and connected through the usual universal joints to the worm or bevel gear on the live back axle. A "direct drive" is thus obtained on the top speed, when only the magnetic clutch is in use, while the lower speed ratios are obtained by running the motor from the alternator, the clutch being free and the whole power transmitted electrically. It is thus seen that both the alternator and the motor have to be of sufficiently large size to develop at times the whole of the power, but the weight of the electrical part of the outfit in the case of a 40 B.H.P. equipment is given as only about 9¾ cwt. The stator of the motor is kept permanently connected to the alternator by three stout copper bars and all control is effected, so far as we can judge by the particulars now available, by variations of the excitation of the alternator. A small independent exciter is used which also supplies the current required for the magnetic clutch. An automatic brake is to be provided which is held off only when current is available and the controller is in certain positions; and when running down hill a considerable effect can be produced by the motor running above its synchronous speed. We understand that the system which is the joint invention of Mr. E. W. Hart and Mr. W. P. Durtnall has not as yet been tried on the road, although some brake tests have been taken on an experimental set. We shall look forward with interest to the results of trials of the system under road conditions, as on paper at any rate the arrangement would appear to offer some advantages over those which have been experimented with hitherto.

Electric Lighting Provisional Orders.—The annual report of the Board of Trade respecting the applications to and proceedings of that department under the Electric Lighting Acts, 1882 to 1902, during the past year is now issued. In all, there were 55 applications, 24 being made by local authorities and 31 by companies or individuals. Nine of the applications were contested in some form or other. The North Metropolitan Electrical Power Distribution Co. (East Barnet Valley) and the Electrical Distribution Co. of Yorkshire (Gomersal) failed to produce the consent of the local authorities in question, but after consideration of the representations made to them, the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament (*The Electrician*, July 6, p. 478), decided to dispense with the consent in each case and granted the order. The application of the Gelligaer and Rhigos Rural District Council for an order for that district was opposed by ratepayers and others, and after holding a local enquiry the Board refused to grant the order. The County of Northampton Electric Power and Traction Co. applied for an order embracing Higham Ferrers, Rushden and Wellingborough (Rural), but could not produce the consent of the Rushden Urban District Council, which was dispensed with, however, and the order granted for the three districts named. Orders for Workington (Brush Electrical Engineering Co.), Seaham Harbour (S. M. H. Tramways Syndicate) and Sunningdale and District (Messrs. Foote & Milne) were not granted owing to the failure of the promoters to obtain the consent of the local authorities, or to convince the Board of Trade that such consent should be dispensed with. The Uxbridge and District Electric Supply Co. were granted an extension order in respect of the Urban District of Beaconsfield (local consent being dispensed with) and portions of the rural districts of Eton and Amersham. An application with regard to the rural district of Watford, by the same company, was refused in the absence of the local consent or satisfactory evidence that this should be dispensed with. Both the Wembley Urban District Council and the North Metropolitan Electrical Power Distribution Co. applied for an order for the district of Wembley, but, in accordance with its usual custom, the Board of Trade gave preference to the local authority. An application by the Brush Electrical Engineering Co. for an order for Maryport was not proceeded with. In all the other cases orders were granted as asked for. Confirming bills Nos. 1, 2, 5, 6 and 7 were introduced into the House of Commons and bills Nos. 3 and 4 into the House of Lords. No applications for licences have been received during the year, but sanction has been given to the transfer of 14 provisional orders since the date of the last report. Up to date 1,233 applications have been made for provisional orders under the Electric Lighting Acts, 981 have been made by the Board of Trade, 965 have been confirmed by Parliament and 209 have been since revoked.

A METHOD FOR THE DETERMINATION OF IRON LOSSES IN POLE SHOES, DUE TO ARMATURE TEETH.

BY THOS. F. WALL, B.Sc., AND STANLEY P. SMITH, B.Sc.

It is well known that, in continuous-current and in synchronous machines with slotted armatures, losses are produced in the pole-shoes by the eddy currents and the hysteresis effect, which owe their origin to the pulsation of the main flux, caused by the movement of the teeth across the pole face. These losses occur to some extent even when the pole-shoes are laminated and their calculation or accurate separation from the total losses of the machine is always accompanied by some difficulty.

The following is a description of a method devised by the authors for the direct measurement of such losses. The method is based on the fact that all the energy consumed by these losses is dissipated in the form of heat. Starting from this assumption, it is at once clear that if this dissipation of heat can be measured, the iron losses—to which it corresponds—will be thus found. Hence, if we can imitate the actual conditions and artificially produce the same heating from an external and measurable source, as that due to the losses caused by the pulsating flux and, at the same time, keep all other conditions the same, then the energy thus supplied must correspond to that consumed by the losses in the iron.

In order to do this the machine must be allowed to run first *with* flux passing through the experimental pole-shoe (and consequent heating due to iron losses) and then *without* flux passing through the experimental pole-shoe (and therefore with no iron losses in pole-shoe)—but with all other conditions unchanged—whilst its temperature is maintained constant by means of an external source of energy. The amount of energy thus needed to give a like temperature to that attained by the heating due to the iron losses will be a direct measure of these losses.

In regard to the artificial heating, the actual conditions, of course, should be as nearly reproduced as possible, that is to say, the heating should be supplied to the surface layer of the pole-shoe next the armature (where the above-mentioned effects take place), so that the distribution of temperature should be practically the same in the two cases. This, however, is not practicable—the most obvious method being to wind resistance wire in slots cut parallel to the length of the pole-shoe and pass a continuous current through this resistance, which, of course, must be so arranged as to dissipate the required amount of energy.

Now, at first sight, it might appear that the energy supplied to these heating coils might be greater than that corresponding to the iron losses. But assume the resistance coils to be *completely embedded* within the pole-shoe, and all other sources of heating to be kept constant—both of which assumptions are realised in the experiment—then it seems to be a perfectly logical conclusion to assume that *provided the distribution of temperature is the same by artificial as by natural heating*, the conduction, connection and radiation, and, therefore, heat dissipation, will also be the same in the two cases. Now, this actually happened to be so, owing, the authors believe, to the good conductivity of iron for heat. Of course, the coil itself must be at a somewhat higher temperature than the surrounding metal in order to supply heat to the latter, but since the temperature distribution is the same in the two cases, no correcting factor will have to be introduced on this account.

One great difficulty, however, appeared to present itself—viz., how to obtain the same conditions of heating due to the field exciting coils both when flux was present in the experimental pole-shoe and when it was not. This difficulty was got over in the following way: In a four-pole machine only two of the poles (which were diametrically opposite to one another) were supplied with exciting coils, see Fig. 1, where C and D represent these two poles. When these poles are so excited that C becomes a north pole and D a south, then—if the four poles are symmetrical—no flux whatever will pass through A or B. That this should be so can be seen after a moment's thought, but it was also demonstrated by the authors during some experiments they were making with machines having commutating poles (see *The Electrician*, Vol. LVI., p. 1,003). Again, if the two poles C and D are both excited to give the same polarity, then both A and B will assume the opposite polarity, since now they serve as paths for the fluxes issuing from poles C and D.

Thus, by simply reversing the current in either C or D, we can have flux or no flux in A and B at once; whilst at the same time the heating of the system due to the exciting current is precisely the same in both cases. Hence, as far as external conditions are concerned, we get the same heating and ventilation in the two cases.

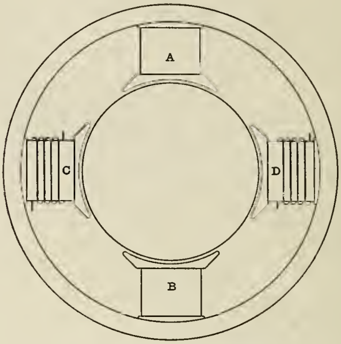

Fig. 1.—Arrangement of Field.

We now turn to the means used for heating the pole-shoes from an outside source and for measuring the distribution of temperature in the shoe. Four slots were cut in the pole-shoe which was to be experimented upon, and resistance coils were wound as shown in Fig. 2, one coil being wound in two slots, and the two coils placed in series or parallel according to the amount of energy it was found necessary to supply. To prevent loss of heat due to conduction, &c., the pole-shoe was coated with mica.

To measure the temperature at different parts of the shoe, thermo-couples were used. These were made by simply soldering thin copper wires to the iron shoe. Thermo elements were placed at four different points—viz., one at each pole tip, one in the centre of the pole-face and one at the centre of the pole-shoe between the magnet core and the shoe. An iron wire soldered to the shoe served as a common terminal for all the couples. To balance the thermo E.M.F.s a very good potentiometer was used, to the terminals of which a battery of 2 volts, with 160,000 ohms in series, was connected. By this means a complete range of pressure was found to be obtainable, and by using a very sensitive galvanometer, the temperature of the pole-shoe at any part was determined to within 1°C.

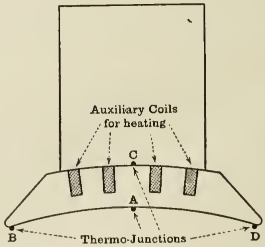

Fig. 2.—Arrangement of Heating Coils in Pole Shoe.

As an illustration of how the experiments were carried out, the following Table is appended :—

Heating due to Iron Losses.

I.—Flux Density in Experimental Pole Shoe = 2,900 Lines per Square Centimetre. Armature Speed = 900 Revs. per Min. Air Gap = 2·2 mm.

Readings on Potentiometer when a Balance was Obtained.

Thermo-junction	A	B	C	D
—	38·8	34·6	38·8	40·5

Heating Produced Artificially.

II.—Flux Density in Experimental Pole Shoe Approximately Zero. Armature Sped = 900 Rev. per Min. Air Gap = 2·2 mm

Auxiliary Coil in Pole Shoe Slots..

No.	Volts.	Amps.	Watts.
1	31·5	1·44	45·4
2	28·0	1·35	37·8
3	25·5	1·14	29·0

Potentiometer Readings when a Balance was Obtained.

No.	Thermo-junction	A	B	C	D
1		41·1	37·0	41 5	41·0
2	—	37·3	34·3	38·4	38·2
3		35·0	32·0	35·8	35·5

I. The machine was first allowed to run at a certain speed under certain excitation with the flux passing through the experimental pole-shoe, and producing heating thereby on account of its pulsations. After running about four hours, by which time the temperature was found to have reached a steady state, the E.M.F. of each of the four thermo-elements was balanced on the potentiometer. II. The connections of the exciting coils were then reversed, so as to allow no flux to pass through the experimental pole, whilst a pressure was supplied to the auxiliary heating coil. After about 1½ hours the distribution of temperature would again have become steady, and, could, therefore, be measured and the pressure and current noted, thus obtaining point No. 1. The applied pressure would then be varied, and after about an hour or so another determination would be made, and point No. 2 would be found. This was continued until a sufficient number of readings were taken, both above and below that given in the first case due to the iron losses, to enable a curve to be drawn. From this curve the energy corresponding to the mean value of the temperature distribution when iron losses were present was at once found. How near the energy thus measured approaches to the correct value may be judged by noting how nearly the distribution of temperature produced by artificial heating agrees with that produced by the actual iron losses. This may at once be seen from the accompanying table, which is a sample of the readings which were taken to determine a point on the curve shown in Fig. 4. It will be observed that the readings are given in potentiometer divisions, there being no advantage gained by reducing them to volts or degrees of temperature.

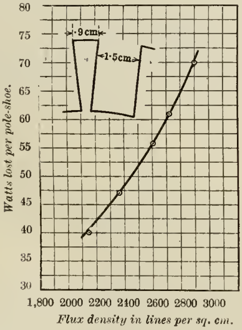

Fig. 3.—Curve Showing how the Losses vary with the Flux Density.
Speed constant 1,300 revs. per min. Air-gap constant 2·2 mm.
No. of slots 28. Area of pole-face 143 sq. cm.
(Section of slot shown in top left-hand corner.)

Two distinct series of experiments were carried out. The first series was to determine how the iron losses in the pole-shoes varied with the flux density. The results of these experiments are shown in Fig. 3 in the form of a curve. The second series was performed to find how the losses varied with the speed, and the results are set forth in a curve, Fig. 4. These curves are merely given as they have been obtained, and have not yet been reduced to formulæ, since the present object of the authors is only to give an account of the method and the experiments performed for the purpose of proving its feasibility.

The machine on which the tests were made was not a large one, and only low flux-densities were obtainable, nor was any load taken from the armature. Since the method, however, has shown itself to be practicable and also accurate, it has been decided to repeat and extend the investigations on a larger machine which will be more convenient for varying the several conditions (air-gap, &c.), and also yield similar proportions to those met with in modern practice. It is then hoped that the results obtained will be quite general, and will further admit of being reduced to practical formulæ (loss per square centimetre of pole-surface, &c.).

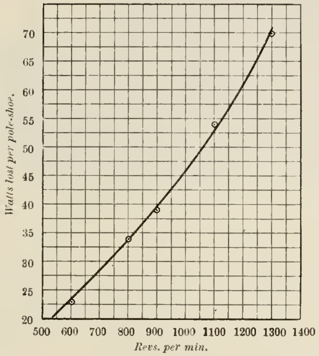

Fig. 4.—Curve Showing how the Losses vary with the Speed.
Flux density constant 2,900 lines per sq. cm. Air-gap constant 2·2 mm.
Area of pole-face 143 sq. cm. Armature teeth as in Fig. 3.

In conclusion, the authors wish to express their appreciation of the interest Prof. E. Arnold has shown throughout in the work and of the valuable advice he has given.

SOME NOTES ON THE MECHANICAL DESIGN OF ELECTRICAL GENERATORS.*

BY R. LIVINGSTONE.

It is frequently stated that in many cases theory does not agree with practice. I do not altogether hold with this statement, but at the same time I have no doubt that many theories are of very little use in practical work; either because the theories are not far enough advanced, or because we have not sufficient knowledge of the practical conditions to be able to apply them accurately. For instance, in some forms of castings, subjected to a bending stress, we may be able to calculate the bending stress very accurately, yet find if we use a factor of safety of four or five, that the casting fails when put to use; failure being due to high initial contraction stresses. This certainly does not prove that the theory of bending was at fault, but it does show that experience is of the utmost value in its application. It is not sufficient to proportion a casting to suit its working stresses only: great care must be taken in design to avoid contraction stresses, and when it is impossible to do away altogether with them, to use such high factors of safety that the risk of failure will be small. It is certainly a mistake to depend solely on calculation for the design of electrical generators, but at the same time it is a much greater mistake to proportion the various parts of a machine only by their appearance or by intuition, as many draughtsmen do. The ideal designer is one who can judge correctly the relation between the calculated stresses and the actual stresses. In a few cases the calculated will be the actual stresses, and very low factors of safety can be used, but in the majority of cases the calculated will only be in proportion to the actual stresses and proportionately higher factors of safety must be used.

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* Based on a Paper read before the Dick Kerr Engineering Society.

The following notes on the mechanical design of generators mostly relate to direct-coupled generators, and it is hoped they will serve as a safe guide in the design of such machines.

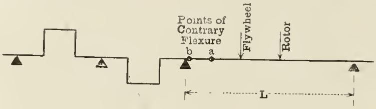

FIG. 1.

Shafts.—In shafts for direct-connected generators the stresses due to bending are so high in comparison with the torsional stresses that the latter may be neglected. The twisting moment, taking the average of a number of direct-coupled machines, may be approximately $\frac{1}{4}$th of the bending moments. Then substituting this value in the equation for the torsional equivalent of the combined moments, $B+\sqrt{B^2+T^2}$ (where B = bending moment and T = torsional moment), we get a value of 2·03 B instead of 2 B, when T is neglected, or an error of 1·5 per cent. This is clearly negligible when we consider that the error in calculating the weight of the rotor and flywheel might be as much as 5 per cent. Although the shaft is really a continuation of the engine shaft, and the point of contrary flexure changes from *a* to *b* (Fig. 1) once every revolution, due to the thrust from the piston being downwards during one-half of a revolution and upwards during the succeeding half, we are quite justified in assuming that the point of contrary flexure may be at the centre line of the engine bearing when calculating the generator shaft, and may calculate the shaft as a simple beam supported on two bearings, the engine bearing at one end and the outboard generator bearing at the other. The stresses obtained in this manner are due to dead loads only and a sufficiently high factor of safety should be used to take care of the increase of stress due to the eccentricity or out of balance of the rotor. As the stresses are alternating, the breaking load is a load which gives a much lower stress than the actual tensile strength of the material. A few results of tests by various authorities are shown plotted in Fig. 2. It is unfortunate that in the records of those tests the periodicities of alternation have not been given, as this is of even more importance than the number of alternations of stress before fracture. Also the chemical composition of the material, particularly the percentage of phosphorus, would have been a valuable addition to the data published. However, the stress in the shaft may, without fear of fracture, run up to one quarter of the breaking stress given by an alternating test if the deflection of the shaft is not too high.

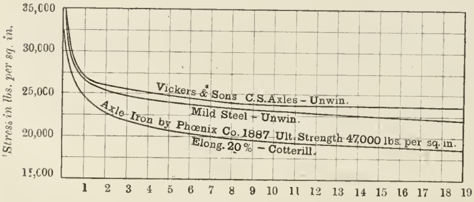

FIG. 2.

The unknown stresses are to such a large extent dependent on the stiffness of the shaft that the allowable deflection is of even more importance than the calculated stress in the material when determining the shaft diameter. This is especially the case in machines which have an unbalanced pull when the rotor is displaced from its central position. It is evident that in such machines the variations of deflection due to small out-of-balance forces cause unbalanced magnetic pulls, which increase the variations of deflection considerably and cause unsatisfactory running of the machine. For this reason the deflection should not exceed a proper proportion of the air-gap. A proportion which is found to give very satisfactory results in practice is 10 per cent. of the air-gap, in machines which have an unbalanced magnetic pull on the rotor when the rotor is displaced. Equalising rings on D.C. armatures are said to do away to a great extent with the unbalanced magnetic pull, and on such machines a slightly higher shaft deflection can be allowed, though in *no* case should the deflection exceed 20 per cent. of the air-gap.

Taking the average of a large number of generators, I find that the distribution of load on the generator shaft is such that

$$\delta=\frac{WL^3}{84{\cdot}5d^4\times10^6}\quad.\quad.\quad.\quad.\quad.\quad(1)$$

when the shaft is proportioned to give a uniform stress throughout, where δ = deflection in inches at the centre line of armature or field, W = weight of flywheel, armature and commutator, shaft and unbalanced magnetic pull, L = length of span in inches (Fig. 1), and *d* = diameter of shaft at centre line of armature in inches.

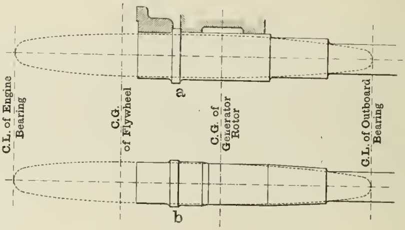

FIG. 3.

Now, if the deflection is limited to 10 per cent. of the air-gap, taking average air-gaps will give the following allowable deflections:—

0·0250 for generators of 100 kw. to 300 kw. capacity.
0·0375 „ „ 300 kw. to 750 kw. „
0·0500 „ „ 750 kw. upwards „

Then, taking formula (1) and inserting the values of allowable deflection, we obtain the diameter of shaft:—

$$d=\frac{\sqrt[4]{WL^3}}{38{\cdot}0}\text{ for generators 100 kw. to 300 kw.}\quad(2)$$

$$d=\frac{\sqrt[4]{WL^3}}{42{\cdot}2}\text{ for generators 300 kw. to 750 kw.}\quad(3)$$

and $$d=\frac{\sqrt[4]{WL^3}}{45{\cdot}4}\text{ for generators 750 kw. upwards.}\quad.\quad(4)$$

The above will give the diameter of shaft which should be used in ordinary cases—that is, moderate speed machines which have an unbalanced magnetic pull when the rotor is displaced. The value of W should include the unbalanced magnetic pull when the rotor is displaced by an amount equal to the allowable shaft deflection. For high-speed machines the allowable deflection should be less than 10 per cent. of the air-gap, and for low-speed machines might be as high as 20 per cent. No definite rule can be put down, as each particular case must be decided on its merits. The following short table may serve as a guide for the deflection which can be allowed :—

——	With unbalanced pull. Per cent. of air-gap.	Without unbalanced pull. Per cent. of air-gap.
Low speed, 50 to 150 r.p.m. ..	12	20
Ordinary speed, 150 to 650 r.p.m.	10	15
High speed, 650 to 1,000 ,,	8	10

When the diameter at the centre line of the rotor has been obtained by this method the shaft should be checked to see that the stresses give a factor of safety of not less than four, and the shaft proportioned for a uniform bending stress throughout.

Any sudden change in diameter is bad, as where a shaft drops from one diameter to another, there is a break in the continuity of the metal fibre, and so a point is provided where fracture can commence. In fact, it is possible to *weaken* a shaft by increasing its diameter at a particular point above what is necessary for uniform stress. Changes in diameter then should be made as gradual as possible and the actual longitudinal section should follow as closely as possible the section calculated for uniform strength. Fillets should not be used if possible as changes in diameter are better made with tapers. Fig 3 will help to illustrate my meaning. The dotted lines show the theoretical section, *a* shows an incorrect shaft and *b* shows the correct section.

THE BRUNNEN-MORSCHACH ELECTRIC RACK RAILWAY.

A recent addition to the group of Swiss mountain railways worked on the three-phase system is to be found in the rack railway, described in a series of articles in the *Schweizerische Elektrotechnische Zeitschrift*, which connects Brunnen, on the Lake of Lucerne, with the village of Morschach, near Axenfels, and finally reaches Axenstein, 258 metres (850 ft.) above the level of the lake. The length of the line is about 12¾ miles, including a short tunnel. The mean gradient is 12·6 per cent, and the maximum gradient 17 per cent. The line is single track 1 metre gauge, with a central rack extending the whole distance.

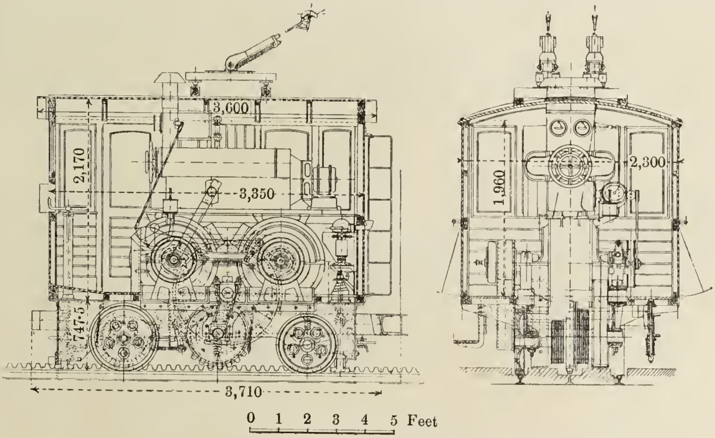

Fig. 2.—Complete Locomotive.

Current is obtained from the power house at Altdorf, from whence there is an 8,000 volt 50 cycle transmission-line, which feeds a transformer station adjoining the line, where the pressure is stepped down to 750 volts. Four open type single-phase transformers are provided, each of 75 k.v.a, one of which is kept as a spare. The high-tension windings are mesh connected, and the low-tension windings are star connected. This course has been adopted with a view of ultimately raising the transmission voltage to 14,000 volts, when the high-tension windings will be changed to star connection, so that the secondary pressure remains unaltered. The combined output of these three transformers is sufficient to supply power for one train running up the steepest gradient, and at the same time for shunting one train in one of the stations. A complete switchboard with oil switches is provided in the transformer house, and the chamber which contains all the high-tension apparatus is fitted with an earthing device which earths all the apparatus when it is opened, so that access to live parts is prevented.

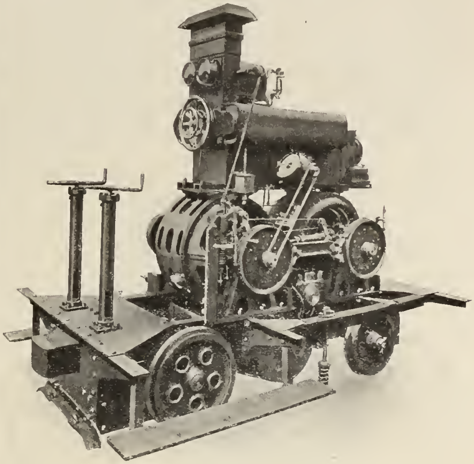

Fig. 1.—Mechanism of Locomotive, with Cover Removed.

One phase is connected to the track rails which are bonded, and two overhead conductors are employed, fixed 500 mm. (about 19½ in.) apart. These are of hard drawn copper and of figure 8 section. A single feeder is taken to a point on the portion of the line distant from the transformer station. The system is designed for a voltage drop, not exceeding 5 per cent., on the overhead line at a maximum load of 120 amperes. The overhead wires are supported mostly by span wires from wooden poles and partly by lattice steel poles with bracket arms. A pair of telephone wires is carried on the same poles.

In view of the great differences in the height of the overhead wire, which varies from 4·5 to 6 metres (15 to 20 ft.) above the rail level, and the lack of space in the tunnels for the accommodation of bow collectors, a special form of spoon collector was adopted, as the current to be dealt with was considered rather high for collection by the ordinary trolley wheel. These collectors are made of aluminium, and the springing of the arms which carry them is so arranged that the pressure upwards against the wire is approximately constant for all heights.

The whole of the electrical equipment, including that of the locomotives, was supplied by Messrs. J. J. Rieter, of Winterthur, and the mechanical portion of the locomotives was built at the Swiss Locomotive Works as Winterthur.

A view of the mechanism of one of the locomotives with the body removed is given in Fig 1, and an elevation of the complete locomotive in Fig. 2. Each locomotive weighs 10½ tons complete, and is stated to be able to exert a pull at 15,500 kg. (34,300 lbs.) on the maximum gradient (17 per cent.) at a speed of 9 km. (5·6 miles) per hour. The locomotive is carried on two axles, which are so arranged that the weight is supported at three points. The pinion which gears into the rack and carries the brake is mounted loose on the rear axle, quite distinct from the main driving pinion. The trailing axles have each one fast and one loose wheel, to facilitate going round sharp curves, and the axle of the main driving pinion, which gears into the rack, is situated between them in the centre of the under frame. This is driven by gearing by the motors through an intermediate shaft, as shown in Fig 2, the total gear ratio thus produced being 10·85 : 1. At the forward end of the locomotive is a pair of jaws, acting through a spring, which hold down the car if there is any tendency to mount the rack by gripping the outwardly sloping sides of the rack. A similar arrangement, but without a spring, is provided at the other end. Both these are so arrranged that they do not interfere with the re-engagement of the pinion after there has been any mounting of the rack from any reason. Projecting guides are also provided, which limit the possible side-play that might take place through the lifting of the front axle and cause derailment.

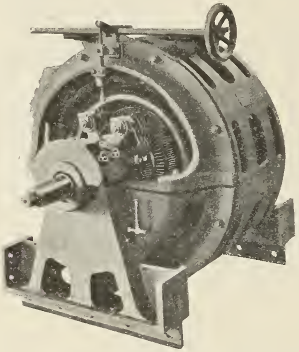

Fig. 3.—Continuous-current Side of Motor.

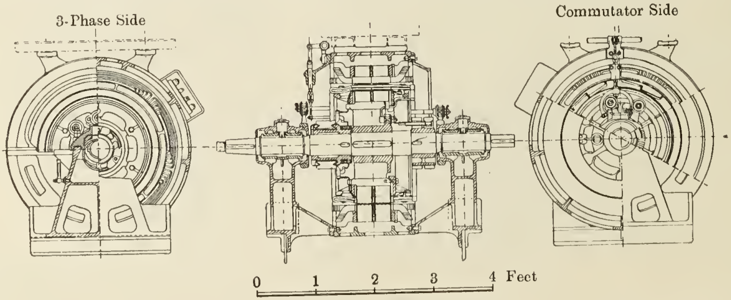

Fig. 4. Elevation and Section of Motor.

The two independent hand brakes act upon drums on either side of the driving and brake pinions, so that the tendency to mount the rack during the braking is less than if they were all on one shaft. These brakes are designed so that either one singly can pull the train up in about 5 seconds, and are water cooled. The hand brakes on the motor shafts can be applied by the driver on the locomotive or the conductor on one of the passenger cars, or they can be put in action by the automatic speed limiting device, or by means of the failure of current in a solenoid connected to the circuit. They are of great power and can pull up a fully-loaded train travelling at full speed down the steepest grade in 2 seconds.

These brakes are so interlocked with the main controller that the latter is automatically returned to the off position when they are applied, but a catch is provided to prevent the application of the brake by the failure of current in the solenoid every time the controller is put in the off position.

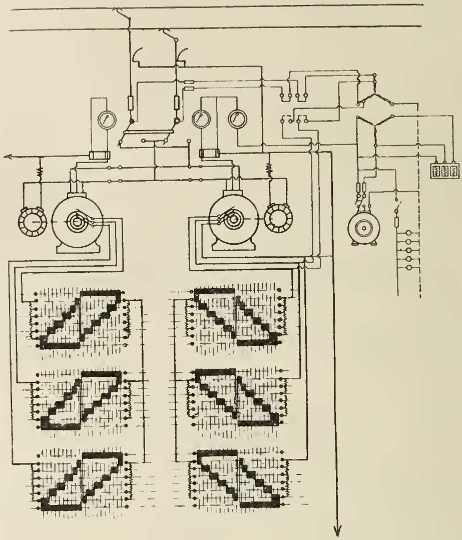

Fig. 5.—Diagram of Connections of Locomotive.

In common with most rack locomotives the motors drive through a clutch which is capable of a certain amount of slip; this lessens the likelihood of a too sudden application of the motor brakes, or a sudden pulling up of a motor from accidental reasons, causing the pinion to mount the rack.

One end of the passenger car nearest the locomotive rests on springs attached to the locomotive, as in the case of the Gornagrat and Jungfrau railways, thus increasing the effective weight on the locomotive, and in all cases the locomotives push the cars up the hill. Each locomotive is fitted with two asynchronous three-phase motors, the pinions of which, as we have seen, drive on to the same gear wheel. When running with a full train at 9 km. (5·6 miles) per hour, about 160 h.p. is required at the shaft of the main driving pinion. The motors are rated at 85 b.h.p. each for continuous running, and will work up to at least 100 b.h.p. without overheating. A view of one of the motors is given in Fig. 3, and Fig. 4 shows a section and elevations.

As will be seen from the diagram of connections (Fig. 5), current is taken from the two overhead collectors to a double-pole switch, which serves at the same time as main switch and reversing switch.

The third phase, which is earthed, is taken direct through the frame to the motors, one terminal of each of which is connected to the casing. In front of the driver are situated two concentric hand wheels, one of which actuates the main and reversing switch mentioned above, while the other is geared to the two controller drums which cut the resistance in and out of the rotor circuits. A mechanical inter-locking arrangement between the two hand wheels prevents the main switch being closed after having been opened, either automatically or by hand, except when all the starting resistances are in circuit.

In order to produce an electrical braking effect when travelling downhill by using the motors as generators, the rotor of each motor is provided, in addition to its ordinary three-phase winding, with a continuous-current winding and a commutator, the brushes of which are connected to two phases of the stator winding, thereby forming a short-circuited series generator working with a very strong field. As the three-phase winding is also moving in this field a three-phase current is generated in it, which, as will be seen from the diagram of connections, flows direct into the resistances, where its energy is dissipated. In this way a powerful braking effect is produced without in any way relying on the current supply. The resistances are cooled by a fan driven by a small 120-volt motor which is supplied from a transformer on the locomotive, which also supplies current for the lighting of the train and for operating the automatic brake solenoid. A change over switch is provided, by means of which, in event of the supply current failing while travelling down hill, the fan motor can be driven by the braking current obtained from the rotors of the main motors.

The turning of the handwheel of the main switch raises the brushes from the commutators on the continuous current sides of the motors by a system of levers before the main current is switched on to the stators and conversely the placing of the handwheel in the off positions lowers the brushes so that when the train begins to move down hill the electric brake comes into action without any further adjustment on the part of the driver.

The motor and auxiliary transformer circuits are provided with fuses, and a pair of horn lightning arresters are mounted on the roof of the locomotive.

THE DESIGN OF BLAST-FURNACE GAS ENGINES IN BELGIUM*

BY PROF. H. HUBERT.

The first attempts at direct utilisation of blast-furnace gas in engines were made in 1895. For a considerable time the gas had been burnt in Cowper stoves for heating the blast for the furnace, and under the boilers which supplied steam to the blowing-engines, and others serving the furnaces. It was natural, therefore, that the idea of directly employing it in gas engines should have occurred simultaneously to several engineers, notably to Lürmann and to Lencauchez, who had pointed out the blast furnace as a powerful gas-producer. Nevertheless, nowhere had any attempt been made to apply it to this purpose up to the end of 1894, when Thwaite proposed it to Mr. James Riley, of the Glasgow Iron and Steel Co.

About the same time investigations were being made in Belgium and in Germany, independently of Thwaite's experiments, which were not generally known on the Continent.

The industrial world, which up to that time had hardly favoured the idea, had thus been gradually prepared to receive it. The gas-engine, long restricted to small sizes and dependent upon the use of an expensive fuel obtainable only in large centres, now began to make headway.

At the Paris Exhibition of 1889 two engines of 100 H.P. were shown and excited much interest amongst engineers. One had four cylinders, and was made at the celebrated works of the Deutz Company, and the other was a single-cylinder engine, exhibited by two French designers, Messrs. Delamare-Deboutteville and Malandin.

In the meanwhile the design of gas-producers had made important progress, completely freeing the new engine from its dependence on the gas-works, enabling it to be installed anywhere, and to realise to the full extent its economic value by supplying it with a cheaper fuel.

In 1892 Delamare installed at the Moulins Leblanc works at Pantin a four cycle, single-acting, single-cylinder engine, using producer gas, and developing 220 B.H.P., with a consumption of about 1 lb. of coal per brake-horse-power per hour. Despite the difficulties met with in this bold attempt, it showed the possibility of economically producing high power with poor gas.

The time had now arrived for engineers to pay attention to the use of gas from blast furnaces, which, although not of great heating value, was less costly; and was the more suitable on account of the progress which had been made in the design and working of blast furnaces, the proportionally lower consumption of coke, and, as a result, the marked reduction in the relative quantity of combustible gases, which only sufficed, with difficulty, to heat the blast and to produce the steam required about the furnaces. Finaly, the progress of the science of heat had brought to light the causes of the low thermal efficiency of the steam engine, and notably of the loss resulting from the employment of boilers.

It is not therefore surprising that the idea of dispensing with the boiler and burning the blast-furnace gases directly in the engine occurred, nearly simultaneously, in three countries, where metallurgical industry had made great progress.

To Messrs. Bailly & Kraft, of the Cockerill Company, belongs the honour of being the first in the field in Belgium. The patent taken out by the Cockerill Company for this new application was dated May 15, 1895, and the first trials were made at the end of that year. They were made with a Simplex engine of 8 H.P., in which it had only been sought to reduce the clearance space, in order to increase the compression and to facilitate the ignition of the mixture. The gas cleaning was very imperfect, and was carried out simply by passing it through two scrubbers, 4 metres in height.

This engine displayed perfect elasticity, and adapted itself to the variations of composition, pressure, and temperature of the gases, giving an efficiency of 77 per cent.

The authors, in an article published in the "Annales des Mines de Belgique" at the commencement of 1897, described the results of the first trials, and the conditions necessary for the direct use of blast-furnace gases, showing that a plant producing 100 tons of pig per day was able to furnish about 18,000 cubic metres of gas per hour with a calorific value of 1,000 calories. Taking into consideration that half this volume is available, and allowing for an efficiency of only 20 per cent. in the engines, the authors showed that it would be possible to obtain from these gases about 3,000 H.P.

The small trial engine consumed about 5 cubic meters per B.H.P., which reduces the preceding figures to 1,800 H.P; but they foresaw at the time that this consumption would be ere long greatly reduced, and that blowing-engines driven by gas would be built. They also foresaw that, by disposing of the great surplus motive power, the blast-furnace would ultimately become a centre for the production of energy for works surrounding, the boilers of which it would gradually supersede.

This remarkable progress was described by Mr. E. P. Martin, President of the Iron and Steel Institute, in his Presidential Address of 1897.

At the meeting of the Institute on May 3, 1898, M. A. Greiner discussed the results published up to that time, which included the author's Paper of February 1897, a note by Galbraith and Rowden on November 18, 1897, one by Lencauchez on November 8, 1897, and another by Lürmann on February 27, 1898.

Mr. Greiner combated the objections which had been specially raised against this new method of employing gas by German metallurgists at the Dusseldorf meeting, and gave reasons for his belief that the consumption would be reduced below 4 cubic metres per brake horse-power per hour, and that the blast-furnace would be able, by superseding the steam boiler as an intermediary in the production of motive power, to place at the disposal of the engineer 20 H.P. per ton of pig produced daily.

Experience soon verified these forecasts. The Cockerill Company have constructed, with the collaboration of Mr. Delamare, a four-cycle, single-cylinder engine of the Simplex type, which in the 24 hour trials, at which the author had the honour to collaborate with Professor A. Witz, gave 1 B.H.P. for an average consumption of 3·329 cubic metres, of a gas possessing a calorific power of 981 calories—say 3,266 calories. (This figure has since been reduced to 3,162).

The principal dimensions of this engine are as follows:—

Diameter of cylinder	800 mm.
Stroke of piston	1,000 mm.
Revolutions per minute	105
Indicated horse-power..................	213
Brake horse-power	182

The construction of this engine is worthy of note. The cylinder proper is cast with a breech carrying at its lower portion the exhaust valve, and at the back a cylindrical prolongation in which the admission valve is placed. This breech or cylinder head has its own water-jacket, and is provided towards the front with flanges bolted to the cylinder jacket, which was a part of the cylinder bayonet casing.

The shaft is not cranked, and carries a heavy fly-wheel. The piston is made in one piece, and is not chilled. The pressure does not exceed 7 kg. The sparking is effected by Delamare's system, in which a succession of sparks, produced by a Ruhmkorff coil, is emitted from a slide valve on the back of the cylinder when its opening comes opposite to an orifice bored in the back. The movement of the sliding valve, and similarly of the other valves, is made by a crank and by cams keyed on to an auxiliary shaft, parallel to the cylinder and revolving at half the speed of the main-shaft. The governing is effected by the hit-and-miss arrangement by means of Delamare's air governor.

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* Paper read before the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on Tuesday last.

Starting is effected by turning the fly-wheel, by a hand-wheel, and by admitting a charge of carburretted air, the explosion of which starts the engine.

The success of this engine, which worked perfectly without the gas being cleaned as effectively as is now done, and is still running after being eight years in service at Cockerill's, encouraged them to build a much more powerful type of engine capable of directly operating a blowing apparatus of 600 H.P., and consequently of liberating the blast furnace from its dependence upon the boiler.

Though the enterprise was considered rash, they still went on with the attempt, which was logically justified, seeing that in modern steam-driven blast-furnace installations the gas produced is only just sufficient for the requirements of the furnaces. To procure gas in excess it was necessary to commence by replacing the existing engines by the more economical gas engines, for by such means only would gas be available. It is necessary to commence with gas-driven blowing apparatus. A motor of this description attracted much attention at the Paris Universal Exhibition of 1900. Another, coupled with its blowing apparatus, in the blast-furnace department of Cockerill Company, and started up on November 20, 1899, was submitted to a series of trials on March 20 and 21, 1900.

The features of this remarkable engine were as follows: regulation by the method of "hit-and-miss," that is to say, suppression of an admission of gas complete.

	Diameter of cylinder	1,300 mm.	
	Stroke of piston	1,400 mm.	
By brake tests	Revolutions per minute	94·4	
	Indicated horse-power	786	with 89% admission and 11% "hit and miss" by governor
	Effective brake horse-power	575	
	Consumption per indicated H.P.-hour	2·556m.^{3} or 2515 calories	
	,, ,, brake ,,	3·495m.^{3} ,, 3440 ,,	
Tests with the blowing apparatus	No. of revolutions per minute	93	
	Indicated horse-power	886·5	full charge without "hit & miss"
	Effective brake horse-power	725	
	Consumption per indicated H.P.-hour	2·334m.^{3} or 2343 calories	
	,, ,, brake ,,	2·853m.^{3} ,, 2864 ,,	

The method of construction of the 200 H.P. motor had generally been retained, saving that the main bearings were separated from the cylinder casing, and were connected by four strong screwed steel stay bolts, giving easy access to the piston. The shaft was cranked and rested on three bearings to support the flywheel, which weighed 33 tons. The piston rod traversed the back space in a stuffing box.

The admission valves were retained below like those of the exhaust. The admission of gas was carried out by separate valves placed in a valve box, separated from the cylinder by a third valve called the mixture valve. The methods of working the valves and those of the ignition slide valve were retained. The regulation was carried out by "hit and miss." The pressure attained 9 kg. per square centimetre. The circulation of water extended to the head and to the piston-rod itself, to which the water penetrated by means of flexible pipes, which adapted themselves to this movement. The exhaust valve was also cooled. This was done with the object of preventing the ignition of the mixture by the dust, which, combining with the products of the decomposed oils on the piston or in the recesses of the explosion chamber, might form concretions retaining a temperature high enough to ignite the gases.

The arrangement of all the valves at the under-side of the cylinder was such as to facilitate the sweeping out of the dust and decomposed oil, and to allow these large engines to work equally as well as the 200 H.P. engines without having recourse to a more perfect gas-cleaning process. This hope was ill-founded. It became necessary to interpose, between the blast furnace and the large engines of this class, apparatus capable of reducing the dust held in suspension by the gas to 0·02 gramme per cubic metre. The means now used in Belgium are centrifugal fans with water injection, and Theisen, Brian and Zchokke apparatus. The latter are not, strictly speaking, purifiers; they are rather coolers.

As they are not the invention of Belgian engineers, and as they will be made the subject of another Paper to be read at this meeting, it is not necessary to deal further with them.

As is well known, the novel idea of the Cockerill Company was vigorously discussed by engineers, who saw therein an economic mistake, and maintained that it was better to divide the power between two or four cylinders. The designers, nevertheless, knew perfectly well that they could obtain in this way, for a 600 H.P. engine, a more regular and perhaps more economical engine. They had already, however, studied the two-cylinder tandem types of 600 H.P. and 1,200 H.P. One of Cockerill's licensees, Messrs. Breitfeld, Danek, of Prague, had since 1901 constructed a four-cylinder, double-tandem engine of 600 H.P. giving remarkably even running; but Messrs. Cockerill wished to demonstrate that it was practically possible to develop 600 H.P. by means of a single cylinder alone, single acting and of four cycles, and consequently to construct engines developing up to 2,500 H.P. without exceeding four cylinders. In addition to this they were, moreover, anxious also to improve the governing by applying to these large engines the principle of variable admission in lieu of the hit-and-miss governing, which required the use of heavy flywheels, and was not well suited for producing alternating electric currents, and needlessly strained the engine when it had to run continuously with reduced loads.

From 1901 they realised, with M. Delamare, that it was essential to obtain a variable admission motor, an air governor, or else a centrifugal force, causing the double air and gas valves to open from the commencement of the suction stroke, but determining the closure earlier in the stroke as the power to be developed becomes lower.

In this manner the mixture admitted possessed the composition most favourable for complete combustion, but the volume admitted to the cylinder varied, and with it the pressure.

The ingenious mechanism which realised this mode of operation which has been described elsewhere by the author,* was applied to a single-cylinder motor of 200 H.P. of the same dimensions as that of 1898.

The trials to which it was submitted in November and December, 1901, established beyond doubt a consumption varying between 3·318 and 3·455 cubic metres per brake-horse-power per hour for full load, the calorific value being 914 to 1,017 calories. The expenditure in calories per horse-power varied between 3,172 and 3,434, and has been on an average nearly 3,298, practically the same as that of 1898. At half-load it was, on an average, 4,320 calories, and at quarter load 7,406 calories.

About the same time (1902) the Cockerill Company produced another engine, designed to give greater regularity with smaller dimensions—viz., the double-acting engine.

It was well known that the first industrial gas engine, that of Lenoir, was double-acting, but the success of the Otto four-cycle and single-acting engine had, for a long time, relegated to the background all other types of engines. Nevertheless, M. Letombe, at the Brussels Exhibition, showed a four-cycle and double-acting engine.

The Körting Company exhibited at Dusseldorf a powerful two-cycle double-acting engine, which attracted much attention. The long-standing prejudice against the adoption of this system was thus broken down.

The direct driving of the blowing apparatus from the piston rod of the engine had accustomed Cockerill's engineers to the adoption of a stuffing box at the back end of the cylinder. They were, therefore, naturally disposed to adopt double action, which enabled them to considerably reduce the size of the cylinder and consequently approach large powers more easily, thus ensuring more steady running with a lighter flywheel.

They retained, firstly, the general arrangement of the single-acting motor, which up to that time they had constructed, notably the disposition of the inlet and exhaust valves underneath the cylinder. However, from that time they introduced an important modification. The cylinder liner with its jacket constituted a part independent of the two cylinder heads. Each of these carried a stuffing box, through which the water-cooled piston rod worked, and an extension downwards of the combustion chamber, in which were installed the valve, which simultaneously admits air and gas and actuates the exhaust valve. The actuating mechanism of the valves was also modified, without departing from the system of variation of the admission, consisting of cutting off the air and gas supply simultaneously. This system had the advantage of preserving the composition of mixture most favourable to complete combustion, but it had the inconvenience of diminishing to some extent the compression as the charge decreased. This diminution reduced the economic efficiency of the engine in the case of light loads, and also when it happened that the gas was very poor it spoilt the ignition and caused misfires, which altogether upset regularity and economy.

This trouble becomes very marked in motors driving dynamos, which very often work with reduced loads, and where economy is a greater consideration than in blowing engines. Therefore no time was lost in introducing another system of variation, consisting of air admission to the cylinder during the whole piston stroke, and only allowing the gas to enter during the last portion of the stroke by the governor, varying the moment at which this admission commences. In this way invariable compression is secured.

It is true that when the mixture is modified it becomes poorer and poorer; but it should be noted that gas is introduced at the back-end of a cylinder already partially filled by a volume of air which follows the piston. Although it is impossible absolutely to rely upon retaining the exact stratification characteristic of the Otto cycle, there persists, nevertheless, an undoubted stratification of mixture, the richest strata remaining at the back-end of the cylinder, close to the igniter.

The sparks then impinge on the explosion mixture which, being strongly compressed, insures that the ignition is readily transmitted to the whole volume. It will be seen that the gas admission valve should be able to move independently of that giving air admission.

In engines of this system the two valves are superposed, the air arriving by a casing which surrounds the gas passage, and the valve spindle passing through the gas valve, which is hollow. The placing of the valves in an ante-chamber of the combustion chamber, leading to a tubular combustion chamber, evidently assists the stratification of which mention has been made, and consequently the ignition of weak charges, but it resulted in cylinder heads of unsymmetrical form, which created difficulties at Cockerill's works, as it had already done elsewhere.

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* *Revue Universelle des Mines*, 1902, Vol. LIX.

The unequal contraction of the metal of the various parts of the cylinder head caused great stress, which, added to the already high stresses due to the explosion and to the heating, have occasionally brought about the fracture of the cylinder heads, even when they have been replaced by steel castings.

This circumstance decided the makers of large engines to revert to the symmetric arrangement of the valves, which is customary in steam engines where the invet valve is placed on the top of the cylinder and that of the exhaust underneath, and thus to obtain an arrangement which lends itself well to expansion, and which, moreover, facilitates access to the valves.

This arrangement has been obtained in different ways by manufacturers, notably at the works at Deutz and Nürnberg and at Seraing. At the Cockerill Company's works the covers are no longer attached to the central body by studs screwed into it, but joined by tie-bolts bolted to flanges on these covers.

These bolts are thus subjected to tension, and, similarly, the body of the cylinder is subjected to a compression stress of the kind which best suits such metal. This arrangement is patented. The frame is formed of two-box girders carrying the cylinder. These girders are joined by tie-bolts to others that contain the slides and carry the crank shaft bearing. The piston is composed of two halves with double walls, each half permitting water circulation, the two halves being bolted together with an india-rubber joint.

The water cooling is effected at a pressure of 3½ kg. to 5 kg. per square centimetre to avoid water hammering in the piston and its rod. The water, furnished to the latter by a duct fixed at one end, passes through the rod and the two halves of the piston, and goes out at the back by another duct.

The ignition is effected by means of one or two high-tension magnetos, through fixed sparking plugs. These magnetos do away with the necessity for a source of electricity external to the motor. The compression has been successively increased up to 14 kg. per square centimetre. The starting is effected by means of air, compressed to 10 atmospheres by a special compressor, and retained in a reservoir in sufficient quantity to enable the engine to revolve several times.

The assembling of the parts, which constitutes one of the features of this motor, must now be described. As shown in the figure, the usual arrangement of the auxiliary side shaft, parallel to the cylinder axes, and actuated by the main shaft by means of gearing in the ratio of 1:2, is retained. On this auxiliary shaft B are keyed the cams C, which actuate the opening of the inlet and exhaust valves.

The exhaust valve E opens a little before the end of the stroke, but always at the same moment in each stroke; it is worked by the cam C by means of a lever and rod carrying a roller at its lower end. The exhaust valve is hollow, and likewise the spindle, to permit of the circulation of cooling water.

The inlet distributor consists of two valves: one for gas, the other for air and the mixture. The spindle of the latter passes through the hollow spindle of the gas valve. Both are constantly brought back to their seats by springs placed in a box above. The air valve is double. It consists of a solid single-seated flap valve opening downwards, and a hollow perforated sleeve valve L. These two parts are attached to the same spindle and move simultaneously.

From a little in advance of the commencement of the suction stroke, the double valve is lowered by the lever D, actuated by the rod *t*, at the lower end of which works the cam C. By this movement the openings of the sleeve valve L are brought opposite the ports formed in the casing, by which the incoming air arrives. The latter is thus drawn in from the commencement of the piston stroke and throughout its entire duration.

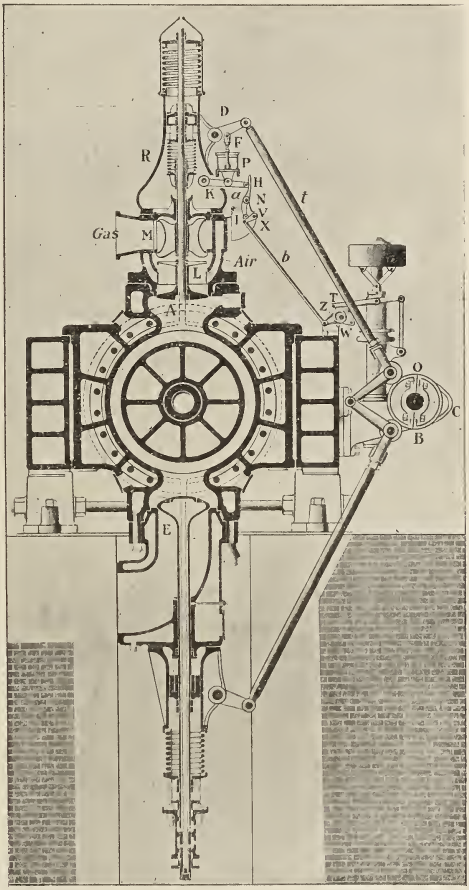
To the lever D is attached a spindle, F, which works a second lever, K, the function of which is to lower the double seated gas valve M. If this spindle was unalterable in length the two levers D and K would work simultaneously, and the gas would pass into the cylinder simultaneously with the air. But the spindle F is composed of two parts, of which one carries the piston and the other the cylinder of a dash pot, P.

The upper part is thus able to rise up, expanding the air in the cylinder, provided that the lower portion remains fixed, and in this case the gas valve does not open. The end of the lever is locked during the period of exhaust by a finger, H, which keeps it from moving as long as the finger remains vertical. If this part is moved to the right the lever K now becomes free, but the descent of the spindle of the mixing valve A compresses the spring R placed upon that of the gas valve M, as long as this is immovable. Immediately K is unlocked, this spring is able rapidly to lower M, causing the valves to resume their original distance. The shock is deadened by the dash-pot, and the spindle F likewise resumes its normal length.

From this time forward the gas penetrates, with the air, into the cylinder, constituting the explosive mixture, which will be afterwards compressed, and ignited by the spark. In order, therefore, to enable the admission of gas to be varied, it suffices to operate at the moment the lever K is unlocked. This instant is determined by the governor in the following manner: the finger H is articulated on a shaft N, from whence it is prolonged to engage a spring, which tends to keep it constantly locked with K.

Its lower extremity I carries a roller, on which is taken the thrust of the cam V, fixed on the oscillating shaft X. It is this cam which produces the unlocking of K, by pushing against I and turning aside H, despite the resistance of *a*.

The oscillating movement of X is produced by a rod *b*, which operates the crank *m*, keyed on X. The rod is attached to one end of a transmitting lever, Z, the other end of which is worked by an eccentric, O, keyed upon the auxiliary shaft B. The lever Z, however, constitutes an extension of the roller of an eccentric strap, T, of which the sheath is keyed on the spindle W. This carries a crank joined by a rocking beam to the centrifugal governor socket. The movements of the governor socket thus modify the position of the shaft W, and consequently the centre around which Z oscillates. This results in an alteration in the proportion of the two arms of this lever, and, as a result, the length of travel of the connecting rod *b*, and increases the oscillation of X. It may be seen, therefore, that the moment at which the gas valve opens is thus determined by the governor, which retards or advances it according as the speed of the engine increases or diminishes.



Section of the Cockerill Co.'s Gas Engine.

When, as a result of the rotation of the shaft B, the cam C ceases to operate the connecting rod *t*, the springs mounted upon the

Table I.

Description of test.	I.H.P.	B.H.P.	E.H.P.	Mech. efficiency per cent.	Elec. efficiency per cent.	Total efficiency per cent.	Consumption per hour and per H P. (*cheval*) in cubic metres, at 0·02760 mm. per			Highest calorific power by Witz bomb per metres³ Calories.*	Calories used per hour and per			Thermal efficiency per cent.	Heat carried away by	
							I.H.P.	B.H.P.	E H.P.		I H.P.	B.H.P.	E.H.P.		Water of circulation %	Ex. gas.
½ load ..	1,250·48	986·00	917·5	78·7	93·1	73·3	2·513	3·187	3 425	979	2,460·2	3,120·1	3,353·1	29·82	16·0	..
¾ load ..	1,463·88	1,333·2	1,250·7	91·10	93·8	85·4	2·313	2·540	2·707	963	2,227·4	2,446·0	2,606·8	28·52	16 2	..
Full load	1,569 45	1,466·15	1,377·45	93·41	93·9	87·76	2·247	2·406	2·560	983	2,208·8	2,365·1	2,516·5	28 77	20·2	..
Full load	1,607·74	1,494 8	1,404·7	92·97	94·0	87·4	2·325	2·497	2·657	943	2,192·5	2,254·7	2,505·6	28·98		..
Overload.	1,755 06	1,581·9	1,487·7	90·00	94 0	84·7	2·155	2·352	2·542	988	2,129·1	2,363·3	2,511·5	29·84	20·2	..

* This is greater than that given by the Junkers calorimetre.

Table II.

Description.	Date of trials.	Power.		Consumption of gas.		Consumption of heat.		Thermal efficiency per cent.
		I.H.P.	B.H.P.	I.H.P.	B.H.P.	I.H.P.	B.H.P.	
8 H.P. engine	1896	5·26	4	4 03	5·30	4,030	5,300	15·77
200 H.P. engine. Single cyl., single acting, constant admission	July 19-20, 1898	213·9	181·82	2·830	3·329	2,775	3,625	22·9
600 H.P. engine. Single cyl., single acting, constant admission	March 20, 1900	825·8	670·0	2·560	3·156	2,520	3,106	25·2
200 H.P. engine. Single cyl., single acting, variable admission	Dec. 2, 1901	246·9	215 3	2·981	3·418	2,766	3,172	23·0
1,400 H.P. engine. Double-acting, tandem, variable admission ..	Jan. 9 & 10, 1906	1,755·06	1,581·9	2·155	2·392	2,129	2,363	29·84

spindles of the two valves bring the latter back to their seats. It will be seen from this that, as a result of the clearance between the parts, or from the expansions, the gas valve closes first, leaving open the mixture valve. This hinders the compression. To avoid this inconvenience the spring of the gas valve is made weaker than the other, so that it is able, despite the arrest of the former, to replace the latter on its seat, by slightly compressing the first spring.

To this somewhat lengthy description of what is really a simple mechanism, and works perfectly, it may be added that the exhaust commences about 15 per cent. in advance, and is prolonged a little beyond the finish of the stroke, during which time the admission has slightly commenced. The result is that the exhaust still continues. At this juncture the burnt gases have attained a high velocity, which causes a powerful suction in the cylinder.

The atmospheric air rushes violently into the explosion chamber, completely sweeping out the burnt gaseous residuals, which would hang in the vicinity of the sparking-plug and tend to spoil the ignition of the mixture.

The application of this ingenious mechanism confers on the double-acting engine very even running, allowing alternators of 50 periods easily to be coupled in parallel.

This type, studied by the Cockerill Company since 1904, was put in service on a two-cylinder tandem engine of 1,400 H.P., installed in the electricity department of the company.

The pistons are 1 metre diameter by 1·10 metre stroke. The shaft makes about 100 revs. per min., and carries a flywheel of 26 tons and drives a continuous-current dynamo.

Engines of this class are made of 500 H.P. (600 mm. × 800 mm. × 135 revs.), of 750 H.P. (750 mm. × 900 mm. × 100 revs.), and of 1,400 H.P. (1,000 mm. × 1,100 mm. × 100 revs.). The Cockerill Company have also constructed a single-cylinder engine of 575 H.P. (1,000 mm. × 1,100 mm. × 80 revs.), one of 1,000 H.P. (1,150 mm. × 1,250 mm. × 80 revs.), and one of 1,300 H.P. (1,300 mm. × 1,400 mm.).

However, for this special purpose, the constant compression, necessary for the economical production of electricity, might become troublesome when the engine is of the single-cylinder type.

It happens, indeed, that the blowing apparatus may be perceptibly slowed down, and then it might be that the centrifugal force of the fly-wheel would be insufficient for passing the dead centre at the time of compression, especially if a miss-fire had just previously taken place. It is advantageous in this case to do away with constant compression and revert to variable quantity admission, of a mixture of constant composition. This is a little more complicated than the other, and has been worked out for two types—one of 575 H.P. (1,000 mm. × 1,100 mm. × 80 revs.), and the other of 1,300 H.P. (1,300 mm. × 1,900 mm. × 80 revs.).

It is interesting to be able to compare the economy of the new type of engine, with those of the preceding types already referred to above.

The Cockerill Company instructed the author to undertake, with Prof. Witz, detailed tests on the 1,400 H.P. two cylinder double-acting and tandem engine installed in their electric service. These tests were made on January 9 and 10, 1906. Arrangements were made for measuring the consumption, a bell, holding about 300 cubic metres, being provided for this purpose.

As the engine working at full load consumes about 2½ cubic metres per horse-power per hour, the bell was only able to feed it for a little more than 5 min. It was then raised again by the gas being pumped into it by an electric rotary pump. In the interval the opening of gas valves allowed the engine to take gas directly from the main, from which these gas valves isolated it during the time of the trials.

The indicated work (I.H P.) was determined by a large number of diagrams, taken by two observers. The useful work (effective horse-power, B H.P) was ascertained by means of the electric energy developed by a dynamo, of which the output had been carefully tested in advance for a series of powers. Samples of the gas were taken, for the determination of the calorific power, by the Witz bomb in the laboratory of Prof. Witz at Lille University. The quantities of water used in cooling the different parts of the engine were measured, as well as their temperatures. It was not found practicable to take the gas at the outlet, because the water injected into the exhaust vaporised instantly and lowered the temperature.

The detailed results of these tests will be published later; but the principal elements, enabling the progress made since the commencement of this novel application of blast-furnace gases, and the enormous economy it has brought about, to be measured, are given in Table I.

It is interesting to compare the results obtained by these trials with those obtained previously with engines made by the same company.

These figures are significant. In comparing the trials of 1906 with those of 1900, which gave results which were considered excellent at that time, there was found a diminution of 15 per cent. of calories used per I.H.P. For the brake-horse-power the reduction attains 31 4 per cent. Finally, the term of efficiency has been increased 18·4 per cent. The advance made is thus very considerable. The advantage obtained, as compared with the employment of steam, is by no means the least interesting of facts brought out by this investigation. Admitting, however, that a 70 per cent. efficiency is obtained by burning the gases under boilers, which is considered satisfactory, and that the steam raised amounts, according to Carnot's cycle, to an efficiency of 40 per cent. (between 200 and 10 deg., which the cycle of Rankine makes 77 per cent. of that of Carnot), and finally that one could succeed in obtaining 80 per cent. of the Rankine cycle, the thermal efficiency becomes

$$0{\cdot}70 \times 0{\cdot}40 \times 0{\cdot}77 \times 0{\cdot}8 \times 100 = 17{\cdot}25,$$

which is lower, by 42 per cent., than that of the motor above described.

It has been assumed, earlier in the Paper, that a blast furnace producing 100 tons of pig iron per day produces about 9,000 cubic metres of gas at 1,000 calories, available for the production of power.

Under these conditions, by obtaining 2,450 H.P. with the steam-engine, and 4,220 by using the gas direct in gas engines, there remains a difference of 1,770 H.P. in favour of this new application over the results obtained by a first-class steam plant of the usual (boiler) type.

These figures explain the success obtained in metallurgy by the direct use of blast-furnace gas.

Besides the Cockerill Company there is but one other company (the Société de Saint Leonard) who have undertaken the construction of blast-furnace gas-engines. This company, who have acquired licences for the construction of the Körting two-cycle double-acting engine, exhibited an engine of this class at the Liège Exhibition. They are installing two engines of this type at the blast-furnaces of Grivegnée, but the results have not, as yet, been made public.

[The Paper is followed by plates and appendixes, giving particulars of large gas engines built by the Cockerill Company and their licensees.]

NOTES ON LARGE GAS ENGINES BUILT IN GREAT BRITAIN.

In a Paper read before the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on Tuesday last, Mr. T. Westgarth gives the following schedules showing the number and particulars of large gas engines which have been built or are building by British makers. In view of the growing size of gas engines, engines of less than 500 H.P. cannot now be included in the category of large gas engines, and therefore engines under that power are excluded.

"Oechelhäuser" type Gas Engines. Built or building by W. Beardmore & Co., Glasgow.

No. of engines.	I.H.P. each.	Type.	Nature of work.	Gas used.
6	2,500	Twin cylinder	Dynamo	Producer
1	1,850	Single cylinder	Rolling mill	,,
4	1,250	Twin cylinder	Dynamo	,,
2	1,250	Single cylinder	,,	,,
4	625	,, ,,	,,	,,
1	625	,, ,,	Rolling mill	,,
1	625	,, ,,	Air compressor	,,
2	500	,, ,,	,, ,,	,,
7	500	,, ,,	Cement mill driving	,,

Total, 28 engines; 32,600 I.H.P.

"Körting" type Gas Engines. Built by Mather & Platt, Manchester.

1	1,250	Twin cylinder	Dynamo	Duff producer
2	875	Single cylinder	,,	Mond producer
2	625	,, ,,	,,	Duff producer
1	625	,, ,,	Flour mill	Mond producer

Total, six engines; 4,875 I.H.P.

"Premier" type Gas Engines. Built or building by Premier Gas Engine Co., Nottingham.

2	1,100	Tandem, single-acting	Dynamo	Bituminous pro.
1	1,000	,, ,,	Blowing	Blast-furnace
5	650	,, ,,	Dynamo	Bituminous pro.
4	600	,, ,,	,,	,, ,,
1	600	,, ,,	Rolling mill	,, ,,
11	500	,, ,,	Dynamo	,, ,,
2	500	,, ,,	,,	Coke-oven
1	500	,, ,,	Paper mill	Bituminous pro.
1	500	,, ,,	Dynamo	Blast-furnace

Total, 28 engines; 16,950 I.H.P.

Gas Engines built by Willans & Robinson, Rugby.

2	900	Tandem, double acting	Dynamo	Mason producer

Total, two engines; 1,800 I.H.P.

Gas Engines built or building by Crossley Bros., Manchester.

4	700	Single acting, vis-à-vis	Alternators	Producer
4	700	Single-acting tandem..	Pumping	,,
4	625	Single acting, vis-à-vis	,,	Coal gas
2	610	Four-cylinder single-acting, vis-à-vis	Alternators	,,
5	560	Single acting, vis-à-vis	Electrolytic work	Producer
1	560	,, ,,	Wire works	,,
1	560	,, ,,	Bleach works	,,
1	560	Single-acting tandem..	Flour mill	,,
1	560	Single acting, vis-à-vis	Blowing	Blast furnace
2	500	,, ,,	Electric lighting	Producer
2	500	Single-acting tandem.	,, ,,	,,
1	500	Single acting, vis-à vis	,, ,,	Coke oven
2	500	,, ,,	Electrolytic work	Producer
1	500	,, ,,	Electric tramway	,,
1	500	,, ,,	Cotton mill	,,
1	500	,, ,,	Mining machinery	,,

Total, 33 engines; 19,360 I.H.P.

"Cockerill" type Gas Engines. Built or building by Richardsons, Westgarth & Co., Middlesbrough.

2	1,500	Twin tandem, double acting	Tube rolling mills	Mond producer
2	1,500	,, ,,	Dynamo	,, ,,
1	1,000	,, ,,	Tube rolling mill	,, ,,
2	950	,, ,,	Dynamo	Blast furnace
10	800	Single cylinder, single acting	Blowing	,, ,,
1	800	Tandem, single acting	Mine fan	Coke oven
2	750	Tandem, double acting	Dynamo	Mond producer
1	650	,, ,,	,,	,, ,,
1	650	,, ,,	,,	Blast furnace

Total, 22 engines; 20,500 I.H.P.

Illustrations are given of several installations of large gas engines in this country.

TRACTION MOTORS WITH AUXILIARY POLES.

A good deal of progress has recently been made with the use of auxiliary poles to improve the commutation of traction motors. Curves giving the results of a number of tests of such an "interpole" railway motor are shown in Fig. 1, which is taken from an article by Mr. C. H. Condict in the *Street Railway Journal.* The motor in question is one of a complete line of traction motors which are being introduced by the Electro-Dynamic Co. in the United States, and of which the behaviour presents some interesting possibilities. The motor was overloaded during the tests more than 300 per cent., and there were no signs of sparking or flashing at the brushes. The value of this characteristic in railway service is of the utmost importance, as the work is intermittent, and often motors of great capacity are employed merely to surmount some excessive grade or for quick acceleration. With the interpole motor the limiting factor is not commutation, as with the ordinary motor, but is the heating. As the extra heating of the motors can be readily taken care of by forced draught, it follows that a motor of

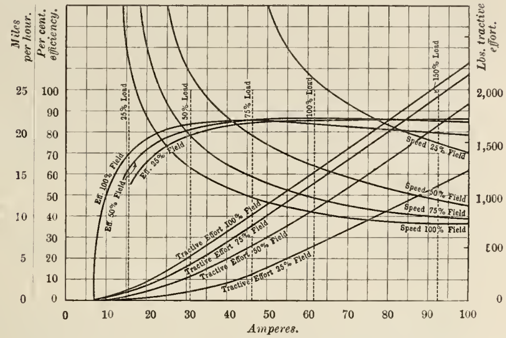


FIG. 1.—CHARACTERISTIC CURVES OF INTERPOLE RAILWAY MOTOR.

35 H.P. 500 volts. Gear ratio 1·5. Diameter of wheel, 33 inches. Efficiency includes gears.

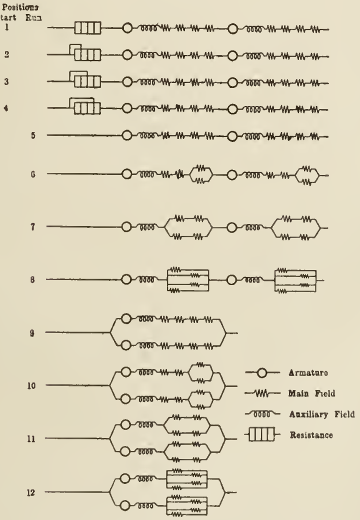


FIG. 2.—SERIES PARALLEL CONTROL FOR INTERPOLE MOTOR, WITH EIGHT RUNNING POSITIONS.

much smaller size may be used for a given service, or a far greater power can be furnished by a motor of a given size.

The accompanying characteristic curves of a 35 H.P. interpole motor show very good performance when running under weak field conditions. On account of the absence of commutator troubles, the field of the interpole motor, as stated, can be weakened to almost any extent, thus delivering high speeds, and at the same time the motor can be run at excessive overloads. Both of these advantages can be secured with a high degree of efficiency, as shown by the curves in Fig. 1. It will be noted, that this efficiency included gears. The motor from which these curves were taken has a weight of less than 1,500 lb.

In Fig. 2 is shown one of the various possibilities of control of the interpole railway motor. This is a series-parallel system in which full use is made of the increased speeds obtained by weakening the fields of the motors. After starting up in series with resistance, the motors are brought into the running series position (No. 5), and from this point on have a number of efficient running positions, in this case eight, which may be obtained without the use of any resistance. A great improvement in economy of current consumption when compared with the ordinary type of railway motor will thus be secured.

A HIGH FALL WATER-POWER PLANT AT PIKE'S PEAK, COLORADO.

The power house of the Pike's Peak Hydro-Electric Co. at Manitou, Colorado, is stated by the *Electrical World* to work with the highest head of any water-power plant in the world, the static head being 2,417 ft., of which about 2,200 ft. is effectively utilised. The water, after driving the turbines, passes on and forms the water supply of the city of Colorado Springs. High up in the mountains is a reservoir, which is partly filled by the drainage of the snows on Pike's Peak, from which, in addition to other sources, the water is obtained. A line of comparatively light piping was laid along the high ridges from the mountain intakes, with only sufficient fall to give head enough to overcome pipe friction, a short length of pressure pipe dropping down a steep descent to the power house.

From the intakes to the point where the pressure pipe begins, the pipe is 20 in. and 21 in. in diameter. The pressure pipe, which is 4,775 ft. long, is 21 in. inside on account of the extra number of rivets and the inside butt strap, which cause additional friction. Great precautions were taken to anchor this pipe thoroughly. For that reason a trench was dug and blasted for the whole length of the pipe, and wherever it passed through solid rock, the trench was filled with concrete after the pipe was laid.

There are no convex curves in the pressure pipe except near the top, so that there is no chance for the pipe to bulge out away from the mountain side. There is only one horizontal curve on the pressure pipe, and at that point there is a shoe. The pressure pipe itself is of $\frac{3}{4}$ in. sheet steel rolled into tubular form and the seam riveted to double-butt straps, one inside and one outside the pipe. The pipe was made up into 32 ft. lengths between flanges, each length being composed of 5 ft. lengths riveted to each other.

From a $\frac{3}{4}$ in. thickness at the bottom, the pressure pipe gradually diminishes in thickness until the top of the steep incline is reached. One flange is counter-bored to receive the ring tunnel on the opposite flange. This counter-bored groove has a gasket of an alloy composed of one-half tin and one-half lead. This was the only kind of gasket that was found that would withstand the pressure. Pure lead was at first tried and probably would have been all right had the counter-bore been turned to fit very accurately over the ring. With the counter-bored groove a loose, sliding fit, as it was made in this case, it was found that the lead would be squeezed out in a thin film when the water was applied.

The laying of the pipe lines was an interesting piece of work, not only on account of the extremely high pressures which part of the line had to withstand, but also because of the long, steep incline of the high-pressure pipe. To carry the pipe and the workmen up this incline, a cable tramway of 30 in. gauge was built. Alongside of this tramway was made the cut into which the pipe was laid. The cable was driven by an electric motor located at the bottom of the incline. The pipe was unloaded from a siding of the Colorado Midland Railway. It was then loaded on cable tramcars, taken up a tramroad to the bottom of the incline and hoisted to whatever point it was to be laid. The low-pressure pipe was also taken to the top of the incline in this way, when it was rolled off and hauled by means of one-horse wagons along the grade which had been made for the pipe.

At the power house the high-pressure pipe line terminates in a cast steel header from which joints are made for the four branches leading to the water wheels. At the end of this are four Crosby relief valves, adjusted to open at 1,100 lb., 1,200 lb., 1,300 lb. and 1,400 lb. pressure per square inch respectively. The four generators are placed at an angle on account of greater convenience in the disposal of the waste water from the water-wheel nozzles. The problem of successfully cushioning the force of the stream from a nozzle from which water is issuing at over 940 lb. per square inch presented some difficulties. If such a stream were allowed to strike masonry or ironwork it would soon destroy whatever it impinged against. The speed of the water wheels is governed by deflecting the nozzle away from the buckets when the load is light, thus allowing part of the water to go past the wheel with full force into the tail race. On very fluctuating load almost the whole jet may occasionally have to be taken care of in the tail race. When the jet is fully deflected from the water wheel it strikes the water in the tail race at such an angle that it has about 40 ft. of water cushion before reaching the cast-iron baffles on the far side of the settling tank. Tests made to determine the effect of the unthrottled jet have shown that the jet will under no circumstances reach the baffle. It ploughs deep furrows in the water, which, when they reach a certain depth, collapse. Each of the large sets is driven by a Pelton wheel, running at 450 revs. per min. Careful tests gave efficiencies at 68·85, 61·50 and 64·51 per cent. respectively.

The wheels are provided with Lombard water wheel governors and are governed entirely by deflecting the nozzle away from the wheel, as it would be out of the question to govern by throttling under such a high pressure. Needle nozzles are also provided, by which the size of the stream can be varied by hand. It is the practice to adjust the needle valve so that the governor on one of the generators will be inactive. This generator will work along on a constant load, allowing the other to do the governing and take the fluctuations. This is found more satisfactory than letting both governors do the regulating. In dealing with a long, high pressure pipe line it is of great importance to make it impossible for an excited attendant to close a valve suddenly, as such closing would wreck the pipe. The gate valve controlling the flow of water to each of these wheels is operated by an electric motor. The motor is geared by a worm to the valve stem. The gear can be thrown in and out by means of a handle on the hub of the large hand wheel. This motor is operated at 125 volts direct current from the exciter circuit. When operating at full speed, it requires 25 minutes to close the valve when it is completely opened. The needle nozzles are also equipped with hand wheels, by which it is impossible for the attendant to close the needle valve rapidly. The pipe line is therefore well insured against shocks due to sudden stoppage of the column of water.

The three General Electric generators which are connected to these water wheels are rated at 750 kw. each. They give 6,600 volt three-phase 60 cycle currents. They will carry full load for 24 hours without attaining a temperature in any part of more than 35°C. above the surrounding air, and an overload of 25 per cent. for 10 hours, and 50 per cent. for two hours within the temperature limits. Their efficiencies are 94·5 per cent. at full load, 93·5 per cent. at three-quarter load and 91 per cent. at one half load. The drop in voltage between no load and full load on non-inductive load, without change in field excitation, or speed, is 5 per cent. Working at rated current capacity with 80 per cent. power factor, this drop in voltage between full current and no load is 20 per cent. There are two 45 kw. 125 volt exciters, direct-connected to small Doble water wheels running at 975 revs. per min.

The switchboard is placed on a raised concrete platform. A special type of oil switch is used, designed by Mr. G. A. Taff, the company's engineer, and made on the premises. These switches are all placed under the board and are operated with compressed air by means of the small handles seen on the switchboard table. Along the bottom of the board are disconnecting plugs, by which the oil switches can be disconnected from the high-tension circuits when the switches are to be cleaned or repaired. The compressed air cylinder and piston for operating these switches are mounted at the bottom of the switch, and the same casting serves both for the switch casing and the compressed air cylinder. Compressed air for operating these switches is supplied by a storage air tank kept filled by a Christensen motor-driven compressor with motor operated off the exciter circuit. The air valves used in operating the switches are the ordinary Christensen air-brake motorman's valves. The upper part of the switch casing is filled with oil and has a wood-fibre lining. The switches have main contacts to carry the current and auxiliary contacts upon which the arc is broken. These auxiliary contacts have an open circuit clearance of $3\frac{5}{8}$ in. The insulating material used is kiln-dried maple wood treated by boiling in paraffin from eight to nine hours until no more effervescence appears on the surface of the liquid.

The middle of the switchboard is given over to feeders, each switch handle representing one feeder. Just above the switch handle is a set of pilot lamps, one pair showing red and the other blue. The Pike's Peak Hydro-electric plant, while an expensive one to build in some respects, is a very cheap one to operate. The regular force consists of six men to operate the power house, make small repairs and patrol the pipe lines.

CONCERNING THE TEMPERATURE OF THE NERNST LAMP.*

BY LEON W. HARTMAN.

The early determinations of the temperature of the incandescent glower of the Nernst lamp gave values which were undoubtedly much too high. These determinations were based on the law of the radiation from a black body. To this class of radiators, however, the Nernst glower does not belong; so that if the glower emits selective radiation as compared with the radiation from a black body, its measured black-body temperature might be much above its actual temperature. This is the case; hence the higher values of its temperature, as found by the early investigators, is explained.

If one avails himself of existing data and methods and applies the data and curves of Angström† to the data of the writer, already published,‡ a value of the temperature much lower than that cited by Lummer and Pringsheim § will be obtained. This discrepancy then makes a determination of the temperature of the incandescent glower by direct measurement very desirable.

When the data for the energy losses from incandescent platinum wires in air had been obtained,‖ an effort was made by the writer to utilise the same method for determining the temperature of the incandescent glower of the Nernst lamp. Briefly stated, this method was as follows: The candle power per unit length for varying power supply was first determined with a number of Nernst glowers. In front of an iridium furnace containing a piece of magnesium oxide, was then mounted a frame for the glowers, in series with which was a suitable regulating rheostat. When the furnace was heated, the magnesium within was heated up to incandescence. Each glower in turn was then mounted on the frame and heated by a current until its colour, as seen against the magnesium oxide as a background, seemed as near the colour of the latter as it was possible to get it. Noting the power supply, the candle-power per centimeter length could be determined from the plotted curves of the first set of observations. As soon as the power supplied was determined, the temperature of the interior of the furnace—*i.e.*, the temperature of the magnesium oxide, was measured by means of a Wanner pyrometer. Some of the data thus obtained are given in the following table:—

Table I.—*Measured Energy Supplied.*

No.	Amp.	Volts.	Watts.	$\frac{\text{Watts}}{\text{cm.}}$	Temp. (abs.).	$\frac{\text{Watts.}}{\text{cm.}}$	C.P.	$\frac{\text{C.P.}}{\text{mm.}^2}$
I.	0·148	173	25·6	16·3	2,360°	1·79	14·8	3·25
II.	0·410	182	74·6	36·1	2,360°	1·83	42·0	3·29
III.	0·846	175	148·0	52·9	2,360°	1·75	86·8	3·22
IV.	0 810	103	83·5	59·6	1,800°	1·90	47·0	3·36

In obtaining these data the writer had the co-operation and assistance of Prof. Nernst and one of his assistants, but at that time some doubt arose as to the accuracy of the temperature determinations thus made, and they have not been published hitherto. The writer has since decided to make some independent temperature measurements following an entirely different method, the details of which are given below.

When Prof. E. L. Nichols made his observations for the determination of the temperature of the acetylene flame,¶ it was the writer's privilege to assist in a small way. It seemed probable, therefore, that the same method used in those former measurements might be used to good advantage in determining the actual temperature of the incandescent glower when the latter was carrying a given constant load. Three specimens of the same platinum and platinum-rhodium wire used in the determinations just mentioned were therefore taken, pulled down to suitable size, and made into thermo-elements. After a 110-volt glower with its ballast had been mounted on a suitable frame, and connected in series with an adjustable rheostat, a current of 0·80 amperes—its rated normal load—was passed through the glower. The junction of the thermo-element was then moved slowly up to the incandescent glower. To the writer's surprise the junction could be brought in contact with the glower without melting or being otherwise visibly changed. This was true of the smallest junction used—the radius of which was 0·00360 cm. The only conclusion to be drawn was that the temperature of the incandescent glower was much lower than the early measurements indicated. The radii of the three junctions used were as follows: No. I. had a radius of 0·00592 cm.; No. II. of 0·00493 cm.; No. III. of 0·00360 cm.

The thermo E.M.F.s generated in these three thermo-elements were then measured on the potentiometer—the junction of the thermo element being meantime in contact with the glower. From a curve, plotted from the values given by Kohlrausch,* the temperature corresponding to each E.M.F. was then read and a curve was plotted with corresponding temperatures as ordinates and cross-sections of the wires as abscissæ. In order to eliminate conduction, this curve was extended back until it intersected the axis of ordinates. Thus one eliminated the conduction of the thermo-elements, and obtained at the intersection of the curve with the axis of ordinates the value of the temperature that would be measured with a wire of zero cross-section. The values obtained from a series of measurements on a half-dozen different glowers gave results varying from 1,780 to 1,800 deg. absolute, as is shown by the following table:—

Table II.—*Temperatures of Various Glowers as Measured with the Three Thermo-elements.*

Glower.	Temperatures for elements.			Exterpolated value.
	No. I.	No. II.	No. III.	
I.	1,223°	1,407°	1,487°	1,505°C.
II.	1,220°	1,430°	1,500°	1,515°C.
III.	1,270°	1,425°	1,520°	1,530°C.
IV.	1,230°	1,385°	1,495°	1.535°C.
V.	1,145°	1,320°	1,460°	1,510°C.
VI.	1,150°	1,330° (?)	1,480°	1,515°C.

Mean value .. 1,791°C. abs.

In some cases the glower was heated by direct current; in others by alternating current. Sometimes the glower was in the plane formed by the two wires of the thermo-junction; sometimes the glower was at right angles to the plane including the two wires. In all cases the glower was horizontal. The mean of all these measurements gives a temperature of 1,791 deg. absolute.

After making these measurements, in order to make sure that the character of the wires of the thermo-elements had not been changed by contact with the hot oxides constituting the glower, the junctions were used to measure the temperature of various parts of the luminous cone of the Bunsen flame. Values concordant with those obtained by Waggoner† were obtained. Although under a microscope the wires did not present a perfectly smooth appearance like that of a newly-drawn wire, yet the tests to which the junctions were subjected made it seem probable that the thermo-junctions used measured the true temperature of the Bunsen flame and of the glowers as accurately as one could expect, considering that there was more or less unavoidable change in the value of the current passing through the glower.

Table III. (*Computed*).—*Watts per Centimetre Length Required by Black Bodies for the Absolute Temperatures Indicated Below.*

No.	Thickness.	1,700°	1,800°	1,900°	2,000°	2,100°	2,200°
		Watts per centimetre.					
I.	0·0290 cm.	4·10	5·11	6·35	7·81	9·50	11·44
II.	0·0618 ,,	8·67	10·91	13·54	16·62	20·20	24·33
III.	0·0964 ,,	13·50	17·00	21·10	26·87	31·50	37·90
IV.	0·1000 ,,	14·10	17·60	22·00	27·00	32·70	..

Some comparisons will now prove of interest. It will be instructive to compare the actual energy supplied to the glower when it is heated to a given temperature, with the energy required to produce the same temperature in a black body of the same dimensions as the Nernst glower. The computed data for the black body are given in Table III. For the absolute temperatures indicated in this table, the energy per centimetre length required by a black body of the same cross-section as the Nernst glower is given. In Table I. data showing the energy supplied to four different glowers are given. The first three are German glowers and the accompanying data were obtained by the method first mentioned above, using the Wanner pyrometer and the iridium furnace to determine the temperature of the glower. The last case, glower No. IV., is one of the American glowers, in which case the temperature of the glower was measured by means of the thermo-element. Glowers Nos. III. and IV. of this table are so similar that a comparison is possible. For example, the current strength in the two cases, the watts per centimetre length, the energy per square millimetre, and the candle-power per square millimetre, are all of such a relative magnitude as to be comparable. In case of glower No. III., whose temperature was determined by the pyrometer, the temperature was found to be 2,300 deg. absolute. Judging from the candle-power per square millimetre, glower No. IV. should be considerably hotter than glower No. III., but with the glower first mentioned the thermo-element showed a temperature of 1,800 deg. absolute. Evidently, therefore, the method used to measure the temperature of No. III. gave values much too high. In other words, the laws of Wien and Paschen do not apply to the Nernst glower, because it is not a black body, but, on the contrary, shows selective radiation when compared with the radiation from the latter. These laws cannot be used, therefore, with the constants now available for a black body, in order to determine the temperature of the Nernst glower.

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* From the *Phys. Rev.*, XXII., p. 351, June, 1906.

† Angström, *Phys. Rev.*, XVII., p. 302, 1903.

‡ Hartman, *Phys. Rev.*, XVII., p. 65, 1903.

§ Lummer and Pringsheim, *Verhd. d. Deutsch. Ges.*, III., p. 36, 1901.

‖ Hartman, *Phys. Zeitschr.*, V., p. 579, 1904.

¶ Nichols, *Phys. Rev.*, X., p. 234, 1900.

* Kohlrausch, *Praktische Physik*, p. 157, 1901, 9th edition.

† Waggoner, *Wied. Ann.*, LVIII., p. 579, 1896.

If now we compute the energy lost by glowers, Nos. I., II. and III., assuming for the time being that the black body law is followed and that the temperature obtained from measurements based on that law are correct, we find the watts lost per centimetre length to be relatively very small, as is shown by the first part of Table IV., and the percentage loss to be very small, ranging from 5 to 7 per cent. On the other hand, if we take the temperature obtained by the thermo-element method as the correct temperature of the glower, and then find the energy required to heat a black body of the same dimensions as the glower to the absolute temperature of 1,800 deg., we find a relative large loss—viz., 42 watts, or a percentage at 1,800 deg. absolute of 70·5 per cent.

The advantage from a commercial standpoint of rating the temperature of the Nernst glower above its actual value, is shown very clearly by these figures. From these considerations, it seems quite evident that the economic superiority of the glower over that of a black body is not so great as has been claimed for it. That it is far from being a black body, as has long been known, is also strikingly emphasised. That its true temperature has been placed too high is conclusive. Temperature measurements on the glower based on its radiating power or its photometric qualities, are alike apt to give values which are much too high.

Table IV.—*Watts per Centimetre Length Lost into the Air due to Conduction, Convection, &c.*

No.	Absolute temps.	Watts lost.	Per cent. watts lost.
I.	2,360°	1·01	6·2
II.	2,360°	4·79	7·6
III.	2,360°	2·61	5·2
IV.	1,800°	42 00	70·5

COHERER ACTION*

BY PIERRE WEISS.

Recent work on this subject is mainly concerned with the "critical tension" (Fisch, Guthe and Trowbridge), the effect of strong currents (Schneider), and the diffusion of ions through the surface layers (Blanc).

The critical tension is the E.M.F. of the horizontal portion of the volt-ampere curve. Over this horizontal portion the resistance decreases with increasing current, so that the curve is characteristic of the coherer action. Fisch obtained the following values of the critical tension between iron terminals plunged in different dielectrics :—

Air	0·22 volts	Water	0·20 volts
Petroleum	0·22 ,,	Paraffin oil	0·29 ,,
Terebenthine	0·21 ,,	Glycerine	0·78 ,,
Alcohol	0·205 ,,		

The figures show that the dielectric does not play any decisive part unless it is highly viscous. This corroborates Blanc's ionic theory of coherer action.

Schneider's work on the same question brings out an analogy between coherer action and the electric arc. The resistance, according to him, decreases by the fusion of the projecting points of the elements or terminals of the coherer. Thus the resistance falls as the current increases, just as in the arc the resistance falls by the widening of the crater at higher current intensities. The volt-ampere curve has a horizontal portion in iron and aluminium only. In platinum, gold, silver, tin, zinc, lead and nickel the corresponding portion ascends gently, while in magnetite it descends.

An increase of initial pressure increases the area of contact. It therefore requires a greater current to bring about the welding and the consequent coherer action.

If the contact is between the flat ends of rods, the heat conducted away will increase with their diameter. Hence the variation of resistance will be greatest in thin rods.

Both these conclusions are supported by experiment.

The weak point in Schneider's experiments lies in the fact that the pressures applied are of a much higher order of magnitude than those occurring in the coherer. As the author remarks : "We might ask ourselves whether he has not, in his laboratory experiments, imitated the electric welding of rails rather than the coherer."

Blanc's† method is free from this objection. The fine polish of the contact surfaces, together with his Newton-ring method of measurement, enabled him to follow the discharges down to molecular intervals, and to prove that discharge as a rule did not set in before actual contact took place. It then appeared that incident waves have the effect of facilitating the diffusion of ions across the surface layers of the metals, just as ultra-violet light liberates electrons from negatively charged bodies.

The author inclines to the view that both these actions, welding and diffusion, are at work in the coherer. That welding is effective is shown by the practical experience that elements or terminals with sharp edges are more effective than those with blunt or polished ends.

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* Abstract from the *Journal de Physique*, V., pp. 462-467, 1906.

† *The Electrician*, LVI., p. 263, 1905.

THEORY OF THE SINGING ARC.*

BY H. T. SIMON.

Elihu Thomson,† Duddell‡ and Peukert§ have shown that a continuous current between homogeneous carbons is capable of maintaining constant undamped oscillations in a parallel system consisting of an inductance and a capacity. The physical part played by the arc is to bring it about that the loss of energy in the vibrating circuit produced by resistance, &c., is automatically made good by the arc circuit. Thus the damped oscillation is converted into a continuous undamped oscillation, just as the vibration of an organ pipe, damped by itself, is made permanent by the blowing mechanism, or that of a violin string by the motion of the bow. The singing arc behaves as if it had a negative resistance, or as if it developed an E.M.F. proportional to the current i_2 in the vibrating circuit. This E.M.F. may be put equal to ci_2, so that its energy ci_2^2 compensates the losses i_2^2w of joulean heat. The main current must be kept steady, and this is possible in practice within reasonable limits.

Generally speaking, a conductor capable of maintaining vibrations in a parallel circuit must increase its P.D. with decreasing current, and diminish it with increasing current. In other words, every conductor with a "falling characteristic" is capable of maintaining continuous oscillations in a parallel system capable of vibration. This law was enunciated by Simon and Reich in 19 2.

But this general law leaves several details unaccounted for. Thus it is known that none but homogeneous carbons make a singing arc, though cored carbons also have falling characteristics. The frequency n depends upon C_2 and L_2 of the vibrating circuit, in accordance with the approximate law

$$n = \frac{1}{2\pi\sqrt{L_2C_2}},$$

but increases with the main current and decreases with increasing length of arc. The limit of n lies at about 40,000, but in wireless telegraphy it is specially important to be able to produce undamped oscillations of very high frequencies.

All the details may, however, be accounted for on the basis of the author's theory of the arc,‖ which takes the hysteresis of the arc into account. The "dynamical" characteristic of the arc—*i.e.*, the characteristic shown with an alternating current—is different from the "static" characteristic obtained with a continuous current. The alternate current characteristic shows smaller potentials with a falling current than with a rising current, and this phenomenon the author calls the hysteresis of the arc.

The process takes place as follows: After the current i_2 in the shunt has passed through its minimum, and the arc current i_1 through its maximum, the arc current rapidly diminishes, since the shunt takes up the current supply and uses it for charging up its capacity. Since the negative crater only slowly loses the white heat of the maximum current, it allows of the emission of electrons in considerable quantities even when the current is diminishing. The conductivity of the arc therefore remains high, and the fall of potential in the arc remains small. Gradually, when the shunt current has passed through its maximum, the supply of current to the arc rises again. But, meanwhile, the crater has cooled down, and the conductivity of the arc has degenerated. The same current strength of the increasing current therefore experiences a greater fall of potential than the decreasing current. The arc P.D. rises until the impulse imparted to the electrons by the potential gradient suffices to enable them to ionise the gas by ionic shock, after which the current increases rapidly and the cathode is again brought to a white heat.

The author determined a number of characteristics with the oscillograph, and found that they are mainly of the rising kind when the arc sings.

These oscillograph records also show that the smaller the continuous current of the supply, the greater is the amplitude of the oscillations. The longer the arc the better it is able to produce oscillations, and the longer is their period. The author's theory assumes that the product TF of the temperature T and the surface F of the crater determines the fall of potential produced by a given current in an arc. This product is connected with the heat proportional to ei by the constant W, thus:—

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* Abstract from the *Physikalische Zeitschrift*, pp. 433-445, July 1st, 1906.

† *The Electrician*, XLVI., p. 477, 1901.

‡ *The Electrician*, XLVI., pp. 269 and 310, 1900.

§ *Elektrotechnische Zeitschrift*, XXII., p. 467, 1901.

‖ *Physikalische Zeitschrift*, 6, p. 297, 1905.

$$ei = W\,(TF)$$

where W is the heat conducted away per second and per unit TF.

In alternate-current circuits, the equation becomes

$$ei = W(TF) + L\frac{d(TF)}{dt}.$$

From these equations the static and dynamic characteristics may be plotted. For the former, the Ayrton equation

$$ei = 40 + 46i$$

may be used in the case of an arc of 1 mm. between solid carbons. It may thus be shown from theory that (1) the singing starts below a certain current strength (say 3 amperes), where the characteristic is decidedly of the "falling" type; (2) with increasing frequency, the falling characteristic becomes more and more of the rising type, so that eventually the note must cease.

With increasing length of arc the static characteristics wander to higher potentials, as shown by Mrs. Ayrton, and this increases the production of notes. But a long arc stands a diminution of its current less well than a short arc, and hence the long arc is more easily extinguished. It is better to employ several successive arcs. This allows an increase of potential gradient without cancelling it by an increased arc resistance. This is therefore the same principle as that of successive sparks applied by F. Braun in wireless telegraphy.

The author sums up as follows with regard to the generation of high-frequency oscillations for wireless telegraphy and telephony:—

"The exciting arc must be generated with a sufficiently small current—*i.e.*, with a high P.D. It must be produced by means of an arc possessing a static characteristic of high gradient and a high value of W/L. Suitable substances are especially to be found among the metals on account of their high thermal conductivity. But in the carbon arc, too, everything that increases W must also increase the frequency of the vibrations. Among such agencies may be mentioned a strong cooling of the electrodes and burning of the arc in a gas of high thermal conductivity, such as hydrogen.

ON THE ORIGIN AND WAVE-FORM OF THE HARMONICS PRODUCED BY THE ARMATURE TEETH OF ALTERNATORS.*

BY DR. K. SIMONS.

It is well known that the magnetic flux proceeding from the field poles of an alternator does not remain constant if the pole-shoe does not cover equal numbers of teeth and slots, and that the fluctuations are the greater the smaller the number of slots. Corresponding to these fluctuations of the main flux there are induced in the armature coils E.M.F.s whose frequency corresponds to the number of teeth, and is thus an *even* multiple of the fundamental frequency. Now, since in the ordinary harmonic analysis of an alternator E.M.F. wave the positive and negative half-waves are assumed to be symmetrical—*i.e.*, not to contain any harmonics of *even* order, it would appear at first sight as if the ordinary methods of harmonic analysis took no account whatever of the harmonics called into play by the armature teeth.

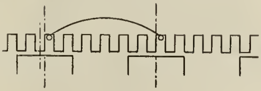

Fig. 1.

The nature of these harmonics may be rendered clear by considering two typical cases: (1) That in which the pole-shoe covers equal numbers of teeth and slots (Fig. 1); and (2) that in which the number of teeth under cover of a pole-shoe is greater or less by unity than the number of slots (Fig. 2), the width of tooth being in each case supposed to be equal to the width of slot.

It will be clear that if a radius be drawn which is the line of symmetry for the flux proceeding from the pole-shoe,† and if the position of this radius be examined relatively to the line bisecting the pole-piece, then in case (1) the line of symmetry of the field oscillates to and fro about the line of symmetry of the pole-piece, while in case (2) the angular velocities of the two lines are the same. On the other hand, while in case (1) the total flux remains constant, in (2) it pulsates with a frequency proportional to the number of teeth. Thus, in case (1), harmonics arise on account of the oscillation of a flux of constant magnitude, while in (2) they are produced by fluctuations in magnitude of a flux whose velocity remains constant.

The following peculiarities are characteristic of the two cases. In case (1), the total flux remaining constant, it is evident that no harmonics will be induced in a coil by the swaying of the flux so long as the sides of the coil are in the interpolar space. As soon, however, as they come under cover of the pole-pieces, ripples in the E.M.F. wave will appear. By drawing a series of diagrams showing relative positions of coil and pole, it is easy to show that the number of complete waves of E.M.F. induced in a coil during the passage of a pole past it is $n_p - \frac{1}{2}$, where n_p is the number of teeth or slots covered by a pole-shoe. During that part of the motion when the pole is completely embraced by the coil the ripples cease. Hence the nature of the ripples due to the teeth is in this case as shown by Fig. 3, and it will be noticed that there is a discontinuity in the ripples.

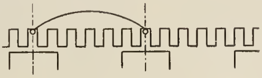

Fig. 2.

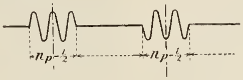

Fig. 3.

Considering next case (2), it is evident that the pulsation of the flux will continue to induce E.M.F.s in the coil for all positions of the latter. By drawing a series of diagrams as before, corresponding to various positions of the coil relatively to the pole-piece, it will be found that the ripples are of the nature show in Fig. 4, and that they exhibit a periodic discontinuity of phase.

It will now be seen that owing to the discontinuities which occur in the ripples the positive and negative half-waves of total E.M.F. will be identical, in spite of the fact that the frequency of any train of ripples is an even multiple of the fundamental frequency.

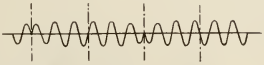

Fig. 4.

In any actual case, the exact nature of the ripples will in general be determined by a superposition of the two cases considered, and will be further modified by the existence of a magnetic fringe, and the ratio of width of tooth to width of slot.

By the use of condensers of suitable capacity, the ripples may be shown greatly exaggerated in the current wave, and the existence of a discontinuity of phase clearly established. The author has succeeded in obtaining oscillograms of this nature.

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*Abstracted from the *Elektrotechnische Zeitschrift*, p. 631, July 5, 1906.

† The alternator is supposed to be running on open circuit, so that there is no distortion of the field.

Extra High-Tension Transmission System.—With reference to the note on page 543 of our last issue, in which we quoted from the *Elektrotechnischer Anzeiger*, that the first European power transmission to employ 40,000 volts is that in Italy—from Gromo, on the River Serio, to Nembro, a distance of 20 miles—Mr. G. Wüthrich, the London representative of the Maschinenfabrik Oerlikon, writes that this is not quite correct. He points out that the transmission system from Caffaro to Brescia, 35 miles long and built by his company, claims this position. Here the 2,340 kw. generators are driven by water turbines working under an effective head of about 800 ft. Three-phase current is generated at 9,000 volts, and is stepped up to 40,000 volts. At the other end of the line the pressure is 36,000 volts, where it is stepped down to 3,600 volts for power purposes. The generating station in Caffaro and the transformer station at Brescia are built upon the Oerlikon cellular system. At Brescia there are also four motor generators, each consisting of a 600 B.H.P. three-phase asynchronous motor and a 450 kw. generator, which supply continuous current at 150 volts to the sodium factories there. A further 2,340 kw generating and transforming set will shortly be added to the main plant.

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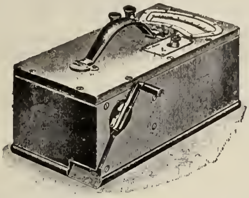

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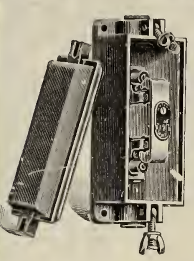

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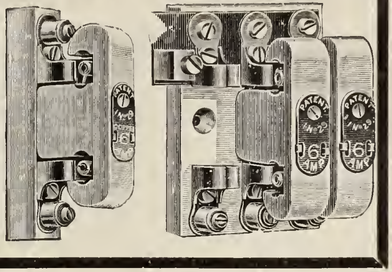

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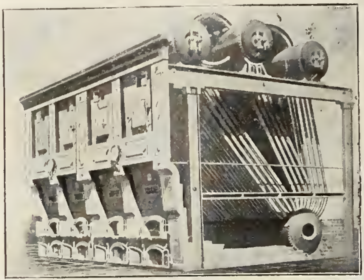

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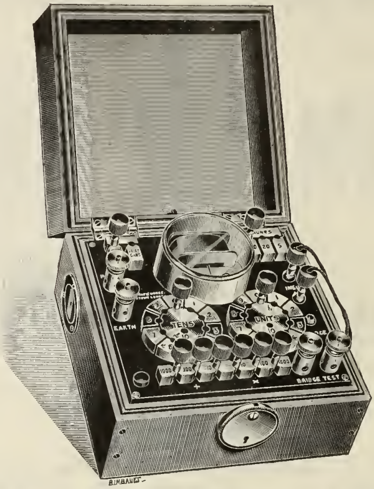

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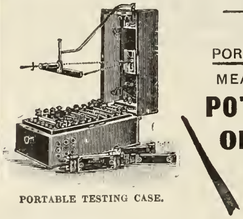

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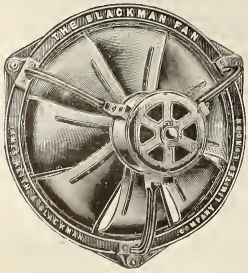

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may be filled. Indeed, it is far better for such matters to be kept out of the election field altogether, for they are only too apt to become identified with party politics, and once that is the case the good of the public or the success of the undertaking becomes of quite secondary importance.

There are both advantages and disadvantages in the financial position of a local authority. Money can be borrowed on favourable terms because the rates are the security. On the other hand, interest and sinking fund must be paid from the time the loan is raised, and this means 6 or 7 per cent., or possibly more, per annum upon the capital expended. It is sometimes regarded as an advantage to have the period of repayment as long as possible, and no doubt for the initial years of the undertaking this is so; but in that case the sum set aside annually for depreciation should be greater. If that is not done, the longer term for repayment may prove a positive disadvantage. It is, moreover, necessary to remember that plant cannot be removed unless that part of the loan allocated to it has been completely repaid. Thus, if some plant, for which the loan is repayable in, say, 25 years, becomes antiquated in, say, 10 years, it cannot be replaced unless the loan relating to it is fully repaid. To repay the outstanding loan may be exceedingly inconvenient, and thus the running of unsuitable plant may be continued as the less of two evils. Nor is it easy to remedy the matter by raising a loan for new plant, because if old plant is to be removed to make way for the new, the new loan will be reduced by the Local Government Board to the extent of the loan still outstanding on the old plant. It therefore becomes necessary for a municipal undertaking to earn at least 8 or 9 per cent. net profit on the capital expended.

The financial working of a company, on the other hand, is more elastic. The interest expected on capital is higher than that which a local authority need pay; but as there is no specified term for repayment, the rate of interest may be lower than the combined interest and sinking fund that is paid on a municipal undertaking. During the first few years, before the paying stage is reached, the ordinary shareholders may be content to receive but a small return on their money in the hope that a higher dividend will come later. But when it does come, then the municipal councillor is apt to consider that the ratepayer is suffering, and that a mine of wealth has been allowed to escape which ought to be giving great relief to the rates.

This idea of relief, however, is a fallacy, for it is assumed that the financial basis and the management will be the same in either case. The engineering may be identical, but the financial basis will be different and the management will be amateur, with the result that the undertaking is likely to show less profit, and the amount available for the relief of rates is likely to be zero and possibly negative. There are, no doubt, exceptions; but supposing a surplus to result, we then come to the question whether it should be used for the relief of rates, or whether a lower charge should be made to the public, or facilities be extended to areas which are not in themselves remunerative. This becomes a difficult question because it involves two classes of the public, namely the class which contributes but little, or only indirectly, to the rates and is desirous of cheap facilities, and the class that contributes heavily to the rates. Since there is an increasing tendency to identify the public with that part only which contributes but little to the rates, the genuine ratepayer is not likely to get much relief, though he would be called upon to meet any deficit that arose. But there is a further difficulty in the fact that municipal accounts are generally involved. If, for example, there is street lighting, the financial result of the electricity works may depend very much on the charge made to the ratepayers for electric energy for that purpose: if the charge is high there may be a surplus for the relief of rates, but the ratepayers are not materially benefited.

In favour of such municipal undertakings as tramways a good deal may be said, but there seems to be some danger of what may be termed municipal trading pure and simple being now introduced. Municipal wiring may be the thin end of the wedge. In themselves, municipal monopolies are not very desirable, for there may be a tendency on the part of a local authority to prevent anything in the way of healthy competition. When it comes, however, to competition with the ratepayers in order to save the ratepayers' money, the position becomes not only undesirable, but absurd, and can only do industrial harm. For a private concern to compete against a local authority is a difficult matter, because the latter is always able to fall back on the rates. If prices are cut down so as to benefit another municipal undertaking—for example, if wiring is done at a very low figure so as to obtain a greater load for the municipal electric lighting station—the private contractor cannot compete, for he must meet his establishment charges. The private contractor may, therefore, be driven out and the rates thereby diminished. As another example, suppose a local authority builds its own cars for the tramway system. This gives employment in its own area, but cuts down the trade of a private concern which may or may not be one of its own ratepayers. It may be suggested that the proper remedy is to rate the local authority's undertaking fully: but rating where rates are taken from ratepayers on the one hand to be restored to them on the other hand can only be regarded as fictitious. Progress in the past has been mainly due to private enterprise, and therefore the outlook will not be improved by municipal competition with private concerns which contribute heavily to the rates, nor in fostering the socialist ideal that all private individuals should be civil servants or in municipal employ.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electricity in Homes and Workshops. By S. F. WALKER. (London: Whittaker & Co.) 5s.

This is a new edition of a work with an almost similar title which appeared in 1889, when it was duly reviewed in our columns (*The Electrician*, Vol. XIII., p. 571), and which has, of course, been for the most part re-written. It is intended for that vague class of individual, the "practical man," and in its efforts to descend to the low level of intellect which he is supposed by writers of a certain class to possess, it lapses not infrequently into the unintelligible and even the inaccurate. For example, the following passage occurs in a chapter headed "Glossary of Terms": "*The Volt* is a perfectly measurable quantity, both in its effects and in its inception. It is taken from the attraction or repulsion between two electrically-charged bodies, and consists of a definite multiple of the force exerted by one charged body of a certain size—the gramme—upon another of the same size at a certain distance—the centimetre." We do not suggest that the author is unacquainted with the difference between the physical dimensions of force and potential, but we must protest against such looseness of expression being employed even in straining after the simplicity considered essential to the untrained reader. Nor does the statement, a few lines before, that the volt is used by electrical engineers in the same way that the pound is used by mechanical engineers contribute to greater clearness. The book is profusely illustrated with representations of bells, telephones, lamps, switches and other apparatus with more or less correct descriptions of their use. The work is up-to-date in its illustrations and covers a large field of the applications of electricity.

THE EFFECTIVE RESISTANCE AND INDUCTANCE OF STEEL RAILS.

BY ERNEST WILSON.

Lord Kelvin and Lord Rayleigh have shown* that when a conductor well removed from the return is traversed by an alternate current of such frequency that it is confined to the outermost layers, the effective resistance is equal to the resistance which would be offered to a direct current, when the surface of the conductor is utilised to a depth of $\frac{1}{\sqrt{2\pi\mu kn}}$ cm. In this formula μ is the permeability, k the specific conductivity, and n the frequency multiplied by 2π.

In the following comparison of experimental results with this formula use is made of data obtained with bull-headed railway rails weighing 70lb. per yard, and having a specific resistance of $21{\cdot}5 \times 10^{-6}$ ohms and perimeter 42 cm.† The formula employed is $d = \frac{\text{length} \times \text{specific resistance}}{\text{perimeter} \times \text{effective resistance}}$, d being the required equivalent depth of penetration in centimetres. The maximum force **H** at the surface of the conductor has been calculated from the formula $2\pi X/10p$, where X is the maximum amperes and p the perimeter. Corresponding to these values of **H** the permeability for a piece of steel‡ has been taken, and the average between this and the permeability when $\mathsf{H} = 0$ has been used in the formula. The results are given in Table I.

The agreement is as good as one might expect, seeing that the theory does not account for all the facts, and the permeability was not obtained from the material of the rail itself. Given, however, the perimeter and properties of the steel, it is possible to obtain a fair estimate of the effective resistance for a given total current and frequency.

Table I.—*Comparison of Experimental and Theoretical Results.*

R.M.S. amperes.	Maximum **H**.	Average permeability μ.	Frequency 100.		Frequency 50.		Frequency 27.	
			d.	$\frac{1}{\sqrt{2\pi\mu kn}}$	d.	$\frac{1}{\sqrt{2\pi\mu kn}}$	d.	$\frac{1}{\sqrt{2\pi\mu kn}}$
50	1·06	105	0·158	0·168	0·389	0·237	0·553	0·323
100	2·12	120	0·141	0·157	0·277	0·222	0·363	0·302
150	3·18	145	0·129	0·143	0·210	0·202	0·276	0·275
200	4·24	175	0·107	0·130	0·175	0·184	0·219	0·250

Lord Rayleigh has also shown§ that the self-contained inductance of a strip of unit breadth and length l of the surface of two coaxial cylindrical conductors, one the outgoing and the other the return, their radii being so large that the influence of the curvature on the magnetic force may be neglected is equal to $l\sqrt{\frac{2\pi\mu}{nk}}$ where the distance between the conductors is very small. Taking the same values as before, the results given in Table II. have been arrived at. The agreement is not so good as in the case of the equivalent resistance (Table I.). A correction is due to the ½ in. air space between the rails. The theory would increase the theoretical value by about 10 per cent.

Table II.—*Comparison of Experimental and Theoretical Results.*

R.M.S. amperes.	Frequency 100.		Frequency 50.		Frequency 27.	
	Self-induction in 10^3 C.G.S. Experimental.	$\frac{l}{\text{perimeter}}\sqrt{\frac{2\pi\mu}{nk}}$ in 10^3 C.G.S.	Self-induction in 10^3 C.G.S. Experimental.	$\frac{l}{\text{perimeter}}\sqrt{\frac{2\pi\mu}{nk}}$ in 10^3 C.G.S.	Self-induction in 10^3 C.G.S. Experimental.	$\frac{l}{\text{perimeter}}\sqrt{\frac{2\pi\mu}{nk}}$ in 10^3 C.G.S.
50	19·5	13	25	19	31	25
100	21·0	14	27	20	36	27
150	22·5	16	29	22	41	30
200	24·0	17	31	24	46	33

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* "Gray's Absolute Measurements," Vol. II., Part I., pp. 336 and 341.

† *The Electrician*, Feb. 23, 1906, and July 6, 1906.

‡ *Phil. Trans.*, R.S., Vol. CLXXXIV. (1893), A, p. 995.

§ *Ibid.*

LIVE STEAM-HEATED FEED WATER: ITS EFFECT ON THE OUTPUT AND EFFICIENCY OF STEAM BOILERS.

Mr. G. Wilkinson has sent us the following reply to the discussion on the Paper which he read on the above subject at the eleventh annual convention of the Incorporated Municipal Electrical Association on Friday, June 22nd. The Paper itself was given in *The Electrician*, June 29th, p. 416, and the discussion of the Paper, conjointly with Mr. W. A. Vignoles' Paper on "Efficiency of Steam Plant," was reported on p. 460 of our issue of July 6th:—

I have listened to the discussion upon my Paper with much interest, and before dealing with the questions raised by the various speakers, I wish to correct a false impression entertained by several who have taken part in the discussion. In the section on "Heat Transmission through Boiler Plates" I state that a 30 ft. by 8 ft. 6 in. Lancashire boiler "is deemed to be doing excellent duty when producing 7,000 lb. of steam per hour," this duty is approximately equal to an output of 6½ lb. of steam per square foot of heating surface per hour and a coal consumption of 25 lb. of fuel per hour per square foot of grate area, and this is a generous average duty for such a boiler in regular work under the conditions obtaining in most boiler houses at the present time. I do not state, however, as several speakers imply, that 7,000 lb. is the maximum evaporation obtainable from a Lancashire boiler of the size stated, nor do I regard the output of 12,000 lb. of steam with economiser heated feed as quoted by one speaker as a very high duty. I have obtained 13,500 lb. of steam per hour from this size of boiler with ordinary economiser heated feed, and 14,400 lb. of steam per hour with steam-heated feed water.

As stated in the Paper, the maximum temperature of the steam-heated feed used in the tests was 10°F. below that of the steam, and it is probable that if the last few degrees can be added to the temperature so as to obtain feed water as hot as the steam, an increase in efficiency and output would be obtained much in excess of the pro rata temperature added to the water—*i.e.*, the efficiency and output curves may be expected to rise more rapidly the nearer the feed temperature is to that of the steam. Mr. Shawfield suggested obtaining full steam temperature feed water by using superheated steam: this would probably be an expensive and difficult method, and the writer hopes shortly to obtain absolute steam temperature feed water by employing saturated steam only. The writer begs to thank Mr. Crossland for his suggestions as to the probable cause and cure for the flaming gases in the flues and economiser settings; also his suggested addition of heated air draught would probably substantially increase the output and efficiency of any boiler house plant, but the writer cannot find any system of forced hot air draught which admits of the employment also of automatic stokers, and to abolish the latter in most power houses would entail additional cost in stoking which would more than counterbalance the advantages obtained from the hot-air draught.

Mr. Stromeyer's remarks are astounding, and in some particulars inaccurate. I can only assume that he has not carefully perused the Paper prior to entering into the discussion. I do not claim in any part of the Paper that the output of a boiler which, if producing, say, an average of 6 lb. of steam per hour per square foot of heating surface, can be quadrupled; but in the case of boilers giving as low duty as from 1·5 lb. to 3 lb. of steam per square foot of heating surface, I say that it is possible to replace them with boilers having half the heating surface, and giving double the amount of steam per square foot of such heating surface, and in some cases it might be possible to modify the existing boilers to produce this result.

The first test criticised is No. 2, in which Mr. Stromeyer states the chimney heat works out at 32·5 per cent., which he adds to the 70·8 per cent. combined efficiency of the plant and produces the extraordinary and impossible figure of 103 per cent. The true chimney loss in this example works out as follows:—Theoretical maximum quantity of CO_2 with theoretical minimum quantity of air (viz., about 12 lb.) is 18·9 per cent. The amount of air in this case, making no allowance for air infiltration, is 18·9 (theoretical possible)/8·6 (actual CO^2 of sample) = say 2·2 lb. × 12 lb. of air, or 26·4 lb. of air per pound of coal consumed and the chimney loss per pound of fuel is 27·4 × say 350 deg. × 0·24 = 2,201 B.T.U. The percentage loss with coal of 14,200 B.T.U. per pound is therefore 15·5 per cent. *and not 32·5 per cent. as stated.* Possibly Mr. Stromeyer has taken the temperature of the gases entering the economiser flue in error as the temperature of the gases leaving for the chimney which in this test is not given.

Mr. Stromeyer's fantastic figures have perhaps a comic side, but as meetings such as these, although they may be enlivened by a few pleasantries with advantage, have in the main instruction and useful information for their object, it is perhaps a better use of precious time to adhere reasonably to such objects. Probably my omission to show the "possible" in opening the subject is responsible for some useless talk, and for this I beg to apologise. Coming to the point at once, of seeing where we are in the matter of efficiency, as against the "possible"; if it is admitted that 18 lb. of air is a minimum weight per pound of coal, and 350°F. above the atmosphere is a reasonable minimum temperature of chimney gases which will give any sufficient natural draught as well as being a practical minimum of commercial value in any case, we can soon come at the "possible" and at the same time judge of the "impossible."

Although in our case no test was made for radiation, other sources of information on the point are available, and in the record of a test made by Messrs. Kennedy & Donkin, contained in Mr. Bryan Donkin's admirable book on boiler tests, the item is given for a similar boiler as 7 per cent., which probably in our case, with a three-bank economiser (288 pipes) and a bare side of network, is rather low. We will, however, take this 7 per cent. for the radiation and 3 per cent. for superheat which was what we actually got. These two make 10 per cent. to begin with. Taking the specific heat of the gases at 0·24, and the terminal temperature at 350 deg. above the atmosphere, this would give 84 units of heat per pound of the gases at the chimney, and reckoning 18 lb. of air and 1 lb. of combustible we should have 19 lb. of products at 84 units per pound, thus giving 1,596 units of heat to the chimney. The calorific value of the coal is 14,200 B.T.U. per pound, and 1 per cent. of this would be 142 units.

We have now got 10 per cent. for superheat and radiation and 1596/142 = 11·22 per cent. for heat to the chimney. These quantities make 21·22 per cent. for the lowest possible estimate for quantities of heat outside that contained in the steam, which, according to the foregoing, would contain 78·78 per cent. of the total heat of the coal, and with the superheat would bring the total efficiency possible to 81·78 per cent. The quantity of air taken, however, is much too low for what is necessary to avoid smoke, which was a thing we had to do in our tests, and which in the 20 lb. to 25 lb. per square foot of grate combustions, we did perfectly. We have reason to believe that we used quite 24 lb. of air per pound of coal, as we had, in addition to the steam jet draught, a large quantity of top air in the furnaces. This difference of air would bring up the percentage of heat to the chimney to 14·95 per cent., which would bring down the "possible" efficiency to 78 per cent. all told; and 78 per cent. of 14,200 (calculated value) is about 11,075 units, which, divided by the total heat per pound of steam generated above the feed temperature of 47°F., or 1,177 B.T.U., gives 11,075/1177 = 9·4 lb. of steam per pound of coal as the practical "possible" for the fuel. When it is realised that in the tests we reached 9·218 lb. when burning 22·147 lb. of coal per square foot of grate, which is 98 per cent. of the "possible," it is plain that no more efficient plant of any kind can be hoped for, and no better testimonial to the system can be desired, and this from Lancashire boilers of the plainest type. 98 per cent. of 78 per cent. efficiency gives about 76·4 as the efficiency realised, or about 1·6 below the "possible." A close examination of all abnormally high percentage results as usually published, reveals the fact that the tests on which they are based are at ridiculously low rates of combustion, such as 13 or 14 and down to 8 lb. or 9 lb. of coal per square foot of grate per hour, and nobody in these days of energetic competition desires or can afford to waste plant in any such manner.

Again, taking Mr. Stromeyer's criticism of test No. 4, which he states leaves 28 per cent. for radiation, I may explain that during some high duty tests made shortly before the date of test No. 4 we had one or two slight explosions of gases in the flues which disturbed the brickwork settings and joints, thus greatly increasing the already large infiltration of cold air which seriously cooled the gases before they reached the recording thermometer at the base of the chimney. The temperature of the gases are obviously let down below the "possible" by the infiltration of air, and are, therefore, of no value for reference, but they were put in as they occurred. I regret that this explanation of low terminal temperatures at the chimney inlet was not given in my Paper.

The extended experience which Mr. Boot has had of the advantages of steam heated feed water is valuable testimony as to its advantages, and I am convinced that if he introduced a system of de-æration the feed water would be raised to an increased temperature more nearly equal to that of the steam, and the results would be further improved—especially if, in addition, means were provided for blowing out the deposit as thrown down, and also for delivering the hot feed below the level of the furnaces.

The abnormal size of the economiser used has been commented on—the reason for this is that an economiser was put down large enough to serve for the five large boilers to be installed in this portion of the boiler house, only two of which are at present laid down.

The question of air infiltration through the brickwork settings and joints, damper and economiser, chain openings, &c., is one which has been long neglected, money spent in preventing such leakage would be well spent; special metal casings and covers should be provided for this purpose.

Mr. Kolle's remarks appear to entirely confirm my contention that fire grates and furnaces should be increased in size and that the "tail end" of water-tube boilers should be cut out, the efficiency of the remaining heating surface being thereby increased. This is precisely what the Babcock-Wilcox Company are doing in their latest practice, as Mr. Kolle tells us that in the modern plants at the Paris Metropolitan and Carville stations the boilers have short tubes and large grate areas, thus increasing the evaporation per square foot of heating surface. A continuance of this practice, together with the introduction of steam temperature feed water and hot air draught will ultimately increase the efficiency and output of boiler-house plant to such an extent (with a corresponding reduction in the number and sizes of boilers required for a given output) that less boiler houses will be necessary and a less expensive equipment.

In conclusion, I wish to state that the results presented in my Paper are not intended as final conclusions, my investigations are still proceeding with the valuable aid of the steam draught and coal indicators referred to in the latter part of my Paper, and I hope to be in a position to supplement my Paper at some future time.

[Mr. Wilkinson also calls our attention to a clerical error which occurred in the original Paper. In test No. 5 (p. 420), where the combined efficiency of the plant is put at 79 per cent., the superheat having been added twice to the efficiency of the boiler and economiser, this figure should be 76·4 per cent.

ELECTRIC SMELTING OF CANADIAN IRON ORES.*

BY EUGENE HAANEL, PH.D.

INTRODUCTION.

The only experiments which the members of the Commission appointed by the Government in December, 1903, to investigate the different electro thermic processes for the smelting of iron ores and the making of steel in operation in Europe† were able to witness in the electric smelting of iron ores were those made by Dr. Héroult at La Praz, and Mr. Keller, of Keller, Leleux & Co., at Livet, France. The first was a mere trial, furnishing no reliable quantitative results; the latter more extended experiments, continued for a number of days, were made with a very porous hematite containing 3·21 per cent. of manganese and only 0·02 per cent. of sulphur, an ore, therefore, easily reduced and easily desulphurised. Two sets of experiments were made at Livet. In the first experiment 0·475 E.H.P. years were required per ton of 2,000 lb. of pig iron, corresponding to an output of 5,769 tons per 1,000 E.H.P. days In the second experiment 0·226 E.H.P. years were required per ton of product, corresponding to an output of 12·12 tons per 1,000 E.H.P. days In this experiment, moreover, most of the iron produced was white, for which cold working is required and consequently less energy consumed.

The difference in output of these two experiments was so great, being more than double that of the first in the second experiment, that no conclusion could be drawn as to the amount of energy required per ton of product, and Mr. Harbord, the metallurgist of the Commission, was compelled to adopt 0·350 E.H.P. years, the mean of the two experiments, as the probable energy required per ton of product. This would correspond to an output of 7·827 tons per 1,000 E.H.P. days. Before, therefore, a sound judgment could be formed as to the practicability of the electro-thermic process for the smelting of Canadian ores, it was desirable to establish with some degree of exactitude the amount of electric energy required per ton of product, and also the following important points referring to Canadian conditions, which were either not taken up or were left in doubt by the Livet experiments:—

1st.—Can magnetite, which is our chief ore, and which is to some extent a conductor of electricity, be successfully and economically smelted by the electric process?

2nd.—Can iron ores with comparatively high sulphur content but not containing manganese be made into pig iron of marketable composition?

3rd.—The experiments made at Livet with charcoal as a reducing agent in substitution for coke having failed, could the process be so modified that charcoal, which can be cheaply made from mill refuse and other sources of wood supply useless for other purposes, could be substituted for coke? This is especially important since charcoal and peat coke constitute home products, while coal coke for metallurgical processes requires to be imported into the provinces of Ontario and Quebec.

The settlement of these questions was of such paramount importance for the formation of a judgment as to the feasibility of introducing electric smelting of iron ores as an economic process in those provinces of Canada which lack coal for metallurgical coke, but are abundantly supplied with water powers and iron-ore deposits, that the experimental investigation of the subject by the erection of an electric-smelting plant in Sault Ste. Marie, Ont., was authorised.

DESCRIPTION OF EXPERIMENTAL FURNACE AND ELECTRODE HOLDER.

The furnace, as first designed by Dr. Héroult, consisted of an iron casing $\frac{1}{4}$ in. thick, bolted to a cast-iron plate 48 in. in diameter. This casing was vertically slit to break the magnetic circuit and render the inductance as small as possible. The gap formed by this slit was bridged over by a plate of copper 10 in. wide, which was securely riveted to the iron casing.

The bottom plate, which formed one of the terminals for the current, had iron rods cast in for the purpose of insuring a good contact with the carbon paste rammed in the lower part of the casing to form the crucible.

The casing was made in two parts, the lower part being 3 ft and the upper 4 ft. high.

The electrode holder was made of four copper plates riveted together, and to a steel shoe (*d*) (*see* Figure) into which fitted the electrode (*e*). In this construction the sides of the electrode and electrode holder were flush, which allowed the holder to penetrate the charge without resistance. This was intended to permit of the consumption of the electrode to nearly its full length and obviate the necessity of throwing away from 2 ft. to 3 ft. of unused electrode, which in any other construction would be the case. To keep the contact cool a pipe (*K*) was introduced, by means of which air circulation was effected. It was found, however, that to secure proper contact between the steel shoe and electrode a clamp had to be placed around the shoe, the bolts of which in descending into the charge would have offered resistance to vertical regulation of the electrode. This change in the contact rendered the long copper attachment useless.

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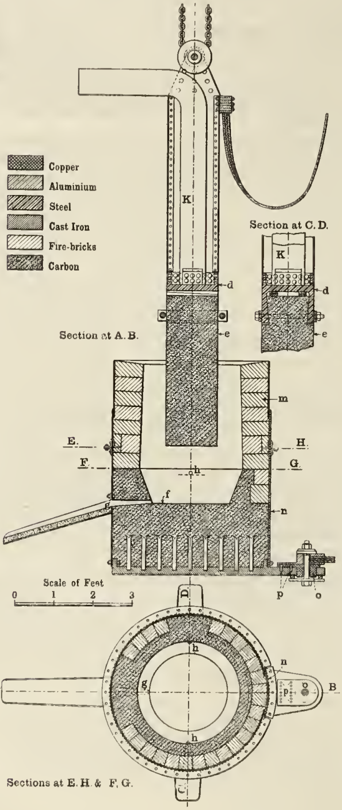
* Preliminary report of the experiments made at Sault Ste. Marie under Government auspices. A Paper read before the Faraday Society on Monday, July 2, 1906.

† Report of the Commission, Department of the Interior, Ottawa, 1904.

To utilise as much of the electrode as possible, the height of the furnace was diminished to dimensions shown in the figure, which represents the final modification of the furnace as used for the majority of the experiments made.

The contact did not prove entirely satisfactory, as there was a constant loss of from 2 to 3 volts, but as this loss could not be remedied during the experiments a bolt was screwed into the electrode and connected to a voltmeter, which allowed of the determination of loss of volts by taking the difference between the volts indicated in main circuit and on the electrode.*



Experimental Electric Furnace.

The contact with the bottom plate was at first made by driving a conical copper plug into a conical hole in the projecting part of the bottom plate and making contact by pressing the aluminium block (holding cables), copper plug and bottom plate together by means of a bolt. Owing to the oxidation of the surfaces in contact, this method of making contact proved inefficient. A new contact was, therefore, made by turning a copper plug from a block of copper 10 in. by 12 in., leaving an oblong flange, which was dressed on both sides to make a good bearing. Two rows of holes (p), (14 in all), of ¾ in. diameter were drilled through the copper flange and into the bottom plate for a depth of about 1 in., into which was run melted aluminium. This aluminium also filled any crevices which existed between the surfaces of contact. The method of connecting cables to copper plug was the same as that described above.

This contact proved to be fairly satisfactory, although a loss of 1 volt or less was realised.

The lining of the furnace was given the shape of a double cone set base to base. Changes in the dimensions of the interior were made from time to time, as indicated by experience, but during the latter part of the experiments they were as follows:—

Diameter of bottom of crucible	24 in.
Height of lower cone	11 ,,
Height of upper cone	33 ,,
Diameter of joint base of the two cones	32 ,,
Diameter at top of furnace	30 ,,

The electrodes, manufactured by the Héroult process and imported from Sweden, were prisms of square cross-section 16 in. by 16 in. by 6 ft. long. The contact with the cables carrying the electric current consisted of a steel shoe riveted to four copper plates which ended in a support for a pulley. The electrode with its contact was supported by a chain passing under the pulley, one end of the chain being fastened to the wall, the other end passing over a winch operated by a worm and worm-wheel. This formed a convenient arrangement for regulating the electrode by hand.

Electrical Machinery.

The electrical energy was furnished by one phase of a three-phase 400 kw. 30 cycle 2,400 volt alternating-current generator coupled by belt to a 300 h.p. 500 volt direct-current motor. A current of 2,200 volts was delivered to an oil-cooled transformer of 225 kw. capacity, designed to furnish current to the furnace at 50 volts. The transformer was placed in a separate room in the furnace building, close to the furnace. From the transformer the current was led to the bottom plate contact of the furnace and to the electrode contact by conductors consisting each of 30 aluminium cables ⅝ in. in diameter.

The measuring instruments consisted of a voltmeter, an ammeter, a power-factor meter and a recording wattmeter. The transformer and electric meters were manufactured by the Westinghouse Electric & Mfg. Co.

An additional voltmeter reading from 10 to 80 volts, supplied by the Keystone Electric Co., which proved very satisfactory, was also placed in circuit to serve as a check.

Experiments.

A number of experiments required to be made to adjust the capacity of the crucible of the furnace to the energy available and to determine the shape to be given to the interior of the furnace to insure easy passage of the charge into the reducing and melting zones. After this, attempts were made to utilise the calorific energy of the carbon monoxide resulting from the reduction of the ore, which in all experiments so far recorded had been wasted. To accomplish this, air under pressure was introduced into the furnace about 12 in. below the upper level of the charge. The carbon of the charge, in the form of coke dust, was mixed with fire clay and briquetted to prevent it from being consumed by the air blast. It was hoped that by thus utilising the carbon monoxide in preheating the charge and partially reducing the ore the output would be materially increased.

It was found, however, that the great heat evolved by the combustion of the carbon monoxide caused the charge to become sticky and to hang. Nor could this be remedied by stoking, the space between the walls of the furnace and the electrode being too narrow. Moreover, the electrode, although it had been protected with asbestos and iron sheeting, was found after the experiment to have been badly corroded. The furnace was not at all adapted for these experiments, and further attempts in this direction were abandoned. The experiments, however, showed that with a differently constructed furnace, in which the electrode is isolated from the charge, the output might be greatly increased by the introduction of an air blast.

The official experiments were begun about the middle of January, the furnace being in operation night and day, with some few intermissions, until March 5. During that time about 150 casts were made, yielding about 55 tons of pig iron.

The following classes of ore were treated:—

1. Hematite (Negaunee).
2. Magnetite from the Wilbur Mine, Ont. (Wm. Caldwell, Esq.).
3. Magnetite from the Blairton Mine, Ont. (Pierce Co., Marmora).
4. Magnetite from the Calabogie Mining Co. (J. G. Campbell, Esq., Perth).
5. Magnetite from the Calabogie Mining Co. (J. G. Campbell, Esq., Perth).
6. Magnetite from the Calabogie Mine (T. B. Caldwell, Esq., Lanark).
7. Roasted pyrrhotite from Lake Superior Corporation.
8. Titaniferous iron ore from Quebec (J. G. Scott, Quebec).

The materials for the charge—ore, flux and carbon—were crushed to pass through a ¾ in. ring and roughly mixed. The composition of the charge in each run, as given in this preliminary report, was slightly modified from time to time by varying the percentage of charcoal and flux.

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* Later an entirely new contact was made, which proved entirely satisfactory.

CHARGING.

In starting the furnace a small quantity of charcoal was placed on the bottom of the crucible and the electrode lowered until an arc was developed between the charcoal and the electrode. The arc was maintained for from 16 to 20 hours to preheat the furnace. The furnace was then filled up with the charge, and by lowering or raising the electrode the current was kept as constant as possible at 5,000 amperes.

In most experiments, when charcoal was used as the reducing agent, the electrode occupied a position of about 16 in. from the bottom of the crucible, and required very little attention.

THE SMELTING OF MAGNETITE.

It was expected that considerable difficulty would be experienced in the smelting of magnetite on account of its conductivity. It was thought that with the furnace in use, in which the electrode was immersed in the charge, the current would disseminate itself laterally from the sides of the electrode through the charge, preventing the current at the reducing and fusion zone from attaining such density as would be required for the high temperature necessary for reduction and fusion. With charcoal as a reducing agent this difficulty was not experienced, nor was the inductance of the furnace increased by the presence of magnetite.

It should, however, be mentioned that the phenomenon of rapid temporary decrease of ohmic resistance of the charge shortly after current is put on, when the charge consists of conductors in the form of small pieces, described by J. Bronn in his article entited "Zur Anwendung lose geschichteter Kleinstückiger Leiter für Elektrische Heizwiederstände,"* was occasionally observed in some of the runs made. This trouble occurred chiefly at the beginning of a new experiment, before the furnace had acquired its normal temperature. By adding a few shovels of iron ore, omitting flux and charcoal, it was sometimes possible to cause the electrode, which, to keep the current constant, had by hand regulation been elevated, to return to its normal position. In a few instances, however, this method failed, and since the electric installation did not permit the compensation of the temporary increase of conductivity of the charge (Bronn's "Anheizungsphase") by decrease of voltage with constancy of current, the electrode rose to the top of the furnace. In such case it became necessary to melt down the charge and start anew.

If the explanation offered by Bronn is correct, that the decrease of the ohmic resistance during the Anheizungsphase is occasioned by the more intimate contact of the conducting pieces of the charge, due to pressure of escaping gases from the pores of the carbon and the carbon dioxide evolved from the limestone, it is evident that preheating the charge, which might be effected by utilising the carbon monoxide resulting from reduction, would entirely overcome this difficulty, and the electrode would maintain its normal position throughout the operation, required to be lowered only to keep step with its consumption.

THE USE OF CHARCOAL AS A REDUCING AGENT.

It was of great importance to ascertain whether charcoal without being briquetted with the ore could be used instead of coal-coke. No difficulty whatever was experienced; in fact, so admirably adapted was charcoal, when crushed to pass a $\frac{3}{4}$ in. ring, as a reducing agent in the electric furnace, that coke and briquettes of coke with clay were abandoned, and all the experiments with magnetite and roasted pyrrhotite described were made with charcoal. Some of the charcoal available was of very poor quality, some of it being little better than charred wood containing only about 56 per cent. of fixed carbon. This, and the fact that a considerable quantity of the charcoal was consumed on top of the furnace, account for the large quantity of charcoal used per ton of product. A modification of the furnace, protecting the upper layer of the charge from the atmosphere, and the use of charcoal properly carbonised, would decrease considerably the amount of charcoal which was actually used in the experiments, and consequently reduce the cost of production as given.

CONSUMPTION OF ELECTRODE.

For the production of 42,711 lb. of pig iron 384 lb. of electrode were consumed, the same electrode having been in commission for 13 days.

Consumption of electrode per ton of pig iron:—

$$\frac{384 \times 2,000}{42,711} = 17{\cdot}98 \text{ lb.}$$

During the time this electrode was in commission the material in the furnace was melted down several times, exposing the red hot electrode to the oxidising atmosphere. The consumption of electrode was found to be greater for white iron than for grey iron, and since the 42,711 lb. of pig iron produced included several casts of white iron, the consumption of electrode was on that account greater than it would have been had only grey iron been produced.

POWER FACTOR.

The power factor of the furnace was determined by Mr. Chas. Darrall, of the Canadian Westinghouse Co. of Hamilton, Ontaria, and was found to be 0·919. This high power factor is due to the construction of the furnace casing, as described above.

Since the true electric power is the apparent electric power multiplied by the power factor, it is evident that any error made in the determination of the power factor which tends to decrease its value will appear to decrease the consumption of energy per ton of product. The large output of 12·12 tons per 1,000 electric horsepower days—*i.e.*, the small amount of electric horse-power absorbed per ton of product in the second Livet experiments—was obtained in a furnace with the abnormally low power factor of 0·564. Whatever doubt may be engendered as to the correctness of the figure obtained for the absorption of electric energy on account of this low power factor of the Keller furnace, such doubt cannot arise regarding the figures obtained with the Héroult furnace for the absorption of electric energy in the Government experiments on account of its remarkably high power factor 0·919.

Moreover, since the cost of alternate-current generators increases with increase of capacity, furnaces with high power factors (which can utilise a high percentage of the capacity of the generators) will be more economical as regards the first cost of the electrical installation of an electric smelting plant than furnaces with low power factors.

MODIFICATION OF EXPERIMENTAL FURNACE FOR COMMERCIAL PRODUCTION OF PIG IRON.

Probably the largest unit which can at present be constructed on the model of the experimental furnace will not exceed 1,500 E.H.P. The construction of the experimental furnace to fit it for the production of pig iron on a commercial scale will require to be modified in the following important particulars:—

1. The top of the furnace requires to be modified to permit of the application of labour-saving machinery for charging.

2. Provision requires to be made for the collection and utilisation of the carbon monoxide produced by the reduction of the ore; this involves also the protection of the charcoal of the charge from combustion on top of the furnace.

The greater capacity insuring less loss of heat by radiation and the modification of the furnace to permit of the utilisation of the carbon monoxide will materially increase the output beyond that ascertained by the experimental furnace. The experiments indicated that under *normal* conditions about 11·5 tons were produced by an expenditure of 1,000 E.H.P. days. (See runs Nos. 8 and 13.) It is, therefore, not unreasonable to assume that under similar conditions with a properly constructed plant the output per 1,000 H.P. days would certainly reach 12 tons. This figure has been adopted in calculating cost of production per ton of pig.

The protection of the charcoal of the charge from combustion on top of the furnace will materially decrease the amount of charcoal necessary for reduction and consequently lessen the cost of this item. This saving has, however, not been taken into account in the estimate of cost.

On account of the value of the product, the smelting of roasted nickeliferous pyrrhotite by the electro-thermic process, as carried out with the Government experimental plant, admits of immediate commercial application without other modification of the furnace than increase of its capacity.

GENERAL REMARKS.

The ores treated, with the exception of the hematite and the roasted pyrrhotite, contained a high percentage of magnesia, producing a very infusible slag. When the furnace had been running for some time this infusible material formed a scale around the crucible, the electric energy available not being sufficient to keep it in a molten condition. The crucible and lower part of the furnace were, therefore, partially filled up, preventing easy access of the charge to the reducing and melting zone. This slower feeding left the charcoal on top of the furnace exposed to the air a longer time, thus increasing the amount of charcoal required and decreasing the output. With a greater current than was available and consequent higher temperature, the formation of the scale would have been prevented and the output correspondingly increased.

The electric installation at our disposal was far from ideal for electric smelting experiments. Aside from the drop of voltage due to the frequent slipping of the belt connecting motor and generator, it was impossible to increase the current beyond 5,000 amperes at from 35 to 40 volts. This inelasticity of the system prevented the determination of the most suitable current and voltage for a given charge in the furnace.

SUMMARY OF THE RESULTS OF THE EXPERIMENTS.

1. Magnetite can be as economically smelted by the electrothermic process as hematite.

2. Ores of high sulphur content not containing manganese can be made into pig iron containing only a few thousandths of a per cent. of sulphur.

3. The silicon content can be varied as required for the class of pig to be produced.

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* *Elektrotechnische Zeitschrift*, 1906 Heft 9.

No. of run.	8.	13.	14.	15 (two runs).	16.	17.	18.
Ore treated	hematite	magnetite from Wilbur Mine.	magnetite from Blairton Mine.	magnetite from Calabogie.	magnetite from Calabogie.	magnetite from Calabogie.	roasted pyrrhotite.
Reducing agent	briquettes.	charcoal.	charcoal.	charcoal & charcoal braise	charcoal.	charcoal.	charcoal.
Flux	limestone.	sand.	limestone & sand.	limestone.	limestone & qu'rtz	limestone & qu'rtz	limestone.
Length of run	12 hours	61 hrs. 25 min.	65 hrs. 30 min.	23 hrs. 50 min. 16 hrs. 15 min.	38 hrs. 20 min.	43 hrs. 5 min.	56hrs.20min
Mean volts on furnace	38·5	35·75	36·03	36·16 35·85	36·5	36·79	36·05
Mean amperes	4,856	5,000	4,987	5,000 5,000	4,993	5,000	5,000
Power factor	0 919	0 919	0·919	0 919 0·919	0·919	0 919	0·919
Pig iron produced	2,665 lb.	12,858 lb.	11,989 lb.	4,520 lb. 2,722 lb.	7,150 lb.	8,303 lb.	7,336 lb.
Output of pig per 1,000 E.H.P. days	11·57 tons	11·41 tons.	9·92 tons.	10 21 tons 9·10 tons	9·97 tons	10 20 tons.	7 038 tons.

4. Charcoal, which can be cheaply produced from mill refuse or wood which could not otherwise be utilised, can be substituted for coke as a reducing agent, without being briquetted with the ore.

5. A ferro-nickel pig can be produced practically free from sulphur and of fine quality from roasted nickeliferous pyrrhotite.

6. The experiment made with a titaniferous iron ore containing 17·82 per cent. of titanic acid permits the conclusion that titaniferous iron ores up to perhaps 5 per cent. titanic acid can be successfully treated by the electric process.

Estimate for a 10,000 H.P. Plant producing 120 Tons of Pig Iron per Day of 24 hours.*

Furnaces, contacts, overhead work	$24,500
Bins, chutes, elevators	14,000
Crushers	4,000
Hoists and regulators	10,500
Instruments	1,400
Cables for conductors	8,400
Building	10,500
Mixer and casting machine	10,000
Travelling crane and tracks	5,000
Ladles	1,500
Slag trucks	3,000
Ore bins	3,000
Repair shop	5,000
	$100,800
Charcoal plant	50,000
Power plant (assuming cost of developing 1 H.P. = $50 00)	500,000
	$650,800
Electrode plant	6,000
Unforeseen expenditure	43,200
	$700,000

Amortisation, 5 per cent.
Depreciation, 5 per cent. } 15 per cent. on $700,000 = $105,000.
Interest 5 per cent.

On a production of 43,200 tons per year of 360 days per ton of pig iron, $2·43.

Cost of Production per Ton Pig Iron.

Ore (55 per cent. metallic iron) at $1·50 per ton	$2·70
Charcoal, ½ ton at $6·00 per ton	3·00
Electric energy, amortisation, &c.	2·43
Labour	1·00
Limestone	0 20
18 lb. of electrode at 2 cents. per lb.	0·36
General expenses	1·00
Total	$10 69

In the report complete chemical analyses are given and the results obtained in a number of runs of which the above table is a summary:

MAGNETISM AND ELASTICITY.†

BY K. HONDA AND T. TERADA.

Since Thomson, in his "Applications of Dynamics to Physics and Chemistry," formulated a theory of the relations between magnetism and the elastic properties of magnetic substances, much theoretical work has been done by Heydweiller, Kolacek, Gans, Sano and others. The chief theoretical relations may be put in the following three equations:—

$$\frac{\delta e}{\delta H}=\frac{\delta I}{\delta T}+\frac{2\pi}{E}\frac{\delta I^2}{\delta H},$$

$$\frac{1}{E^2}\frac{\delta E}{\delta H}=-\frac{\delta^2 I}{\delta T^2},$$

$$\frac{\delta \tau}{\delta H}=\frac{2}{nR^2}\frac{\delta I}{\delta \tau}=s\frac{\delta I}{\delta L},$$

where e is the dilatation, T the stress per unit area, E the modulus of elasticity, τ the torsion per unit length, n the rigidity, R the radius of the wire, L the twist, s the sectional area of the wire, and H and I the magnetic field and the intensity of magnetisation respectively.

The author's latest results show that in Swedish iron and tungsten steel much depends upon the succession of tension or torsion with respect to the magnetic field. This succession effect is specially marked in weak fields, where the hysteresis is strong. The authors have reason to conclude that the influence of succession is altogether due to hysteresis. In nickel, as might be expected, it does not matter so much whether the force is applied before or after magnetisation.

Nickel steel is distinguished by its high susceptibility in weak fields. With weak fields, tension considerably enhances the magnetisation, but not with strong fields. Torsion reduces the magnetisation, except in weak fields. The amount of change varies in proportion to the percentage of nickel. In a specimen containing 50·72 per cent. nickel, the following values were obtained for $\frac{1}{E}\frac{\delta E}{\delta H}\times 10^3$ under a stress of 890 grammes per square millimeter.

H = 5·5	– 2·34	H = 51·4	– 0·12
= 10·7	– 2·80	= 151	– 0·003
= 23·8	– 0 88	= 360	– 0·01

Generally speaking, the agreement between the formulæ and the experimental results may be described as good. For the tension effect, the formula is, on the whole, improved by suppressing the term $\frac{2\pi}{E}\frac{\delta I^2}{\delta H}$. The discrepancies are sometimes considerable, but this may be expected in view of the smallness of the tensions produced by magnetisation and the dependence of the result upon the succession of magnetisation and tension or torsion. The terms introduced by Gans and Sano do not improve the agreement. They were added on the supposition that the lines of induction emerge normally from the terminal surface, which in general is not the case.

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* This estimate is given on the authority of Dr. P. Héroult.

† Abstract from the *Physikalische Zeitschrift*, pp. 465-471, July 1, 1906.

CORRESPONDENCE.

SOME CAUSES OF ERROR IN PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with extreme interest Mr. Wild's article on the above subject in your impression of the 20th. Such contributions to the discussion of practical problems are of great value.

As he mentions the name of my Company, among others, and deals with an error that can arise in measurements made with the "Flicker" photometer, it is necessary to explain the method we adopt to eliminate this error.

In the first place, the Everett-Edgcumbe pattern is almost never supplied alone, but is used in combination with one of our several patterns of street-lighting photometer or with our central-station photometer.

In the former case, the error mentioned is eliminated by graduating the reading scale by direct comparison with another standard lamp and not from "first principles," and in the latter by "double balance."

Mr. Wild is surely in error when, by his method of arranging his article, he suggests that *all* the subsequent sources of error mentioned "are by no means overcome by making a double balance." That due to "Incorrect Alignment of Lights" is fully compensated for, particularly if, as should be the case, the illumination values of the tested light and the standard are not widely different.

It is not necessary to occupy your space with a discussion of the other sources of error, as our instrument is not mentioned in connection with them. It is sufficient to point out that the "view-angle" error is minimised "better still by viewing the disc through a longish tube," and the "side-play" error by a spring clamp.

In general, I agree with Mr. Wild's remarks entirely, with the reservation that the errors that are found are due to the method of using and not to the design of the instruments themselves.

These remarks apply equally, of course, to the "Simmance-Abady" head of Messrs. Alexander Wright & Co.—Yours, &c.,

87, Victoria-street, July 21. G. J. LEMMENS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am obliged to Mr. Lemmens for his criticism of my article, but I must still maintain that errors in photometry due to want of alignment of lights are not eliminated by making a double balance. To take an instance, suppose we are using a Trotter screen with the two surfaces inclined 60deg. to the perpendicular. Let the distance from the lights to the screen be about 30 in. A standard lamp is placed on one carriage of the photometer and a comparison lamp on the other carriage. The lights are balanced. Then the standard lamp is removed and replaced by the first of the lamps required to be tested. Suppose that the filaments of both the standard lamp and that under test are crooked. If the centre of gravity of the one is $\frac{1}{4}$ in. to the left of the photometric axis of the photometer and the other $\frac{1}{4}$ in. to the right of the photometric axis, then the resulting error will be the difference between cosine $59\frac{1}{2}$ and cosine $60\frac{1}{2}$, or about 3 per cent. I maintain that it is impossible to avoid errors of this order of magnitude when ordinary incandescent lamps are being dealt with and the photomoter screen is inclined at the angle mentioned above.—Yours, &c., LANCELOT W. WILD.

PARLIAMENTARY INTELLIGENCE.

ROYAL COMMISSION ON LONDON TRAFFIC.

In answer to Sir John Dickson-Poynder in the House of Commons on Monday,

Sir HENRY CAMPBELL-BANNERMAN said that the Government would require further time for considering the recommendations of the Royal Commission on London Traffic. In view, also, of the transitional state of means of locomotion, the reports of the Royal Commission on Motor Cars and the Select Committee on Cabs might have some bearing and would have to be taken into consideration.

LONG DISTANCE PRIVATE TELEPHONE LINES.

In a printed answer to Mr. A. Williamson in the House of Commons on Tuesday, who complained of the high charges for private telephone lines between London and Liverpool,

Mr. SYDNEY BUXTON (the Postmaster-General) said that owing to the increasing congestion on the routes available for overhead lines between London and Liverpool and other large cities in the United Kingdem, the provision of any considerable number of private telephone wires involved a very large capital expenditure in the rearrangement of the existing telegraph system, in consequence of the establishment of new routes, wayleave difficulties, &c. Consequently he was unable to lower the present charges. He was, however, considering a scheme by which telegraph circuits might be provided on moderate terms, and he would be glad to hear of any cases in which such circuits were likely to be required.

ROYAL ASSENT.

The following bills have received Royal assent: Wireless Telegraphy Bill, North and South Shields Electric Railway Bill, Brixham Gas (Electric Lighting) Bill, Metropolitan District Railway Bill, Nottinghamshire and Derbyshire Tramways Bill, Huddersfield Corporation Bill, North-East London Railway Bill, Cumberland Electricity and Power Gas Bill, Folkestone and District Electricity Supply Bill.

FIRE RISKS ON TUBE RAILWAYS.

In answer to a question put by Mr. WEIR in the House of Commons on Wednesday, having special reference to the Baker Street & Waterloo Railway,

Mr. KEARLEY said that satisfaction had been expressed both by the inspecting officer of the Board of Trade and the chief officer of the London Fire Brigade as to the arrangements for the prevention of fire on the Baker Street & Waterloo Railway. These complied absolutely with the requirements of the Board of Trade, the list of which were issued in 1904. The attention of tube railway companies existing before that date had been called to the regulations in question and attention had been drawn to the necessity of complying with them as far as possible.

MISCELLANEOUS.

Kent Electric Power Bill.—This bill was considered by a Committee of the House of Commons last week, the preamble being found proved. There was very little opposition, the bill containing references to some minor matters affecting the operations of the company.

The Newcastle-on-Tyne Electric Supply Bill and the Wallasey Tramways Bill were read a third time in the House of Commons on Monday.

The West Yorkshire Tramways Bill was read a third time in the House of Commons on Friday last week.

The Southport-Lytham Tramroad (Extension of Time) Bill was read a third time in the House of Commons on Thursday last week.

The South Wales Electrical Power Distribution Bill was read a second time and the Edinburgh Corporation Bill a third time in the House of Lords on Thursday last week.

The Shropshire, Worcestershire and Staffordshire Electric Power Bill was passed by the Unopposed Committee of the House of Commons on Monday. The Bill authorises an extension of area and the raising of additional capital. The full details were given when the measure was under consideration by the House of Lords. (*The Electrician*, May 18 and 25.)

The Lancashire Electric Power Bill was read a second time in the House of Lords on Tuesday.

LEGAL INTELLIGENCE.

Sir Hiram Maxim Elec. & Eng. Co. (Ltd.) v. National Provincial Electricity Corpn. (Ltd.)

In the High Court on Tuesday Mr. Justice Buckley heard this action. It appeared that an agreement was made between the parties whereby the Sir Hiram Maxim Co. agreed to construct for respondents certain machinery, engines, &c., in connection with a scheme for the supply of electricity in Bridgwater, the work to be executed for £13,000. Under the contract plaintiffs were to be liable for various penalties for delays, &c. The agreement further provided that the £13,000 should be satisfied as to the first £4,000 in cash and as to the balance in debentures of a company called the Bridgwater & District Elec. Supply and Traction Co., or in cash at the option of defendants. The dispute arose as to what was actually due to the contractors from the purchasers, and the matter was referred to an arbitrator. The arbitrator directed the purchasers to pay to the trustees or their receiver £1,461. 9s. 8d. balance of purchase money, and the present application was to enforce that award. The point before the Court was as to how that sum should be paid, having regard to the conditions in the contract.

His LORDSHIP held that the proper form of satisfying the award would be for the purchasers (respondents) to hand over to applicants £1,100 in debentures and pay £361. 9s. 8d. in cash. This purchasers had previously offered by letter to applicants, who would therefore have to pay the costs of the summons.

Commissioner of Taxes for New Zealand v. Eastern Extension, Australasia and China Telegraph Co.

On Wednesday the Judicial Committee of the Privy Council (Lords Macnaghten, Davey and Atkinson, Sir Arthur Wilson, Sir Eleazar Taschereau and Sir Alfred Wills) dismissed this appeal from a judgment of the Court of Appeal of New Zealand of Aug. 25, 1904, varying a decision of Mr. Justice Cooper. The respondent company carry on business at Wakapuaka, New Zealand, and various places in Australia and elsewhere, owning and working submarine cables between Wakapuaka to La Perouse, near Sydney (N.S.W.) and from Port Darwin, S. Australia, to Madras, and the business of the company was to transmit telegraphic messages by cable between various parts of the world, and they solicited and received messages in New Zealand addressed to all parts of the world. As the New Zealand Government owns the land telegraph lines in the colony, there was an arrangement between the Government and respondents under which the Government officials received the full charge of 5s. 2d. per word from the sender of the message for sending the telegram to final destination, and thereupon forwarded the message to the respondents' station at Wakapuaka, whence the respondents sent it over their cable to La Perouse, and the telegram was then transmitted over the New South Wales and South Australian land lines to Port Darwin, where the company's officials again took possession of the message and forwarded it by the company's cables. The Government of New Zealand deducted 1d. per word from the total charge for their services, 3d. per word for respondents' charge for forwarding to Australia, and then forwarded the balance to the New South Wales Government, who deducted 1d. per word for their services, forwarding the balance to the South Australian Government, who deducted 7d. per word for their services in sending messages on to the respondents' receiving station at Port Darwin, and handed over what remained (4s. 2d. per word) to the company. In 1902 a dispute arose as to the amount of income tax chargeable to respondents in New Zealand. The Government put the gross sum chargeable for 11 months of 1901 at £24,137 gross and £17,817 net, whereas the respondents said the gross income chargeable was only £10,080. The Government brought an action in 1903 to recover £890. 17s. 6d., alleged to be due for income tax received for 11 months ended March 31, 1901, being at the rate of 1s. in the £. Judge Cooper gave judgment in favour of the New Zealand Government for the full amount, with costs; but on appeal the Court allowed the appeal so far as the tax charged on income derived by the respondent company for transmitting messages beyond La Perouse was concerned, and remitted the case to the Supreme Court to ascertain what income tax was payable in respect of profits made only on telegrams transmitted between Wakapuaka and La Perouse. On the basis of that judgment income tax would be payable by the company on £2,404 only, and appellants appealed to the Privy Council on the ground that the whole of the profits derived by the company in respect of the transmission of telegrams received by them in New Zealand and sent by them from New Zealand were "profits derived from their business in New Zealand" within the meaning of the Land and Income Tax Act, 1900.

The appeal was now dismissed with costs.

Neale v. Electric & Ordnance Accessories Co. (Ltd.).

This case came before the Court of Appeal (the Master of the Rolls and Lords Justices Moulton and Farwell) on Wednesday. The facts were reported in our issues for March 30 and July 6. After hearing legal arguments, their lordships held that, as plaintiff had exercised his option to have compensation assessed under the Act of 1897, and having got the award, which was apparently unimpeachable and properly made, he was barred from pursuing the present appeal, which was accordingly dismissed with costs.

York Electrical Co. (Ltd.) v. Sharp.

At the N.E. Riding (of York) Assizes last week, before Mr. Commissioner Pickford, K.C., and a special jury, plaintiffs sued defendant (a pawnbroker, of York) to recover damages for an alleged libel on plaintiffs' business capacity, contained in an anonymous letter which appeared on Feb. 12th in the "Yorkshire Evening Press," and of which it was alleged defendant was the author. The libel was contained in the following letter:—Dear Sir,—I read with interest the remarks of Mr. Ald. Scott at the last Council meeting *re* the fitting department. I have had work done by several of the electric lighting firms in the city, and also by the Corporation. I have found the workmen of the Corporation very efficient, doing their work in a thorough practical way. Quite a lesson to the electric firms in York, who are the most unbusinesslike and incompetent of any class of tradesmen in the city, and quite behind the times.—Signed, "A Large Consumer of Electric Light."

Plaintiffs alleged that the letter suggested that plaintiffs' conduct of their business was inefficient, incompetent and behindhand in every way; and that they had suffered damage and great injury in character, credit and reputation. Defendant pleaded that the letter did not refer to plaintiffs, that the words did not bear the construction placed upon them, and that, taken in their natural meaning, they were bona fide comment upon a matter of public interest. They also denied that plaintiffs had suffered damage.

Mr. SCOTT FOX, K.C., submitted that the letter reflected on the business competence and ability of (among other people) plaintiffs. No attempt had been made by defendants to say that the allegations were true. When the letter appeared the three electric lighting firms in the city met, and regarding it as a serious reflection on their business, inquiries were made and they accepted the explanation of the editor that the letter was published by an oversight—the editor, or whoever it was, had seen the two first paragraphs, which seemed to be a recommendation of the York Corporation electricity works, and it was said that the latter part, where the libel was contained, was written smaller at the bottom of the letter, and in the haste it escaped observation. The original of the letter was handed by the paper to plaintiffs, and Mr. Wainhouse, managing director of plaintiffs, thought he recognised the hand-writing of defendant, with whom he had had correspondence previously. The authorship was not denied. The three firms affected instructed their solicitor to write and demand an apology, failing which immediate proceedings were to be taken. That letter was not answered till a writ was issued in the April following.

Mr. WAINHOUSE, managing director of plaintiffs, gave particulars of work done for various large firms in York and elsewhere, and also on two occasions for defendant, the latter amounting to about £60. He urged that his firm had suffered considerable damage as a result of the publication of the letter.

By Mr. KEMP: The only work done by witness for defendant since the business was turned into a limited company amounted to 6s. 8d., and some of that related to work done before the formation of the company. He did not know that there were any other firms in the city which did electric work besides his own and Messrs. J. Naylor & Sons and Mr. A. W. House.

Mr. KEMP, K.C., submitted that the words bore a general application, and had no special reference to plaintiffs, who had been unable to point to a single person who had ceased to give them work. Moreover, the next day a recantation by the editor appeared in the paper, stating that in the comment of the writer of the letter they had inadvertently permitted to appear a comment on the competency of the electrical firms, which remarks were unjustifiable, and they added an expression of regret that an unfounded and unwarranted statement should have received publicity.

Mr. SCOTT FOX characterised the attempt of defendant to shelter himself behind the apology of the editor, who was less guilty than himself, as a totally unheard-of proceeding, when defendant did not himself apologise.

In summing up, the learned COMMISSIONER said the only really important question was whether they were satisfied the libel referred to plaintiffs. In regard to damages, they would probably find that the actual damage sustained was visionary. He did not think any actual malice was proved.

The jury found for plaintiffs, with a farthing damages. Judgment accordingly, costs to abide the event.

In a second action by John Naylor & Sons against defendant a similar verdict was agreed to.

Electrical Fittings Co. v. Bryant.

At Bournemouth County Court last week plaintiffs sued Mr. E. G. Bryant, local electrical engineer, for £53. 12s. 11d., due on a bill of exchange in respect of goods supplied.

Defendant counter-claimed for £30 damages for alleged breach of agreement, contending that it was agreed that he should have the sole right of sale of plaintiffs' fittings in Bournemouth and neighbourhood, but the same goods were displayed and sold by a local firm of ironmongers, who were one of his keenest competitors, and in consequence he had suffered loss of sale. Defendant also claimed that the period of credit had not expired.

Plaintiffs pleaded that defendant had only the exclusive sale in Bournemouth proper.

Judgment was given for plaintiffs for £52. 5s. 11d., and for defendant for £1 on the counter-claim.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Acton District Council require an experienced general clerk and commercial assistant in their electricity department. Salary £100, rising by annual increments of £10 to £130 per annum. Form of application, &c., from the resident electrical engineer (Mr. J. Martin Blair), 130, Churchfield-road, Acton, W. Applications to the clerk to the Council (Mr. Wm. Hodson), 242, High-street, Acton, W., by July 30. See an advertisement.

The Council of the University of Leeds invite applications for the appointment of assistant lecturer and demonstrator in electrical engineering, to date from Sept 1. Salary £175. Applications by Aug. 1 to the Registrar, from whom particulars can be obtained. See also an advertisement.

A vacancy occurs for a premium pupil at Whitby District Council's electricity works. Particulars from the electrical engineer, Mr. L. H. King. See an advertisement.

A shift engineer is required at Walsall electricity works. Wages £2 a week, increasing to £2 5s. Applications to the borough electrical engineer (Mr. Alex. Wyllie) by Aug. 3. See an advertisement.

Teachers of electrical engineering and chemistry are required for Keighley Technical Institute evening classes. Applications to the Principal by Aug. 4.

Battersea (London) Council have made the following appointments on the staff of their electricity department: Mr. E. F. Evans (of Newton Abbott) as shift engineer, Mr. A. W. Dumbrill as commercial assistant, Mr. S. Clarke as mains assistant and Mr. H. W. Healy as draughtsman.

Mr. S. A. Lovick has been appointed canvasser to East Ham electricity department for three months at £2 per week, plus 3d. per 8 c.p. or 16 c.p. lamp (or equivalent), 2s. per arc lamp and 2s. per horse-power of motors connected.

Mr. C. F. Barrett, of Kirkcaldy, has been appointed draughtsman at Brighton electricity works.

Mr. F. R. Bridger, assistant borough electrical engineer at Southampton has resigned, to take up an appointment at Buenos Ayres.

Mr. A. J. Foord has been appointed second assistant electrical engineer at H.M. Dockyard, Chatham.

EDUCATIONAL NOTICES.

University of Birmingham.—The 1906-7 session commences on Monday, Oct. 1. The full course in the department of engineering extends over four years. The technical engineering classes include lectures on the strength of materials, the theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing the course includes the design of tools, prime motors, dynamos and other forms of machinery. The engineering laboratory course includes determination of strength of materials, experimental study of the steam engine and boiler, frictional efficiency tests, the flow of water over weirs, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work includes the testing of continuous and alternating-current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing work. The courses also include mathematics, physics, chemistry, geology and metallurgy. Detailed syllabus can be obtained from the secretary.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Electrical Standardising, Testing and Training Institution.—As a result of the entrance scholarship examination held at Faraday House on July 18, 19 and 20 the following awards have been made: A Faraday scholarship of 80 guineas a year, tenable for two years, to Arthur L. Ballard, Dunheved College, Launceston. An exhibition of 20 guineas a year, tenable for two years, to N. J. Cook, Allhallows School, Honiton.

City and Guilds of London Institute.—At a meeting of the Council on Tuesday the diploma of associate was awarded to 67 matriculated third-year students (37 in civil and mechanical and 23 in electrical engineering and 7 in chemistry) of the Central Technical College who have completed a full course of instruction as prescribed by the Council. The following are the students in electrical engineering:—

E. A. F. Goodfellow (Siemens medal and premium), H. L. Saunders, S. Rudd, B. M. Venables, W. M. Huggins, A. R. McCallum, J. A. Sadd, L. King, G. Geoghegan, E. C. Laughton, W. D. Stewart, E. W. K. Foote, P. F. Harris, A. Ash, H. Craske, R. H. Gordon, J. E. Wilks, R. Savarinathen, J. Archer, A. E. S. Minett, H. G. Barkley, D. H. Gervers and F. F. Grimwood.

In addition to the above, certificates have been awarded to 41 matriculated third-year students who have completed a full course of instruction at the Central Technical College and to 82 students who have completed a similar course at the Technical College, Finsbury.

Institute of Chemistry.—Of 14 candidates who entered for the July Intermediate Examination the following nine passed:—

L. C. W. Bonacina, W. R. S. Ladell, D. J. Law, W. M. Seaber, B.Sc., P. Stutfield, J. M. Weir, M.A., B.Sc., W. A. Whatmough, J. M. Wilkie, B.Sc., and C. H. Wright, B.A. In the final examination for the associateship (A.I.C.), of three examined in the branch of mineral chemistry two passed—J. W. Agnew and I. M. Heilbron; of three in the branch of organic chemistry two passed—R. Le Rossignol, B.Sc., and G. W. Monier-Williams, M.A., Ph.D.; and of eight who entered in the branch of the analysis of food and drugs and of water, including an examination in therapeutics, pharmacology and microscopy, the following six passed—J. G. Annan, B.Sc., C. T. Bennett, B.Sc., G. W. Glen, F. W. Harris, E. H. Merritt, B.Sc., and F. Tattersfield.

Argentina.—The "Review of the River Plate" says that the United River Plate Telephone Co. have commenced the work of placing their cables underground.

It is expected that the first section of the electrified tramways in Rosario will be opened next month.

Work will shortly be commenced on the construction of the electric tramway from the Calle Irala, Buenos Aires, to Ardrogue, and the Allgemeine Electricitäts Gesellschaft hope to complete the work in six months. Current will be supplied by the Compania Alemana Transatlantica de Electricidad.

Residents between Quilmes and Conchitas, Buenos Aires, ask that the company owning and working the electric tramway between Avellaneda and Quilmes be compelled to continue the line to Conchitas.

The Anglo-Argentine Electricity Co. has been formed with a capital of $500,000 m/n to acquire the electricity works at Concordia, Uruguay, Gualeguaychu, Chascomus and Tandil.

E. M. Coll & Co. have, it is stated, applied to Congress for a concession for laying and working a submarine telegraph cable from Bahia Blanca and the River Plate (Argentina) to England via Tristan D'Acunha, Canaries and Cadiz.

The Belgian Electric Tramway Co., who own local tramways now being constructed under a concession granted to M. Gaston-Roux, have asked Buenos Aires municipality for leave to extend their lines along routes which would involve running over the lines of other companies. The first section of the company's system, which is being constructed by Colson, Brookhouse & Pyne, is expected to be opened by the end of October.

The "Review of the River Plate" says that M. F. Dirube & Co. have made an offer to the Government of the province of Buenos Ayres to construct electric light and other public works in all the principal towns of the province.

Ashington.—It was reported at the last meeting of the Council that the cost of electric current for the past season's public lighting was £600. 1s. 5d., equal to £1. 17s. 2d. per lamp. The cost per lamp per night was 1¾d. Before electric lighting was commenced gas and oil lamps were used at a cost of £2. 12s. 6d. per lamp per annum.

Australasia.—At the opening of the South Australian Parliament recently the Governor referred to the purchase of tramways, and said the Government proposed to vest electrified lines in a trust representing the Government and Metropolitan Corporations, with a view to ultimate municipal ownership.

Melbourne City Council are erecting 135 flame arc lamps for street lighting.

Richmond (Victoria) Council invite the co-operation of other metropolitan municipalities in the preparation and realisation of a scheme for the utilisation of the waters of the River Yarra in the generation of electrical energy.

At the adjourned meeting of representatives of the municipalities of Prahran, St. Kilda, Caulfield, Malvern, Kew, Camberwell and Hawthorn a resolution was carried that the Government be requested to pass an Act giving municipalities power to construct tramways within their own boundaries, and giving those municipalities which have a community of interests power to form trusts to construct tramways running through the districts forming the trusts.

The Trade Marks Act, 1905, came into operation on July 2 instant.

Austria.—Owing to increase in the price of raw materials, Austrian firms who manufacture low-tension electrical apparatus announce an increase in price of from 10 to 15 per cent.

Bedford.—Messrs. W. H. Allen, Son & Co. have recently asked the Electricity and Street Lighting committee to state their terms for giving a supply of electrical energy for power to the works. The committee have offered to supply a minimum of 320,000 units per annum on a three years' agreement at 1d. per unit, and the borough electrical engineer, Mr. R. W. L. Phillips, has been instructed to proceed with the extension of mains and machinery for giving such supply at an estimated cost of £2,340.

Bexley.—The Council have decided to construct a tramway from Bexley-road to Upper Belvedere.

Customs Duties.—Under the new convention between Roumania and Belgium the following duties (which will, on the ratification of the convention, also apply to British goods) are imposed upon imports to Roumania:—Vehicles not running on rails driven by electricity or other mechanical power, under 100 kilogs each 90 lei per 100 kilogs (=£1. 6s. per cwt.), under 250 kilogs 75 lei per 100 kilogs, under 500 kilogs 60 lei, under 1,000 kilogs 45 lei, 1,000 kilogs or more 30 lei, these rates being in each case half the duty previously in force. Parts of automobiles are also reduced to half the previous rate (*i.e.*, to 90 lei per 100 kilogs).

Derby.—An inquiry was held on Wednesday into the application of the Council for sanction to borrow £8,490 for extensions of the electric lighting undertaking.

The town clerk (Mr. G. T. LEE) explained that of the sum required it was proposed to expend £3,360 on mains, £600 on services, £1,500 on meters, £490 on spare armatures, £1,180 on motors, and £360 on street lighting, together with one or two small items.

East Ham.—An electric light cable is to be laid to the Isolation Hospital at a cost of £886.

Electric Lighting Notices.—The following additional notices of intention to apply for provisional electric lighting orders have been given:—

Adlington,—A. C. Tupp and W. A. Mitchell.

Birkhampstead.—Home Counties Electricity Supply Co. and Empire Electric Light & Power Co.

Buckhurst Hill.—Mutual Electricity Supply Co.

Castleford.—Electrical Distribution of Yorkshire & Mutual Electricity Supply Co.

Crompton.—Mutual Electricity Supply Co.

Egremont.—Foote & Milne.

Harpenden.—North Metropolitan Electrical Power Distribution Co.

Rawmarsh.—U.D. Council (to transfer order to Mexborough & Swinton Tramways Co.).

Rickmansworth.—Mutual Electricity Supply Co.

Selby.—U.D. Council and Electrical Distribution of Yorkshire.

Skipton.—Electrical Distribution of Yorkshire.

Edmonton.—The Council resolved on Tuesday to seal the transfer of the Council's Electric Lighting Order (1902) to the North Metropolitan Electric Power Supply Co., the company paying £2,800 towards the cost of obtaining the order and expenses.

Until otherwise agreed the following rates are to apply for public lighting: For 26 arc lamps (at least) on route of mains for not less than 15 years, £20 per annum for each 500 watt arc lamp for all night lighting and £14 for half night lighting, and £16 per annum for each 350 watt arc lamp for all night lighting and £11 for half night lighting, to include erection and completion by company of lamps, pillars, &c., and trimming, cleaning, renewing and maintenance. If the lamps are specially lighted by order of the Council during ordinary daylight hours an extra payment at the rate of 1d. per hour for each 500 watt lamp and ¾d. per hour for each 350 watt lamp is to be made. At Dec. 31, 1930, the Council may, upon giving six months' notice, require the company to sell the undertaking, and in that event the Council will repay the £2,800 received from the company, and will also pay a sum equal to the amount of capital properly expended by the company in connection with land, buildings, works, plant, mains, &c., chargeable to capital account, plus one-tenth of such expenditure. At the end of 36 years the Council will be entitled to acquire the undertaking upon the terms of the Electric Lighting Act, 1888, as amended by the North Metropolitan Co.'s Act.

Gloucester.—On Wednesday the Council rejected a motion to dispose of the electric tramways to a company.

Hastings.—An inquiry was held on Monday into the Council's application for sanction to borrow £8,761 for extensions of the electricity undertaking.

Technical particulars were supplied by the borough electrical engineer, Mr. R. F. Ferguson, and Councillor Bones said that every member of the Electricity committee favoured the proposals with one exception. There was some opposition by ratepayers, but the Inspector (Mr. H. R. Hooper) said no doubt the capital expenditure on the undertaking had been very considerable, but it appeared that the Corporation aimed at nothing less than an insurance for the supply of electricity, and desired to dispense with plant which was taking up room and earning no revenue.

Inquest.—An inquest was held at Cwmaman on Friday into the circumstances attending the death of Daniel Williams and James Hunter, who were killed at the Cwmneol Colliery last week.

John James, electrical draughtsman, explained that two pulley blocks were being used to lift a flywheel. When the flywheel touched the ground a point of one of the blocks touched the cable and severed the insulation, the consequence being that the electric current passed through the blocks, and deceased received a shock.

Mr. E. T. Jones, electrical engineer, said the pressure of the current was from 1,700 to 1,800 volts. Williams knew what to do, but was afraid of electricity.

A verdict of accidental death was returned.

Islington (London).—Last week the Lighting committee reported that they had made a careful inspection of the stock in hand at the electricity works, and they were of opinion that its value, as shown in the accounts for the year ended March 31, should be depreciated by £595. 19s. 10d.

The Chairman (Mr. Vorley) said that by the irony of fate at the last Council meeting the balance-sheet went through without a single comment, and so also did the most important recommendation with respect to depreciation. The undertaking, after paying interest and redemption of loans, had shown a profit of £9,056. That must be admitted as the most satisfactory balance-sheet yet submitted. During the last three years there had been a capital expenditure of £40,000, and during the two years prior to that the expenditure was £66,000. For those two years the increase in units sold was only about £40,000, while for the past three years the units sold had increased by 1,030,000. During the last 12 months the coal consumption had only increased by some 160 tons, costing some £100, but during that period they sold some 300,000 extra units which, taken roughly at 3d. per unit, brought in £3,500. There were also economies in water, waste, and other matters. The question of depreciation was not their prime difficulty; it was not depreciation, but rather antiquation. At present they did their own repairs, so that in course of time each machine would be practically renewed, but it was the type of machinery and plant that was the trouble, because modern inventions had rendered them out of date, and as they had to compete with modern electric stations and incandescent gas they needed economical plant. After eulogising the work of the electrical engineer and his staff, Mr. Vorley referred to the assistance rendered by Mr. Samuel Lambert, the first chairman of the committee.

Mr. Cowling moved an amendment that a special committee (empowered to engage the services of financial and technical experts) consisting of 16 members be appointed to inquire into the working of the electricity undertaking.

After debate the amendment was rejected.

Italy.—Electric lighting in the city of Taranto (Province of Lecce) was until recently confined to the arsenal, but has now been extended to the whole town, a local company having been formed to work a concession to supply current for lighting and power to private consumers. There is a contract for the public lighting by gas, which has still some years to run.

Light Railways.—The Board of Trade have confirmed the North Lindsey Light Railways Extensions, 1906, Order.

London County Council.—On Tuesday the Finance committee submitted a report of the L.G. Board auditor on the Council's finance.

In the course of this report the auditor states that up to March 31, 1905, sums amounting to £89,305 had been charged to tramways account in respect of expenditure on street widenings, but he found that up to that date the Council had decided in 23 cases of street improvements that the tramways should bear a proportion of the cost, and in one case the whole of the cost. The total sum estimated to have been charged in those cases was £377,260. The Council did not appear to have had any data when this proportion was fixed, and it seemed to be of a somewhat arbitrary character.

Tramways at Hammersmith and Putney.—The adjourned report of the Highways committee, recommending that votes of £13,800 and £6,520 be made for the altering of gas mains, widening Putney Bridge, &c., in connection with the Hammersmith and Putney tramways, was agreed to.

Lighting of Avery Hill Residential Training College.—The Education committee reported as to the most economical method of lighting the residential and training college at Avery Hill, and recommended that an expenditure of £770 be sanctioned for repairing and renewing the present electric generating plant and in providing a spare boiler.—Agreed.

Westminster Bridge and Victoria Embankment Tramways.—The Highways committee recommended that subject to Parliamentary authority being obtained for the construction of tramways over Westminster Bridge and along Victoria Embankment, capital expenditure of £96,800 be approved for the construction on the underground conduit system of these tramways. The committee also recommend that the existing contracts of £33,670 be extended with the following firms for supply of various materials or plant required: Siemens Bros. & Co., Ferranti Limited, Eckstein, Heap & Co., J. Smith, Reid Bros., Bolckow, Vaughan & Co., Frodingham Iron & Steel Co., Steel, Peech & Tozer, Western Electric Co., and W. T. Henley's Telegraph Works Co.—Postponed.

Aldwych and Islington Tramways.—The Highways committee proposed that an additional £7,350 be sanctioned for the execution of track work on this line of tramways.—Postponed.

Hampstead-road Tramways.—The same committee submitted an estimate of £6,200 for the reconstruction for the conduit system of the short length of tramway in Hampstead-road, effected by the widening of that thoroughfare.—Postponed.

System of Traction on New Tramways.—A lengthy report was submitted by the Highways committee as to the steps to be taken for the reconstruction of existing tramways and the construction of new lines during the present year, and they recommended that application be made to the Board of Trade and other road authorities with regard to the adoption of the conduit system on nine routes and the overhead system on five routes. Four of the latter were referred back and the rest carried.

Madagascar.—A French company (La Société Civile d'Études de Concessions et Travaux, 57, Boulevard des Batignolles, Paris) has secured a 50 years' concession for the electric lighting of Antananarivo. Under the terms of this concession a maximum of 20 per cent. of material may be of foreign manufacture. Subject to the approval by the colonial authorities of plans to be submitted by the same company, it is announced that an electric tramway concession for the city of Antananarivo is to be granted.

Marylebone (London).—The Council have agreed to pay St. Helens Cable & Rubber Co. £1,000 for extra expenses occasioned by delay in commencing the work of laying the mains under their contract. The company claimed £1,350, but have now accepted the Council's offer.

Noisy Tramcars.—In our issues of Jan. 26 and Feb. 2 last we referred to the report of Col. Yorke on the alleged noise and inconvenience caused to the residents of Ealing by the tramcars of the London United Tramways. Col. Yorke attributed the noise to three things—viz., some defect in the condition of the cars, the condition of the rails, and the condition of the rail joints.

The borough engineer of Ealing (Mr. Chas. Jones) has recently prepared a lengthy report upon the steps taken by the company to get rid of the causes of the complaints. Mr. Jones takes exception to the means adopted by the company and considers that by still running the cars to which objection has been made on account of the noise they make (in spite of the company's efforts to improve them in this respect), and by the system of piecemeal repairs to the track which the company has adopted, the noises have been intensified and made permanent. With respect to the reparation of the line (continues Mr. Jones) the cutting through of the solid concrete and inserting a small anchor with a bearing of 1½ in. or 2 in. upon bitumen and shingle is wrong. In every case where a long length, perhaps 60 ft., has been taken up at the side of the line, the rail has been prised up by steel wedges, a small amount of fine gravel inserted under the rail, and then filled in with hot bitumen, two or three violent blows on the rail with a sledge hammer, creating a certain amount of vibration, so that the bitumen ran underneath. On several occasions he had watched that being done, and within a few minutes afterwards had seen two or three cars run over the rail. The size of the places dealt with varied from 2 ft. 6 in. to 40 ft. and 60 ft. in length, both the outer and inner rail coming in for these repairs, and the opinion he had arrived at bore out the remark made by Col. Yorke that with those bituminous and plastic materials it was impossible to make a good job. Those continual repairs became a source of weakness along the whole line, and the cutting through of the concrete was a most serious matter. Mr. Jones prognosticates that many years before the 25 years' life of the line expires the whole would be an absolute wreck. In his opinion the primary evil in regard to this trouble was the construction of a comparatively light tram line, not anchored down, and then running over it a number of cars of a size, weight and carrying capacity far above its legitimate and reasonable strength.

Obituary.—The death is announced of the American capitalist, Mr. Russell Sage, in his 90th year. He was interested in many telegraph undertakings, and was president of the Empire & Bay State Telegraph, a director of the American Telegraph & Cable, the International Ocean Telegraph, the New York Mutual Telegraph, the Washington & New Orleans Telegraph, the Western Union Telegraph, the American Speaking Telephone and the Gold Stock Telegraph Companies.

We have to record the death of Mr. M. B. Henry, the recently appointed borough electrical engineer of Nelson, which sad event took place on Wednesday as the result of a bicycle accident. On Sunday Mr. Henry was found lying unconscious in the road at Hellifield, having been thrown from his bicycle. He was conveyed home, but never recovered consciousness.

Overhead Telephone Wires.—At the North London Police Court on Monday, Mr. d'Eyncourt sat as arbitrator in a dispute between Stoke Newington Council and the Postmaster-General as to the erection of a telegraph pole in that borough.

Sir Robert Hunter, solicitor to the Post Office, appeared for the Postmaster-General, and Mr. E. T. Holloway for the Council. A telegraph wire had been affixed to a chimney stack, but it was considered unsafe. Then Mr. Roberts, assistant engineer to the Post Office, cast about for another site, and the only way out of the difficulty appeared to be the erection of a 40 ft. pole near a blank wall. The residents objected, as they considered the pole unsightly, obstructive and detrimental to the property. The pole would cost £11. 5s., but to put the wires underground would cost £244. 14s.

Mr. D'Eyncourt could not see that the pole would be unsightly, obstructive or detrimental to property, and therefore there was no reason why the council should withhold its consent. Each case submitted to him would be dealt with on its merits, and in that case he found in favour of the Postmaster-General with £5. 5s. costs.

On Wednesday Mr. Rose delivered his reserved decision on the dispute between Woolwich Council and the Postmaster-General (reported in our last issue). The decision was in favour of the Postmaster-General, with certain reservations, one being that iron poles must be put down in made-up streets, while wood poles might be used in undeveloped streets until such time they were built up.

Perth.—The Electricity committee have reduced the charge for electric current from 4d. to 3¾d. per unit for private and lighting, and from 1¾d. to 1½d. per unit for traction.

Poplar L. G. Board Inquiry.—As the impression is prevalent that the lighting installation mentioned in the course of the proceedings at this inquiry is in connection with the Borough of Poplar electricity undertaking, the borough electrical engineer and manager (Mr. J. Horace Bowden) asks us to state that the Board of Guardians have their own electric lighting installation at Poplar workhouse, and it is to the latter that reference was made at the inquiry.

Portsmouth.—The statistics of the year's working of the municipal tramways (which appeared in our issue of 13th inst.), are, we are informed, erroneous, as the accounts have not yet been issued officially. We shall give an analysis of the figures as soon as the accounts are available.

Presentation.—Mr. W. H. Taylor, on leaving Ilford to take up his appointment as station superintendent at Walthamstow electricity works, was presented by the staff with an engraved silver cigarette case. The presentation was made by the chief electrical engineer (Mr. Arthur H. Shaw) on 20th inst.

Plymouth—The Council have been authorised to borrow £7,650 for electrifying the West Hoe section of the tramways, and extending the tramways.

St. Pancras (London).—An additional feeding main is to be laid at an estimated cost of £2,067.

Application is to be made to the London County Council for a loan of £10,028 for electric supply purposes.

Tenders are to be invited for wiring the Highgate branch library.

Sanatorium for Post Office Employes.—A matter in which the Post Office Telegraph Department will be interested has just come under the consideration of the Postmaster-General, who has decided that at any post office where an accumulated fine fund exists a contribution may be made from such fund to provide sanatorium accommodation for Post Office employés suffering from tuberculosis. The conditions are (1) that there should be a unanimous or nearly unanimous request from the staff at the office concerned for a contribution from the fine fund, and (2) that it shall be made clear that such donation will not give any member of the staff or any particular office a claim to participate in the benefits of the sanatorium apart from membership of the organisation. Is is pointed out that this sanatorium movement is not official, but that Mr. Sidney Buxton is giving it his warmest sympathy and support.

Selby.—The Council have decided to apply for a provisional electric lighting order.

Southend-on-Sea.—We learn that the borough electrical engineer (Mr. R. Birkett) has withdrawn his resignation.

Swansea.—On Tuesday the Council resolved to give Swansea Improvements & Tramways Co. notice of intention to purchase their Alexandra-road tramway route.

Westminster.—At yesterday's meeting of the City Council the Works committee brought up a report stating that they had reconsidered their report of May 23, which recommended the acceptance of the tender of the Gas Light & Coke Co. for lighting and maintaining high-pressure gas lamps in Whitehall and Parliament-street, and which had been referred back by the Council.

Tenders having been invited (in consequence of the failure of the Scott-Snell Gas Lamp Co. to carry out their contract), three tenders were received, one from the Gas Co. and two from the Westminster Electric Supply Corpn. The former tender was for the supply of new lamp columns and lamps where none now existed for £17 per lamp and for the maintenance and lighting of the whole at £15. 1s. per lamp per annum. The Westminster Corpn. submitted two tenders, one for the supply and fixing of flame arc lamps and lamp posts (to remain the company's property) and for the maintenance and lighting of the lamps on the terms following: No charge to be made for the first 18 months, and the charge for the remaining 3½ years to be the same as charged for the arc lamps in the St. George's, Hanover-square, district. Under this arrangement the total cost per lamp for five years would be £74. 4s., or an average per lamp per annum of £14. 16s. 10d. The Corporation's alternative tender was for supply and fixing of "Oriflamme" 9-amp. flame arc lamps and lamp posts at £42. 10s. per lamp, and for lighting and maintaining the lamps the first 18 months free and for the remaining 3½ years at £17. 15s. per annum, less the rebate in force at the time under the St. George's lighting contract. This charge would work out at a total of £59. 17s. 3d., or an average of £11. 19s. 5d. per lamp per annum. The corporation explained that their offer to maintain the lamps for the first 18 months free of cost was made because the system of lighting by "flame" arc lamps was new, and they wished to gain practical experience of the best type of lamp. They believed the candle-power would considerably exceed that specified, and so the street would be more efficiently lighted with 15 flame arcs (each of 1,200 c.p.) than with 20 gas lamps of 900 c p.. If 20 gas lamps were required, only 15 electric lamps would be necessary, and the actual cost per annum would work out: Electricity, £266. 16s. 3d. (first tender) or £227. 12s. 6d. (second tender); gas lamps, £301.

The report was referred back by the Council, and the committee now state that they consider it advisable under all the circumstances to accept the lowest tender of the Westminster Electric Supply Corpn. (viz., that under which the lamps and posts remain the property of the company), and they recommended accordingly.

Yesterday, after a lengthy discussion, the Council decided by 19 votes to 18 to accept the Gas Co.'s tender.

Brush Annual Sports.—On Saturday last we attended by invitation the annual sports of the Brush Electrical Engineering Co. at Loughboro'. A reserved saloon conveyed a large party of the Brush staff and representatives of the technical press from St. Pancras, and after lunch, which was served in a marquee on the field, the sports programme was followed with much interest. The cyclists especially, rounding the sharp unbanked corners of the track, were closely watched and some spills resulted with several over-zealous riders. Some time was available to look round the shops, which we noticed very full of work in all departments. The steam turbine, car and coach body and tramcar and railway truck shops particularly contained plentiful evidence of a good crop of orders. Two turbo-generators, built up entirely in the works, were being run on the test plate when we went through. The company is to be congratulated on its attention to the welfare of its employés, a circumstance amply testified to in the sports themselves and also in the hearty manner in which the men, not to forget the girls, who ran several races, entered into the spirit of the various events. On our return to town we were guests of the company to dinner on board the train.

Outings.—Poplar (London) Electricity Department held their second annual outing on Saturday last, at Thornwood Common, Epping. At the dinner the borough electrical engineer and manager (Mr. J. Horace Bowden) occupied the chair, and was supported by Councillor H. R. Barge, chairman of electricity committee. Sports (including cricket) occupied the remainder of a very enjoyable day's outing.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Birkenhead.—The income of the tramways department for the past year was £54,595, against £55,025 in the previous year.

Working expenses were £32,910, against £32,932, and the net profit £898, against £1,893. The continual decrease of receipts the manager (Mr. Wyld) attributes to trade depression plus the competition for a short time from the Mersey Railway omnibuses.

Edinburgh.—The Council on Tuesday discussed the recommendations of the Electric Lighting committee (set out in our last issue) as to the disposal of the surplus on the past year's working of the electricity undertaking. It was decided that £4,000 be voted in relief of rates and the balance (£12,361) placed to reserve.

Erith.—The electrical engineer (Mr. Geo. E. Heath) reported to the Council last week that the accounts of the electricity undertaking to March 31 showed a net profit of £572. 2s. 3d. after payment of all charges, including £3,260. 15s. for interest and repayment of loans.

The chairman of the Electric Lighting and Tramways committee (Councillor Mason) said it must be gratifying that they were able to show at least a small profit. They were now able to face the district with the assurance that the electric undertaking was a sound, paying concern. He moved a vote of thanks to Mr. Heath and his staff, and this was agreed to.

The Council have referred back a report recommending acceptance of the terms of London County Council for constructing tramways to link up the Erith tramways with the London system.

Launceston (Tasmania).—The report and accounts of the city electrical engineer (Mr. W. Corin) for 1905 show that capital expenditure on the electricity supply department is £155,417, an increase of £15,455.

Revenue was £13,080 (against £12,292), working expenses £5,533 (against £4,391). Interest on loans required £4,973 and sinking funds £1,021, the net profit being £1,552 (against £2,179). 1,194,369 units were generated (1,043,475) and 281,326 supplied for street lighting (244,958), 496,588 to private consumers (493,226) and 15,392 to other departments and workshops at special rates (20,240). The maximum load was 512 kw. (513 kw.) and the load factor 17·69 (16·83). The total connections are equivalent to 56,425 8 c.p. (44,221).

Mr. Corin is of opinion that the revenue and net profit would have been greater but for difficulty in maintaining the supply during the entire change of plant to the three-phase system, which has been carried out during the year.

Leith.—After paying interest and sinking fund charges there was a net profit of £3,144 on the past year's working of the electricity undertaking.

The receipts of the tramways were £20,670, and after paying expenses, interest, &c., and taking into account a debit balance of £1,841 from 1905, there was a debit balance of £1,998 at the end of the year. During the summer months the tramways were being reconstructed and the routes were only partially available, even for horse traction, but on Dec. 21 all the routes were opened for electric traction.

Marylebone (London).—The income of the electricity department for the year ended March was £105,081, and the expenditure £92,640, leaving £12,441. The Council did not commence supply from its new generating station until August 6 last, prior to which date the Metropolitan Co. were supplying the whole of the consumers under the terms of the working agreement. Since that date consumers had been gradually transferred to the Council's supply. The accountant of the department reported that an approximate division of the year's income and expenditure as at Aug. 6 showed a loss to that date of £5,300 and a profit since of £17,741. All interest charges accruing during the construction period and all establishment charges during the same period had been met out of revenue. The cost per unit sold worked out at 1·601d., exclusive of capital charges and interest on the award, but during the March quarter the equivalent was 1·313d. per unit for an approximate annual output of 5,600,000 units. The profit of £12,441 on the year had enabled the debit balance of 12 months ago (£5,143) to be wiped off, leaving £7,296, which the Electricity committee have decided to carry forward.

Southport.—The capital expended on the electricity undertaking to March last was £186,858, an increase of £3,691 on the year.

The revenue for the past year was £23,659. Working expenses were £8,949, leaving a gross profit of £14,710 ; after paying sinking fund instalments (£6,025) and interest (£5,309) the net profit was £3,376, of which £2,750 has been handed to borough fund, and £626 carried forward. 2,389,074 units were generated ; 121,126 were supplied to public lamps, 1,101,801 to private consumers by meter, and 680,560 sold by contract. The maximum supply demanded was 1,470 kw.

West Ham.—The capital expenditure during the twelve months ended March was £19,082, bringing the total to £337,355.

The total annual income was £51,371, an increase of £7,308, mainly attributable to more current being required for traction. The increase under this head was £5,260. There was also an increase of £1,488 for power, and £882 for public arc lighting. There was a decrease in receipts from private lighting of £657, due to reduction in price of current. The total working expenses were £27,471, against £23,808 last year. The gross profit was £23,900, an increase of £3,646. After paying interest, sinking fund, &c., the balance was £2,523 which is to be transferred to reserve. The net result of the working of the electricity undertaking since its inauguration in 1899 to March, 1906, is a deficiency of £2,683 6s. 7d.

A new application has been made to the L.G. Board to sanction the borrowing of £58,017 for new expenditure, and £17,634 for excess expenditure on the electricity undertaking. The total new expenditure is made up as follows :—generating plant, £17,505 ; Silvertown extension, £17,212 ; distributing cables, £23,300.

TRADE NOTES AND NOTICES.

◆

TENDERS INVITED.

Greenock Corporation invite tenders for the following contracts for the year ending June 30, 1907 : (1) Steam coal (washed singles and doubles), (2) oil and engine room stores, and (3) consumers' electricity meters. Specifications, &c., from the burgh electrical engineer, Mr. J. A. Robertson, Municipal buildings, Greenock, after July 24. Tenders to the town clerk, Mr. C. MacCulloch, Municipal-buildings, Greenock, by 10 a.m. Aug. 7. See also an advertisement.

Manchester Tramways committee invite tenders for supply of electric tramcar bodies, electrical equipments for cars and tramcar trucks. Specifications, &c., from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester. Tenders (addressed to the Chairman of the Tramways committee) by 5 p.m., Aug. 6. See also an advertisement.

Dudley Electricity committee invite tenders for supplying and laying feeder and distributor cables. Specifications, &c., from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria Street, Westminster. Tenders (addressed to the Chairman of the committee) to the Town Hall, Dudley, by noon, Aug. 13. Further particulars are given in an advertisement.

NOW READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1906 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is even more complete and accurate than in previous issues, and has been revised up to day of publication. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Traders purposes. The valuable large sheet Tables, &c., have been very carefully revised and extended, making the 1906 Edition of this indispensable work the most complete book of the kind ever published.

A full Digest of Contents will be sent post free on request.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of certain ports. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17–19, Bedford-street, London, W.C.

Dublin Improvements committee want tenders (by noon 30th inst.) for the electric lighting of Pigeon House-road main drainage pumping station. Specifications from the City Electrical Engineer, Fleet street, Dublin.

Leeds Electricity committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, &c. Tenders to the Town Clerk, by 10 a.m., Aug. 15.

Bathgate District committee of *Linlithgow* County Council want tenders by Aug. 1 for laying 1,170 yds. of electric cable, &c. Specifications from Mr. J. C. B. Henderson, Linlithgow.

South Shields Tramways Committee want tenders by noon, Aug. 11, for permanent way construction, &c. Specifications from borough engineer.

Portsmouth Tramways committee want tenders by noon Aug. 6 for Welsh steam coal. Specification from Mr. V. G. Lironi, Fratton-grove, Portsmouth.

Croydon Corporation want tenders from insurance companies for insurance of tramways against third-party risks. Tenders by 11 a.m. Aug 8.

Barking District Council want tenders by noon Aug. 15 for construction of light railways, overhead equipment and supply of rails, &c.

Dover Electricity committee want tenders by noon Aug. 13 for Welsh steam coals.

The Deputy Postmaster-General, *Adelaide*, wants tenders by noon Sept. 12 for the following telephone material :—

20 strips of tubular fuses (20 in each strip) on vulcanised fibre bases ; eight cross-connecting boards ; one ringing dynamotor for telephone exchange ; one 100-line metallic circuit switchboard ; one lightning arrester board for 100 lines ; one double-pole linked 5-ampere enclosed switch on porcelain base ; two 3-ampere enclosed fuses on porcelain bases ; and 100 condensers, rolled, in tin cases, W. E. Co.'s pattern (40 ½ mfd., 40 1 mfd. and 20 2 mfd.). Tenders must include Customs duty (if any) and must state country of origin. Specifications can be seen and forms of tender obtained at the General Post Offices at Adelaide, Melbourne, Sydney and Brisbane.

The commercial branch of the Board of Trade is notified by the Acting British Consul at Stockholm that tenders are invited for supply to the *Swedish State Telegraphs* of 200,000 kg. of copper wire of 4·5 mm. thickness. Tenders to Kungl. Telegrafstyrelson, Stockholm, by noon July 31. A copy of the specification may be seen at the offices of the Board, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Marylebone (London) Council have provisionally accepted the following tenders : Union Electric Co., 171 arc lamps (for Oxford-street) £915. 16s., globes £28. 15s. and 50 spare economisers 15s. ; and that of H. Windsor & Co., structural alterations at Rathbone-place sub-station £500 (approximate).

West Ham Corporation has accepted the tenders of the British Westinghouse Co. for step-up transformers at £243 10s. each, and the British Electrical Transformer Co. for step-down transformers at £59, £98 and £127 each respectively; also the tender of the British Insulated and Helsby Cables, Ltd., for high-tension cable for the Corporation's Silvertown extension.

For the year's supply of electrical engineering stores Loughborough Corporation have accepted the following tenders: Valvoline Oil Co., oils; F. Mountford, engine-room stores; W. T. Henley's Co., cables and cable accessories; Venner & Co., house-service meters; and Industrial Engineering Co., motors.

Birmingham Electric Supply committee have accepted the following tenders for the supply of motors:—General Electric Co., for ½, 1, 2, 5, 10, 20 and 50 H.P. motors; Roso Electrical Mfg. Co., for 3 and 7½ H.P. motors; J. H. Holmes & Co., for 30 H.P. motors; Thomas Parker (Ltd.), for 40 H.P. motors.

The Metropolitan Railway Co. have accepted the tender of Johnson & Phillips for supply and erection of the electrical plant at their Neasden Yard.

The contractor for the condensing water works at Hackney (T. W. Pedrette) has been allowed to sub-let the following portions of the work:—

Holwell Iron Co., pipe work, &c.; W. E. Farrer and Sheepbridge Coal & Iron Co., valves, &c.; Jukes, Coulson & Stokes, constructional ironwork.

West Ham Corporation have received the following tenders for h.t. switchgear:—

British Thomson-Houston Co. (*accepted*), £985; British Westinghouse Co., £1,265 and £1,077; Ferranti Limited, £1,079; Cowans Limited, £1,423; General Electric Co., 1,342; Siemens Bros. & Co., £1,080.

Salford Education committee have accepted the following tenders:—Electric Construction Co., 40 H.P motor, £89. 10s.; General Electric Co., two 15 H.P. motors, £57 each; and Veritys, Limited, 1 H.P. motor, £15. 16s. 3d.

King's Norton and Northfield Council have accepted the tender of Wm. Underwood & Bro. for construction of permanent way and road bed and the paving and bonding of the Moseley and King's Heath tramways and the extension to Alcester Lanes End for £29,462.

Erith Council have provisionally accepted the tender of Raworth's Traction Patents for two demi-tramcars at £1,346, the tender comprising Raworth's equipment, Westinghouse motors, Milnes-Voss body and Mountain & Gibson truck.

Hastings Corporation have placed an order with Oliver & Co. for 104 Oriflamme arc lamps, with raising and lowering gear, transformers, switches, &c., at £1,847. 19s. 3d.

Mansfield Corporation have accepted the tender of the D.P. Battery Co. for a battery of accumulators and reversible booster and switch gear for £1,531. 10s.

Bermondsey (London) Council have accepted the tender of Johnson & Phillips for supply and erection of arc lamp lowering gear for all the lamps in the borough.

Westminster City Council have accepted the tender at £534 of Speedy, Eynon & Co. for re-wiring Caxton Hall; 12 selected firms tendered.

Belfast Corporation have accepted the tender of British Insulated and Helsby Cables for feeder switch pillars, and that of Mayne & Co. for cast iron bases for tramway poles.

Mexborough Council have accepted the tender of Callender's Co for 10 tons of refined Trinidad bitumen at £5. 15s. per ton.

Warwickshire County Buildings committee have accepted the tender of Jas. Plucknett & Co. for wiring the Shire Hall at £500.

Heaton Norris Council have accepted the tender of G. H. Scholes & Co. for wiring the Council offices.

Herts County Council have accepted the tender of Dick, Kerr & Co. for constructing the Barnet tramways at £21,652.

Willesden District Council have accepted the tender of Newtons Limited for the supply of motors.

BUSINESS NOTICES.

Mr. A. Goldie Engholm, A.M.I.E.E., A.M.I.M.E., 30, Church-street, Birmingham, has taken over the entire steam department of Robert W. Blackwell & Co. for the sale of wrought-iron pipes, fittings, valves and pumps. He has also been appointed sole agent for the Midlands for Robert W. Blackwell & Co. (for the sale of their electric tramway supplies, circuit-breakers, P. & B. and other insulating materials), Hayward-Tyler & Co, the Buffalo Forge Co. and the Trussed Concrete Steel Co.

Messrs. J. G. White & Co. (Ltd.) announce that they have extended their present offices by taking a lease of the new building recently erected by the Skinners' Company in Cloak-lane, and that the registered address of the company, and the public entrance to the offices, is now 9, Cloak-lane, Cannon-street, London, E.C.

We are informed that Mr. G. H. Corringham, A.M.Inst.C.E., A.M.I.E.E., who formerly represented the Reason Mfg. Co., is now representing Messrs. Venner & Co.

Harry Knight & Ernest Claude Sparks, electrical engineers, &c., 45, Upper Russell-street, Brighton, have dissolved partnership. Debts by Mr. Sparks.

The Langdon-Davies Motor Co., Southwark Works, Deverell-street, London, S.E., notify that their works and offices will be closed from Aug. 6 to 11, and they ask that goods should not be dispatched to arrive during this period. A small staff will remain to deal with urgent matters.

Owing to increase of business in the north, Mr. J. W. Speight, M.I.E.E., has removed from his London office, and proposes to open offices in Manchester. For the present communications should be sent to Mr. Speight at The Elms, St. Annes-on-the-Sea.

The head offices of the Lancashire United Tramways, the South Lancashire Tramways and the Lancashire Light Railways Companies have been removed to Atherton, Lancs. The telegraphic address is "Tramways Atherton," and the telephone is No. 36 Atherton.

Frank Wm. Read and Frank Hy. Gale, electrical engineers, 10 and 11, Cursitor-street, London, W.C., have dissolved partnership. Debts by Mr. Gale, who continues under the old style of the Electrical Installation, Maintenance & Construction Co.

Messrs. J. B. Saunders & Co., electrical engineers, have removed to the White Mansion, 91, York-street, Westminster, S.W.

Harry Chas. Peirson has retired from the Hanway Art Metal Works, electrical engineers, &c., 1, Hanway-place, and 4, John-street, London, W. The remaining partners, H. C. Petitjean & Richd. F. Curtis, continue under the old style.

BANKRUPTCIES, LIQUIDATIONS, &c.

Thos. H. Hunter, electrical engineer, West Hartlepool, was examined last week. Debtor lost over £200 in the last three years' trading. Examination adjourned.

On Wednesday an application was made for the discharge of James T. Armstrong, electrical engineer.

Liabilities were estimated at £5,046. £3,925. 19s. 10d. had been realised and a further £20 was expected. Bankrupt, who had worked on inventions for wireless telegraphy and telephony, &c., attributed his failure to pressure by creditors, inability to realise his household furniture and effects and to his failure to obtain repayment of moneys paid on behalf of a company registered to take over some of his patents.

The Senior Official Receiver reported that, having regard to the financial position of the bankrupt, his financing the company to the extent mentioned was a rash and hazardous speculation, by which he had contributed to his failure, and the bankrupt had been guilty of other misconduct in relation to his affairs.

The discharge was suspended for two years and four months.

Claims against the Electro-Medical Supply Co., Ltd. (in liq.) to be sent by Sept. 14 to Mr. H. C. Howard, 70a, Basinghall-street, London, E.C.

A meeting will be held at Donington House, Norfolk street, London, W.C., on Aug. 31 to receive an account of the winding up of the Taunton & West Somerset Electric Railways & Tramways Co. (Ltd.) (in liq.)

The Pfluger Akkumulatorenwerke A.G., Berlin, has gone into liquidation, with Herren Carl Sievert and Carl Emdem and Dr. Ziemssen (all of Berlin) as liquidators.

The Liquid (Electric) Register Synd. (Ltd.) is being wound up voluntarily. Messrs. Evans & Fripp, 14, Finsbury-circus, London E.C., are liquidators.

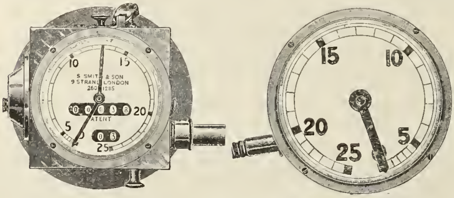
The Hong Kong Tramway (Electric) Co., (Ltd.) is being wound up voluntarily. Claims to Mr. G. G. Walker, 19, St. Swithin's-lane, London, E.C., by Sept 1.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co., have received instructions from the liquidator of the City & Suburban Electric Carriage Co., 1903 (Ltd.) (in voluntary liquidation) to sell by auction (if not previously sold privately) on the premises on Tuesday, July 31, and Wednesday, Aug. 1, 1906, the modern freehold works, 157A, Manor-street, Clapham, London, S.W.; also (in lots) the stock of new motors and parts, machinery utensils, &c., comprising a large quantity of carriage motors, gearing, frames, springs, meters, wheels, controllers and other parts used in the manufacture of electric vehicles; also the machine-shop repair plant. Further particulars and catalogues from Messrs. W. B. Peat & Co., C.A., 11, Ironmonger-lane, London, E.C., or from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. An advertisement gives further information.

Plant Wanted.—Mr. A. Underwood, 3, Queen-street, London, E.C., wishes to purchase (or hire for one month) a direct-coupled compound engine and dynamo, 80 kw. to 100 kw. 220 volts.

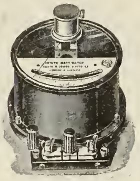
National Telephone Directory.—The National Telephone Co. have just issued their indispensable volumes of names, trades and professions, addresses and telephone numbers of the whole of their subscribers throughout the United Kingdom. The Metropolitan section of the directory contains, in addition, all the subscribers to the Post Office London telephone system. The whole of these names, &c., are issued in two complete volumes, and, to the busy man, form a desk companion which it must be difficult for him to do without. Vol. 1 is devoted to the London, Midland, Southern and Western areas, and Vol. 2 to the Northern, North Western, Scottish and Irish areas. The London section contains 546 large double column pages of small type, the Midland section 266 pages, the Southern section 220 pages, the Western section 154 pages, the Northern section 304 pages, the North-Western section 324 pages, the Scottish section 310 pages, and the Irish section 72 pages, or nearly 2,200 pages in all, which give the best idea of the labour and expense incurred in the compilation of a work in which each page comprises about 200 entries. The preparation and issue of a complete telephone directory is not the least of the services rendered by the National Telephone Co. to the professional and commercial classes.

Tram and Motor 'Bus Speedometer.—Messrs. S. Smith & Son, 9, Strand, London, W.C , have introduced a new form of motor 'bus and tram speed indicator, which promises to become extremely popular, as by its means both the driver and the police can see at a glance at what speed the vehicle is travelling. This gives the driver the power of keeping within the speed limit and puts the police in a position to check him if he exceeds it. The indicator is also fitted with a tell-tale or supplementary hand which is under lock and key, enabling the police to prove their statements correct or, on the other hand, saving the driver from an unjust summons. The figure to the left shows the dial opposite the driver with the supplementary or maximum hand and locking-up arrangement and that to the right the dial facing the road showing the speed of the vehicle to the police or passers by. The illustrations are one-fourth size. We learn that there are between 3,000 and 4,000 of these instruments in actual use at the present time.



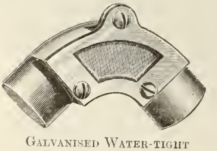
Messrs. S. Smith & Son's New Motor Vehicle Speedometer.

Catalogues.—Messrs. Kelvin & James White have ready a pamphlet describing a new horizontal scale portable wattmeter. This instrument is used as a sub-standard for testing meters in a number of towns and also at the Board of Trade laboratory. Exactly similar instruments have also been supplied to the majority of the large engine, dynamo and alternator manufacturers for use on their test beds, and these have been found to work very satisfactorily. The movement of the instrument being astatic, and the instruments being fitted in a case of insulating material, all trouble due to external fields and eddy currents is eliminated. Some notes on wattmeters on single, two and three-phase circuits are given in the pamphlet, and a curve showing a graphic method of determining the power factor of a three-phase circuit will interest engineers. We illustrate the new portable wattmeter in the accompanying figure. The main coils can be arranged to give either one or two ampere-ranges. The latter are obtained by bringing leads to connect blocks (as shown in the figure) so that by means of plugs the coils can be connected in series or in parallel.



Lord Kelvin's Portable Wattmeter.

The General Electric "Progress Sheet" for July gives particulars of reduced prices of the "Adaptor" fan, in G.E.C. sunk pattern brass switches, Stanley-D'Arsonval moving coil volt and ampere meters, and in iron, mining and outdoor bells. Particulars are also given in this sheet of "Union" steel conduit, of which the accompanying illustration shows a galvanised watertight inspection elbow.



Galvanised Water-tight Inspection Elbow.

Veritys Limited have a new list of improved type "Aston" motor starters. Copies can be obtained on application.

Nalder Bros. & Thompson are publishing a list of N. A. and O. K. ammeters and voltmeters, showing the reduced prices at which these instruments are now being supplied. Reduced prices are also shown in a separate list of the N.C.S. automatic accumulator switch. This switch is entirely electro-magnetic, permanent magnets being dispensed with. It is, therefore, impossible for it to become reversed. It is purely differential in action and switches the cells into the charging circuit as soon as the voltage of the latter has risen sufficiently above the cell voltage, whatever it may be at the time. It cuts out the cells directly the charging current falls to zero, there being, therefore, no sparking at the mercury cups. Another list issued by this firm shows Cox's patent Ohmer, which, weighing less than 14 lb , is claimed to be the lightest, best and cheapest instrument of this description on the market. Some interesting particulars of the Ohmer are included in the list.

An interesting price list (No. 104) of overhead line material is issued by the British Thomson-Houston Co. and contains complete particulars of a large variety of accessories for overhead tramway working. Illustrations of each of the items are given.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from July 18 to 24, with the ports of destination :—

Africa—Alexandria, £664 (including £156 telegraph material); Beira, £422; Cape Town, £328 (including £200 telegraph material); Delagoa Bay, £193; Durban, £582 (including £160 telegraph cable); East London, £3,174; Port Elizabeth, £482 (including £66 telegraph material). Sekondi, £25; Suakim, £668. *Argentina*—Buenos Aires, £2,714 (including £1,863 telegraph material and 3 ton tramway crossings). *Australasia*—Adelaide, £11; Fremantle, £174; Lyttelton, £128; Melbourne, £60 (including £6 telegraph material); Perth, £625; Rockhampton, £54; Sydney, £823; Wanganui £277; Wellington, £1,734 (including £1,673 telegraph material). *Belgium*—Antwerp, £96 (including £85 telegraph cable); Brussels, £8; Ostend, £246. *Brazil*—Pernambuco, £123; Rio Janeiro, £17. *British Guiana*—Demerara, £11. *Canada*—Toronto, £14. *Ceylon*—Colombo, £434 (including £83 telegraph material). *Channel Islands*, £5. *China*—Shanghai, £404 (including £194 telegraph material); Tientsin, £67. *Cyprus*, £21 (telegraph material). *Fiji*, £40. *Gibraltar*, £264 (including £26 telegraph material). *Holland*—Amsterdam, £20 *Hong Kong*, £25. *India*—Bombay, £1,728 (including £35 telegraph material); Calcutta, £1,495 (including £90 telegraph material); Karachi, £50; Madras, £127. *Japan*—Kobe, £186; Nagasaki, £2,017; Yokohama, £1,869. *Mauritius*, £71. *North Atlantic*, £3,100 (telegraph cable). *Russia*—Libau, £95; St. Petersburg, £404. *Straits Settlements*—Penang, £12 (telegraph material); Singapore, £2,406 (including £543 telegraph material). *Sweden*—Stockholm, £26. *Uruguay*—Monte Video, £81. *U.S.A.*—New Orleans, £250; New York, £195. *Zanzibar*, £20 (telegraph material). Total £28 857, against £14,576 in the corresponding week last year (July 19 to 25).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

June 13, 1906.

13,567 Siemens Bros. & Co. & Turner. Controlling electric motors.*
13,568 Schaffler & Weiss. Electrical apparatus for firing mines or blasting charges.
13,585 Auvert & Ferrand. Transformation of a single-phase alternating current into a continuous current. (Date applied for, 7/3/05.)*†
13,589 Miura. Electrolytic meters for electricity.
13,594 North. Signalling or telegraph apparatus.
13,596 B.T.-H. Co. (G.E. Co., U.S.) Incandescent electric lamps.
13,597 B.T.-H. Co. (G.E. Co., U.S.) Electric heaters for vulcanising tyres.
13,600 Schattner. Electric circuit interrupting devices.
13,601 B.T.-H. Co. (G.E. Co., U.S.) Switches.
13,602 White. Switches.
13,603 White. Brush-holders for dynamo-electric generators and motors.

June 14, 1906.

13,654 Wynberg & de Vries. Reproduction of letters or devices by electricity.
13,670 Jenczewsky. Electrically-operated safety valve.*
13,673 Fricker. Starting and regulating electric motors.
13,690 B.T.-H. Co. (G.E. Co., U.S.) Reactive coils for systems of distribution employing vapour rectifiers.
13,691 B.T.-H Co. (G.E. Co., U.S.) Electric motor control systems and apparatus.
13,693 Kuhlo. Insulated conductors. (Date applied for, June 17, 1905.)*†
13,697 Allgemeine Elektricitäts Ges. Electric traction systems. (Date applied for, June 14, 1905.)*†
13,699 Cowper-Coles. Electro-deposition of iron.

June 15, 1906.

13,731 Terry. Accumulator plates.
13,750 Neilson. Insulation protection and manufacture of electric conductors.
13,760 Hamilton. Electrical contact breakers for internal combustion engines.

13,782 Leitner. Electric motor generators.
13,790 Stave. Automatic tell-tale indicators.
13,795 Berry. Electrical production of heat for cooking and other purposes.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

11,703 B.T.-H. Co. (G.E. Co., U.S.) Synchronous alternating-current dynamos.
12,473 Reader. Junction box for electric cables.
11,654a. Schanschieff. Accumulator plates. (Date applied for, 4/12/05.
12,778 Lake. (Ingersoll-Sergeant Drill Co.). Electric unloaders for air compressors.
12,928 & 12,940 Goldsborough. Turbines.
13,108 Parsons. Dynamo-electric machinery.
13,112 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
13.130 Pringle. Apparatus for cleansing the rails of tramways and railways.
13,975 B.T.-H. Co. (G.E. Co., U.S.) Semaphore signals.
14,959 Soc. d'Electricité "Nilmelior" & Michel. Sparking coil with multiple winding.
16,631 Ruzicka. Electrical resistances.
17,238 Joel. Electrodes for secondary batteries.
17,643 Gerard. Electrical tractors.
18,208 Phillips & Parkin. Contrivances for truing the surfaces of commutators.
18,447 B.T.-H. Co. (G.E. Co., U.S.) Motor-starting and controlling switches.
18,519 Allgemeine Elektricitäts-Ges. Electric control systems. (Date applied for, Sept. 13, 1904.)
22,675 Westinghouse. Fluid pressure turbines. Date applied for, 17/11/04.
25,257 Janeck. Arc lamps.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The sixty-eighth half-yearly general meeting of this Company was held on Wednesday, under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY (Mr. A. R. Hardie) read the notice convening the meeting and the auditors' certificate.

The CHAIRMAN then said: Although the accounts now submitted to you do not show such a large net profit as those for the corresponding period to March 31, 1905, the result of the half-year's working may, I think, be considered satisfactory. Before moving the customary resolution for the adoption of the report and accounts, I will, as usual, make a few cursory remarks on some of the more important items contained therein. The gross income for the half-year amounted, in round figures, to £628,300, as against, for the corresponding period, £676,200, or a decrease of £47,900. The most important reductions are in the receipts from India, China and Japan, South Africa and Egypt. The decreases in the receipts from India and Egypt are principally due to the reduction of the tariff from 2s. 6d. to 2s. per word in the former case, and from 1s. 5d. to 1s. per word in the latter. These reductions only took effect from August 1, 1905, and we are now consequently comparing a full six months at the reduced tariff with the half-year which was not affected by the alteration in rate. I dealt very fully with the Indian section of traffic on the last occasion I had the pleasure of addressing you, when I stated that we might, perhaps, look forward to be to some extent recouped for the loss of revenue resulting from the reduction of tariff by the normal development of trade in the Indian Empire. I am glad to say that this traffic is, on the whole, showing an upward tendency, though, with fluctuations in the opposite direction, but I am afraid it will take some considerable time before the "standard" figure is again reached. We are, in the half-year under review, comparing our revenue from traffic with China and Japan with the abnormal revenue earned on that traffic during the war between Japan and Russia, and naturally the cessation of hostilities has caused a considerable reduction in Government and Press traffic. From the progressive tendencies, however, showing themselves in China, and the commercial activity which is bound to take place in Japan, we look forward to a growth of commercial traffic with these countries. Although the traffic with Egypt has increased since the reduction of tariff in August last, it will, as in the case of India, take some considerable time before we are able to earn the same revenue as we derived from that traffic before the reduction came into force. The reduction in our earnings from South Africa is caused entirely by the diminution in business. It was believed by many that the development of commercial enterprise after the cessation of hostilities would have been rapid, but this has not been the fact, and we can only trust that South Africa will soon experience a more prosperous period. When this much-desired result has been achieved, and the country settles down and recovers from the effects of the prolonged war, our receipts from messages may be expected, as a natural sequence, to improve. I am glad to say that the traffic with Australia has shown a substantial improvement, and as the Associated Companies have continued to carry approximately the same proportion of the total traffic as they have done since the opening of the opposition Government Pacific Cable route, this Company has participated in this general increase of business. It is satisfactory to note that the traffic exchanged with South America has for some time past shown considerable expansion, and the Boards of the Eastern and Western Co.s have decided to enlarge their cable-carrying capacity between Great Britain and St. Vincent. We have considered this necessary for several reasons. In the first place, we desire to improve our system for this important South American correspondence. We have also to meet the action taken by the French Government in laying a cable from Brest to Dakar to connect their existing cable from the latter place to Pernambuco, thus giving France a direct route to South America. We have also to provide against the competitive opposition of the Central & South American Co. who have lately laid additional cables along the West Coast of South America. It has been decided to lay our new cables via Fayal, in the Azores, not only opening a new route by this means, but also enabling the Western Co. to effect a junction with the Commercial Cable Co. at Fayal for the more rapid interchange of traffic between North and South America. The Eastern Co. will lay the section between Porthcurnow and Fayal, and the Western Co. will lay that between Fayal and St. Vincent. The expedition will leave London about Aug. 3, and the cables should be laid and in working order by the end of that month or the beginning of September. This additional route will also have the effect of relieving our existing lines between Porthcurnow and Portugal of a considerable amount of traffic, thereby enabling us to have more carrying capacity for our Mediterranean, Egyptian and Far East traffic.

Leaving these general considerations, I will now deal with the expenditure side of the revenue account. It will be seen by the accounts that the total ordinary expenditure for the half-year shows an increase of £5,300 when compared with the half-year to March 31, 1905. The principal increase is under the heading of "Working expenses at Stations," the total expenses under this head being £157,100 against, for the corresponding period, £145,400, or a difference of £11,700. Salaries and wages account for £5,500, while our contributions towards the expenses of stations worked by other companies with which we are associated have increased to the extent of £6,000. With a view to improving the service to South Africa, it has been found advantageous to alter the system of working the West Coast route, and for this purpose arrangements were made to carry the cable into the Madeira Station of the Western Telegraph Co., who deal with the traffic over this line on our behalf. We have, therefore, now to bear a share of the expenses of that station, and from this fact a large proportion of the increase referred to is due. As a set-off against the increase under Abstract B, general expenses in London show a decrease of £1,500, while the expenses attending maintenance of cables are £8,000 less than they were in the corresponding half-year. There are various, though unimportant, variations in the different items of expenditure, some showing increases and some decreases, and the net result being, as before stated, an increase of £5,300. We have recently built a small cable repairing steamer named the "Sentinel," specially designed for carrying out repairs in comparatively shallow water. She will be stationed on the West Coast of Africa, where a considerable proportion of cable is laid in shallow water. We have always one of our larger vessels stationed on that coast, fully manned and ready to proceed to sea at short notice. Although the small ship will not take the place of the larger steamer, she will be able to carry out many of the repairs in these regions, and we shall have the additional security of a second ship on this coast, while it is anticipated that the saving in coal and other matters through being able to keep the larger vessel for longer periods in port, will result in the annual expenditure not being much increased. When I last addressed you, I intimated that the amount of £115,000, representing the balance of expenditure on new cables, would be written off during the current half-year. Effect has been given to this, and the sum named has been charged against the General Reserve Fund. This completes the outpayment for the new cables from Great Britain to the Cape and to Mauritius, &c., and is our contribution to the new main route to Australia via South Africa. The large sum involved, about £2,000,000, has been met out of our Reserve Fund, and the financial operation has taken us seven years to complete. We could not have done this in so short a period had our traffic not been abnormally increased owing to the South African and the Russo-Japanese wars. The policy adopted by your Directors of applying the reserve fund from time to time, as necessity arises, in strengthening our system and so giving a better service to the public, enables us to deal with the increase of business which we hope will accompany the important reductions of rates and the increasing development of the world's commerce. I think it necessary to emphasise what I have said at former meetings as to the financial burden on this Company through reduction of rates. Not only does the annual outlay for additional staff and all other incidental expenses at stations become greater, but large capital outlay has in most cases to be incurred to provide sufficent cable capacity to carry the number of words required if the loss of revenue caused by the reduction in rates is to be recouped. This is a point which is generally either forgotten or ignored by those who are constantly urging further reductions, but it is one which is ever before us as a Board, and must be taken into serious account before any further important reductions can be effected. What we have done has thus a two-fold aspect. The public have gained an improved service with a large reduction of tariff. The Company have strengthened their position by being able to meet all reasonable requirements. Without our reserve fund none of these objects could have been secured, and the consistent policy of the Board has been amply justified from both points of view. Our General Reserve Fund now amounts to about £1,000,000, and, in view of our possible cable requirements in the future, I would like to see it increased as much as our ordinary dividends will permit. We shall, no doubt, be able to add to this fund in future, but, unless something unforeseen happens, we cannot expect to be able to carry such large sums to reserve as we have been able to do during the last five years. I now move the adoption of the report and the declaration of the dividends and bonus set out therein.

The VICE-CHAIRMAN and MANAGING DIRECTOR (Sir John Denison-Pender, K.C.M.G.) seconded the motion.

Mr. C. D. STACEY suggested the establishment in connection with the Company of a fund for the benefit of widows and orphans of the staff—a fund to which the latter might subscribe. There was a most generous pension fund for the benefit of the employés, but if one of them died his pension died with him.

The CHAIRMAN: In reply to the remarks made by the proprietor who has just addressed us, it is quite true that we have no special fund in the Company for widows and orphans, but we have a very efficient superannuation and pension fund to which the Company largely contributes. I may say that any pressing case which may be brought before us relating to widows or orphans always receives consideration, but, as I have just stated, we have no special fund for this purpose, and I do not know that we propose to establish a fund, as I think that this is a matter for the employés to deal with during their lifetime. He then put the motion and declared it carried unanimously.

The Right Hon. ST. JOHN BRODRICK moved a vote of thanks to the Chairman and the Directors for their admirable report to the stockholders and for their services in the past year.

Mr. NIALL seconded the motion, which was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

Direct United States Cable Co. (Ltd.)

The fifty-eighth ordinary general meeting was held on Tuesday, under the presidency of Mr. E. M. UNDERDOWN, K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, the report is now before you, and I think you will agree with me that the excellent expectations we had formed of the position and working of the Company have been abundantly established, and that we can now congratulate ourselves upon three or four topics which are extremely satisfactory. In the first place, business is very active between this country and the United States, which is generally a pretty good index that business is good throughout the world. We are in the most excellent relations with our friends and allies, including, of course, the organisation in the United States. Our cables are in good order, which is a very important matter; and I think you cannot but admit that our financial position is a very strong one, arising, as it does, from the prudent use of our resources over a great many years. The revenue for the six months to June 30 last, after deducting outpayments, amounted in round figures to £56,265. The working and other expenses, including provision for the pension fund and income tax, but exclusive of the cost of maintenance of the cables, absorbed £23,924, leaving a balance of £32,341 as net profit, making with £5,848 brought forward from the previous half-year, a total of £38,189. This has been appropriated as follows: An interim dividend of 4s. per share to March 31 has been paid, absorbing £12,142, and we propose a final dividend of 4s. per share and a bonus of 2s. 6d. per share to June 30, which will require £19,731. The balance we propose to carry forward is £6,316, but I should like to mention a matter which may come up later for our consideration—namely, that our carry forward is not limited to that amount, because although we said that when we had arrived at the very satisfactory value of half a million as reserve fund we should cease to add to that fund in the ordinary way—still making use, of course, of the dividends and interest upon it as far as might be necessary—yet, in point of fact, we have more than £4,000 over the £500,000 to which I have referred. It is not necessary that we should tie ourselves strictly down to £500,000, but the result of that is that with the £6,316 carried forward on the revenue account and the £4,000 odd which I have mentioned, we have got practically a carry over of nearly £11,000, which I think you will agree with me is a very ample provision in that respect. For the first time for many years we make no transfer from the revenue to the reserve fund account, and this is in accordance with the policy foreshadowed in my speech at the last general meeting, when, with reference to the fact that the reserve fund had reached £500,000, I said: "Having reached the point we have now attained, the Board feels that it may with justice and prudence give the shareholders the advantage of having, if not all, a very substantial amount of the whole net profit of the earnings." That, you will observe, has been carried out by our giving you the very satisfactory bonus of 2s. 6d. per share, and there is very great satisfaction in considering that the somewhat large capital of this Company is now reaching its proper appreciation. The revenue has shown considerable improvement during the past half-year as compared with the corresponding period of 1905, the increase amounting to £6,795, or nearly 14 per cent., due to the expansion of Atlantic cable business generally; and I may here state that during the portion of the half-year from July 1 to date we show an increase of about 11 per cent. over the corresponding period of last year. In the working expenses in London and at the stations there are some increases and some decreases as compared with the corresponding period of the year 1905, but on the whole, having regard to the increased business dealt with, these outgoings do not compare unfavourably with those of the previous year. The remaining expenses and other payments which appear on the revenue account are more or less of a fixed character, but with regard to the item of income tax, which has been for some time entered in your accounts as "subject to adjustment," you will be glad to know that the Company's appeal to the Government has been settled in what we consider a very fair and satisfactory manner. We have secured an appreciable reduction in our assessment, and the result of that will appear in our future accounts. The reserve fund account having been credited with £8,407 from interest on the investments and £2,219 from profit on the sale of securities, and having, on the other hand, been debited with £7,143 for cost of maintenance of the cables, the balance of the fund now amounts to £504,184. A summary of the results of working during the whole financial year shows as follows: The receipts were £112,618, less expenses and other ordinary payments amounting to £47,223, leaving a balance of £65,395. We have paid in dividends £51,604, we have placed to reserve £10,000, and we have an increased balance in hand as compared with June, 1905, of £3,791. This makes up the £65,395 I just mentioned. The reserve fund account has been increased on balance during the year by £21,236, as follows: Transferred from revenue £10,000, interest on investments, &c., £16,160, and profit on sale of securities £2,219, making together £28,379, less the cost of maintaining the cables £7,143, leaving an increased balance, as I said, of £21,236. The investments have been increased during the year by the amount of £29,386. Now, gentlemen, under these circumstances, I have no hesitation in bringing to your favourable notice the balance sheet before us and in congratulating you upon the results shown, which, I trust, may be maintained. I now move the adoption of the report and accounts, and the declaration of the dividends set out therein.

Sir JAMES PENDER, Bart., seconded the motion, which was at once carried unanimously without discussion; and resolutions were afterwards passed re-electing the retiring Directors, Sir James Pender and Mr. Charles E. Gunther and the retiring auditors, Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. J. & J. Sawyer & Co.

A cordial vote of thanks to the Chairman, Directors and staff having been unanimously accorded, the proceedings terminated.

South Wales Electrical Power Distribution Co.

An important meeting of debenture holders and consumers was held at Cardiff on Wednesday.

The CHAIRMAN (Mr. R. Fleming) said it was no use reverting to the past, which had been most unfortunate, and he dared say the consumers were as indignant as the debenture and shareholders. Two or three months ago, for the first time, they were made aware of the precarious position of the company. They had conferences, and they immediately engaged the best engineering talent they could command to come down and look the situation over, and they came to the conclusion that the concern was worth saving. Their next consideration was as to how it could be saved. They looked at the bill for increasing the capital and they found it would not cover the ground. The bill was radically changed, and had passed both Houses of Parliament. It was now only waiting Royal Assent and would give them power to issue securities that would enable them to do what they wanted—raise money enough to put the plant in first-class condition; in fact, to make an entirely new plant which would generate power on most economical terms, and be reliable in every respect. Those who had indicated their willingness to advance the necessary money made one condition as an absolute essential, and that was that there should be some guarantee that, the plant being there, consumers should take power from it. They had been disappointed in the past at the slowness with which connections had been made, and it would be impossible to raise the money unless something definite was secured in advance in that direction.

Mr. C. H. MERZ said that he was not connected with the old scheme in any way, and until a month ago he had not been over the district. He had since then covered the area fairly fully, and had spent a considerable amount of time in calculating what could be done. Speaking with some experience and knowledge of similar work, he did not think there was any question at all that the district could be supplied with power much more cheaply from a central plant—from a comprehensive system for the whole district—than by individual plants installed by the different collieries. He did not know of any district in the kingdom where there would be more advantage from carrying out the scheme in a comprehensive way. That arose for one reason because the water supply must be a difficulty in the cases of many plants. He knew from the engineers to the biggest installation which had been set up in their district (the Powell Duffryn) that they had to go in for engines, and could not go in for the advantages of steam turbines largely because of the difficulties of obtaining water for condensing. Those difficulties were got over by having a comprehensive supply scheme, and they could take it that the South Wales district 10 years hence would be at a great disadvantage to the extent of tens of thousands, and perhaps hundreds of thousands, of pounds if it were developed by individual plants as against a comprehensive scheme. A tremendous saving would be effected by centralisation. They could buy a 15,000 H.P. turbine for a third of the price per horse-power they had to pay for a 500 H.P. machine. Therefore, he would urge them to seriously consider whether it was not the right thing to get a complete scheme started. He understood that latterly the installation of the company had run fairly well, but he could only say that in the North of England where he was connected with a large power undertaking, he had no hesitation in advising the biggest firms to depend upon the power company for their supply. On the north bank of the Tyne thay would have a difficulty in finding a steam engine of any kind at work. They would find even the railways run by electric power, all taken from the comprehensive supply system which was now installed throughout Northumberland. Firms like Armstrong Whitworth's, with a capital of £10,000,000, were not likely to take supply from a power company unless they were satisfied it was right. The people who originated the old Lancashire scheme made a great mistake in the way they put things before consumers. He was a great believer in centralisation, and for that reason he was a disbeliever in doing the thing partially. The thing ought in the first place to have been put before the consumers in such a form that it would have paid them to use power for all purposes. It seemed absurd to him that they should have a hauling engine at a colliery and displace it by a motor, and not drive their pumps or even their fans from the same source. It was the pumps and fans that consumed the coal, and the power was there to save the coal. From his knowledge of what had been done the power was used chiefly for intermittent work, and the price they paid (¾d. per unit) could not be remunerative to the company.

Mr. W. A. CHAMEN, engineer and manager of the company, said that several colliery owners had come to him and said they could not put their pumps and fans on to the company's supply at ¾d. per unit. They had put on their haulages and saved considerably, but that had proved unremunerative to the company. The colliery companies having that flat rate before them had sought to find the uses which paid them best. No concern could make a living by supplying haulages at ¾d. per unit. If they put in their own generating plant, the colliery owners at once proceeded to convert everything to electric driving. They put on their fans and pumps and everything else, and in that way they gave themselves what was denied to the company, viz., a good load factor.

After considerable discussion as to tariffs, reliability of supply, &c.,

Sir W. T. LEWIS moved: "That a committee of consumers be appointed to confer with the debenture-holders' committee with a view to a guarantee being forthcoming for taking a minimum of power at prices satisfactory to them, should the necessary capital be forthcoming, to place the power company upon a sound commercial basis."

The resolution was put and carried unanimously, and a number of prominent gentlemen were thereupon appointed members of the committee.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The total receipts for the half-year to June 30 (including balance of £846. 16s. brought forward) amounted to £204,919. 0s. 8d. The traffic receipts show an increase of £17,801, compared with the corresponding half-year of 1905. The working expenses were £80,224. 6s. 8d., an increase of £9,298. 19s. 6d. Quarterly interim dividends of 15s. per cent. on the ordinary stock and of £1. 10s. per cent. on the preferred stock were paid on May 1 (absorbing £52,500), and second quarterly interim dividends of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (amounting to £52,500) will be paid on the 4th prox. The balance (£19,694. 14s.) will be carried forward. The directors greatly regret to announce the resignation of their esteemed colleague Mr. William S. Cunard.

CENTRAL LONDON RAILWAY CO.—The capital expended during the half-year ended June 30 was £14,270. 2s. 4d. Receipts amounted to £180,225. 14s. 5d., a decrease of £5,650. 13s. 2d., and the working expenses to £94,048. 1s. 11d., a decrease of £1,626. 7s. 6d. compared with the corresponding period of last year, leaving £86,177. 12s. 6d. The number of passengers carried during the half-year was 22,336,489, compared with 23,037,435 and 21,694,066 in the June and December half years of 1905. The adoption of electric traction by the other underground railways, and the introduction of motor omnibuses on the Oxford-street route, have somewhat affected the company's traffic. The average receipt per passenger for the half-year was 1·86d., the same as in the June half-year of 1905. After providing for debenture interest and other payments, the balance is £92,257. 9s. 3d. (including £25,393. 17s. 2d. from last half year), and the directors recommend dividends at the rate of 4 per cent. per annum on the undivided ordinary and the preferred ordinary stock, reserving £10,884. 6s. 5d., proportion of dividend applicable to deferred stock, which is not payable until the result of the year's working has been ascertained. £32,257. 9s. 3d. remains to be carried forward. The assessment of the Central London Co.'s line now represents no less than 18½ per cent. of the net revenue.

CITY & SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30 shows that receipts from all sources amounted to £77,395. 3s., and working costs £34,781. 2s. 2d., leaving a profit of £42,614. 0s. 10d. Inclusive of the balance brought forward, the net revenue shows an aggregate total of £45,712. 8s. 2d. After providing for debenture stock interest and transfer to renewal fund of £1,500, there remains available for dividend £32,987. 9s. 4d., and the directors recommend that the full preference dividends be paid and a dividend at the rate of 2¼ per cent. on the consolidated ordinary stock for the half-year, leaving £1,870. 17s. 10d. to be carried forward. The ordinary dividend compares with 2 per cent. for the June half of 1905. The number of passengers (exclusive of season ticket holders) carried during the half-year was 9,045,120, compared with 8,662,588 in the corresponding period of 1905. The directors express satisfaction with the progress made by the contractors on the extension of the line to Euston. Notwithstanding the difficulties encountered, the tunnelling is rapidly nearing completion. The arrangements for providing the electric equipment of the extension and the new rolling stock are in progress. The short subway communication between the company's Elephant and Castle station platforms and those of the Baker-street and Waterloo Railway is completed, and satisfactory arrangements for through bookings between the two companies have been arrived at. The opening of this valuable connection may be expected to take place next month. To cope with the increased traffic which it is anticipated will follow the opening of the Euston extension and the Baker-street and Waterloo-line, and to provide accommodation for new rolling stock, a contract has been entered into for the construction of additional sidings at Stockwell, and this work is proceeding.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—At the meeting on Tuesday Mr. W. M. Murphy explained the various items in the report and accounts (abstracted in our last issue), and said that the profit on the parcel department for the year was £3,062, or more than ½ per cent. per annum on their ordinary share capital. Parcel traffic on a comprehensive scale had been attempted on very few tramways systems, and those which had tried it had not always been successful. The chairman of the Tramways committee of the Manchester tramways had to admit a loss of £5,500 last year on their parcels department, and anticipated further loss during the present year. Besides the great public convenience afforded by the Dublin tramways parcel system, they might, therefore, congratulate themselves on the revenue they got from what he might call a bye product of their business. The expenditure on electrical energy showed an increase of £266, as the price of coal was 3d. a ton dearer, and the consumption was 130,223 units in excess of last year; but notwithstanding the increased price of coal the cost of electric current per unit worked out at practically the same figure as in 1905. In anticipation of the exhibition in Dublin next year, from which they anticipate a large increase of traffic, it would be necessary to make some special expenditure on maintenance and renewals before the opening of the exhibition. During the half-year a short length of tramway through Lower Baggot-street, connecting the Donnybrook line at the corner of Fitzwilliam-street with Stephen's Green and Dawson-street, was opened for traffic.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—At the meeting on Monday Mr. H. Wolfenden explained the cause of the reduced dividend. Whatever might be the state of trade now business generally was not brilliant in the early part of the past year. Economy was practised by users of current for lighting, and that was continued throughout the year. They thought they saw evidences of an improved demand. Whilst their stations generally showed progressive results for the year, one of them (Guernsey) had slightly retrograded, notwithstanding that about £2,000 to £3,000 additional capital had been expended. Hamilton also had not done so well as in 1904. Inverness had contributed scarcely any profit to the parent undertaking, as it commenced to generate only in May, 1905. The Scarborough investment showed an increase of nearly £12,000, with an increase of income of only £189. The Lancashire Power Co. began to supply current in October, but owing to the limitations imposed by the original act practical difficulties were created in approaching consumers direct. These difficulties had just been removed, as the company's bill now awaited the Royal assent. The local authorities were expressing their willingness, and even anxiety, to make arrangements with the Power Co. which would enable the company to cover the ground, and the Power Co. were taking steps actively to push the business. Ramsgate only commenced supplying current in October, 1905, so they did not derive any profit from that station, but at the end of June, 1906, it had 8,151 equivalent 8 c.p. lamps installed. The Urban Electric Supply Co. was showing a distinct advance, the units sold during the half-year ended June 30 being about 30 per cent. in excess of those for the corresponding half of 1905. Alderley and Isle of Wight were making good progress also. As to the immediate future, they felt that their concern needed rest, and they intended to confine themselves to developing their existing undertakings and bringing them to a remunerative state, limiting capital expenditure as far as possible consistent with the proper carrying on of the business. They were in a state of transition from a fluctuating to a permanent income.

ELECTRIC SUPPLY CORPN. (LTD.)—At the meeting on Wednesday Mr. C. F. Tufnel said the report recorded steady progress in the number of consumers and lights installed in every town in which the company's operations had commenced. With the exception of the Chelmsford undertaking, their business of electricity supply had only recently commenced, and under those circumstances it could not be expected that the accounts would show much profit. It had been considered desirable that the results of all the undertakings owned or controlled by the company should be pooled, and the board proposed to promote a bill to provide for transferring all the undertakings to the company. Last year an arrangement was made for guaranteeing the earnings of the company during its first few years. Under that guarantee they were now receiving a first instalment, and were able to declare an interim dividend at the rate of 5 per cent. on the paid-up share capital for the six months to June 30. The operations of the company were now assuming large proportions. The capital expenditure at Dec. 31 last was £184,289 and was rapidly growing, the increase during 1905 being more than £61,000. The directors looked forward with confidence to a most successful future for the company.

GENERAL ELECTRIC CO. (LTD.)—At the meeting on Friday the chairman (Mr. G. Byng) said the company's profits were about £3,000 less than last year. They, however, proposed that 5 per cent. should be paid upon the ordinary shares, but the amount carried to reserve suffered to the extent of £3,600, but this account still stood at the respectable figure of £108,000, or more than 50 per cent. of the amount of their debentures. They had added £30,000 to their property account during last year. They had extended both Witton and Salford works; they had added a large wing to their engineering shops, and had almost doubled their testing and power-houses. At Salford they had built new instrument works and had transferred the whole of their wood-working shop to new premises. All those additional works had been equipped with new machinery, and he trusted that they would help the output and profits of the coming year. Their profits had suffered very largely on account of the rise in raw materials—iron, copper, lead, tin, spelter, platinum, indiarubber, timber, manganese, mica; almost every raw material they used had gone up in price. He attributed the rise to the fact that all American and Continental factories were full up with orders, and these practically ruled prices; but those foreign factories had that advantage over them, that they could and did combine to obtain increased selling prices, while they in England could not effect any serious combination. Although they had had to pay more for their raw materials, they had not been able to recoup themselves by a corresponding increase of selling prices. While profits had suffered, the volume of their trade and their turnover had increased, all their factories having been able to work full time. Their large enterprises at Witton had progressed favourably. The Witton engineering works had turned out an increasing quantity of dynamos and motors, especially of three-phase plant. The report on their carbon factory was more encouraging; they had not reached the dividend-paying period yet, but they had been fully occupied at more remunerative prices, and the factory had continued to receive orders and support of the Home as well as Colonial Governments and of many municipalities. He could not pretend to be satisfied with the profits which the company had been able to make during the last few years. They were purely a manufacturing concern, with immense liabilities and risks, and a dividend of 5 per cent. on the ordinary share capital was not an adequate or encouraging return, being merely interest which could easily be obtained on a non-risk and non-work basis. But there were causes at work which fully, to his mind, accounted for this condition of things.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—The capital expended during the half-year ended June was £1,039,928 and the estimate for the current half year is £800,000. The running tunnels and station tunnels between Finsbury Park and Hammersmith have been completed, and the permanent way and conductor rails have been laid the entire distance, with the exception of a small piece at Covent Garden. The lifts, stairways and ventilation system are nearing completion. The sub-stations are completed, with the exception of Hyde Park Corner, which it is anticipated will be ready early in September. The car sheds and repair shops at Lillie Bridge are ready for the reception of the rolling stock, which is arriving at the rate of 15 cars per week. The construction of the surface station buildings is progressing, and it is expected that the railway will be opened for traffic in January. The rent due to June 30 from the Underground Electric Railways Co. of London permits of a dividend at the rate of 4 per cent. per annum.

METROPOLITAN RAILWAY CO.—The total receipts for the half-year ended June 30 (deducting proportion of revenue of City lines and extensions) were £389,014. 3s. 4d., and the expenses £213,032. 4s. 2d., leaving a profit of £175,981. 19s. 2d. The receipts show a decrease of £51,316. 0s. 7d., and the expenses a decrease of £3,653. 11s. 7d., compared with the corresponding half-year of 1905. After providing for debenture interest and other fixed charges and preference dividend, a balance of £46,658. 4s. 3d. is available for dividend upon ordinary stock, and directors recommend a dividend upon this stock for the half-year at the rate of £1. 10s. per cent, the balance (£3,667. 14s. 11d.) being carried forward. The falling off in revenue is (the directors consider) due partly to the diversion of the Great Central Railway traffic to their new route, and also to the new and increasing competition of motor omnibuses. From circumstances entirely beyond the control of the company the electrification of the trains has not yet been completed, and the company is, therefore, not reaping the full advantage of the new method of working. The effect of this is that the working expenses are for the time being increased, and there has not been that development of passenger traffic which the company might reasonably have expected. The number of passengers carried for the six months to June 30 was 49,552,411, compared with 95,694,616 for the whole year 1905.

THOMAS PARKER (LTD.)—The directors, in their report for the year ended April 30, regret that competition and continued low prices, combined with large increases in price of raw material, have adversely affected the year's working. Deducting general charges, maintenance and debenture interest, there is an adverse balance. To meet this £5,000 is transferred from reserve, carrying forward £289. 1s. 5d. The orders (says the report) for the last six months of the year show an improvement, which still continues, the total orders received for the year ended April being in excess of those for the previous 12 months. The number of men employed fell to about half that of three years ago, but all departments have been kept on full time, and in several shops overtime has had to be resorted to. The number of hands is now increasing again. The report continues: "Before the beginning of the year the management were led to the opinion that a radical change in the type and design of continuous-current machinery was imminent, and it was decided to break away from the then universal practice and prepare for the new development." The changes adopted have, it is said, reduced cost of production, and even at present low prices reasonable profits are secured on standard machines. The directors have acquired rights for certain new patents which they believe will be the means of increasing the output of the works largely in the near future.

WESTINGHOUSE ELECTRIC CO. (U.S.A.)—The directors' report for the year ended March 31 states that the total sales amounted to $24,940,000, an increase of $8,369,000. For the current year they are estimated at $34,000,000. Six years' gross earnings are given as $114,619,000, and the net earnings as $16,893,000; a total income of $20,557,000, and a surplus, after deducting all charges, of $21,463,000.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

S. BORNETT & CO. (LTD.) (89,565).—Reg. July 19, capital £2,000 in £1 shares, to acquire the business of a chemical engineer, &c., carried on by S. Bornett, and to carry on the business of electrical, chemical, mechanical and general engineers, manufacturers of and dealers in engineering, electric, chemical and other appliances, &c. First directors, S. Bornett and E. Hatchek (governing).

CARACAS CONSTRUCTION CO. (LTD.) (89.576).—Reg. July 20, capital £17,000 in £10 shares, to adopt agreements with the Caracas Electric Tramways Co. (Ltd.) and the United Electric Tramways Co. of Caracas (Ltd.) and with J. G. White & Co., and to carry on the business of tramway, railway, omnibus, motor and van constructors and proprietors, carriers, electricians, electrical and general engineers, &c.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.) (89,539.)—Reg. July 18, capital £1,000,000 in £5 shares (70,000 5 per cent. cumulative preference, with priority as to capital, 70,000 6 per cent. participating ordinary entitled to moiety of profits after such 6 per cent., and with priority as to capital over deferred shares, and 60,000 deferred), to acquire over 99 per cent. of the shares in the Cleveland & Durham County Electric Power Co. and the majority of the shares in the Northern Counties Electricity Supply Co. (Ltd.), to develop the supply of electric power in Cleveland and the county of Durham and in certain districts in Northumberland on lines similar to those adopted by the Newcastle-upon-Tyne Electric Supply Co. (Ltd.) and the County of Durham Electric Power Supply Co. on Tyneside, and to carry on the business of generators, transmitters, distributors and suppliers of electrical or other energy, &c. First directors, J. H. Armstrong, M. L. Bell, C. Emmott, J. Falconer, the Hon. Robert James and Sir John D. Milburn, Bart Reg. office, Royal Exchange-buildings, Newcastle-on-Tyne.

LONDON SHERADISING CO. (LTD.) (89,533).—Reg. July 17, capital £20,000 in £1 shares, to acquire an exclusive licence to use and to exercise certain processes for depositing metals on metals known as the "Sheradising and analogous processes," to adopt agreements with P. Dawson and with the Sheradising Synd. (Ltd.), and to carry on the business of galvanisers, zinc workers, smelters, manufacturers and blenders of alloys, &c.

STATUTORY RETURNS.

ELECTROMOTERS (LTD.)—Return to June 4 gives capital as £50,000 in £1 shares, of which 40,870 have been taken up. 16s. per share has been called up, and £32,696 has been received. Mortgages and charges, nil.

FLADBURY ELECTRIC LIGHT & POWER CO. (LTD.)—In return to May 28 capital is £2,000 in £1 shares, of which 855 have been taken up and paid for in full. Mortgages and charges, £300.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—Return to June 8 gives capital as £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £65,902.

MORTGAGES AND CHARGES.

DULVERTON ELECTRIC LIGHTING CO. (LTD.)—A memorandum of satisfaction in full of a mortgage dated May 9, 1905, securing £150, has been filed.

FRANK SUTER & CO. (LTD.)—Particulars of £5,500 debentures, created June 27, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been filed pursuant to sec. 14 (4) of Companies' Act, 1900. No trustees.

CITY NOTES.

MEMORANDA (July 26).—Bank rate 3½ per cent. (since June 21, 1906). Price of silver 30$\frac{1}{16}$d. per oz. Consols 87⅜—87½ for money, 87⅜—87½ for account; 2½ per cent. annuities 86—86½. Consols Pay Day, August 1; Stocks and Shares Continuation Day, Aug. 13; Ticket Day, Aug. 14; Pay Days, July 27 and Aug. 15; Mining Share Carry-over Day, Aug. 10.

BROWN, BOVERI & CO. A.G. (BADEN).—A dividend of 7 per cent. has been declared for the year ended March 31, compared with 10 per cent. for the previous year.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 on the ordinary shares at the rate of 4 per cent. per annum. The transfer books and register of members will be closed from August 14 to 21 inclusive, preparatory to payment of an interim dividend on the preference and ordinary shares for the half-year ended June 30.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)—An interim dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ending June 30 will be paid on August 8.

LANCASHIRE AND YORKSHIRE RAILWAY CO.—The directors recommend a dividend for the past half-year at the rate of 4 per cent. carrying forward about £20,000.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show a balance of £6,796. 16s. 3d., and the directors recommend a dividend at the rate of 5 per cent. on the (1892) preference shares which will absorb £3,000. The carry forward is £3,796. 16s. 3d.

MONTREAL LIGHT & POWER CO.—For the year ended April 30 the gross earnings were $3,186,100, an increase of $284,800; and the net profits (after providing for fixed charges and interest) were $1,278,500, an increase of nearly $150,000. The usual quarterly dividends have absorbed $690,000, and after including $603,500 brought forward and allowing for various appropriations there remains $901,000.

NORTH-EASTERN RAILWAY CO.—The directors propose a dividend at the rate of 5¼ per cent.. carrying forward £62,000, against 4¾ per cent. and £41,349 forward in 1905.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold for the quarter ended mid summer is returned at 1,695,766 units, estimated to produce £21,894, against 1,573,443 units, which produced £22,487 for the corresponding week last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Aug. 1 a special settling day in, and have granted a quotation to, a further issue of 100,000 £5 fully-paid ordinary shares of the *Anglo-Argentine Tramways Co. (Ltd.)*, and have also appointed Aug. 1 a special settling day in 3,000 £5 fully-paid ordinary shares and further issues of 1,049 and 7,332 £5 fully-paid ordinary shares of *Bruce Peebles & Co. (Ltd.)* and 100,000 £1 (11s. paid) 6 per cent. preferred and participating shares of the *Delhi Electric Tramways & Lighting Co. (Ltd.)*. The committee have also ordered a further issue of £325,620 4 per cent. debenture stock of the *Western Telegraph Co. (Ltd.)* to be quoted. The committee have been asked to allow £1 fully paid shares of the *Anglo Portuguese Telephone Co. (Ltd.)* to be quoted.

WATERLOO & CITY RAILWAY CO.—The directors recommend a dividend on the ordinary stock for the past half-year at the rate of 3 per cent. per annum (the same as last year), carrying forward £738, compared with £658 in 1905.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 18	1,662	− 200	7	10,867	− 412
Airdrie	„ 13	253	+ 20	28	6,174	+ 617
Anglo-Argentine	„ 22	14,252	+ 1,699	29	429,103	+ 45,465
Ashton-under-Lyne Corp.	„ 21	358	+ 27	17	5,972	+ 622
Ayr Corporation	...	..	...	...	...	...
Baker St. & Waterloo Ry.	„ 21	1,352	...	3	4,238	...
Barnsley	„ 13	160	+ 8	28	4,479	+ 33
Barrow	„ 13	321	+ 45	28	6,680	+ 334
Bath Electric Trams, Ltd.	„ 18	1,007	+ 184	29	22,196	+ 3,439
Birkenhead Corporation	„ 22	1,169	+ 81	...	...	...
***Birmingham Corporation**	...	...	...	...	...	...
Birmingham & Mid.	„ 13	10,557	− 137	28	284,140	+ 19,480
Blackburn Corporation	„ 18	1,073	− 50	¶16	17,636	+ 1,013
Blackpool Corporation	„ 19	1,991	− 52	15	17,792	+ 594
Blackpool and Fleetwood	„ 21	1,312	+ 45	3	3,200	− 25
Blackp'l, St. Anne's & Lytham	„ 19	722	− 126	§37	11,209	+ 1,169
Bolton Corporation	„ 22	2,206	+ 129	16	35,127	+ 2,158
Bournemouth Corporation	„ 18	1,736	+ 140	†16	25,838	+ 5,979
Bradford Corporation	„ 21	4,617	− 52	16	74,944	+ 2,833
Brighton Corporation	„ 22	1,079	− 258	16	16,929	− 979
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	„ 20	5,400	− 71	28	115,497	+ 8,617
Buenos Ayres & Belgrano	„ 15	3,990	+ 694	29	103,390	+ 6,203
	„ 22	3,492	+ 69			
Buenos Ayres Elec. Trms.	June 28	1,213	+ 61	25	34,659	+ 6,707
Burnley Corporation	July 21	1,079	− 48	16	18,722	+ 733
Burton Corporation	„ 22	337	− 10	§16	4,941	− 345
Bury Corporation	„ 15	1,014	...	15	15,214	...
Calcutta Tramways Co.	„ 21	R43,748	+ R728	3	R133,031	+ R3,601
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	...	...	...	...	...	...
Cavehill	„ 13	238	+ 143	28	2,282	+ 754
Central London Railway	„ 21	5,747	− 185	5	17,774	− 582
Chatham & Dist. Lt. Rys.	„ 19	769	− 86	†28	18,266	− 209
City & South London Rly.	„ 22	2,494	+ 266	3	7,413	+ 627
Colchester Corporation	„ 19	243	− 24	51	9,788	− 1,113
Cork Electric Trams Co.	„ 19	578	− 44	29	13,465	− 393
Croydon Corporation	„ 20	1,538	− 1	7	11,725	+ 839
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	„ 13	651	+ 39	23	12,284	− 408
Dover Corporation	„ 21	296	+ 50	16	4,156	+ 544
Dublin & Lucan Railway	„ 20	160	− 7	§3	390	− 50
Dublin United	„ 20	5,801	+ 175	‡3	15,733	− 509
Dundee Corporation	„ 18	1,106	+ 209	§9	9,924	+ 2,019
East Ham Council	„ 21	983	+ 11	16	15,254	+ 1,459
Exeter Corporation	„ 20	802	− 29	16	4,642	− 454
Falkirk and District	„ 18	318	...	3	872	...
Gateshead & Dist. Trams	„ 13	1,274	+ 315	28	26,653	+ 1,584
Glasgow Corporation	„ 21	12,765	+ 193	8	124,576	+ 7,257
Glossop	„ 22	136	+ 4	29	3,777	+ 340
Gloucester Corporation	...	...	...	..	...	...
Gravesend—Northfleet	„ 13	272	− 5	28	6,403	+ 276
Gt. Northern & City Rly.	„ 21	1,601	+ 179	3	4,925	+ 517
Greenock & Port Glasgow	„ 13	671	− 127	28	18,104	+ 784
Halifax Corporation	„ 18	1,616	− 170	16	27,139	+ 1,128
Hartlepool Tramways	„ 13	370	+ 68	28	7,911	+ 830
Hastings Elec. Trams Co.	„ 19	760	...	3	2,410	...
Huddersfield	„ 21	1,586	+ 92	16	24,[illegible]02	+ 7,464
Hull Corporation	„ 21	2,325	+ 93	16	36,157	+ 978
Ilford Dist. Coun.	„ 21	501	− 60	16	8,263	+ 107
Ilkeston Dist. Council	„ 18	14[illegible]	+ 7	16	2,115	+ 85
Ipswich Corporation	„ 21	512	− 18	16	7,092	− 231
Isle of Thanet Co.	„ 21	1,143	− 171	41	17,137	− 1,580
Keighley Corporation	„ 19	156	− 1	3	428	− 26
Kidderminster & District	„ 13	186	− 2	28	3,129	− 52
Kilmarnock Corporation	„ 21	183	− 9	10	1,550	− 78
Kirkcaldy Corporation	„ 18	803	− 1	3	769	+ 28
Lanarkshire Trams Co.	„ 19	1,029	+ 23	‡29	25,125	+ 5,607
Leamington	„ 13	253	+ 198	28	4,785	+ 2,906
Leeds Corporation	„ 21	6,258	+ 82	16	101,954	+ 4,454
Leicester Corporation	„ 21	2,309	− 22	3	6,967	− 28
Leith Corporation	„ 14	584	+ 285	‡9	5,291	+ 2,826
	„ 21	602	+ 317			
Liverpool Overhead Rly.	„ 22	1,601	− 83	3	4,719	− 217
Liverpool Corporation	„ 14	12,374	+ 45	28	297,035	+ 5,836
***London County Council**	„ 14	26,860	+ 9,952	15	399,427	+ 174,553
London United	„ 20	7,279	+ 3	†29	173,800	+ 9,[illegible]31
Lowestoft	...	...	...	...	...	..
Maidstone Corporation	„ 19	120	− 133	16	1,894	− 167
Manchester Corporation	„ 21	13,816	+ 368	16	219,657	+ 8,117
Mersey Railway	„ 21	1,670	+ 207	3	4,862	+ 427
Merthyr	„ 13	208	− 7	28	5,364	+ 46
Metropolitan Dist. Railway	„ 22	7,682	+ 1,231	3	23,849	+ 3,298
***Metropolitan Elec. Trams**	„ 13	8,873	+ 423	28	41,888	+ 25,460
Middleton	„ 13	431	− 18	28	9,587	+ 331
Nelson Corporation	„ 21	153	+ 6	17	2,456	+ 107
Newcastle-on-Tyne Corp.	„ 21	8,874	..	16	66,608	+ 4,380
***Newport (Mon.)**	„ 2[illegible]	610	− 4	16	10,164	+ 375
Northampton Corporation	„ 20	489	− 8	16	7,241	+ 27
Oldham, Ashton & Hyde	„ 13	632	− 11	28	15,525	+ 496
Oldham Corporation	„ 22	1,947	+ 180	17	30,646	+ 2,454
Perth (N.B.) Corporation	„ 18	174	...	9	1,466	...
Perth (W.A.) Elec. Trams	„ 20	1,495	+ 1[illegible]9	29	43,222	+ 2,563
Peterborough	„ 13	263	+ 95	28	3,391	− 805
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	„ 21	2,370	− 64	16	33,019	− 214
Potteries	„ 13	1,730	+ 22	28	49,245	+ 2,584
Preston Corporation	„ 18	764	+ 42	8	2,376	+ 321
Reading Corporation	„ 19	661	− 32	8	1,352	− 125
Rochdale Corporation	„ 21	1,107	+ 185	16	17,272	+ 5,[illegible]80
Rotherham Corporation	„ 19	503	+ 37	16	7,875	+ 655
Rothesay	„ 13	520	+ 156	28	4,[illegible]05	+ 1,2[illegible]7
Salford Corporation	„ 23	4,711	+ 279	16	74,49[illegible]	+ 189
Sheerness	„ 11	68	− 24	28	1,515	− 817
Sheffield Corporation	„ 22	5,398	+ 407	17	89,861	+ 4,503
Singapore Trams	„ 21	$7,563	...	3	$21,[illegible]51	...
Southampton Corporation	„ 18	1,050	− 21	†16	15,290	− 6
Southend Corporation	„ 1[illegible]	516	− 31	16	[illegible],180	+ 126

(*a*) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	July 18	378	− 7	28	8,312	+ 111
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	„ 21	985	+ 80	16	16,021	+ 5,265
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	„ 18	424	...	29	10,956	...
Swansea Trams	„ 13	919	+ 12	28	23,041	+ 4,354
Swindon Corporation	...	...	...	...	...	...
Taunton	„ 13	48	− 12	23	1,214	− 101
Tynemouth and District	„ 13	887	− 38	28	6,454	− 179
Tyneside Trams Co.	June 27	1,399	+ 141	26	11,323	+ 658
Wallasey District Council	July 21	910	− 40	16	13,201	+ 840
Walsall Corporation	„ 14	537	+ 25	26	14,678	+ 813
	„ 21	517	− 179			
Warrington Corporation	„ 19	371	+ 10	16	5,945	+ 550
West Ham Corporation	„ 19	2,352	+ 561	16	87,058	+ 11,607
Weston-super-Mare	„ 11	829	+ 12	28	2,723	+ 133
Wolverhampton Corpn.	„ 18	905	...	3	2,711	...
***Worcester**	„ 13	334	− 34	28	7,480	− 678
Wrexham	„ 13	105	− 7	28	2,753	− 11
Yorkshire W.R. Trams	„ 22	858	+ 55	29	23,428	...
Yorkshire Woollen District	„ 18	939	+ 222	28	24,613	+ 7,815

(*a*) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., July 25.	Rate per Cent. Yielded.	Dividend Due.	Business. Week to July 25.	
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
5	5/0	**Anglo-Argentine Ord. Shs.**	$6\frac{13}{16}$—$7\frac{1}{16}$	5 13 6	Ap, Oct	7	$6\frac{31}{32}$
5	2/9	**Do. 5½% Cum. Pref.**	$5\frac{3}{4}$—6	4 11 8	—	$5\frac{15}{16}$	$5\frac{13}{16}$
St.	6%	**Do. Permanent 6% Deb. Stock**	138—141	4 5 0	—	..	..
St.	5%	**Auckland Elec. Trams 5% Deb. (red.)**	102—104	4 16 3	—	$103\frac{3}{4}$	..
5	..	**Brisbane Electric Trams. Invest. Ord.**	$1\frac{1}{2}$—$1\frac{3}{4}$	..	..	..	..
5	2/6	**Do. 5 per Cent. Cum. Pref.**	$4\frac{3}{8}$—$4\frac{5}{8}$	5 10 0	—	$4\frac{9}{16}$	$4\frac{1}{2}$
St.	4½%	**Do. 4½ per Cent. Db. Prov. Cts.**	99—104	4 6 6	—	$100\frac{1}{2}$	..
St.	6%	**British Columbia Elec. Rlwy. Def. Ord.**	116—119	5 0 6	—	$117\frac{1}{2}$	..
St.	5%	**Do. Pref. Ord. Stk**	107—110	4 11 0	—	107	..
10	5%	† **Do. 5% Cum. Perp. Pref. Stock.**	105—103	4 13 0	—	$105\frac{1}{4}$	..
40	4½%	**Do. 4½ per Cent. 1st Mort. Dbs.**	103%—105%	4 5 6	—	..	—
100	4½%	† **Do. Vancouver Power Debs.**	101—104	4 6 0	—	..	
5	3/0	**Buenos Ayres and Belgrano Ord.**	$2\frac{3}{4}$—$3\frac{1}{4}$	5 0 0	—	$3\frac{3}{8}$	$3\frac{5}{16}$
5	3/0	**Do. 6 per Cent. "A" Cm. Pref.**	$5\frac{5}{8}$—$5\frac{7}{8}$	5 2 6	—	$5\frac{1}{2}$	..
5	3/0	**Do. "B"**	$4\frac{7}{8}$—$5\frac{3}{8}$	5 9 0	—	$5\frac{1}{16}$	..
St.	5%	**Do. 5 per Cent. Debs.**	104—106	4 14 4	—	105	$104\frac{1}{2}$
St.	5%	**Do. 5% 2nd Deb. (red.)**	101—104	4 16 8	—	102	..
St.	5%	**Buenos Ayres Elec. Trams (1901) Ltd.**	93—10[illegible]	5 0 0	..	..	..
100	5½%	**Buenos Ayres Grand National 5½% Pref. Debs.**	101—105	5 4 9	..	..	—
100	6%	**Do. 6% 1st Deb. Bonds**	102—107	5 12 0	..	..	..
5	4/6	**Calcutta Tramways (Nos. 1 to 105)**	8—$8\frac{1}{2}$	4 15 0	—	$8\frac{1}{16}$	8
5	2/6	**Do. Nos. 105,001 to 137,610**	$7\frac{9}{16}$—$8\frac{1}{16}$	4 18 6	..	$7\frac{3}{4}$	..
10	4½%	**Do. 4½% 1st Deb. Stock (red.)**	102—104	4 6 6	—	..	..
1	[illegible]/6	**Cape Electric Tram Shares**	$\frac{9}{16}$—$1\frac{3}{8}$	6 3 0	—	..	..
St.	5%	**Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)**	100—102	4 18 0	—	..	..
..	5%	†**Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.**	94—96%	5 4 0	..	96	$95\frac{1}{2}$
St.	5%	**Kalgoorlie Elec. Trams 5% "A" Deb. Stock**	92—93	5 7 0	..	..	..
St.	6%	**Do. 6% "B" Ditto**	88—93	6 9 0	..	..	..
1	1/0	**Lisbon Elec. Trams Ord.**	$1\frac{3}{8}$—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	**Do. 6% Cum. Pref.**	$1\frac{1}{8}$—$1\frac{3}{8}$	4 7 4	..	..	..
100	5%	**Do. 5% Reg. Mort. Debs.**	100—103	4 17 0	..	..	..
St.	5%	**Madras Elec. Trams 5% Deb. Stk.**	100—103	4 7 6	Ja, Jul	..	..
100	4½%	**Montreal St. Ry. Sterling 4½% Debs. (1922)**	102—104	4 6 6	—	..	..
St.	5%	**Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.**	104—106	4 14 8	..	..	..
..	$2	**Sao Paulo Tramway, Light and Power Co. $100 Stock**	139—14[illegible]	5 13 6	..	..	..
..	5%	**Do. 5% 1st Mt. $500 Dbs.**	97%—99%	5 1 0	..	98	$97\frac{1}{2}$
		ELECTRICITY SUPPLY.					
5	3/0	**Adelaide Elec. S'ply Co. 6% Cu. Pr.**	$4\frac{3}{4}$—$5\frac{1}{4}$	5 14 6	..	..	..
5	5/[illegible]	**Calcutta Elec. (1-60,000)**	8—$8\frac{1}{2}$	4 18 6	—	$8\frac{11}{32}$	$8\frac{1}{8}$
50	5%	**City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.**	48—50	5 0 0	..	..	..
..	5%	**Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.**	92—94	5 6 4	..	..	..
5	..	**Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.**	$2\frac{1}{2}$—3	..	..	..	—
St.	5%	**Do. 5% Debs.**	85—89	5 12 4	—	..	..
St.	6%	**Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.**	110—113	5 6 0	—	..	..
1	0/7½	**Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.**	$\frac{25}{32}$—$\frac{29}{32}$	6 18 0	—	..	..
1	1/6	**Rand Electric**	$1\frac{5}{8}$—$1\frac{1}{16}$	—	—	—	..
1	..	**River Plate Electricity Co. Ord.**	$\frac{7}{16}$—$\frac{9}{16}$	..	..	..	..
1	1/2⅞	**Do. 6% Non. Cum. Pref.**	$\frac{7}{8}$—1	6 0 0	..	..	..
St.	5%	**Do. 5% Deb. Stock**	99—102	4 18 1	..	..	..
5	3/0	**Rosario Elec. Co. 6% Pref. (1-20,000)**	$5\frac{1}{8}$—$5\frac{5}{8}$	5 8 6	..	..	..
100	4½%	***Royal Elec., Montreal 4½% 1st Mort. Deb**	99—102	4 8 0	Ap, Oct	—	...
..	5%	**Shawinigan Water and Power 5% Bds., Scrip**	99—101	4 19 0	..	99	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., July 25.	Rate % Yielded.	Dividend Due.	Business, Week to July 25. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10½–11½	6 3 6	..	–	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11–12	5 0 0	..	–	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104–106	4 4 0	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛–8⅝	4 18 0	..	8⅜	8¼
St.	4½%	Do. Do. 1st Debs	101–104	4 7 6	–	103½	103
1	5/6	Brompton & Kensington Elec. Sup. Ord.	8–9	5 11 6	–	..	..
1	3/6	Do. 7 per Cent. Pref.	7¾–8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100–103	3 17 9	–	..	..
1	2/6	Charing Cross (W. End & City) El. Sup. Co.	4–5	5 0 0	Feb, Aug	–	..
5	2/8	Do. 4½ per Cent. Pref.	4–4½	5 2 0	Feb, Aug	4 7/16	..
St.	4%	Do. 4% Deb. Stock (red.)	99–102	3 18 8	–	..	..
5	2/8	Do. City Undertaking 4½% Cm. Pref.	3⅝–4⅛	5 9 0	–	..	..
5	2/8	Do. Do. (1903)	3⅝–4⅛	5 9 0	–	..	..
5	3/9	Chelsea Electric Supply Ord.	5½–5¾	6 6 0	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106–108	4 3 3	Jn, Dec	107	.
10	5/0	† City of London Electric Lighting Ord.	10–10¾	5 10 6	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122–125	4 0 0	Jn, Dec	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	99–102	4 8 3	..	.	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	[illegible]–1 1/32	3 19 0	April, Oct	.	..
5	5%	Do. Do. 5% non cum. pref.	5 1/16–5 5/16	4 15 3	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	5 14 0	–	8	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12¼	4 18 0	Mar, Sept	12	11⅝
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106–109	4 2 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101–104	4 6 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	101–104	4 6 6	–	..	..
5	5/0	Hove Electric Lighting Ord.	7½–8	5 11 0	–	8⅛	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98–101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtnbdg. Ord	10–11	4 11 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98–101	3 19 2	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101–103	3 17 6	–	..	..
8	2/4½	London Electric Supply Ord.	2–2½	4 0 0	–	..	..
5	3/0	Do. 6 per Cent. Pref.	5–5½	5 7 0	–	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96–99	4 0 10	Mr, Jn, S, D	.	..
5	10%	Metropolitan Electric Sup. Ord.	8–9	5 10 0	April, Oct	8⅛	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 5/16–5 9/16	4 1 0	Jan. July	5 15/32	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109–113	4 1 10	Jn, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	94–96	3 13 0	–	95½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98–101%	4 9 1	–	99¾	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11–11½	5 17 2	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103–104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7¾–7⅞	5 2 6	Feb, Aug	7⅞	–
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅞–6	4 1 0	Feb, Aug	5 15/16	..
100	4%	Do. 4% Mort. Deb. red. 1907	100–101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1¼–1 9/32	2 7 4	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	101–102	4 8 9	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97–99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅝–6⅞	4 17 0	March	..	..
St.	4%	† Do. 4% Deb. Stock	97–99	4 1 0	–	..	..
5	7/6	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7–8	4 7 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95–97	3 12 2	–	96½	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2–2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76–80	5 0 0	–	..	..
5	4/0	South London Electric Supply Ord	2½–3	6 18 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	..	..	–	–
1	0/8¾	Do. 7% Cum. Pref.	1 3/16–1 5/16	5 9 0	..	1 3/16	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105–106	4 5 0	–	..	.
5	2/6	Urban Electric Supply Ord.	3–4	6 10 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4¼–4¾	5 5 0	–	4½	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100–102	4 8 0	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	10¼–11¼	6 0 0	Mar, Sept	10⅝	10½
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 15/32	5 11/32
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	† Baker St. & Waterloo 4% Perp. Db. St.	88–91	4 8 0	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	–	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100–104	4 6 6	–	102	100¾
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98–100	4 10 0	..	98½	..
10	8½%	Bristol Tramways and Carriage Ord.	15¼–15¾	5 8 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	10–10½	3 18 0	..	..	–
St.	4%	Do. 4 per Cent. Debs.	101–103	3 17 6	Feb, Aug	..	.
10	6/0	† British Electric Traction Ord.	11⅜–11⅞	5 2 0	–	11⅝	11⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	8⅝–9⅛	6 11 0	Feb, Aug	9⅛	8¾
St.	5%	Do. 5 per Cent. Perpetual Debs	109–113	4 8 6	..	112¼	111
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	89–92	4 19 0	..	91	90
St.	4%	Central London Ordinary Stock	85–87	4 12 0	June, Dec	87	86½
St.	4%	Do. 4 per Cent. Pref. Stock	99–101	3 19 0	..	99½	..
St.	4%	Do. Deferred Stock	73–76	5 5 0	..	..	.
100	4%	† Do. 4 per Cent. Debs.	108–110	3 12 8	..	109⅜	109
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88–91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf	5–5½	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100–103	3 17 6	..	102	101¾
St.	1¾%	City and South London Rly. Con. Ord	42–44	4 6 0	Feb, Aug	43½	42¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120–123	4 1 4	Feb, Aug	–	..
St.	5%	* Do. (1896)	114–117	4 5 3	..	..	..
St.	5%	Do. (1901)	114–117	4 5 3	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104–107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord	14¼–15¼	3 18 6	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14–15	4 0 0	..	..	.
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼–3¾	10 13 4	..	3 15/32	3 7/16
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100–103	4 7 6	..	101½	..
10	9%	‡ Imperial Tramways Ord	15–16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11–11½	5 4 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	–	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2–2½	..	–	..	–
St.	4%	Do. 4 per Cent. Deb. Stock	77–83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8⅛–8⅜	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99–102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8–8½	5 17 4	–	8¼	8
St.	4%	Do. 4% 1st Mort. Deb. Stock	92–95	4 4 0	–	..	..
St.	..	Mersey Con. Ord. Stock	4–6	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8–11	–	–	..	..
1	–	Metropolitan Elec. Trams Def.	⅛–¼	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	13/16–15/16	5 9 0	–	29/32	..
St.	4½%	Do. 4½% Deb. Stock	100–102	4 8 3	–	..	..
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	¾–1¼	..	May	1¼	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¾	5 5 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½–8½	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100–103	4 7 8	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89–92	5 8 8	–	91	90½
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90–92	5 8 8	–	..	..
St.	3½%	Waterloo and City Ord.	100–103	3 3 0	June, Dec	102	100¼
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3–3½	..	..	..	..
St.	4½%	Do. 4½% 1st Debs.	93–95	4 14 9	–	..	–

Shre.	Last Dividend	Name.	Price Wed., July 25.	Rate % Yielded.	Dividend Due.	Business, Week to July 25. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.		£ s. d.			
	10½d.	Aron El. Met. 6% Cm. Pf.	1 7/16–1 9/16	..	–	..	..
1	2/4½	Babcock & Wilcox Ord	3¾–4	4 14 0	..	3 11/16	3 11/16
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	–
1	4/0	British Insulated & Helsby Cables Ord.	6⅜–6⅞	5 18 0	July, Feb	..	..
1	8/0	Do. 6 per Cent. Pref.	[illegible]	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102–105	4 5 6	..	..	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96–98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1¾–2¼	..	..	1 15/16	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77–83	4 16 6	..	–	..
1	1/0	Brush Electrical Engineering	⅝–⅞	..	March –	..	..
2	2/4¾	Do. 6 per Cent. Pref. Non-Cum.	1⅝–1⅞	6 8 0	Mar, Sept	..	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97–99	4 11 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82–84	5 7 2	Jan, July	..	–
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5 13/16	5⅝
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108–110	4 2 0	Nov, May	..	..
1	7½d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97–102	4 8 0	–	..	..
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	–	–	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	1 11/16–1 13/16	3 19 0	Jan, July	1¾	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	94%–97%	5 3 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1 11/16–1 13/16	5 12 0	Sept –	1 5/16	..
5	8/0	Do. 6% Cum. Pref.	1⅛–1⅝	4 5 0	Sept –	1 5/16	..
St.	4½%	Do. 4½% Deb. Stock	103–106	4 5 0	..	..	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1⅜–1⅝	4 18 0	Feb, Aug	..	..
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85–87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90–95	5 5 0	–	..	..
5	2/6	Edmundson's Elec. Corp. Ord.	3¼–4¼	8 10 0	H'lf-yearly	8	..
5	8/0	Do. 6 per Cent. Cum. Pref.	4½–5	6 0 0	..	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	100–103	4 7 4	–	102½	100
2	1/7½	Electric Construction Co.	⅝–⅞	11 4 0	July –	..	..
2	2/9⅜	Do. 7 per Cent. Cum. Pref	2–2½	5 12 0	July	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. (red.)	86–89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9–9½	5 5 8	..	9½	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93–97	4 2 6	–	..	..
5	10/0	Henley's Telegraph Works Ord.	12–13	5 15 0	Feb, Aug	..	–
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 1 6	Feb, Aug	..	–
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107–109	4 2 6	..	107½	..
St.	12/6	Do. Do. Scrip (all paid)	107–109	4 2 6	..	..	–
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17–18	2 17 2	Feb, Aug	17¼	..
100	..	Do. 4% Debs. Red.	100–102	3 19 6	..	101	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11¾–12¼	4 1 8	Mar, Sept	..	–
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 13 6	–	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	96–99	4 11 0	..	..	..
12	12/0	† Telegraph Construction & Mainten'ce.	32½–34½	6 1 6	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100–102	3 18 3	Jan, July	..	..
1	5/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16–2 9/16	5 17 0	..	2½	2 13/32
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1¼	4 0 0	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	114–117	4 5 4	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103–105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105–107	4 4 6	–	..	..
5	–	Willans and Robinson Ord.	1–1½	–	Apr, Oct	1	..
5	–	Do. 6 per Cent. Cum. Pref.	5¾–6¼	–	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77–82	4 17 6	May Nov	79¾	78
		TELEGRAPHS.					
10	–	Amazon Telegraph	8–8½	..	Jn, Dec	..	..
100	5%	Do. 5% Debs. (red.)	80–85	5 17 8	..	..	..
St.	15/0	Anglo-American	65–67	4 17 0	F, My, Ag, N	..	..
St.	10/0	Do. Preferred	112½–113½	5 7 0	F, My, Ag, N	113½	112⅝
St.	10/0	Do. Deferred	21½–21¾	2 9 0	F, My, Ag, N	21 9/16	21¼
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–98½	4 0 6	Jn, Ap, Jy, O	98½	97¾
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17–18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8½–9	5 11 0	April, Oct	..	–
100	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	4/0	Direct United States Cable.	15¾–16¼	4 12 6	Ja, Ap, Jy, O	16	15¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99½–101½	4 8 9	Jn, Dec	..	..
St.	25/0	Eastern Ordinary	144½–145½	4 16 0	Ja, Ap, Jy, O	144½	143½
St.	17/6	† Do. 3½ per Cent. Pref. Stock	89–91	3 17 0	Ja, Ap, Jy, O	90½	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107–109	3 13 4	May, Nov	108½	107
10	2/6	† Eastern Extension	14–14½	4 16 6	Ja, Ap, Jy, O	14½	14
St.	4%	Do. 4 per Cent. Deb. Stock	106–108	3 14 6	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	100–102	3 19 3	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37–39	6 8 0	Jan, July	38¾	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½–101½	4 8 9	June, Dec	..	..
25	12/6	Indo-European	47½–49½	5 6 3	May, Nov	..	..
100	4%	Mackay Companies Common	73 11/16–74 3/16	5 8 0	Jan, July	–	..
100	4%	Do. Preference	73¾–74 3/16	5 8 0	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	1 1/16	31/32
100	4%	Pacific & European Tel. 4% Guar. Dbs. (rd.)	99–102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	–
5	–	West Coast of America	¾–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	99–102	3 17 0	Jan, July	..	..
10	–	West India and Panama	⅜–½	..	May, Nov	1	..
10	4/0	Do. 6% 1st Pref.	6–7	8 11 4	May, Nov	6½	–
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	5½	..
100	5%	* Do. 5 per Cent. Debs.	99–102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	14½–14¾	4 15 0	Mr, Jn, O, D	14⅝	14⅜
100	4%	Do. 4% Debs. (2nd Series, 1906)	–	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	102–105	3 16 2	..	104½	103¾
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94–96	4 8 4	..	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101–103	4 17 0	..	..	..
5	3/0	Chili Telephone (fully paid)	7⅞–8⅛	4 18 0	August –	8 1/16	–
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 8	–	–	..
1	0/6	Do. 6% Pref.	⅞–1	6 0 0	..	..	..
St.	6%	National Co. Pref. Stock	110–112	5 7 0	–	111½	110⅝
St.	5%	Do. Def. Stock	110–112	4 9 3	–	111½	110¾
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11–13	4 13 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10–12	5 0 0	Feb, Aug	11⅛	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅜–5⅞	4 5 0	Feb, Aug	5 13/16	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	90½–92½	3 11 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102–104	3 17 0	–	104	103½
1	0/9⅜	Oriental	1 1/16–1 3/16	4 8 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16–1 5/16	4 11 0	–	..	–
St.	4%	Do. 4% Red. Deb. Stock	97–99	4 1 0	..	97	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100–103	4 7 6	..	..	..
5	3/0	United River Plate xd & rights	6¾–7¼	5 11 0	July –	6⅝	6¼
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	108½–111½	4 9 9	June, Dec	111	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	–	..	..
10	5/0	Globe Telegraph and Trust	10⅞–11⅛	4 19 0	Ja, Ap, Jy, O	11⅛	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅜–14⅞	4 0 6	Ja, Ap, Jy, O	14 11/16	14⅝
10	6%	Submarine Cables Trust (Cert.)	127½–130½	4 11 9	April, Oct	129	

* In calculating the yields, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE British Association gathered at York on Wednesday in glorious summer weather. It was in this ancient metropolis of the North that the British Association was born 75 years ago, and it is claimed that the Association largely owes its existence to the Yorkshire Philosophical Society, the founders of the York Museum. This is, however, the fourth meeting held here, the third being the great jubilee meeting of 1881. The district is one of very great interest to the archæologist, geologist and palæontologist, and is, besides, an ideal centre for the holiday maker. Perhaps it is this last consideration that has caused this meeting to be fixed earlier in the year than is usual. The attendance, however, is not phenomenal, the number of subscribers enrolled up to Thursday noon being 1,868.

FOR the ordinary member the proceedings opened with Prof. RAY LANKESTER's presidential address on Wednesday evening. In the main it was the president's endeavour to delineate the great changes that the lapse of 25 years has wrought in the scope and outlook of all the sciences. But, undoubtedly, the part of the address that called from the audience the most sympathetic response was that which bewailed the too slow growth of that influence in public affairs which ought to belong to men of science. Special stress was laid on those affairs where men of science come into contact with public men and officialdom in general. Of these matters the president has himself had personal experience; it is well known, for instance, that his resignation from the directorship of the Natural History Museum is at the present moment under consideration.

PROF. LANKESTER approached the subject of the neglect of science with something of an apology, fearing that the subject might cause some personal annoyance, for his aim was not that general neglect of science with which Prof. PERRY has made us familiar, but rather the neglect of science by officialdom in this country. Feeling that the subject is thorny, he suggested that it might be handled more effectively by a committee appointed by the Council of the Association than in a Presidential Address. That Government Departments having charge of scientific matters should be administered by scientific men is only reasonable, and reform in that direction should not be difficult. But it is much less easy to influence a Government in special matters. Nevertheless, the idea that the Directorship of Kew Gardens could be assigned "to a young man of influence, devoid of all knowledge of botany," is an absurdity that should be made impossible. Prof. LANKESTER's one remedy is that the governing class should have a scientific education as against one of classics and athletics. It is difficult at present to know what the governing class will be in the future; but, however that class may change, there is not likely to be much sympathy between our legislators and our men of science. If only a greater number of scientific men would take up Parliamentary life things might be materially improved. Unfortunately, however, it would be difficult to find two more antagonistic subjects than politics and science.

THE report of the Royal Commission on motor cars issued last week cannot fail to be of interest, not only to engineers and constructors of automobiles, but to the large and increasing class who make use of independent mechanically-propelled vehicles for business purposes as well as for pleasure. The most important of the recommendations of the Commission is the abolition of the present arbitrary speed limit of 20 miles an hour, which has proved such an inefficient means of ensuring the safety of the public, and has led to so much annoyance as enforced by the rural police and magistracy. In the words of the report, "The object of the law should be not to punish speed because it is speed, but because and where it is dangerous or otherwise injurious to the public."

◆

The general character of a large part of the report is, however, the admission of difficulties without suggesting adequate solutions. The desire to be fair to all parties is evident throughout, and there is a total absence of that prejudice which has too often disfigured both official and unofficial utterances on motor car questions in the past. A number of alterations to the present law are suggested: some matters of detail, such as the exact position of number-plates and lamps, and some of greater moment. We cannot but think that the recommendation to limit the speed of vans over 2 tons in weight with non-resilient tyres to 5 miles an hour will be a set-back to a rapidly developing section of the automobile industry. Much of the annoyance caused by badly constructed heavy vehicles is already covered in another recommendation, which very rightly seeks to characterise as an offence the causing of excessive noise or vibration not of a momentary description. A large section of the report is devoted to the all-important dust question, but no satisfactory conclusions are drawn. It is, however, proposed to slightly raise the taxes on motor cars, and to devote the revenue thus collected to the improvement of the roads.

◆

We have received from Messrs. Preece & Cardew the following remarkable letter, which was addressed to them by a Scotch boiler maker: "Gentlemen, with reference to my tender of this date for the boilers, &c., for the Shanghai Municipal Council, I beg to state that I do not know what other makers' prices for water-tube boilers are. I am of opinion, however, that my water-tube boilers can be made and sold at prices at least 5 per cent. less than what Messrs. Babcock & Wilcox will charge, but as I have no desire to cut prices and undersell Messrs. Babcock and Wilcox, the price I have quoted for the boilers, &c., amounting to . . . . , carries 5 per cent. for you.—Yours faithfully, ..."

◆

From the above it is evident that the "secret commission" is by no means dead, legislation notwithstanding. Probably every consulting engineer has had the inducement of a commission held out to him from time to time, and it would be well if consulting engineers could combine to deal effectively with such illegalities. As a rule, offers of this kind are made with such discretion that very little action of a public kind can be taken, though in some cases the course adopted by Messrs. Preece & Cardew of returning the tender unopened can be adopted, and should have a salutary effect.

◆

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Bolama—Bissao	July 24, 1906

A New Professorship of Electrical Engineering.—Mr. Clarence H. Mackay and Mrs. John W. Mackay have given a sum of £20,000 to endow a professorship of electrical engineering at the University of California. The chair will be known as the John W. Mackay professorship in memory of Mr. Mackay's late brother, and will be filled by Prof. C. L. Cory.

Electric Traction on the Midland Railway.—The directors of the Midland Railway have approved of a scheme to convert a portion of their line to electrical working. The full details of the project are not yet settled, but it is said that the commencement of the scheme will be the equipment of the lines between Lancaster, Morecambe and Heysham Harbour, and that a single-phase system will be adopted.

Mr. Alfred Beit's Will.—Our attention has been called to the fact that the sum bequeathed by the late Mr. Alfred Beit to the College of Technology at South Kensington is really considerably larger than might at first sight appear. For, as pointed out in *The Times*, the 5,000 preferred shares at £2. 10s. in De Beers Consolidated Mines are worth, at present prices, about £85,000, so that the sum actually left to the College of Technology represents about £135,000.

Wireless Telegraphy.—The "Sudan Gazette" publishes the text of an Ordinance (No. 2 of 1906) constituting wireless telegraphy in the Sudan a Government monopoly by providing that no person shall instal or make use of any apparatus for wireless telegraphy, or transmit or receive messages by means of any such apparatus within the Sudan except the Department of Telegraphs or a duly authorised officer or official of the Sudan Government, unless such person is in possession of a special licence in writing from the Governor-General.

Greenwich Observatory and the London County Council.—In addition to the appointment of Sir Benjamin Baker to act as the representative of the London County Council on the Committee suggested by the Admiralty for investigating the effect of the working of the new power station at Greenwich on the Observatory, to which we referred last week, the Council have arranged with Prof. C. V. Boys for him to act in an advisory capacity. The other two members of the Committee, Lord Rosse and Prof. J. A. Ewing, will represent the Admiralty.

An Electrical Recording Target.—A volunteer correspondent of the *Newcastle Daily Chronicle* mentions a self-recording target, the invention of Lieut.-Col. Peters, a Canadian, who has been at Bisley this year. The hits are electrically recorded at the elbow of the firer by numbers on a disc. The target is a metal one, there being a row of sensitive hammers behind it. The bullet on striking the target operates a hammer which completes the electric circuit and records the value of the hit at the firing point. The value of the invention appears to lie in the elimination of human markers and their attendant fees.

The Crystal Palace School of Engineering.—The 101st presentation of certificates to the students of the Crystal Palace Company's School of Practical Engineering was held on Wednesday last at the lecture room of the school. Mr. Maurice Fitzmaurice, C.M.G., chief engineer to the London County Council, presided, and Mr. Maurice Wilson, the vice-principal of the school, read the examiner's report, which spoke very favourably of the students' work during the session. The chairman addressed the students, and Mr. J. W. Wilson, the principal, also spoke. After the ceremony an exhibition of the students' work was held, and the visitors were given the opportunity of inspecting the several departments of the school.

Electrical Signalling Gear at Crewe.—The whole of the new signalling equipment of the extensions and rearranged portion of Crewe station and yard will be on the "Crewe" all-electric system patented by the late Mr. F. W. Webb and Mr. A. M. Thompson. According to the *Railway Engineer*, there will be, when the work is completed, nine electrically-worked signal boxes in all at Crewe. Five of these in the marshalling sidings have been in operation for some years. For the passenger station there will be four other cabins. That at the North Junction will contain 266 levers and that at the South Junction will have 247 levers. There will also be two smaller boxes in the station, each containing 26 levers. The whole installation will, when completed, comprise 1,002 levers.

Thunderstorms.—Considerable damage is reported to have been done by the recent severe thunderstorms. On Tuesday last, one or two persons were killed in Yorkshire when sheltering under a tree, and at Redcar the post office was set on fire. A fire at the house of Sir Andrew Noble at Jesmond, Newcastle, is also attributed to the effects of the storm, which is said to have effected the fusing of a wire. An accident is reported to Mrs. Hine, daughter of Sir Walter Gilbey, who received a severe shock during the storm last Friday while speaking on a telephone at Elsenham Hall. The lightning also struck the telegraph wires near Saffron Walden station and caused communication on the branch line to be interrupted. Some damage was also done on Friday to an electric tramcar at the corner of Plashet-road and Green-street, Upton Park, West Ham, at about 2 p.m. The light wires were burnt and broken and the current evidently shorted across a trolley plank screw before reaching the lightning arrester.

Voltages used on Board Ship.—It is announced in *The Times* that there is reason to believe that the voltage in use in the Royal Navy, which is now fixed at 80 volts in most war ships, is to be changed gradually to 100 volts. Attention is also called to the lack of uniformity of voltage in the mercantile marine, and the following list is given of the voltages employed by different steamship companies :—

P. & O. Co. 95 and 100; Royal Mail Steam Packet Co., 110; Orient Line, 55; Lund's Blue Anchor Line, 100 and 60; Nippon-Yusen-Kaisha (Japanese Mail Line), 65 and 80; Elder, Dempster Line, 60 and 65; Canadian Pacific Railway Co.'s steamers, 60, 65, and 100; Federal Steam Navigation Co., 60 and 75; Union Castle Line, 100; Houston Line, 100; Shaw-Savill & Albion S.S. Co., 100; New Zealand Shipping Co., 100; Allan Line, 100 and 110; Dominion Line, 60 and 100; White Star Line, 60; Tyser Line, 65 and 100; Corry & Co. (Star boats), 100; Indra Line (T. B. Boyden), 60; Turnbull, Martin & Co., 60 and 100; Houlder Line, 60 and 100; Glen Line, 65 and 100; and Aberdeen Line, 60.

The Electrical Equipment of the Aberdeen Tramways.—The report of Mr. J. Alex. Bell, city electrical and tramways engineer, on the condition of the electrical and mechanical equipment of the Aberdeen tramways mentions one or two alterations to the overhead construction. Due to trouble having been experienced with section breakers during the year 1904-5 (the trolley wire ends drawing out in severe frost), half anchor ears and anchors were installed on all of the section breakers throughout the system. Since this has been done, there has been no recurrence of this form of breakdown. The Brooklyn strain insulators used on the trolley span wires have, in a few cases, broken down through failure of insulation—this being most noticeable on the Sea Beach section, where they are most exposed to the salt air—and are now being replaced on this section with porcelain reel insulators, some of which were installed on trial during the last few months. Various types of mechanical ears have been tried for supporting the trolley wires instead of soldered ears, and on the next occasion it is necessary to renew ears on any of the routes, it is intended to make a more extended trial of the type of ear which is found most satisfactory. In speaking of the repairs to rolling stock, Mr. Bell attributes the increased wear on the rails directly to the addition of canopy tops to some of the cars, and considers that the breakdowns to motor armature and field coils were due partly to the magnetic brakes, but anticipates the extra care in their use will help to keep down trouble of this sort. The majority of failures in field coils occurred at the time when the track was salted for snow, as the salt water penetrated the insulation. There has been a substantial reduction in the cost of rolling stock repairs as compared with previous years, the figure now standing at 0·42d. per car mile.

An Improved Recording Instrument.—An improved form of recording instrument, specially intended for use on electric tramcars and for railway tests, is described by Prof. F. W. Springer in the *Electrical World*. The records are obtained by puncturing the paper strip with a series of sparks obtained from an induction coil. The tip of the pointer of the ammeter, voltmeter or other instrument whose indications are to be recorded, is connected to one secondary terminal of the sparking coil and moves in front of a row of 150 thin metallic strips embedded in an insulating block. Highly insulated leads are taken from each of these strips to a corresponding row of metallic points embedded in a similar block almost touching the paper on the recording drum, while the metal recording drum is connected to the other terminal of the induction coil. A series of sparks is thus caused to pass through the paper from the sparking point corresponding to insulated strip opposite which the tip of the pointer of the indicating instrument is situated at any instant, so with the points very close together a practically continuous curve is produced. In the actual instrument illustrated three indicating instruments are provided for line voltage, speed and current respectively, and each is fitted with its own row of sparking strips connected to the sparking points over the paper so that the three curves are traced on the one strip. A motor-driven distributor connects the pointers, all three in turn, with the coil. A second coil, connected to a contact-maker driven by a clock, serves to mark the scale of time on the record in a similar way. Any number of copies of the curves can be made with a stencil ink roller. The apparatus has been used with success at the University of Minnesota, and tests have been taken of a high-speed interurban car of the Twin City Rapid Transit Co. of Minneapolis.

A 60,000 Volt Sub-station and Transmission Line.—The equipment of the sub-station of the Syracuse Rapid Transit Co. for the supply of current for traction purposes and the new 60,000 volt transmission line by which power is conveyed to it, is described in a recent article in the *Street Railway Journal*. Current is obtained from the Niagara Falls plant of the Ontario Power Co. and transmitted partly over the lines of the Niagara Falls, Lockport & Ontario Power Co. and partly on the Syracuse Rapid Transit Co.'s short length of new line, at 55,000/60,000 volts, 25 cycles. The line loss for the whole distance, about 165 miles, is approximately 8 per cent. The three high-tension cables drop from an anchor tower situated 10 ft. from the west wall of the sub-station building to anchor insulators suported on angle-iron brackets projecting from this wall. From these insulators the cables pass through the wall of the building to a second set of insulators on the inside wall corresponding to those on the outside wall. The method of bringing the H.T. cables into the sub-station building is somewhat unique. At the point of entry the building wall is pierced with three sections of 36 in. vitrified pipes, one for each branch of the three-phase circuit. Within each pipe is set a circular disc of ½ in. plate glass, each plate having a 3 in. hole through its centre, through which passes one cable of the circuit. The H.T. cables within the sub-station are enclosed in ⅜ in. brass tubing. The whole of the H.T. switch gear, together with the multi-gap lightning arresters, static interrupter, &c., are in a room apart from the transformer room. Three single-phase 1,000 kw. oil-insulated water-cooled Westinghouse transformers are provided, which step down from 55,000 to 430 volts. Each transformer has three independent secondaries for supplying the three rotary converters. A thermometer is provided near the top of the case of each transformer for indicating the temperature of the surface oil, and attached to each thermometer is an electrical contact device for operating an alarm should the temperature of the oil become excessive. In the converter room are three 8-pole 1,000 kw. six-phase 25 cycle compound wound rotary converters, designed for a normal output of 1,667 amperes at 600 volts continuous current. Each converter is provided with a small induction motor for starting up, and is fitted with an oscillator which maintains a slight lateral motion of the armature to prevent ridging of the commutator. The new part of the high tension transmission line referred to above for the most part runs alongside the Erie canal and crosses over three railways, besides several factories and buildings. It is carried entirely on lattice steel towers, of which there are 40 along the two miles of route ranging from 45 ft. to 63 ft. in height, measured from the ground to the lowest insulator. An unusual feature of the line is the employment of steel cables for the conductors. Each conductor consist of a $\frac{7}{16}$ cable of seven strands and is strung in one length from the junction with the main transmission line to the sub-station. Steel was used instead of copper or aluminium principally on account of its greater strength. The average span is about 240 ft., and the longest single span 407 ft. The insulators are of the triple petticoat pattern, carried on the cross-arms by special malleable iron pins. These insulator pins are 21 in. in height over all, and have flat bases some 9 in. square bolted to the cross-arms by four ⅝ in. bolts. The insulators themselves are made in several parts cemented together. The three insulators on each post form the corners of an equilateral triangle with sides 7 ft. long.

OILS FOR HIGH-TENSION SWITCHES.

BY JOS. H. BOLAM, M.Sc.

The necessity of manipulating heavy currents at high voltages has tended to the development of oil-break switches and fuses, and most modern installations are equipped with this type of circuit-breaker. In its elemental form the oil circuit-breaker consists of contacts supported from insulators, and connected by a short-circuiting strip, moved by a handle, also efficiently insulated. The contacts and short-circuiting strip are totally enclosed in a vessel containing oil, the function of the oil being dual—viz., the extinguishing of the arc caused on opening circuit, and the necessary insulation of the contacts from each other and the short-circuiter, as well as from the containing vessel.

It would seem that but little attention has been paid to the necessity of securing a proper and suitable oil for use in switches, and the published records of oil insulation tests certainly point to the fact that the question has not been deemed of much importance.

The safe and efficient working of this type of switch, especially when it is automatic in action, is affected in a larger measure than is generally supposed by the quality and properties of the oil used. In modern equipments the main switches or circuit-breakers are so arranged that a current of predetermined strength, or a reverse current, operates an automatic gear which causes the switch to open—that is to say, an overload or reverse current automatically operates the switch. It is not proposed to enter into the details of such attachments, suffice it to say that the usual method is to free or bring into action a spring against which the switch is closed, the spring catch being released through the agency of a trip coil.

Trouble has been experienced by the use of oils which in process of time tend to, as it were, glue the switch-contacts together, and so upset the adjustment that the spring, on release, failed to open the switch. That is to say, a short circuit on a feeder takes place, the maximum current-release closes the trip-coil circuit and this in turn opens the spring catch, but the switch does not operate. This is, of course, a serious danger, and the fact that it is not only possible but has actually happened shows that there is room for more care in the selection of a suitable oil.

As to the points to be observed in such a selection it would seem that the following essentials should be borne in mind:—

1. The oil should have a high insulation resistance, so that there is no possibility of leakage between contacts or from contacts to frame or box.

2. It should be capable of quickly extinguishing the arc set up on opening the switch. In doing this the deposit of carbon should be a minimum, no damage should be done to the contacts, and the oil should not, so to speak, blow out of the containing vessel.

3. It should be free from acids, sulphur, or any other compounds liable to attack or corrode the contacts of the switch.

4. It should not "gum" or leave any deposit which could in any way alter the adjustment of the switch in the manner before mentioned.

5. It should be as fluid as is consistent with the requirements of "2," and should remain fluid at all working temperatures—that is to say, the oil should not become thick at any temperature at which the switch may be employed; probably, for outside work special oil must be used.

6. It should have a high-flash point, so that overheating does not mean danger of firing. High-flash point also indicates comparatively low evaporation under ordinary conditions of temperature and reasonable immunity from risk of fire if a switch case were to break. A flash point of not less than 400°F. should be insisted upon.

7. It would be advantageous if the oil were transparent, so that deposits caused by heavy arcs or any foreign materials could be easily seen without emptying the switch box.

The above qualities of a switch oil require, in a greater or less degree of importance, consideration in selecting a standard. It is not possible to combine all these properties in any type of oil perfectly, but experience points to the best results being obtained with mineral oil. Nearly all oils are good insulators when pure and not deteriorated, and there is little to choose between the three types (vegetable, animal and mineral) on this score, provided the oils are good. But the action of the arc on the oil altogether alters the aspect of the case, for certain oils are so decomposed as to be practically useless in a very short time. Tests on castor oil, for example, show that, although a voltage of over 5,000 may be required to break down a thickness of 0·05 in., the arcing is maintained, gas evolved, and the contacts quickly covered with a deposit of carbon.

The oils used for switch work are generally mineral or resin, and in recent years the latter has fallen into disfavour, so that a brief comparison of the properties of the two types may be of interest. The insulation properties are so nearly alike that there is little to choose between the two oils; the resin oil is slightly the better, but it is possible to obtain a mineral oil to withstand 15,000 volts between contacts 0·1 in apart without any trouble. Curves showing the actual sparking resistances of various oils are given below, and it will be seen that little danger is to be apprehended on the score of insulation if the oil be clean and dry.

The arc is readily extinguishable by either oil, but a certain amount of disintegration and consequent deposit is unavoidable. The more quickly the arc is extinguished, the less is the deposit; moreover, the oil should be of sufficient fluidity to free itself, so to speak, of gas bubbles, and present a fresh layer between the contacts. Certain mineral oils, especially those chemically purified, animal and most vegetable oils are on this score unsuitable; constant switching with heavy currents will ultimately render any oil unsafe. The deposit will, in time, not only spoil contacts but will cause conduction and leakage between the contacts and the case. Hence, however good the oil, periodic renewal and cleaning must be carried out.

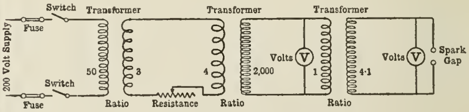

Fig. 1.—Arrangement of Testing Circuit.

An oil untreated by chemicals is essential, so that a mineral oil of high quality only should be used.

A resin oil tends, so to speak, to glue the contacts, and for this reason alone its use in automatic switches should be condemned. The flash point of resin oils is low; a sample supplied for switches tested at 200°F., and this is altogether unsuitable. A resin oil can be obtained, however, to flash at 340°F.

It would thus appear that the best switch oil is: A pure mineral oil refined by distillation only; of flash point (C.F.P.) not less than 400°F., free from suspended matters, acids, sulphur or deleterious chemicals, transparent, and fluid at 20°F. The oil should not lose more than 0·5 per cent. when heated to 212°F. for 12 hours, and must be absolutely free from moisture. The minimum di-electric strength—as hereinafter set forth—should be, for a thickness of 0·1 in., 14,000 volts.

The importance of freedom from moisture cannot be exaggerated. It was found that exposure of a vessel of oil for only two days in a damp room caused a drop in the di-electric strength of as much as 25 per cent.; the amount of water actually present was not, however, determined.

The attached curves are the results of a series of tests on various switch oils, and for comparison an ordinary engine oil was tested and the results also plotted. Through some seeming coincidence the curve for this oil is nearly a straight line.

The method of testing was to immerse two polished brass balls $\frac{1}{2}$ in. diameter, and formed on the ends of brass rods, in a cylinder containing the oil. The distance between the two balls—*i.e.*, the width of the spark-gap, was measured by a micrometer-gauge attached to the top rod. The top ball was let down on to the bottom fixed-ball and then lifted vertically by the micrometer, thus recording the distance between. The voltage was, of course, applied by joining one pole to each ball, and tests were carried out with spark-gaps from 0·03 in. to 0·16 in. As already mentioned, the presence of moisture lowers the sparking resistance, and in the tests recorded care was taken to secure dry and clean oil for each gap.

The voltage was measured by means of a Kelvin electrostatic balance connected to the ball terminals, and checked by using electrostatic voltmeters on the primary of the step-up transformer.

Transformation from 210 volt alternate-current supply down to 12 volts from 12 up to 6,000 and from 6,000 to 25,000 with regulation on the low voltage (12) gave the required range of pressure. The arrangement is shown diagramatically in Fig. 1.

The oils tested included (*a*) resin oil, C.F.P. 200°F.; (*b*) mineral oil, C.F.P. 410°F.; (*c*) mineral oil, C.F.P. 430°F.; (*d*) mineral oil, C.F.P. 320°F.; (*e*) mineral oil, C.F.P. 380°F.

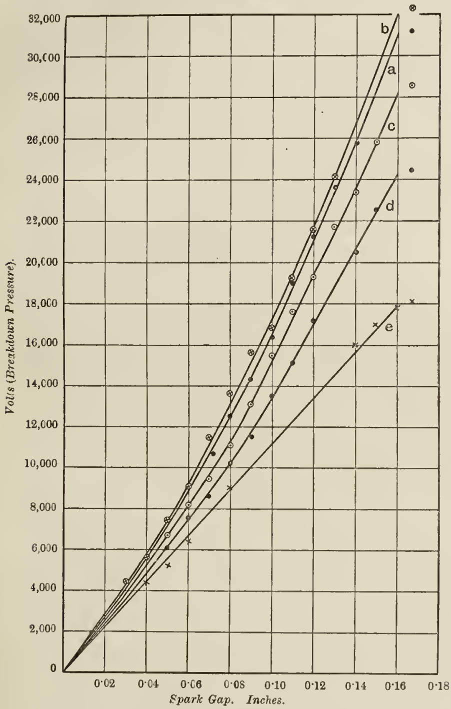

FIG. 2.

a. Resin Oil, C.F.P. 200°F. *b*. Mineral Oil, C.F.P. 410°F.
c. Mineral Oil, C.F.P. 430°F. *a*. Mineral Oil, C.F.P. 320°F.
e. Mineral Oil, C.F.P. 380°F. (Engine Oil).

Of these (*b*) was in every way the most satisfactory, it was transparent and frequent sparking did not appreciably deteriorate the oil; (*a*) was dark in colour, opaque and had every tendency to gum; (*c*) resembled (*b*) but was not so good an insulator; whilst (*d*), although a pure mineral oil, deteriorated rapidly on sparking; (*e*) was an ordinary engine oil tested as a comparison, it is a pure mineral and did not appear to contain moisture.

Other oils were tested but space forbids further details either of these or of a minute description of the testing gear. Fig. 2 shows the respective dielectric strengths and may be of interest.

THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.*

BY K. REINHARDT.

The idea of burning blast-furnace gases directly in gas engines, instead of under steam boilers, as had previously been done, was first put into practice barely 10 years ago, almost simultaneously in Great Britain, Germany and Belgium.

The pioneers of this movement made their first experiments with small engines. After these experiments had given satisfactory results, and it had been shown that the thermal value of the poor blast-furnace gases, in spite of defective scrubbing, could with safety be directly transformed into mechanical work in the gas engine, there very soon arose a considerable demand for gas engines of large power, similar to the large steam engines employed in metallurgical works.

In face of these sudden requirements, the gas engine builders were placed in a difficult position; for up to that time the gas motor was considered as suitable for small engines only, and it was generally believed that the limit of size had been attained with 100 to 150 effective horse-power in a single cylinder.

Manufacturers of gas motors, however, did not underrate the advantages offered by this new field for their manufactures, and it so happened that in Germany the Berlin-Anhaltische Maschinenbau-Gesellschaft of Dessau, was the first to undertake the construction of a 600 H.P. two-cycle gas engine, with two cylinders of the Oechelhäuser-Junkers type, for the Hoerder Mining and Smelting Co. The engine was started in 1898, and after a few improvements and alterations, is still working satisfactorily. The engine worked with astonishly high efficiency, considering the period. The builders were therefore in a position to prove in Germany that the gas-motor, even as a large engine, was suitable for the utilisation of blast-furnace gases. The results obtained by the Hoerder Smelting Co., combined with the fact that the use of blast-furnace gases in gas engines is much less dangerous than the burning of the same under steam boilers, and is at the same time from three to four times as efficient,† encouraged other ironworks—*e.g.*, the Friedenshütte and the Differdingen ironworks, similarly to introduce gas engines; and during the last few years the example of these ironworks has been followed by a number of collieries, with a view to the more perfect utilisation of the gases from their coke ovens.

Even though, as was only natural, all these early gas engines showed certain defects of design and insufficient purification of the gas, nevertheless, from the results obtained, and especially from those of the large installations of gas engines supplied by the Cockerill Company of Seraing to Differdingen, it could be concluded that, with a small reserve, the power supply of an ironworks and, to a certain extent, of a rolling mill could be assured with gas engines as the motive power, without serious disturbance of the existing arrangements. This can no longer be doubted when the improvements made by engineers engaged in the manufacture of gas engines in their designs, as shown by the Oechelhäuser two-cycle motor, the Koerting double-acting two-cycle motor, and the Deutz double-acting four-cycle motor are considered. The Maschinenbau-Gesellschaft of Nürnberg, the Cockerill Society and other manufacturers have also entered the field. It would not otherwise have been possible for the application of blast furnace gas to have become so widely spread in so short a space of time.

The present Paper may be regarded as a continuation of those read before the Society of German Ironmasters by Dr. Lürmann,‡ Prof. Meyer,§ and the author.¶

The object of the present Paper is to review—

(I.) The extent of the application of gas engines in ironworks and collieries in Germany;

(II.) The working results, including the influence of purification on the gases; and

(III.) Present practice in the design of large gas engines in Germany.

In order to arrive at conclusions as correct and complete as possible, the ironworks and collieries possessing gas engines were invited to answer a series of questions, and the manufacturers of gas engines to supply detailed drawings. And in taking this opportunity of thanking them, the author wishes to say that he received from all the ironworks and collieries complete and descriptive replies, which he was authorised to make use of to his questions; the information received from the manufacturers being sufficient to enable the various types to be compared.

The questions, which were circulated through the kindness of the

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* Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on July 24th. Slightly condensed.

† *Stahl und Eisen*, 1899, p. 484.

‡ *Ibid.*, 1898, No. 6; 1899, No. 10; 1901, Nos. 9 and 10.

§ *Ibid.*, 1899, No. 10; 1905, Nos. 2 and 3.

¶ *Ibid.*, 1902, Nos. 21 and 24.

Society of German Ironmasters in February of this year, were as follows:—

How many gas engines have you at work, in course of erection, or on order? What type do they belong to? What size are they? What are they used to drive? What proportion of horse-power of the above are for continuous working, and how many are kept as reserve?

With what kind of gas are the engines worked—blast-furnace gas, coke-oven gas, or a mixture of both?

Is a gas-producer plant provided as a reserve?

How are the gases purified and cooled?

What power and how much water is employed for the purification of the gases consumed by the engine?

What proportion does this power bear to the power obtained from the purified gases?

What is the cost of purifying per cubic metre of gas?

What apparatus is employed to dry the gases after purification?

What is the percentage of dust contained in the gases before and after purification?

Are pressure regulators arranged in the gas-main to the engines, and, if so, are they provided for each engine or for the whole installation?

What is the capacity of the pressure regulator?

What is the pressure of the gases before they reach the engine, and within what limits does it vary?

At what temperature and with what percentage of moisture in grammes per cubic metre is the gas supplied to the engines?

After what period of working is a complete cleaning of the internal parts of the whole apparatus undertaken, and how long does this take?

Which parts require cleaning first of all, or more frequently than the rest, and how long does the cleaning of these parts take?

Do stoppages and troubles occur, and what are the causes of these: (*a*) broken springs? (*b*) hanging of the valves? (*c*) failing to start? (*d*) failure of ignition?

Have important parts of the machine already become defective, and how long after the first starting of the engine? What do you consider the causes: (*a*) cylinders? (*b*) cylinder covers? (*c*) pistons? (*d*) bell boxes? (*e*) piston rods?

How much water is used for cooling per horse-power and per hour: (*a*) for the cylinders? (*b*) for the pistons and rods?

At what pressure is the water used for cooling the pistons?

How much fresh oil is used per effective horse-power and per hour in the case of: (*a*) cylinder oil? (*b*) machine oil?

Has the consumption of gas by the engine been determined? If so, by what method, and what was it?

What sizes of units are, in your opinion, the most suitable for blowing engines and for driving dynamos?

Can alternating-current dynamos driven by gas engines be coupled in parallel without difficulty in your works?

A similar series of questions dealing with the special conditions at collieries was also sent out.

I.—The Extent of the Application of Gas Engines in Ironworks and Collieries in Germany.

The author received answers to the questions in the beginning of March of this year.

From the inquiry it was ascertained that of the 49 German smelting works questioned, 32 had already gas engines at work and 9 had ordered such engines.

		H.P.
There were at work—	203 engines having a total effective power of about	184,000
In course of erection, being erected and on order	146 engines having a total effective power of about	201,000
Together	349 engines having a total effective power of about	385,000
	Of these Engines there were—	
	64 having a power of about of older construction (single-acting four-cycle motors)	34,000
	88 engines having a power of about two-cycle motors, and	91,000
	197 engines having a power of about double-acting four-cycle motors.	260,000

In addition to the above there were ordered by German ironworks and collieries from March 1 up to July 1, 1906, the following:—

		H.P.
There were at work—		
	7 two-cycle motors of about	7,800
	24 double-acting four-cycle motors of about	28,350
Together	31 engines of about	36,150
	Of these Engines there will be working, for driving Blowing Engines—	
	7 two-cycle motors of about	7,800
	7 double-acting four-cycle motors of about	9,400
Together	14 engines of about	17,200
	For driving Dynamos—	
	— two-cycle motors of about	—
	17 double-acting four-cycle motors of about	18,950
Together	17 engines of about	18,950
	For Driving Blowing Engines there will be at work—	
	15 old form single-acting four-cycle motors of about	8,200
	44 two-cycle motors of about	50,100
	77 double-acting four-cycle motor of about	103,000
Together	136 engines. Of about	161,300
	For Driving Dynamos there will be at work—	
	48 older model single-acting four-cycle motors of about	25,600
	41 two-cycle motors of about	35,700
	110 double-acting four-cycle motors of about	144,800
Together	199 engines. Of about	206,100
	For Driving Rolling Mills there will be at work—	
	— older model single-acting four-cycle motors	—
	3 two-cycle motors of about	5,200
	7 double-acting four-cycle motors of about	10,900
Together	10 engines. Of about	16,100
	For other purposes—	
	4 engines of about	1,500

The largest aggregate power of gas engines at a single works amounts to 35,000 effective horse-power. Sixteen works possess over 10,000 H.P., and 27 works possess over 5,000 H.P., in actual working.

In most ironworks the whole of the gas engines work continuously without any reserve; a few have up to 40 per cent. reserve of gas engines, and a few have a similar reserve of older types of steam engines or steam turbines.

Nearly all engines in ironworks, naturally, work with blast-furnace gases. Two plants use only coke-oven gases, three use blast-furnace gas and coke-oven gas separately, and one plant uses the two gases mixed. Further, the Mansfield Company utilises the waste gases from the copper-smelting furnaces for driving gas engines. Producers employing coke as fuel are kept as a reserve at seven works. They are really only of use in case of a strike, to assure the working of the most necessary part of the plant.

The application of gas engines in collieries is much less important. This is due to the fact that the heat given off by the older type of coke oven can only be utilised under steam boilers, and consequently for these older plants, steam boilers are inevitable in collieries. Only the excess gas produced in the coke ovens is available, so that steam engines and gas engines will always be found in conjunction, and indeed in larger proportion as regards steam engines than is the case in ironworks. In the new regenerative coke ovens the waste heat is utilised for pre-heating the oven itself, whereby there is an economy in gas, and a greater excess of gas is available for driving gas motors. The irregular production of gas can, however, only be considered available or free from drawbacks for motor driving when at least 60 coke ovens are in operation. To this must be added, that the production of gas in coke ovens is much more irregular than in blast furnaces.

Perhaps in the near future, in addition to the excess coke oven gases used for driving motors in collieries, producer gas, which will be obtained in the ring-producer patented by Bergrat Jahns,* may also be used. The chief object of this producer is the utilisation of the waste heaps or culm banks, and the production of gas, as far as possible free from tar. The gas from the producer mentioned is naturally also suitable for the driving of gas engines, which is demonstrated by the gas-engine plant at the Von der Heydt mine.

The same object is effected by the Turk and other producers; but, so far as the writer is at present aware, the utilisation of the waste heaps and of low-grade coal in gas-producers is only just being introduced, so that, for gas engines in collieries, at present only coke-oven gas need be taken into consideration. So far as he is aware, in the beginning of March of this year, 16 collieries possessed 35 gas engines at work, in course of erection, or on order.

The aggregate power of all these engines was 30,300 effective horse-power. Of these 24 engines were already working at 15,600 effective horse-power, nearly all for the production of electricity.

The introduction of large gas engines in collieries was subsequent to their introduction into ironworks, and, therefore, only engines of comparatively modern construction are to be found. Exception must, however, be made in respect to the smaller motors, which were early employed in plants for the recovery of the by-products in coke-oven gas.

II.—Practical Experience obtained in Working.

From what has been learned up to the present time it is clear that a thorough purification and drying of the gas is undoubtedly the principal factor in assuring a continuous and undisturbed working of gas engines. German gas engine manufacturers have from the very first considered the cleaning of the gas an essential condition, while, on the other hand, the Cockerill Company considered it unnecessary.

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* *Zeitschrift des Vereins deutscher Ingenieure*, 1904, p. 311.

As a matter of fact, at many places Cockerill engines were working satisfactorily without any cleaning whatever, while at other works this practice resulted in very disagreeable experiences; in one case, owing to the excessive wear of the working surfaces of the cylinder, and another time owing to premature ignition caused by the formation of a crust, chiefly on the piston ends, favoured probably by excessive lubrication. If at one works the engines gave satisfaction without the gas being cleaned, and at another works similar engines were unsatisfactory, this only proves that the gas is not cleaned, contains different percentages of dust at various works as it issues from the furnace throat, and that it may become partially cleaned in the gas-main. It proves further that the same quantity of dust does not everywhere have the same effect, since it may be composed, in some works, of soft substances which do not so quickly cause excessive wear of the working-surfaces.

The design of the older Cockerill engines was, moreover, as regards the inlet-valves, not very sensitive to the effect of dust, the units most frequently constructed being 600 H.P. in one single-acting cylinder, and in consequence the sections of the gas passages before the valve and of the inlet-valve itself were of rather large dimensions, and parts likely to be injured by the dust were not present with the system of governing then employed.

The methods of governing, and of mixing the gases in newer constructions in which more stringent specifications for smaller variations of speed are laid down, are much more sensitive to the presence of dust, owing to their being combined with springs as delicate as possible, in order to keep the resistance of the governor and back pressure upon it as low as possible.

If the spindles or regulating slide valves are covered with a coating of dust, for instance, the springs are no longer sufficiently powerful to move these parts at all, or at the right moment, irregular working results and disturbances in working result. This also occurs if dust is deposited on the valves or slides, the positions of which are regulated by the governor according to the load on the engine. The valves and throttle valves (manipulated by hand) of the gas main leading to the engine are also very sensitive to dust. The dust deposits on them very readily, and renders them difficult to move, and the areas at these places for the time being unduly restricted, so that the engine does not receive sufficient gas to maintain its normal power. In all the above cases, in addition to the percentage of dust, the percentage of water contained in the gas when admitted to the engine also exercises an injurious effect.

It is easily understood that moist dust adheres with greater facility to the surfaces with which it comes in contact than dry dust, the greater part of which passes through the engine without being deposited.

Great trouble is experienced with moist and dusty gas when the engine does not run continuously, but stops working on Sundays, for instance. It may then happen that the deposit of wet dust, which, while the engine is continuously working, does not offer very great resistance to the motion of the valve-gear, dries to a hard crust while the engine is not running, and causes these moving parts to become jammed, rendering the starting of the engine impossible.

The circumstances mentioned above are the result of the gas not being sufficiently purified or dried, as well as of the greater consumption of oil necessitated, and the consequent increase of dirt inside the motor, and, as a matter of fact, are the cause of most of the troubles experienced in working. For this reason, in all new plants, great importance is attached to the effective cleaning of the gas.

Before the introduction of blast-furnace gas engines the washing of blast-furnace gas was considered necessary or advantageous for blast-heating and steam-raising purposes; the presence of dust diminished the efficiency of the combustion and of the heat transmission, and rendered frequent cleaning of the hot-blast stoves necessary, although cleaning the gas for the above purposes did not have to be carried out to the degree necessary for the working of motors.

The whole of the gas from the blast furnace is now subjected to a certain amount of washing, determined by experience, while the gas destined for utilisation in the motors undergoes still further purification.

For a standard type of purifying plant for blast-furnace gas, the following may be observed :—

The gases on leaving the blast furnace are led through a series of so-called dry purifiers, and hence through long pipe-lines into the coolers or scrubbers, and from these into the so-called centrifugal purifiers (Theisen apparatus or fans with water spray). After leaving the above plant the purification of the gas should be complete, so that before being admitted into the engine the gas has only to be dried in filters or in capacious tanks.

In several plants, by drying and by passing through a long main to the engine, a further noteworthy purification of the gas takes place.

With regard to the construction and manner of working of the various apparatus, the following remarks may be made :—

The dry purifiers consist generally of a combination of cylindrical vessels, in which the gas is led downwards with a rapid motion and upwards with a slow motion. During this movement, and especially during the change of direction of the stream of gas, the coarsest particles of dust are separated. The pipes leading from the above should be made as long as possible, with as large a section and as many sudden changes of direction as possible, in order that the gas may be further freed from coarse particles of dust.

The coolers or scrubbers are vessels in which the gas flows from the bottom to the top, and the water from the top to the bottom. The water must be finely sprayed in order to moisten the dust, and thereby increase its weight and cause it to settle to the bottom. At the same time the gas is cooled in the scrubbers, in which the water vapours are condensed, and the dust is deposited.

The vessels are either empty, in which case the water is finely divided by spraying nozzles, or the interior is arranged with sieves, wire-netting, coke, or wooden trays. The best example of the latter form is the Zschocke scrubber.

The interior of the Zschocke scrubber consists of a series of wooden trays, one above the other, intended to reduce the velocity of the falling water, and by reason of their special form to divide the water into fine streams, so that the large surface exposed may effect a satisfactory cooling of the gas. The precipitated dust is removed at the bottom of the scrubber.

In centrifugal purifiers the further separation of the dust is effected by centrifugal action on the wet dust. The application of this apparatus renders it possible to attain a satisfactory purification of blast-furnace gas. The first centrifugal purifier in Germany was the Theisen apparatus, patented by Mr. Theisen, of Munich.

In Duedelingen it was subsequently discovered accidentally that an ordinary fan, with water injection, was also very efficacious for gas cleaning.*

The Theisen apparatus (Figs. 1, 2, 3, 4), according to a description given by one of the makers, the Dingler Maschinenfabrik, consists essentially of the following parts :—

1. The suction chamber A.
2. The pressure chamber B.
3. The middle chamber C.
4. The drum with shaft and bearings D.
5. The grating E.

Water enters at F tangentially to the casing of the middle chamber C, and leaves the apparatus through the pipe G.

The manner of working this apparatus may be described as follows :—

After the gas has been cooled and charged with water vapour, it is drawn in by the vanes *h*, and the coarse dust is separated in the suction chamber. Through the action of the fans at both ends of the drum D the gas is then drawn through the space between the drum and the casing. The outer circumference of the drum (Figs. 1—4) is provided with a number of inclined spiral vanes *i*, so that the gas has also to travel a long way in the form of a spiral. Hence, by injecting water at the same time through the pipes F, a high degree of purification of the gas takes place, and the accompanying water vapour is simultaneously condensed. The dust is then projected against the spiral meshes of the coarse grating E fixed to the interior surface of the casing. By centrifugal action the water entering in a tangential direction is at the same time distributed over the surface of the grating, which prevents it from becoming clogged and incrusted with the separated dust. In addition to this, the surface of the water is broken up, thus favouring cooling and condensation. This washing of the gas absorbs carbonic acid and sulphurous gases.

The purified gas then enters the discharge chamber B, from which the water is thrown out by the vanes *k*, and the gas is forced to the engines with a pressure of from 50 to 100 millimetres of water. The washer reduces the dust from 3 or 4 grammes per cubic metre of gas to 0·02 or 0·03 gramme, with a consumption of 0·8 to 1·5 litres of water per cubic metre. The washer is generally driven by a direct-coupled electromotor, and the smaller sizes by belting, at a speed of from 300 to 450 revs. per min. The sizes generally used range from 6,000 to 33,000 cubic metres per hour, and the power required from 50 to 150 effective horse-power.

Theisen imputes the useful action, during purification, in his washer to the steam present in the blast-furnace gas and to that formed by contact with the injected water, and on this account recommends his apparatus to be placed, not behind the scrubber, but without such apparatus by introducing simple gas pre-moisteners immediately behind the dry purifier, in order that the gas may be as hot as possible at the entrance into the apparatus. On the other hand, Prof. Osann,† in an exhaustive investigation of the purification of blast-furnace gases, chiefly by the action of cooling surfaces for the water vapours and the deposition of dust, considers it preferable to clean and cool the gases previous to their being introduced into the Theisen washer, so that the latter has only to remove the finer particles of dust which are otherwise difficult to separate. He hopes by this arrangement to effect a saving of power.

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* *Stahl und Eisen*, 1901, p. 447.

† *Ibid.*, 1902, p. 153.

The fans employed for the purification of the gases, as constructed by R. W. Dinnendahl at Steele, only differ from ordinary air fans in the construction of the vanes and bearings, which are of much heavier construction, to cope with the injection of water and the higher temperature of the gas They are provided with a water inlet at the suction opening, and with an arrangement, as in disintegrators, for pulverising the water, so that a sort of water curtain is formed through which the dust has to pass. The cohering particles of dust and water are separated by centrifugal action through which these particles are thrown against the inner circumference of the fan-casing. The under portion of the fan-casing opens into a tank A, from which the separated slimes flow away and the purified gas escapes at the top outlet. The method of purification resembles that of the Theisen apparatus, except that in the former the passage for the opposing action of the gas and water is not so long.

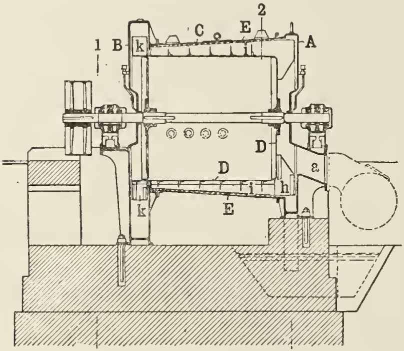

Fig. 1.

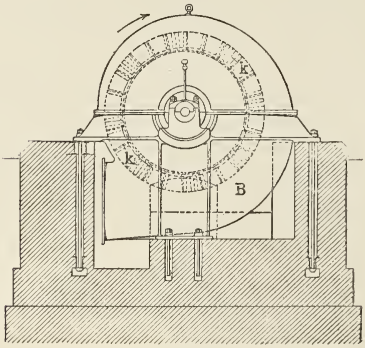

Fig. 2.

The usual sizes of gas-cleaning fans, according to Dinnendahl, are from 15,000 to 70,000 cubic metres of gas per hour, requiring from 40 to 110 H.P. The circumferential velocity of the impellers is up to 56 metres per second, with a diameter of from 1·1 to 1·75 metres. For 1 cubic metre of gas from 1½ to 2 litres of water are required, and the dust is reduced from 3 grammes to 0·2 gramme; as a rule the percentage of dust is reduced to one-tenth of the percentage before washing.

When two or more fans are arranged parallel to one another for the purification of large quantities of gas, it is often difficult to obtain outputs equal in quantity and quality. It is therefore advisable to provide regulating dampers behind the fans, and, above all, to make the mains, both before and after the branches to the fans, of large diameter, so that they can at the same time act as air vessels. As a certain preventive of the above difficulties, which are often of a very annoying character, the author can only offer one sggestion, namely to drive the fans and the electromotors alike with the same speed in such a manner that their axes could be connected with friction couplings, so that the fans produce equal difference of pressure.

Of the other purifying apparatus employed, only the Bian cooler may be mentioned.* This consists of a horizontal shaft turning within a cylindrical casing and carrying a number of discs of wire-netting. The lower halves of the discs dip into water, and the gas passes through the meshes of the upper halves. The purification of the gas is continued in centrifugal apparatus until the desired degree of cleanliness is attained, after which it has only to be dried. This is effected by forcing the gas through a series of layers of wooden fibre or wool in large cylindrical casings, to which it yields its water. Naturally the resistance caused in passing the layers of wool requires a large expenditure of power, and the renewal of the wet wool together with the cost of attendance, necessitates the installation of a spare drier. Large vessels containing various materials through which the stream of gas is forced, with frequen changes of direction, are employed for the separation of the water, and these vessels are further aided by long pipes with frequent changes of direction. If a large gas-holder is erected between the cleaning plant and the engines, in addition to its quality as a pressure regulator, it does excellent service in the separation of water, and renders the previous drying of the gas and the expenditure for attendance on the plant and power superfluous.

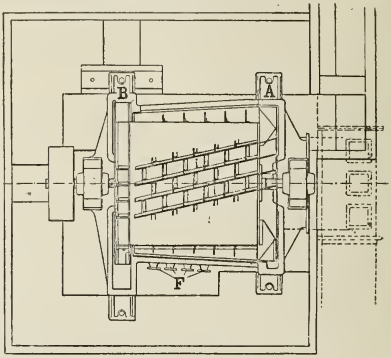

Fig. 3.

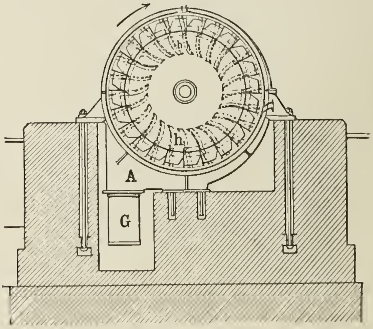

Fig. 4.

It must here be mentioned that in several ironworks it was not found possible to reduce the percentage of moisture in the gas arriving at the engine to the point of saturation at the corresponding temperature of gas. In such cases, after the supply of water to the scrubbers had been cut off, so that they were only employed as dry coolers or purifiers, the gas was not so perfectly cleaned, but was drier, and worked with less harmful results in the gas-motors than before.

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* *Stahl und Eisen*, 1905, No. 17, pp. 1-31; 1906, No. 1, p. 32; and 1906, No. 8.

A few remarks concerning the purification of coke-oven gas for utilisation in gas engines must still be added.

The gas at disposal for this purpose has already been so far purified by the recovery of by-products that, as a rule, only the remains of tar, and also sulphur and cyanides, have to be removed. The tar residues are removed in so-called tar separators, which consist of high cylinders of boiler plate in which a number of platforms or ledges are arranged alternately to the left and to the right, so that the gases pass through in a zigzag direction and the tar is deposited on the ledges. Other apparatus work in a similar manner, the main stream of gas being divided into a large number of smaller streams and by the resulting sudden alterations of direction, and also by impinging on the plate walls, the gas is freed from tar (Pelouze apparatus). Further, rotary cleaners are in use, which serve for the separation of ammonia, naphthalin, cyanide, and sulphuretted hydrogen, and according to the form of the rotating surface are arranged as hurdle, brush, or ball washers (patented by Zschocke*), The Theisen washer can also serve this purpose; but, as far as the author is aware, it has not as yet been so employed. The inventor hoped to obtain good results, especially in the separation of tar.

The separation of sulphur and cyanide is, according to Prof Baum, best obtained by filters. The filtering material employed consists of Laming composition, a mixture of bog-iron ore and wood shavings. The composition in layers of 6 in. to 8 in. deep is carried by plates or gratings; the gas passes through two to four such layers, one after the other, and the iron combines with the sulphur to form iron sulphide, and with the cyanide to make iron cyanides (Prussian blue). The composition is from time to time taken out of the filter and exposed to the air, by which means the sulphur is oxidised and the composition regenerated and ready to be used again.

In passing through the filter not only the sulphur, but also the tarry liquors, water and heavy oils remain behind. For this reason plants which do not require the removal of sulphur often employ filtering apparatus, the Laming composition being replaced by sawdust or wood fibre. Gasometers, which are frequently placed as near as possible to the engines, and, as in the case of blast-furnace gas, at the same time regulate the pressure, also serve to dry the gas.

With reference to the purification and its influence, the following may be seen from the answers to the questions: All smelting works have centrifugal apparatus in use for removing the fine dust, and, indeed, about half of them have scrubbers or Bian coolers with fans, and the rest scrubbers with Theisen apparatus, Theisen apparatus alone, or fans alone. The respective merits of the various apparatus or processes cannot well be ascertained from the information received from the ironworks, as it is not easy to reduce the results to a common basis. The following results nevertheless are perhaps of interest:—

The power expended in cleaning 1,000 cubic metres of gas per hour varies mostly between 6 and 13 effective horse-power. Accordingly, the power expended in cleaning varies from 1·8 to 4 per cent. of the power obtained by the purified gas.

The amount of water used for cleaning varies greatly. It requires on an average from 3 to 8 litres per cubic metre of gas, and is naturally dependent on the temperature of the water. Generally speaking, the water used with centrifugal apparatus alone is less than when it is employed in combination with scrubbers. Similarly, the cost of cleaning varies considerably, and includes interest and depreciation of the purifying plant (0·03 to 0·06 pfennig per cubic metre).

The percentage of dust in the gas after the dry purification is on an average 4 to 6 grammes per cubic metre. In a few cases, however, it is only 1 to 1·5 grammes. In most instances the gas for working the motors is reduced to a percentage of 0·015 to 0·03 grammes of dust per cubic metre, in a few works even to 0·005 to 0·004 grammes per cubic metre.

All these remarks concerning the percentage of dust are to be judged from the point of view that the determination of the same at one and the same ironworks, if not absolutely correct, will always be proportionately exact; but that this latter will perhaps not always be the case of tests carried out by different ironworks. It would therefore be of importance to adopt a standard method for the determination of the percentages of dust and water, so that all results could be exactly compared.

If the purification effected by the Theisen apparatus is compared with that by fans, it will be found that, according to the manufacturers, the Theisen apparatus cleans in the proportion of 140:1. Thus for 1,000 cubic metres of gas cleaned per hour there is required 5 effective horse-power, and per cubic metre 1·15 litres of water on an average.

With a fan the cleaning is on an average 10:1, the power required being 2·2 H.P. and the water used 1·75 litre.

In order to obtain a similar result, two to three fans would have to be placed one behind the other, which would require perhaps 5 H.P. to 6 H.P. per 1,000 cubic metres gas per hour, and a consumption of about 4 litres of water per cubic metre of gas.

From the information supplied by the ironworks only the total result can in most cases be reviewed; however, in a few cases the result of the cleaning by each apparatus is given, and from this the author concludes that a single Theisen apparatus cleans better than a single fan, since with the former the proportion of cleaning is between 90:1 and 25:1, with about 6·5 effective horse-power per 1,000 cubic metres gas, and with a fan the proportion is about 12:1 and the average effective horse-power 2·3. From two fans, one placed behind the other, a proportion of cleaning from 50:1 to 200:1, and power employed from 6·5 to 10 effective horse-power per 1,000 cubic metres per hour, has been attained. Without taking the consumption of water into consideration, one Theisen apparatus is approximately equal to two fans.

With one exception, all ironworks possess apparatus for drying the gas as described above.

In no case does the gas contain any suspended water—that is, no water above the quantity at the point of saturation at the corresponding temperature.

This temperature is, in most cases, the same as the temperature of the air, or only a few degrees higher. In a few cases the percentage of water is even lower than that corresponding to the point of saturation at the temperature of the gas, but this is only possible when the water used for cooling is at a very low temperature and the gas is cooled to below the temperature of the gas arriving at the end of the gas main.

A further cooling of the gas would be of great utility, favouring the separation of water and purification, and thereby assuring the continual working of the gas engines without disturbance.

The particulars which the author received from the collieries are not so complete as those received from ironworks, owing to the collieries not yet having so much experience.

Of 15 collieries which were questioned, two had no special plant for the purification of the gas, but only plant for the recovery of the by-products—four collieries have plant for the separation of sulphur and tar, six a similar plant for sulphur only and three a plant for tar only. The power expended is only that necessary to overcome the resistance of the gas passing through the purifier, which is on an average about ¼ per cent. of the power developed. The other working expenses consist only of the renewals of the filtering material which amounts on an average to about 0·03 pfennig per cubic metre; whilst the expenses of the purification plant itself increases greatly with the sulphur in the gas.

Only traces of tar have to be removed by the purifier, but it is much more important to remove the sulphur, which attacks the cylinders, piston-rings, piston-rods and stuffing-boxes. In one case it is stated that the percentage of sulphur was reduced from 5 grammes to 0·7 gramme per cubic metre.

The heating value of coke-oven gas varies from 2,500 to 4,600 calories per cubic metre. The amount of gas available for gas engines also varies extraordinarily, ranging from 3¼ to 50 per cent. according to the quality of the coal used, and above all according to the type of coke-oven.

In the replies to the questions addressed to ironworks, attention should be called to the fact that about one-half of the works place gas-holders between the purifying plant and the motors. The capacity of the holders in proportion to the gas consumption varies considerably. One ironworks places a gas-holder of smaller size, arranged as an equaliser of pressure, before each engine.

The pressure of the gas at the engines is on an average from 2 in. to 4 in., but in many plants it is 8 in. and over. The variations in the gas pressure naturally depend on the number of gas engines at work and of furnaces in blast, and on whether the blast-furnace tops are provided with a double seal or not. As a rule, it is recommended that the gas pressure be maintained as regularly as possible, and not much above the pressure of the atmosphere (about equal to from 1¼ in. to 2½ in. water). This can, of course, only be done by using a gas-holder, which, besides being an excellent separator for water, possesses the advantage of preventing a reduction of speed or even the stopping of the gas engines when the supply of gas is suddenly interrupted for a short period, as may happen when only a small number of blast furnaces are at work. Long gas mains of large section also serve as a reserve, although not so effectively, and for a short period tend to equalise the pressure.

The intervals at which the engine or its several parts have to be cleaned vary greatly. From information received from ironworks, it may be concluded that with gas well cleaned (0·015 to 0·03 gramme of dust per cubic metre), and at the same time well cooled and dried, the inlet gear—that is, the parts before the cylinder of the engines—must be cleaned at intervals of two to three months, and a complete internal cleaning must be undertaken every six or eight months.

In a few plants using gas which is specially clean, the engines require less frequent cleaning. In others the inlet-gear, throttle-valves, and other similar parts require cleaning at periods of 14 days. At the same time, when the lubrication is not excessive, and even when the gas is not well cleaned, an internal cleaning of the engine every two to three months is sufficient.

The parts before the cylinder require for cleaning on an average from six to twenty hours, according to the size and build of the engine and the number of men employed, and the internal cleaning requires from two to eight days.

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* Baum, *Glückauf*, 1904, No. 17, p. 457.

The quantity of water used for cooling the cylinders and pistons averages 8·8 to 11 gallons per hour and per effective horse-power, of which 2·2 to 2·6 gallons are for the pistons. The consumption of oil in most plants is reckoned at 1 to 1·25 grammes per hour per effective horse-power. The consumption of gas has not yet been sufficiently tested to compare the various systems.

According to trials made at ironworks, the heat employed by the engines varies from 2,200 to 3,300 calories per hour and per effective horse-power. Most ironworks are at present not yet in a position to determine the consumption of gas in their engines, and content themselves with testing the exhaust gases, and thereby determining the completeness of the combustion in the motor.

From the answers received from the collieries, engines using coke-oven gas require cleaning after similar periods to those using blast-furnace gas.

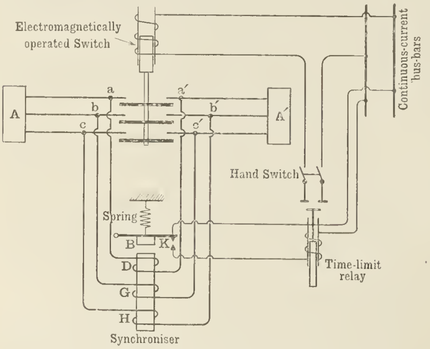
Generally speaking, however, at present the collieries have not sufficient experience to answer this and other questions authoritatively. The traces of tar in coke-oven gas, which are difficult to remove and to burn, probably necessitate more frequent internal cleaning; and, above all, the piston-rings, stuffing boxes, oil-holes, and other similar parts require greater attention.

(*To be continued.*)

AUTOMATIC SYNCHRONISER FOR THREE-PHASE GENERATORS.[*]

BY DR. GUSTAV BENISCHKE.

In order to throw two generators into parallel with each other, it is necessary to have them (1) running at synchronous speeds and (2) in direct opposition of phase. Thus the complete process of synchronisation involves two distinct conditions, and it is evident that neither an instrument of the differential tachometer type, nor a phase meter, could, if used alone, be adapted to the automatic closing of the parallelling switch. An automatic synchroniser must be constructed so as to be incapable of acting unless the two conditions mentioned above are both satisfied, and unless the speed of the incoming machine is sufficiently steady to enable the synchronising switch to be closed with perfect safety. This last condition requires a suitable form of time-limiting device, so constructed that unless the speed remains synchronous for a predetermined period the synchroniser will not act.


Electromagnetically operated Switch
Continuous-current bus-bars
a
a′
b
b′
c
c′
A
A′
Hand Switch
Spring
B
K
D
G
H
Time-limit relay
Synchroniser

CONNECTIONS OF AUTOMATIC SYNCHRONISER.

The connections of the new synchroniser, described by the author, are shown in Fig. 1. A and A′ are the two three-phase generators to be synchronised. Their terminals are connected through the three coils D, G and H wound on the core of the synchroniser magnet. This magnet acts on the armature B of a pivoted lever supported by a spring and capable of closing the contacts K when pulled down by the magnet. The closing of these contacts causes a current to flow through the solenoid of the time-limit relay. The plunger of this relay carries a contact disc which is capable of closing the circuit of the electromagnetically-operated main switch. The rod supporting the contact disc is prolonged beyond it (this is not shown in the sketch) and terminates in a large disc which presses against a flexible bag filled with air. The air in the bag communicates with the atmosphere by means of a tiny aperture whose size may be adjusted. Before the relay can close the circuit of the main switch, it has to drive the air out of the bag. Should in the meantime the speed of the incoming machine have altered, causing the contacts K of the synchroniser to be separated, the relay plunger falls back and the air bag is immediately filled with air by the action of an air inlet valve, so that it is again ready for use.

In order that the synchroniser may act properly, the three coils D, G and H must be arranged so that the resultant magnetomotive-force reaches its maximum value at the instant when the E.M.F.s are in exact opposition of phase. It will be noticed that while coil D is across the corresponding terminals *a* and *a′* of the two machines, the connections of the remaining two coils G and H are transposed on the A′ side. If each coil were equally effective in producing a pull on the armature, then it might be shown that the pull would attain a maximum when the P.D. across *aa′* was removed by 30 deg. from its zero value. But by winding the coils as shown in the figure, D being placed nearest the armature end of the core, the phase of the pull relatively to the P.D across *aa′* is displaced in such a manner that the maximum value of the pull occurs at zero value of the P.D. across *aa′*, which is the condition required for satisfactory working.

The time limit relay is being manufactured by the Allgemeine Elektricitäts-Gesellschaft from designs due to the General Electric Co., and the time which elapses between the closing of the relay solenoid circuit and that of the main switch may be varied from 2 to 20 seconds.

It is obvious that the time-limit relay may be combined with the synchroniser, or the synchroniser coils may be wound directly on the relay bobbin. This, however, is not to be recommended, as the relay takes a good deal of current, and if supplied from instrument tranformers would occasion an excessive drop.

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[*] Abstracted from the *Elektrotechnische Zeitschrift*, XXVII., p. 642. July 5, 1906.

A PROJECTED SCHEME FOR TRANSMISSION OF POWER FROM THE RHONE TO PARIS.

We have received a long and interesting description of the scheme for utilising the power of the River Rhone for the electricity supply of Paris which was drawn up by MM. Blondel, Harlé and Mâhl and presented to the Paris municipal authorities for consideration, along with the various other power schemes which have been proposed. After discussing in a general way the needs of the French capital as regards power supply and the inadequacy of the present methods, the proposers of the scheme recapitulate some of the considerations which have led to the choice of the system put forward. Steam generating stations in Paris itself are dismissed in a few words, principally on account of their lack of economy, nor do gas-driven stations at the pit's mouth appear promising to the originators of the scheme, as compared with the possibilities of water power.

The question of the feasibility of a water-power scheme depends, of course, on the possibility of finding an adequate source of hydraulic energy within a distance of Paris compatible with economic electric transmission. In this connection, the distances are considered over which electric transmission lines have already been worked with success, and several examples on both sides of the Atlantic are mentioned, notably the 60,000 volt three-phase line over 200 miles in length from Colgate to San Francisco. These examples show that, with three-phase working, the transmission of power on a large scale is no Utopian scheme.

It is, however, pointed out that it is possible to extend the distance over which power transmission can be satisfactorily accomplished by the employment of the continuous-current series system originally proposed by Marcel Deprez and perfected by Thury. Recent experiments by M. Thury have indicated the possibility of reducing the line losses by employing an earth return, and that there is now no difficulty in satisfactorily insulating the generating and receiving machinery up to pressures of over 50,000 volts from conductors to earth. If, however, the central point of the series of machines in the generating station and also the central point of the receiving station be earthed, it is obvious that the insulation required from line to earth is never more than half that corresponding to the total pressure employed. Thus, with insulators capable of standing 50,000 volts, a line voltage of 100,000 volts may be employed, whereas for this same working pressure on a three-phase system the insulators must withstand something like a maximum of 150,000 volts.

These and other considerations show that by means of the continuous-current series system greater distances can be accomplished than those already attained, and there is reason to anticipate that a transmission of over 300 miles could be easily carried out. In addition to the scheme now put forward a project is under consideration in the south of France, between Orlu and Bordeaux, where it is proposed to transmit some 24,000 H.P. over a distance of about 250 miles, and a scheme has been proposed to transmit 60,000 H.P. to Stockholm from a waterfall distant about 370 miles.

Having thus established the possible radius within which the generating station must be situated, the authors find a suitable source of power in a portion of the River Rhone, near the entry of that river into French territory, in the neighbourhood of Bellegarde, a point situated about 400 km. (about 250 miles) in a direct line, or approximately 450 km. (280 miles) following the road. The section of the river selected has a minimum flow of 130 cubic metres (4,600 cubic ft.) per second, and over a length of 22½ km. (14 miles) there is a fall of 65 metres (213 ft.). A minimum of 80,000 H.P. is therefore available, but for about 300 days out of the year the flow is nearly double that amount, reaching as much as 1,250 cubic metres (44,200 cubic ft.) per second when the river is in flood. The local conditions are such as to make a certain amount of storage and regulation possible, so that a very considerable proportion of the total power can be utilised. The flow is of course, to some extent, controlled and equalised by the existing water-power works higher up the river in the neighbourhood of Geneva, especially the installation at Chèvres, just below the junction of the Rhone and the Arve.

It is proposed to erect a barrage 34 metres (110 ft.) in height at Grésin which will permit of a storage of a considerable amount of water in an artificial lake in the plain of Collogny. The generating station is placed at Monthoux, some distance down the river just above Pyrimont, where the navigable portion of the river commences. At this point a fall of 63 metres (207 ft.) can be utilised, and it is proposed in the first instance to instal plant of a total capacity of 120,000 kw. Details of the purely hydraulic aspects of the question are gone into at some length, including the arrangements proposed for regulating the river below the works, so that the changes of flow consequent upon the variations of load at different parts of the day shall not unduly affect the navigable portion of the river below.

The intake above the dam at Grésin is to be connected to the power house at Monthoux by two parallel tunnels, each with a cross-section of 45 sq. metres (485 sq. ft.). These tunnels will follow a practically straight course, considerably shorter than the winding bed of the river, so that they will be about 4½ km. (7¼ miles) in length. The power station itself is to be excavated out of the rocky sides of the gorge through which the river runs, so that the tail races of the turbines discharge directly into the river. The whole of the hydraulic equipment would be so arranged that any part could be isolated for inspection or repairs without any interruption of the working.

It is proposed to provide in the power house a series of 48 continuous-current series-wound generators, each capable of an output of 1,000 amperes at a maximum voltage of 2,500 volts. These machines would be divided into two groups of 24 each, and eight 10,000 H.P. turbines would be provided in each group. Thus every turbine would drive three generators in tandem through Raffard couplings. The machines would be connected all in series, and, of course, carefully insulated from the earth. The central point between the two groups is, however, earthed, so that the full-load difference of potential between line and earth would be 60,000 volts, although the total voltage at the extreme terminals would be 120,000 volts, rising to 130,000 volts on overload. The number of machines in service, and therefore the voltage, would be varied according to the load by short-circuiting and cutting out those not required, the current being kept constant at 1,000 amperes.

The receiving stations in Paris would contain a similar series of motors whose central point would be earthed in a similar way. In addition to the advantage which this system of earthing has in limiting the voltage to which the line insulators have to withstand to half the value which it would have in a fully-insulated system, there is the further advantage that, in the event of a breakdown of one line, the other half of the system can still continue to work, using the earth as a return. The practicability of this has been fully demonstrated by recent experiments conducted by M Thury, and it is proposed to take advantage of this possible earth return at times of light load to effect inspection and repairs of the transmission lines one at a time. Other advantages of the continuous-current system are the avoidance of capacity and self-induction difficulties, and effects of resonance. The fact also that the full voltage is only used at times of full load and is not continuously present is favourable to the behaviour of the insulators, and during the first period of working, before the load has reached its full extent, it would be possible to work with a low voltage, which would be increased as the load grew, and at the same time the experience of the staff in dealing with high pressures became more complete.

The two transmission lines are to follow entirely different routes, avoiding towns as much as possible, and finally reach the outskirts of Paris. A loss of 10 per cent. on full load has been allowed for in the calculation of the lines. Each line is to consist of six conductors carried on separate insulators, and each to carry 166 amperes at 60,000 volts. Stranded silicon-bronze cables of 98 per cent. conductivity and a breaking strain of 45 kg. per square millimetre (about 29 tons per square inch) are to be used, of a cross section of 150 sq. mm. (0·24 sq. in.). The insulators are to be carried on wooden cross pieces by lattice steel poles ranging from 12 to 16 metres (about 40 ft. to 50 ft.) in height. The distance apart of the poles would vary at different parts of the line according to circumstances, but would be as a rule from 40 to 50 metres (130 ft. to 160 ft.). Due precautions would be taken for guarding the wires at crossings and a complete system of lightning arresters would be provided.

The two lines would probably approach Paris one on each side of the Seine, and a receiving station is proposed either at Ivry or Charenton alongside the river, in which the whole or part of the energy would be transformed by a series of motor generators, the motors of which would be in series in a similar manner to the generators at Monthoux. The exact details of the receiving and distributing system cannot be settled until a further decision has been come to as to the future régime of electric supply in Paris. Either the Ivry station could transform the whole of the power to alternating current at 15,000 volts and a radiating group of feeders could be laid to various distributing centres in the city, or another arrangement might be transformation of a part of the power at Ivry and the provision of a number of sub-stations all in series with the main sub station at various points in the central portion of the city, from which small groups of motor generators could supply a continuous-current network at 110, 220 or 440 volts in those centre portions of Paris already supplied with continuous current, alternating-current distribution being used as before for the more outlying districts. In this case the existing generating stations could for the most part be used as sub-stations, but the steam plant could be in some measure retained as a reserve. In this case underground cables would be used between Ivry and the ring of continuous-current sub-stations, but it is pointed out that these cables would never have to withstand anything approaching the full voltage of 50,000 between conductor and earth, as the sub-station sets would be grouped on either side of the central earthed point and would be in series with the two groups of machines at Ivry, one on each side of the system. The machines in each of the sub-stations would be grouped half on each side of the system, so that both cables would enter each sub station. In order to avoid earth currents through the town, a cable would be taken from the sub-station which contained the central point to a point well outside Paris, where it would be earthed. It is anticipated that current could be supplied at a much cheaper rate than it is at present, even taking into account the high capital cost of the transmission line and hydraulic works. Estimates of capital costs and working expenses are gone into, and finally the figure at which power could be supplied at the secondary terminals of the receiving station is given as 3 to 4 centimes per kilowatt-hour.

The proposers of the scheme are of opinion that the system could be completed in three to four years.

ELECTRICAL EQUIPMENT OF THE HASARD COLLIERIES, BELGIUM.

One of a series of articles on electricity in mines, by M.M. Orban, published in the *Journal* of the Société Belge d'Electriciens, contains some notes on the equipment of the Hasard Collieries in Belgium, which is of interest as including an example of electrical winding plant which presents some points of difference to the systems which have hitherto been more usual.

The generating station contains four three-phase alternators, each for an output of 250 k.v.a. at 225 volts with a frequency of 48 cycles per second. Three of these machines are sufficient for the load, one being kept as a stand by. A small steam exciter set of sufficient size for one alternator only, is provided for starting up, but the usual source of excitation for the whole plant is one of a pair of exciters driven by induction motors, the other being kept in reserve. Although the alternators only generate at 225 volts, the working pressure of a part of the transmission is 2,000 volts, so that four step-up transformers are employed, each for 100 k.v.a. Two entirely separate switchboards are provided for the high and low voltage circuits respectively. Armoured cables are used for the 2,000 volt feeders, both above and below ground, but the 225 volt circuits which supply part of the lighting and power in the neighbourhood of the generating station are of overhead bare copper on insulators.

Coming then to the subject of the winding plant the author briefly considers the various arrangements of plant which have been proposed and used for electrically-driven winding engines, commencing with the direct three-phase systems of the well-known Grand Hornu and Preussen II. pits, and passing on to the various modifications of the systems involving the use of a heavy flywheel for the equalisation of the load.

Five different combinations are reviewed. In the first, the flywheel is mounted on the shaft of the engine, driving the generator, which is for continuous current, no motor generator being used. This system, although of great simplicity, has the disadvantage that a perfect equalisation cannot be obtained as the power developed by the steam engine necessarily falls off when the speed is reduced. The next two systems employ a flywheel on the shaft of a motor generator set driven either by a continuous-current or an alternating-current motor and depending on some form of automatic regulator for keeping the power input to the set constant. Examples of this arrangement are found in the Siemens-Schuckert installations at the Zollern II. mine at Gelsenkirchen, the system used by the firm of Lahmeyer and others, although the methods of automatic control vary somewhat in the different systems. In the fourth arrangement described, the equaliser set consists of a single continuous-current machine provided with a heavy flywheel connected in parallel with the main generator and acting either as motor or generator, according as the demand for power is less or greater than the normal output of the main generator, and the winding motor is connected directly to the main generator terminals. In this case it is usually necessary to employ an auxiliary booster in series with the winding motor to obviate the heavy variations of voltage that would be produced. This extra machine is mounted on the same shaft as the equaliser.

The last system, due to M. Léon Creplet, is that used in the Hasard Collieries, and is a series system. The use of two auxiliary machines is avoided by connecting the flywheel equaliser in series with the winding motor. Where a continuous-current supply is available, no further machines are required, but on three-phase systems, such as that in use at the Hasard Collieries, a motor generator to transform to continuous current is needed as well as the flywheel machine and the winding motor. Reversal of the direction of motion of the winding motor is effected by reversing the circuit in its armature, but care has to be taken that the main circuit is not interrupted, so its terminals are short circuited while the connections are being reversed. As the armature current depends in a series system such as this on considerations of the generator and not of the motor, all regulations of torque is done by variation of the strength of the motor field, which is likewise short-circuited when the winding motor is at rest or is desired to run light without either driving or electric braking effect. The speed regulation is obtained by variation of the voltage of the terminals of the motor. Suppose it is fully excited, its speed of rotation will be sensibly proportional to the applied voltage. This is, of course, the algebraic sum of the E.M.F.s of the generator and flywheel equaliser, the former always in the same direction and the latter subject to regulation from zero to a maximum value in either direction. When the winding motor is not working, the E.M.F.s of the generator and the equaliser are equal and opposite, provided the flywheel has reached its maximum speed. In order to start the winding motor, the excitation of the equaliser is gradually decreased and passed through zero to its maximum in the reverse direction to obtain the highest speed, the reverse process being adopted for slowing down or stopping. A great advantage possessed by this system over some better known systems lies in the possibility of shutting down the flywheel machine and running directly off the mains, either in case of breakdowns to the equaliser or in cases of light load, when the absence of heavy overloads renders it not worth while to incur the losses incidental to the running of the flywheel set.

The plant at the Fléron pit of the Hasard Collieries, which is rather more than a mile distance from the main generating station mentioned above, has been working since February, 1905, and was installed by the Compagnie Internationale d'Electricité at Liège from the designs of M. L. Creplet. The 160 H.P. motor generator which is employed to convert the three-phase 2,000 volt. supply from the transmission line is driven by a synchronous motor which is appropriately over-excited in order to improve the power factor of the system. The normal output of the set is 700 amperes at 157 volts. The flywheel set in series with the winding motor is designed to absorb the whole output of the generator at any speed from 300 to 600 revs. per min., and can develop an E.M.F. equal and opposite to that of the generator. It is coupled to a flywheel weighing 3,200 kg. with a diameter of gyration of 1·7 metres made from a single steel casting. An automatic governor is fitted which interrupts the main circuit, if from any cause the speed rises above 800 revs. per min.

The winding motor drives the drums through a single reduction spur gear with a ratio of 5 : 1. Flat manilla ropes are used with the successive turns coiled one over the other instead of side by side along the drum; by this means very light short drums can be used, the guide checks on either side being composed of a light iron framing. Thus the effective radius of the drum varies from 1·38 to 2·27 metres. An output of 250 tons of coal and 50 tons of rock can be wound per working day from a depth at 440 metres, in addition to the necessary hoisting and lowering of materials and men. The cages are designed for a useful load of 2 tons and the mean speed is fixed at 4·3 metres per second, with an initial acceleration of about 0·75 metres per second per second. Results of a number of tests are given, which show an overall efficiency varying from 58·0 to 61·7 per cent.

A separate motor generator provides the continuous current for the excitation of all the machines and for a limited amount of lighting and some small motors on the surface. Starting up of the main motor generator from the continuous-current side is also effected by this auxiliary set.

The apparatus by which the driver controls the winding motor is of the simplest character. The starting lever to the driver's right hand controls the excitation of the equaliser. When the lever is in its vertical position the excitation is zero; forward of this point the equaliser tends to become a motor, and when it is in the backward position to act as a generator. The reversing lever is on the driver's left. In its central position the motor is stopped, and several forward and backward positions are provided corresponding to various degrees of excitation of the motor. The reversing controller consists of a group of switches actuated in the proper sequence by a series of cams on the controller shaft. Another lever is provided which is used to regulate the generator voltage and thereby settles the limit of speed which the winding motor can attain. A hand-brake lever is also placed near the driver which acts in the usual way, and an electromagnetic brake is also used. In addition to the depth indicator, an ammeter and a voltmeter are placed in full view of the driver, who can thus see that all the apparatus is working properly. Some figures of the expenses of working, as compared with the ascertained costs of steam winding, are given, which show a substantial annual saving from the adoption of electrical working.

PROF. RAY LANKESTER'S ADDRESS TO THE BRITISH ASSOCIATION.*

My lords, ladies and gentlemen, it is, first of all, my privilege to thank you for the distinguished honour you have done me in electing me president of this great scientific association—an honour which is enhanced by the fact that our meeting this year is once more held in the venerable city of York, in which 75 years ago the British Association for the Advancement of Science held its first meeting.

It is a great pleasure to me to convey to the Lord Mayor and the dignitaries and citizens of York your hearty thanks for the invitation to meet this year in their city. It seems to have become a custom that the Association should be invited at regular intervals to assemble in the city where it took birth and to note the progress made in the objects for the furtherance of which it was founded. A quarter of a century ago we met here under the presidency of that versatile leader in public affairs—Sir John Lubbock, now Lord Avebury. That occasion was the jubilee—the 50th anniversary—of the Association.

Lord Avebury on that occasion gave as his presidential address a survey of the progress of science during the 50 years of the Association's existence. He had a wonderful story to tell, and told it with a fullness which was only possible to one of his wide range of knowledge and keen interest in the various branches of science. If I venture on the present occasion to say a few words as to the great features in the progress of our knowledge of Nature during the last 25 years, it will be readily understood that the mere volume of new knowledge to be surveyed has become so vast that a full and detailed statement such as that which Lord Avebury placed before the Association at its jubilee is no longer possible in a single address delivered from the President's chair.

Let me ask you before we go further to take for a few moments a more personal retrospect and to think of the founders of this Association, then of the great workers in science who were still alive in 1881, when last we met here, and have since gone from among us, leaving their great deeds and their noble enthusiasm to inspire now and for all future time those who have vowed themselves to the advancement of science in this realm of Britain.

There must be some here who had the privilege of personal acquaintance with several of the men who founded this Association in York 75 years ago. I myself knew Prof. John Phillips, Sir Charles Lyell, Sir Roderick Murchison, Sir David Brewster, Dr. Whewell and Mr. Harcourt of Nuneham. All these fathers of our Association had passed away before our last meeting in York, and now, in the quarter of a century which has rolled by and brought us here again, we have lost many who took an active part in its annual meetings and were familiar figures in the scientific world of the later Victorian period. Huxley and Tyndall, Spottiswoode and Cayley, Owen and Flower, Williamson and Frankland, Falconer and Busk, Prestwich and Godwin Austen, Rolleston and Henry Smith, Stokes and Tait and many others are in that list, including one whose name was, and is, more often heard in our discussions than any other, though he himself never was able to join us—I mean Charles Darwin. Happily, some of the scientific veterans of the nineteenth century are still living, if not with us in York. Sir Joseph Hooker, who visited the Antarctic with Ross in 1839, is still hale and hearty, and so are Alfred Russel Wallace, Lord Kelvin,

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* Extract of the Address delivered by Prof. E. Ray Lankester, D.Sc., F.R.S., at York on Wednesday last.

Sir William Huggins and many others who were already veteran leaders in scientific investigation when last we visited York: they are still active in thought, observation and experiment.

In attempting to give an outline of the advancement of science in the past 25 years I think it is necessary to distinguish two main kinds of advancement, both of which our founders had in view. Francis Bacon gave the title "Advancement of Learning" to that book in which he explained not merely the methods by which the increase of knowledge was possible, but advocated the promotion of knowledge to a new and influential position in the organisation of human society. His purpose, says Dean Church, was "to make knowledge really and intelligently the interest, not of the school or the study or the laboratory only, but of society at large." This is what our founders also intended by their use of the word "advancement." So that, in surveying the advancement of science in the past quarter of a century, we of the British Association must ask not only what are the new facts discovered, the new ideas and conceptions which have come into activity, but what progress has science made in becoming really and intelligently the interest of society at large. Is there evidence that there is an increase in the influence of science on the lives of our fellow-citizens and in the great affairs of the State? Is there an increased provision for securing the progress of scientific investigation in proportion to the urgency of its need, or an increased disposition to secure the employment of really competent men trained in scientific investigation for the public service?

I. The Increase of Knowledge in the Several Branches of Science.

The boundaries of my own understanding, and the practical consideration of what is appropriate to a brief address, must limit my attempt to give to the general public who follow with friendly interest our proceedings some presentation of what has been going on in the workshops of science in this last quarter of a century. My point of view is essentially that of the naturalist, and in my endeavour to speak of some of the new things and new properties of things discovered in recent years, I find it is impossible to give any systematic or detailed account of what has been done in each division of science. All that I can attempt is to mention some of the discoveries which have aroused my own interest and admiration. I feel, indeed, that it is necessary to ask your forbearance for my presumption in daring to speak of so many subjects in which I cannot claim to speak as an authority, but only as a younger brother full of fraternal pride and sympathy in the glorious achievements of the great experimentalists and discoverers of our day. The duty of attempting some indication of their work is placed upon me as your President, and it is for my effort to discharge that duty that I ask your generous consideration.

As one might expect, the progress of the knowledge of Nature (for it is to that rather than to the historical, moral and mental sciences that English-speaking people refer when they use the word "science") has consisted, in the last 25 years, in the amplification and fuller verification of principles and theories already accepted, and in the discovery of hitherto unknown things which either have fallen into place in the existing scheme of each science or have necessitated new views, some not very disturbing to existing general conceptions, others of a more startling and, at first sight, disconcerting character. Nevertheless, I think I am justified in saying that, exciting and of entrancing interest as have been some of the discoveries of the past few years, there has been nothing to lead us to conclude that we have been on the wrong path—nothing which is really revolutionary that is to say, nothing which cannot be accepted by an intelligible modification of previous conceptions. There is, in fact, continuity and healthy evolution in the realm of science. Whilst some onlookers have declared to the public that science is at an end, its possibilities exhausted, and but little of the hopes it raised realised, others have asserted, on the contrary, that the new discoveries—such as those relating to the X-rays and to radium—are so inconsistent with previous knowledge as to shake the foundations of science, and to justify a belief in any and every absurdity of an unrestrained fancy. These two reciprocally destructive accusations are due to a class of persons who must be described as the enemies of science. Whether their attitude is due to ignorance or traditions of self-interest, such persons exist; and it is one of the objects of this Association to combat their assertions and to demonstrate, by the discoveries announced at its meetings and the consequent orderly building up of the great fabric of "natural knowledge," that Science has not come to the end of her work—has, indeed, only as yet given mankind a foretaste of what she has in store for it—that her methods and her accomplished results are sound and trustworthy, serving with perfect adaptability for the increase of true discovery and the expansion and development of those general conceptions of the processes of Nature at which she aims.

New Chemical Elements.—There can be no doubt that the past quarter of a century will stand out for ever in human history as that in which new chemical elements, not of an ordinary type, but possessed of truly astounding properties, were made known with extraordinary rapidity and sureness of demonstration. Interesting as the others are, it is the discovery of radio-activity and of the element radium, which so far exceeds all others in importance that we may well account it a supreme privilege that it has fallen to our lot to live in the days of this discovery. No single discovery ever made by the searchers of Nature even approaches that of radio-activity in respect of the novelty of the properties of matter suddenly revealed by it. A new conception of the structure of matter is necessitated and demonstrated by it, and yet, so far from being destructive and disconcerting, the new conception fits in with, grows out of, and justifies the older schemes which our previous knowledge has formulated.

Before saying more of radio-activity, which is apt to eclipse in interest every other topic of discourse, I must recall to you the discovery of the five inert gaseous elements by Rayleigh and Ramsay, which belongs to the period on which we are looking back. It was found that nitrogen obtained from the atmosphere invariably differed in weight from nitrogen obtained from one of its chemical combinations; and thus the conclusion was arrived at by Rayleigh that a distinct gas is present in the atmosphere, to the extent of 1 per cent., which had hitherto passed for nitrogen. This gas was separated, and to it the name argon (the lazy one) was given, on account of its incapacity to combine with any other element. Subsequently this argon was found by Ramsay to be itself impure, and from it he obtained three other gaseous elements equally inert—namely, neon, krypton and xenon. These were all distinguished from one another by the spectrum, the sign-manual of an element given by the light emitted in each case by the gas when in an incandescent condition. A fifth inert gaseous element was discovered by Ramsay as a constituent of certain minerals which was proved by its spectrum to be identical with an element discovered 25 years ago by Sir Norman Lockyer in the atmosphere of the sun, where it exists in enormous quantities. Lockyer had given the name (helium) to this new solar element, and Ramsay thus found it locked up in certain rare minerals in the crust of the earth.

But by helium we are led back to radium, for it has been found only two years ago by Ramsay and Soddy that helium is actually formed by a gaseous emanation from radium. Astounding as the statement seems, yet that is one of the many unprecedented facts which recent study has brought to light. The alchemist's dream is, if not realised, at any rate justified. One element is actually under our eyes converted into another; the element radium decays into a gas which changes into another element—namely, helium.

Radium, this wonder of wonders, was discovered owing to the study of the remarkable phosphorescence, as it is called—the glowing without heat—of glass vacuum tubes through which electric currents are made to pass. Crookes, Lenard and Röntgen each played an important part in this study, showing that peculiar rays or linear streams of at least three distinct kinds are set up in such tubes—rays which are themselves invisible, but have the property of making glass or other bodies which they strike glow with phosphorescent light. The celebrated Röntgen rays make ordinary glass give out a bright green light; but they pass through it, and cause phosphorescence outside in various substances, such as barium platinocyanide, calcium tungstate and many other such salts; they also act on a photographic plate and discharge an electrified body such as an electroscope. But the most remarkable feature about them is their power of penetrating substances opaque to ordinary light. They will pass through thin metal plates or black paper or wood, but are stopped by more or less dense material. Hence it has been possible to obtain "shadow pictures" or skiagraphs by allowing the invisible Röntgen rays to pass through a limb or even a whole animal, the denser bone stopping the rays, whilst the skin, flesh and blood let them through. They are allowed to fall (still invisible) on to a photographic plate, when a picture like an ordinary permanent photograph is obtained by their chemical action, or they may be made to exert their phosphorescence-producing power on a glass plate covered with a thin coating of a phosphorescent salt such as barium platinocyanide, when a temporary picture in light and shade is seen.

The rays discovered by Röntgen were known as the X-rays, because their exact nature was unknown. Other rays studied in the electrified vacuum tubes are known as cathode rays or radiant corpuscles, and others, again, as the Lenard rays.

It occurred to M. Henri Becquerel, as he himself tells us, to inquire whether other phosphorescent bodies besides the glowing vacuum tubes of the electrician's laboratory can emit penetrating rays like the X-rays. I say "other phosphorescent bodies," for this power of glowing without heat—of giving out, so to speak, cold light—is known to be possessed by many mineral substances. It has become familiar to the public in the form of "phosphorescent paint," which contains sulphide of calcium, a substance which shines in the dark after exposure to sunlight—that is to say, is phosphorescent. Other sulphides and the minerals fluor-spar, apatite, some gems, and, in fact, a whole list of substances have, under different conditions of treatment, this power of phosphorescence, or shining in the dark, without combustion or chemical change. All, however, require some special treatment, such as exposure to sunlight or heat or pressure, to elicit the phosphorescence, which is of short duration only. Many of the compounds of a somewhat uncommon metallic element, called uranium, used for giving a fine green colour to glass, are phosphorescent substances, and it was, fortunately, one of them which Henri Becquerel chose for experiment. Henri Becquerel is professor in the Jardin des Plantes of Paris: his laboratory is a delightful old fashioned building, which had for me a special interest and sanctity when, a few years ago, I visited him there, for a hundred years before it was the dwelling house of the great Cuvier. Here Henri Becquerel's father and grandfather—men renowned throughout the world for their discoveries in mineralogy, electricity and light—had worked, and here he had himself gone almost daily from his earliest childhood. Many an experiment bringing new knowledge on the relations of light and electricity had Henri Becquerel carried out in that quiet old-world place before the day on which, about 12 years ago, he made the experimental inquiry: Does uranium give off penetrating rays like Röntgen's rays? He wrapped a photographic plate in black paper, and on it placed and left lying there for 24 hours some uranium salt. He had placed a cross, cut out in thin metallic copper, under the uranium powder, so as to give some shape to the photographic print should one be produced. It *was* produced. Penetrating rays were given off by the uranium; the black paper was penetrated, and the form of the copper cross was printed on a dark ground. The copper was also penetrated to some extent by the rays from the uranium, so that its image was not left actually white. Only one step more remained before Becquerel made his great discovery. It was known, as I stated just now, that sulphide of calcium and similar substances *become* phosphorescent when exposed to sunlight, and lose this phosphorescence after a few hours. Becquerel thought at first that perhaps the uranium acquired its power similarly by exposure to light; but very soon, by experimenting with uranium long kept in the dark, he found that the emission of penetrating rays, giving photographic effects, was produced spontaneously. The emission of rays by this particular fragment of uranium has shown no sign of diminution since this discovery. The emission of penetrating rays by uranium was soon found to be independent of its phosphorescence. Phosphorescent bodies, as such, do not emit penetrating rays. Uranium compounds, whether phosphorescent or not, emit, and continue to emit, these penetrating rays, capable of passing through black paper and metallic copper. They do not derive this property from the action of light or any other treatment. The emission of these rays discovered by Becquerel is a new property of matter. It is called "radio activity," and the rays are called Becquerel rays.

From this discovery by Becquerel to the detection and separation of the new element radium is an easy step in thought, though one of enormous labour and difficulty in practice. Prof. Pierre Curie (whose name I cannot mention without expressing the grief with which we all heard in last April of the sad accident by which his life was taken) and his wife, Madame Sklodowska Curie, incited by Becquerel's discovery examined the ore called pitch-blende which is worked in mines in Bohemia and is found also in Cornwall. It is the ore from which all commercial uranium is extracted. The Curies found that pitch-blende has a radio-activity four times more powerful than that of metallic uranium itself. They at once conceived the idea that the radio-activity of the uranium salts examined by Becquerel is due not to the uranium itself, but to another element present with it in variable quantities. This proved to be in part true. The refuse of the first processes by which in the manufacturer's works the uranium is extractad from its ore, pitch blende, was found to contain four times more of the radio-active matter than does the pure uranium. By a long series of fusions, solutions, and crystallisations the Curies succeeded in "hunting down," as it were, the radio-active element. The first step gave them a powder mixed with barium chloride, and having 2,000 times the activity of the uranium in which Becquerel first proved the existence of the new property—radio-activity. Then, step by step, they purified it to a condition 10,000 times, then to 100,000 times, and finally to the condition of a crystalline salt having 1,800,000 times the activity of Becquerel's sample of uranium. The purification could go no further, but the extraordinary minuteness of the quantity of the pure radio-active substance obtained and the amount of labour and time expended in preparing it may be judged of from the fact that of one ton of the pitch-blende ore submitted to the process of purification only the one hundredth of a gramme—the one-seventh of a grain—remained.

The amount of radium in pitch-blende is one ten-millionth per cent.; rarer than gold in sea water. The marvel of this story and of all that follows consists largely in the skill and accuracy with which our chemists and physicists have learnt to deal with such infinitesimal quantities, and the gigantic theoretical results which are securely poised on this pin-point of substantial matter.

The Curies at once determined that the minute quantity of colourless crystals they had obtained was the chloride of a new metallic element with the atomic weight 225, to which they gave the name radium. The proof that radium is an element is given by its "sign-manual"—the spectrum which it shows to the observer when in the incandescent state. It consists of six bright lines and three fainter lines in the visible part of the spectrum, and of three very intense lines in the ultraviolet (invisible) part. A very minute quantity is enough for this observation; the lines given by radium are caused by no other known element in heaven or earth. They prove its title to be entered on the roll-call of elements.

The atomic weight was determined in the usual way by precipitating the chlorine in a solution of radium chloride by means of silver. None of the precious element was lost in the process, but the Curies never had enough of it to venture on any attempt to prepare pure metallic radium. This is a piece of extravagance no one has yet dared to undertake. Altogether the Curies did not have more than some 4 or 5 grains of chloride of radium to experiment with, and the total amount prepared and now in the hands of scientific men in various parts of the world probably does not amount to more than 60 grains at most. When Prof. Curie lectured on radium four years ago at the Royal Institution in London he made use of a small tube 1 in. long and of one-eighth bore, containing nearly the whole of his precious store, wrenched by such determined labour and consummate skill from tons of black shapeless pitch-blende. On his return to Paris he was one day demonstrating in his lecture room with this precious tube the properties of radium when it slipped from his hands, broke, and scattered far and wide the most precious and magical powder ever dreamed of by alchemist or artist of romance. Every scrap of dust was immediately and carefully collected, dissolved, and re-crystallised, and the disaster averted with a loss of but a minute fraction of the invaluable product.

Thus, then, we have arrived at the discovery of radium—the new element endowed in an intense form with the new property "radio-activity' discovered by Becquerel. The wonder of this powder, incessantly and without loss, under any and all conditions pouring forth by virtue of its own intrinsic property powerful rays capable of penetrating opaque bodies and of exciting phosphorescence and acting on photographic plates, can perhaps be realised when we reflect that it is as marvellous as though we should dig up a stone which, without external influence or change, continually poured forth light or heat, manufacturing both in itself, and not only continuing to do so without appreciable loss or change, but necessarily, having always done so for countless ages, whilst sunk beyond the ken of man in the bowels of the earth.

Wonderful as the story is, so far it is really simple and commonplace compared with what yet remains to be told. I will only barely and abruptly state the fact that radio-activity has been discovered in other elements, some very rare, such as actinium and polonium; others more abundant and already known, such as thorium and uranium, though their radio-activity was not known until Becquerel's pioneer discovery. It a little strange, and no doubt significant, that, after all, pure uranium is found to have a radio-activity of its own and not to have been altogether usurping the rights of its infinitesimal associate.

The wonders connected with radium really begin when the experimental examination of the properties of a few grains is made. What I am saying here is not a systematic technical account of radium, so I shall venture to relate some of the story as it impresses me.

Leaving aside for a moment what has been done in regard to the more precise examination of the rays emitted by radium, the following astonishing facts have been found out in regard to it: (1) If a glass tube containing radium is much handled or kept in the waistcoat pocket it produces a destruction of the skin and flesh over a small area—in fact, a sore place. (2) The smallest trace of radium brought into a room where a charged electroscope is present causes the discharge of the electroscope. So powerful is this electrical action of radium that a very sensitive electrometer can detect the presence of a quantity of radium five hundred thousand times more minute than that which can be detected by the spectroscope (that is to say, by the spectroscopic examination of a flame in which minute traces of radium are present). (3) Radium actually realises one of the properties of the hypothetical stone to which I compared it giving out light and heat. For it does give out heat which it makes itself incessantly and without appreciable loss of substance or energy ("appreciable" is here an important qualifying term). It is also faintly self-luminous. Fairly sensitive thermometers show that a few granules of radium salt have always a higher temperature than that of surrounding bodies. Radium has been proved to give out enough heat to melt rather more than its own weight of ice every hour; enough heat in one hour to raise its own weight of water from the freezing-point to the boiling-point. After a year and six weeks a gram of radium has emitted enough heat to raise the temperature of a thousand kilograms of water one degree. And this is always going on. Even a small quantity of radium diffused through the earth will suffice to keep up its temperature against all loss by radiation! If the sun consists of a fraction of 1 per cent. of radium this will account for and make good the heat that is annually lost by it.

This is a tremendous fact, upsetting all the calculations of physicists as to the duration in past and future of the sun's heat and the temperature of the earth's surface. The geologists and the biologists have long contended that some thousand million years must have passed during which the earth's surface has presented approximately the same conditions of temperature as at present, in order to allow time for the evolution of living things and the formation of the aqueous deposits of the earth's crust. The physicists, notably Prof. Tait and Lord Kelvin, refused to allow more than ten million years (which they subsequently increased to a hundred million)—basing this estimate on the rate of cooling of a sphere of the size and composition of the earth. They have assumed that its material is self-cooling. But, as Huxley pointed out, mathematics will not give a true result when applied to erroneous data. It has now, within these last five years, become evident that the earth's material is *not* self cooling, but, on the contrary, self-heating. And away go the restrictions opposed by physicists on geological time. They now are willing to give us, not merely a thousand million years, but as many more as we want.

And now I have to mention the strangest of all the proceedings of radium—a proceeding in which the other radio-active bodies, actinium and thorium resemble it. This proceeding has been entirely Rutherford's discovery in Canada, and his name must always be associated with it. Radium (he discovered) is continually giving off, apart from and in addition to the rectilinear darting rays of Becquerel—an "emanation"—a gaseous "emanation." This "emanation" is radio-active—that is, gives off Becquerel rays—and deposits "something" upon bodies brought near the radium, so that they become radio-active, and remain so for a time after the radium is itself removed. This emanation is always being formed by a radium salt, and may be most easily collected by dissolving the salt in water, when it comes away with a rush, as a gas. Sixty milligrammes of bromide of radium yielded to Ramsay and Soddy 0·124 (or about one-eighth) of a cubic millimetre of this gaseous emanation. What is it? It cannot be destroyed or altered by heat or by chemical agents; it is a heavy gas, having a molecular density of 100, and it can be condensed to a liquid by exposing it to the great cold of liquid air. It gives a peculiar spectrum of its own, and is probably a hitherto unknown inert gas—a new element similar to argon. But this by no means completes its history, even so far as experiments have as yet gone. The radium emanation decays, changes its character altogether, and loses half its radio-activity every four days. Precisely at the same rate as it decays the specimen of radium salt from which it was removed forms a new quantity of emanation, having just the amount of radio-activity which has been lost by the old emanation. All is not known about the decay of the emanation, but one thing is absolutely certain, having first been discovered by Ramsay and Soddy, and subsequently confirmed by independent experiment by Madame Curie. It is this: After being kept three or four days the emanation becomes, in part at least, converted into helium—the light gas (second only in the list of elements to hydrogen), the gas found 25 years ago by Lockyer in the sun, and since obtained in some quantities from rare radio-active minerals by Ramsay! The proof of the formation of helium from the radium emanation is, of course, obtained by the spectroscope, and its evidence is beyond assail. Here, then, is the partial conversion or decay of one element, radium, through an intermediate stage into another. And not only that, but if, as seems probable, the presence of helium indicates the previous presence of radium, we have the evidence of enormous quantities of radium in the sun, for we know helium is there in vast quantity. Not only that, but, inasmuch as helium has been discovered in most hot springs and in various radio-active minerals in the earth, it may be legitimately argued that no inconsiderable quantity of radium is present in the earth. Indeed, it now seems probable that there is enough radium in the sun to keep up its continual output of heat, and enough in the earth to make good its loss of heat by radiation into space, for an almost indefinite period. Other experiments of a similar kind have rendered it practically certain that radium itself is formed by a somewhat similar transformation of uranium, so that our ideas as to the permanence and immutability on this globe of the chemical elements are destroyed, and must give place to new conceptions. It seems not improbable that the final product of the radium emanation after the helium is removed is or becomes the metal lead!

It must be obvious from all the foregoing that radium is very slowly, but none the less surely, destroying itself. There is a definite loss of particles, which, in the course of time, must lead to the destruction of the radium, and it would seem that the large new credit on the bank of time given to biologists in consequence of its discovery has a definite, if remote, limit. With the quantities of radium at present available for experiment, the amount of loss of particles is so small, and the rate so slow, that it cannot be weighed by the most delicate balance. Nevertheless, it has been calculated that radium will transform half of itself in about 1,500 years, and unless it were being produced in some way all of the radium now in existence would disappear much too soon to make it an important geological factor in the maintenance of the earth's temperature. As a reply to this depreciatory statement we have the discovery by Rutherford and others that radium is continually being formed afresh, and from that particular element in connection with which it was discovered—namely, uranium. Hypotheses and experiments as to the details of this process are at this moment in full swing, and results of a momentus kind, involving the building up of an element with high atomic weight by the interaction of elements with a lower atomic weight, are thought by some physicists to be not improbable in the immediate future.

The delicate electric test for radio activity has been largely applied in the last few years to all sorts and conditions of matter. As a result it appears that the radium emanation is always present in our atmosphere; that the air in caves is especially rich in it, as are underground waters. Tin-foil, glass, silver, zinc, lead, copper, platinum and aluminium are, all of them, slightly radio-active. The question has been raised whether this widespread radio-activity is due to the wide dissemination of infinitesimal quantities of strong radio-active elements, or whether it is the natural intrinsic property of all matter to emit Becquerel rays. This is the immediate subject of research.

Over and above the more simply appreciable facts which I have thus narrated, there comes the necessary and difficult inquiry: What does it all mean? What *are* the Becquerel rays of radio-activity? What must we conceive to be the structure and mechanism of the atoms of radium and allied elements, which can not only pour forth ceaseless streams of intrinsic energy from their own isolated substance, but are perpetually, though in infinitesimal proportions, changing their elemental nature spontaneously, so as to give rise to other atoms which we recognise as other elements?

I cannot venture as an expositor into this field. It belongs to that wonderful group of men, the modern physicists, who, with an almost weird power of visual imagination, combine the great instrument of exact statement and mental manipulation called mathematics, and possess an ingenuity and delicacy in appropriate experiment which must fill all who even partially follow their triumphant handling of Nature with reverence and admiration. Such men now or recently among us are Kelvin, Clark Maxwell, Crookes, Rayleigh and J. J. Thomson.

Becquerel showed early in his study of the rays emitted by radium that some of them could be bent out of their straight path by making them pass between the poles of a powerful electromagnet. In this way have finally been distinguished three classes of rays given off by radium: (1) the *alpha* rays, which are only slightly bent, and have little penetrative power; (2) the *beta* rays, easily bent in a direction opposite to that in which the alpha rays bend, and of considerable penetrative power; (3) the *gamma* rays, which are absolutely unbendable by the strongest magnetic force, and have an extraordinary penetrative power, producing a photographic effect through a foot thickness of solid iron.

The *alpha* rays are shown to be streams of tiny bodies positively electrified, such as are given off by gas flames and red-hot metals. The particles have about twice the mass of a hydrogen atom, and they fly off with a velocity of 20,000 miles a second: that is 40,000 times greater than that of a rifle bullet The heat produced by radium is ascribed to the impact of these particles of the alpha rays.

The *beta* rays are streams of corpuscles similar to those given off by the cathode in a vacuum tube. They are charged with negative electricity and travel at the velocity of 100,000 miles a second. They are far more minute than the alpha particles. The mass is equal to the one-thousandth of a hydrogen atom. They produce the major part of the photographic and phosphorescent effects of the radium rays.

The *gamma* rays are apparently the same, or nearly the same, thing as the X-rays of Röntgen. They are probably not particles at all, but pulses or waves in the ether set up during the ejection of the corpuscles which constitute the beta rays. They produce the same effects in a much smaller degree as do the beta rays, but are more penetrating

The kind of conceptions to which these and like discoveries have led the modern physicist in regard to the character of that supposed unbreakable body—the chemical atom—the simple and unaffected friend of our youth—are truly astounding. But I would have you notice that they are not destructive of our previous conceptions, but rather elaborations and developments of the simpler views, introducing the notion of structure and mechanism, agitated and whirling with tremendous force, into what we formerly conceived of as homogeneous or simply built-up particles, the earlier conception being not so much a positive assertion of simplicity as a non-committal expectant formula awaiting the progress of knowledge and the revelations which are now in our hands.

As I have already said, the attempt to show in detail how the marvellous properties in radium and radio activity in general are thus capable of a pictorial or structural representation is beyond the limits both of my powers and the time allowed me; but the fact that such speculations furnish a scheme into which the observed phenomena can be fitted is what we may take on the authority of the physicists and chemists of our day.

Intimately connected with all the work which has been done in the past 25 years in the nature and possible transformations of atoms is the great series of investigations and speculations on astral chemistry and the development of the chemical elements which we owe to the unremitting labour during this period of Sir Norman Lockyer.

Wireless Telegraphy.—Of great importance has been the whole progress in the theory and practical handling of electrical phenomena of late years. The discovery of the Hertzian waves and their application to wireless telegraphy is a feature of this period, though I may remind some of those who have been impressed by these discoveries that the mere fact of electrical action at a distance is that which hundreds of years ago gave to electricity its name. The power which we have gained of making an instrument oscillate in accordance with a predetermined code of signalling, although detached and a thousand miles distant, does not really lend any new support to the notion that the old-time beliefs of thought-transference and second sight are more than illusions based on incomplete observation and imperfect reasoning. For the important factors in such human intercourse—namely, a signalling instrument and a code of signals—have not been discovered, as yet, in the structure of the human body, and have to be consciously devised and manufactured by man in the only examples of thought-transference over long distances at present discovered or laid bare to experiment and observation.

High and Low Temperatures.—The past quarter of a century has witnessed a great development and application of the methods of producing both very low and very high temperatures. Sir James Dewar, by improved apparatus, has produced liquid hydrogen and a fall of temperature probably reaching to the absolute zero. A number of applications of extremely low temperatures to research in various directions has been rendered possible by the facility with which they may now be produced. Similarly, high temperatures have been employed in continuation of the earlier work of Deville, and others by Moissan, the distinguished French chemist.

Progress in Chemistry.—In chemistry generally the theoretical tendency guiding a great deal of work has been the completion and verification of the "periodic law" of Mendeléeff; and, on the other hand, the search by physical agents, such as light and electricity, for evidence as to the arrangement of atoms in the molecules of the most diverse chemical compounds. The study of "valency" and its outcome, stereo-chemistry, have been the special lines in which chemistry has advanced. As a matter of course, hundreds, if not thousands, of new chemical bodies have been produced in the laboratory of greater or less theoretical interest. The discovery of the greatest practical and industrial importance in this connection is the production of indigo by synthetical processes, first by laboratory and then by factory methods, so as to compete successfully with the natural product. Von Baeyer and Heumann are the names associated with this remarkable achievement, which has necessarily dislocated a large industry which derived its raw material from British India.*

Astronomy.—A biologist may well refuse to offer any remarks on his own authority in regard to this earliest and grandest of all the sciences. I will therefore at once say that my friend the Savilian Professor of Astronomy in Oxford has turned my thoughts in the right direction in regard to this subject. There is no doubt that there has been an immense "revival" in astronomy since 1881; it has developed in every direction The invention of the "dry plate," which has made it possible to apply photography freely in all astronomical work, is the chief cause of its great expansion. Photography was applied to astronomical work before 1881, but only with difficulty and haltingly. It was the dry-plate which made long exposures possible, and thus enabled astronomers to obtain regular records of faintly luminous objects such as nebulæ and star-spectra. Roughly speaking, the number of stars visible to the naked eye may be stated as eight thousand; this is raised by the use of our best telescopes to a hundred million. But the number which can be photographed is indefinite and depends on length of exposure: a thousand million can certainly be so recorded.

The serious practical proposal to "chart the sky" by means of photography certainly dates from this side of 1881. The Paris Conference of 1887, which made an international scheme for sharing the sky among 18 observatories (still busy with the work, and producing excellent results), originated with photographs of the comet of 1882, taken at the Cape Observatory.

Prof. Pickering, of Harvard, did not join this co-operative scheme, but has gradually devised methods of charting the sky very rapidly, so that he has at Harvard records of the whole sky many times over, and when new objects are discovered he can trace their history *backwards* for more than a dozen years by reference to his plates. This is a wonderful new method, a mode of keeping record of present movements and changes which promises much for the future of astronomy. By the photographic method hundreds of new variable stars and other interesting objects have been discovered. New planets have been detected by the hundred. Up to 1881 220 were known. In 1881 only one was found—namely, Stephania, being No. 220, discovered on May 19th. Now a score at least are discovered every year. Over 500 are now known. One of these—Eros—(No. 433) is particularly interesting, since it is nearer to the sun than is Mars, and gives a splendid opportunity for fixing with increased accuracy the sun's distance from the earth. Two new satellites to Saturn and two to Jupiter have been discovered by photography (besides one to Jupiter in 1892 by the visual telescope of the Lick Observatory). One of the new satellites of Saturn goes round that planet the *wrong way*, thus calling for a fundamental revision of our ideas of the origin of the solar system.

The introduction of photography has made an immense difference in spectroscopic work. The spectra of the stars have been readily mapped out and classified, and now the motions in the line of sight of faint stars can be determined. This "motion in the line of sight," which was discernible but scarcely measurable with accuracy before, now provides one of the most refined methods in astronomy for ascertaining the dimensions and motions of the universe. It gives us velocities in miles per second instead of in an angular unit to be interpreted by a very imperfect knowledge of the star's distance. The method was in 1881 a mere curiosity, which Huggins was almost alone in having examined, though visual measures had been begun at Greenwich in 1875, and were continued for many years, only to be ultimately found to be affected by systematic error. The photographic method started by Vogel in 1887 really has made all the difference, and this work is now a vast department of astronomical industry. Among other by-products of the method are the "spectroscopic doubles," stars which we know to be double, and of which we can determine the period of revolution, though we cannot separate them visually by the greatest telescope.

Work on the sun has been entirely revolutionised by the use of photography. The last decade has seen the invention of the spectroheliograph—which simply means that astronomers can now study *in detail* portions of the sun of which they could previously only get a bare indication.

More of the same story could be related, but enough has been said to show how full of life and progress is this most ancient and imposing of all sciences.

A minor though very important influence in the progress of astonomy has been the provision, by the expenditure of great wealth in America, of great telescopes and equipments.

In 1877 my distinguished predecessor in the presidency of the British Association started a line of mathematical research which has been very fruitful and is of great future promise for astronomy. He was able himself last year to give some account of this research to the Association. On the present occasion I may mention that as recently as last April, at the Royal Astronomical Society, two important Papers were read—one by Mr. Cowell and the other by Mr. Stratton—which have their roots in Sir George Darwin's work. The former was led to suggest that the day is lengthening 10 times as rapidly as had been supposed, and the latter showed that in all probability the planets had all turned upside down since their birth.

And yet M. Brunettière and his friends wish us to believe that science is bankrupt and has no new things in store for humanity.

[Part I. of the address concludes with references to geology, animal and vegetable morphography, physiology of plants and animals, psychology, Darwinism and disease.]

II.—The Advancement of Science as Measured by the Support Given to it by Public Funds and the Respect Accorded to Scientific Work by the British Government and the Community at Large.

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this Association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding "advancement" of science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the advancement of science, and I claim the right to say to them without offence to the representatives of institutions which I criticise, what is in my mind.

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* I had at first intended to give in this address a more detailed and technical statement of the progress of science than I have found possible when actually engaged in its preparation. The limits of time and space render any such survey on this occasion impossible, and, moreover, the patience of even the general meeting of the British Association cannot be considered as unlimited. With a view to the preparation of a more detailed review, I had asked a number of friends and colleagues to send me notes on the progress and tendency in their own particular branches of science. They responded with the greatest generosity and unselfishness. I must entirely disclaim for them any responsibility for the brief detached statements made in the address. At the same time I should wish to thank them here by name for their most kind and timely help. They are: Sir William Ramsay, Prof. Soddy, Prof. H. H. Turner, Prof. Marr, Prof. Haddon, Dr. Smith Woodward. Prof. Sherrington, Prof. Farmer, Prof. Vines, Mr. D. Scott, Prof Meldola, Mr. Macdougal, Prof. Poulton, Mr. C. V. Boys, Col. MacMahon and Prof. Mackinder.

It is unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of Government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries, and clerks who are wholly ignorant of science, and naturally enough dislike it, since it cannot be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of State and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are in our opinion of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavour to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your President to press upon the attention of the members of the British Association. Probably an inquiry into and discussion of the neglect of science and the questionable treatment of scientific men by the administrative departments of Government would be more appropriate to a committee appointed by the council of the Association for this purpose than to the presidential address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining "advancement" in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamour or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

Within the past year a letter has been published by a well-known nobleman, who is one of the trustees of the British Museum, holding up to public condemnation the method in which the system laid down by the officials of the Treasury and sanctioned by successive Governments as to the remuneration of scientific men, was applied in an individual case. I desire to place on record here the Earl of Crawford's letter to *The Times* of October 31, 1905, for the careful consideration of the members of the British Association and their friends. When such things are done, science cannot be said to have advanced much in public consideration or Governmental support:—

> TO THE EDITOR OF THE TIMES.
>
> SIR: The death, noted by you to-day, of my dear friend and colleague Dr. Copeland, His Majesty's Astronomer for Scotland, creates a vacancy in the scientific staff of Great Britain.
>
> Will you permit me, Sir, to offer a word of warning to any who may be asked to succeed him?
>
> Students or masters of astronomy are not, in the selfish sense, business men, nor are they as a general rule overburdened with this world's goods. It behoves them henceforth to take more care as to their future in case of illness or physical infirmity, and not to trust to the gratitude or generous impulse of the Treasury Department.
>
> In old days it was the custom when a man distinguished in science was brought into a high position in the Civil Service that he was credited with a certain number of years' service ranking for pension. This practice has been done away with, and a bargain system substituted. A short while ago the growing agonies of heart disease caused Dr. Copeland to feel that he was less able to carry on the duties of his post, and he determined to resign; but he learnt that under the scale, and in the absence of any special bargain, the pension he would receive would not suffice for the necessities of life. The only increase his friends could get from the Treasury was an offer to allow him about half-a-crown a week extra by way of a house.
>
> Indignant and ashamed of my Government, I persuaded Dr. Copeland to withdraw his resignation and to retain the official position which he has honoured till his death.
>
> I trust, Sir, that this memorandum of mine may cause eminent men of science who are asked to enter the service of the State when already of middle age to take heed for their future welfare.
>
> I am, Sir, your obedient servant,
>
> 2, Cavendish-square, October 28. CRAWFORD.

It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the Association by Her Majesty the Queen. Until 1871 the Association spent annually a large part of its income—as much in later years as £600 a year—in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological and physical observations. In 1871 the Association handed over the observatory to the Royal Society, which had received an endowment of £10,000 from Mr. Gassiot for its maintenance and had further devoted to that purpose considerable sums from its own donation fund and Government grant. Further aid for it was also received from private sources. From this observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the State, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the Government has contributed altogether £34,000 to the capital expenditure on new buildings, fittings and apparatus, and has further assigned a grant of £6,000 a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the State, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins and the active body of physicists in the Royal Society, who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew, which has at length expanded into this splendid national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who have ever occupied the position of a Minister of the Crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of £1,000 a year from the Government and a contribution of £5,000 towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the Government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands, it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The Mastership of the Mint held by Isaac Newton, and finally by Thomas Graham, has been abolished and its salary appropriated by non-scientific officials.

Only a few years ago it was with great difficulty that the Government of the day was prevented from assigning the Directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is, therefore, with especial pleasure that I call your attention to a great gift to science in this country made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some 16 years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds were sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift to another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organisation and finance of this army should be the care of the State.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the mechanic's institutes and lecture societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes, and other entertainments more diverting, but not really more capable of giving pleasure than those in which science was popularised. No doubt the organisation and professional character of scientific work are to a large extent the cause of this falling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centres of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our Society. It seems to me not inappropriate that a Society for the Advancement of Science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific spirit and what is called the religious sentiment. "Religion," says Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electrical Handbooks issued by the Institution of Electrical Engineers in connection with the visit of the Foreign Engineers, June and July, 1906: London; Manchester, Liverpool and Districts; Glasgow, Edinburgh, Newcastle and Districts. (London: The Institution).

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"Lichtstrahlung und Beleuchtung." By Paul Högner. No. 8 of "Elektrotechnik in Einzel-Darstellungen." Edited by Dr. G. Benischke. (Brunswick: Friedrich Vieweg und Sohn.) 3m.

"Construction des Induits à Courant Continu." Partie Mécanique. By E. J. Brunswick and M. Aliamet. ("Encyclopédie Scientifique des Aide-Mémoire." Edited by M. Léauté.) (Paris: Gauthier-Villars.) 2fr. 50c.

"Mitteilungen der Physikalischen Gesellschaft Zürich. No. 9. 1906. (Zürich: J. Leemann.)

THE MAGNETIC SURVEY OF THE NORTH PACIFIC.

An interesting article by Mr. L. A. Bauer in *Terrestrial Magnetism and Atmospheric Electricity* describes the instruments, methods and preliminary results of the magnetic survey of the North Pacific Ocean, undertaken under the auspices of the Department of Terrestrial Magnetism of the Carnegie Institute of Washington. There has been up to the present a great lack of magnetic data relating to the great ocean areas, especially the Pacific, and there is reason to believe that errors in the accurate magnetic constants have been introduced by too much attention having been paid to measurements made on islands and along the sea coast There are several important problems in terrestrial magnetism which can only be solved by a sufficiency of data both over sea and land, as, for example, the verification of the statement made some three years ago that the earth was seemingly losing its magnetic energy. Computations based on the best data hitherto available have indicated a shrinkage of the earth's magnetic moment during recent years at the rate of about $\frac{1}{2400}$ part annually, but fresh observations are required for confirmation of this figure.

There are questions also of atmospheric and earth currents awaiting more complete data for their solution. An exhaustive examination of all magnetic data possessed up to date points to the existence of a system of vertical earth-air electric currents passing from the air into the earth and vice versa, these currents being associated apparently with the general circulation of their air, so that over the region of the earth where we have in general upward air currents, as in the equatorial regions, we have an upward flow of positive electricity, and where the air currents proceed in general downward, we have a downward stream of positive electricity. Students of atmospheric electricity, however, have difficulty in harmonising the strength of the current deduced with the known electric facts of the atmosphere.

It has been suggested that the matter can be settled by a magnetic survey along a line, or rather a small strip, around the entire globe, near the parallel of 50 deg. north. If the line integral of the magnetic force taken along this closed circuit be found equal to zero, the non-existence of the electric currents above referred to will be proven, at least for that part of the earth. If, on the other hand, the line integral be found to have had an appreciable value, then conclusions will result regarding the existence and direction of the currents. The present survey will thus contribute to the settlement of this question. The practical and economical importance of an accurate magnetic survey of the North Pacific, as affecting the needs of navigation, in view of the incomplete nature of the present charts, needs no comment.

The vessel used for the observation was a wooden sailing brig of about 600 tons displacement and named "The Galilee." The principal changes required were the substitution of the steel rigging by hemp rigging; the removal, as far as practicable, of the iron parts in the vicinity of place of observation; the construction of an entirely non-magnetic flying or observing bridge, running fore and aft between the two masts and elevated above the deck so that the instruments would be at a height of 15 ft. above the deck and 25 ft. or more from the principal bolts in the sides of the vessel, and the building of the living quarters for the scientific personnel. While, then, this vessel was not entirely non-magnetic, not having been especially built for the purpose, the effect of the remaining iron was so slight as to produce, at the places of observation, the smallest coefficients of any vessel thus far engaged in magnetic work.

The first cruise consisted of an experimental trip from San Francisco to San Diego, California, in the summer of 1905, when various adjustments and observations were made, and later in the year, after some slight alterations to the equipment, a three months' cruise was made embracing the Hawaiian Islands, Fanning Island and the Magnetic Equator, when a quantity of magnetic observations were made, concluding with the necessary harbour "swings" and control-shore observations on the vessel's return to San Diego. This year's cruise commenced in March, and is still in progress. Fanning Island, the Samoan Islands and Fiji had been visited at the time the account was written, and the Marshall Islands, Guam, Yokohama and the Aleutian Islands were to be included in the cruise, the vessel being expected back about the end of the year.

The general principle kept in view in the arrangement of the apparatus on board was to secure complete control of each instrumental constant in every available manner, and to obtain independent checks upon the observed values of the magnetic elements by securing simultaneously two independent determinations of each element, as far as possible, under different conditions—*i.e.*, different observers, different instruments, and at different stations on the observing bridge, so that the ship correction will be either of varying amount or even of different sign. Besides the usual harbour swings for the determination of constants, swings were carried out at sea at as frequent intervals as possible, and for this purpose a small naphtha launch was carried to assist in turning the ship.

Upon arrival at a port, besides harbour swings, shore observations were made, both with the set of absolute land magnetic instruments

(Cooke magnetometer and Dover dip circle), and with the ship magnetic instruments, consisting of a dip circle, standard liquid compass, and special deflector, described below. And wherever there is a magnetic observatory—*e.g.*, at Honolulu, Samoa, Tokio, and Sitka—all instruments were compared with the observatory standards.

The measurements of magnetic declination on board ship were made chiefly with a standard 8in. Ritchie United States navy liquid compass and azimuth circle of latest patterns and some secondary results were also obtained with a second Ritchie liquid compass provided with a Negus azimuth circle and also with a Kelvin dry compass with azimuth attachment. The progress of the survey as regards declination measurements was greatly impeded by cloud and fog, when no observations of celestial bodies could be made.

The dip or inclination was determined with a Lloyd-Creak dip circle. Each of the two operations for total intensity (deflections and loaded dip observations) were treated separately in the reductions and the constants independently determined. Each deflection observation, long distance and short distance, gives, moreover, a dip determination, and, in addition, regular dip observations were made with the two needles provided for this purpose. After some slight alterations, very satisfactory results were obtained with this instrument. Special attention was paid to accurate balancing and levelling, with the aid of an adjustable counterpoise, when mounted on board ship on the gimbal stand. For certain shore work, a compass attachment and an astronomical telescope was also added so as to make it a universal instrument, a theodolite, dip circle and magnetometer combined.

In addition to obtaining the *horizontal intensity* by means of dip and total intensity measurements with the dip circle, a simple deflection apparatus was devised for observing the horizontal intensity direct. The device consists of a sine deflection method, the deflecting magnet, instead of being mounted in the same horizontal plane with the deflected magnet, and off to one side, as in most forms of field magnetometers, is mounted *vertically* above the centre of the deflected magnet system, which, in the present instance, consists of an ordinary 8 in. Ritchie-Negus liquid compass. A bridge, with a disk on top for carrying the deflecting magnet, was attached at right angles to the sight line or sight bows of the latest form of Negus azimuth circle, provided with the said liquid compass. These sight bows, consisting of two stout parallel brass wires bent into bows, and somewhat over a millimetre apart, define the sight plane passing between them and a brass pointer, with the aid of which the compass is read, or any point thereof set upon; they take the place of the telescope in the field magnetometer. To make a setting with the deflecting magnet mounted on the disc, turn the azimuth circle, carrying the deflector and sight bows, until the brass pointer is over the south end of the compass card; then, since the magnet, by construction, is mounted at right angles to the sight line or bows, and as the latter were set directly over or parallel to the north and south diameter of the compass (assumed for the present to define the magnetic axis of the compass card), it follows that in the position of equilibrium between magnet and card, the magnetic axes of the two are at right angles to each other, and hence the condition of the simple sine deflection method secured. Both lubber lines, marked on the inside of the compass bowl, are then directly read on the compass card to the nearest tenth of a degree, holding the eye so as to avoid parallax. Thus, one of four operations required to complete a set is made. Let us say, in operation *a*, the north end of magnet was towards the east, and the setting of the brass pointer, with the aid of the bows, was made on the south point of the compass card; then, in *b*, the azimuth circle would be turned so as to make a setting on the north point of the compass card, the north end of the magnet now being to the west; next, *c*, turn magnet around on its support, so that north end will be east, setting, however, again on north point of compass, and finally *d*, turn azimuth circle, set pointer on south point of compass, north end of magnet being now west. In brief, practically the same four deflection positions usual in land magnetometers are carried out with this apparatus at sea. Thus the difference in the lubber line readings for operations *a* and *b*, or *c* and *d*, or *b* and *c* or *a* and *d*, gives twice the angle by which the compass card is deflected from the magnetic meridian due to the presence of the deflecting magnet overhead, and the mean of any two of readings mentioned gives the magnet meridian, barring errors of eccentricity of mounting and of magnetic axes. The mean deflection angle, or the mean magnetic meridian reading, will be free of errors, due to the latter causes. As a matter of fact, the magnetic meridian reading of the card is also read before the deflecting magnet is mounted, and again after removal. For each of the operations noted above, the temperature of the magnet is read, as well as the time noted for each reading.

At every port corresponding observations were made ashore with this deflector and the standard field magnetometer, and thus a combined intensity constant determined at various temperatures, this constant being a function of the magnetic moment of the magnet, deflecting distance, &c. Observations were reduced as soon as possible after each observation and forwarded by mail to Washington whever a ship touched at a port.

Some specimens of results are given and discussed in the Paper, and the following conclusions have been reached regarding the attainable accuracy in the values of the magnetic elements at sea:—

1. On a vessel like the "Galilee," with the small deviation coefficients encountered at the positions of the various instruments, whenever she can be swung completely to the port and to the starboard, whether on 16 or 8 equi-distant headings, even in a moderate or a choppy sea, employing the methods introduced and having skilled observers, the average results obtained from the complete swings need not be much inferior in accuracy to the values obtained on shore with the best field instruments handled by expepienced observers. The degree of accuracy appears to depend chiefly upon the amount of time or the number of days that can be spent on the work at any one place. Under ordinary conditions and in the absence of magnetic storms, if about the same time be spent on the complete observations at sea as would be devoted to similar observations on land on one day, it would appear that the magnetic declination, as well as the magnetic inclination or dip of the needle, can be determined within five minutes of the absolute value, and the horizontal component of the earth's magnetic force within about $\frac{1}{500}$ part of its absolute value. If two or three days be devoted to the observations at one place, it is possible, as already stated, to reach results still more accurate; however, it will suffice for all purposes, regarded even from a purely scientific standpoint, to secure the accuracy in the determination of the magnetic elements at sea derived from a complete swing forward and back.

2. In a moderately rough sea, which still permits making observations, the average results derived from a complete swing forward and back, on about six to eight points, may be absolutely correct within five to ten minutes as far as the magnetic declination and dip are concerned, and the value of the horizontal intensity be absolutely correct within about $\frac{1}{200}$ to $\frac{1}{300}$ part.

3. Under favourable conditions of sea and weather, observations made on the *course* of the vessel—*i.e.*, simply on one heading, if they be extended over about an hour, will yield average results that will be relatively correct within five to ten minutes in magnetic declination and dip and horizontal intensity to within $\frac{1}{200}$ to $\frac{1}{300}$ part. The absolute accuracy depends upon how correctly the deviation corrections, to be applied to the observations due to magnetism of the ship for the direction in which she is headed, can be determined from "swings" made several days before and after the observations.

The following summary exhibits the differences between the values of the magnetic elements determined by the "Galilee" in 1905 and those scaled from the latest magnetic charts (declination, inclination and horizontal intensity) of the German Admiralty for 1905, as also from the latest isogonic chart of the British Admiralty for 1907:—

1. The British Admiralty isogonic chart is, on the average, more correct than the German one; however, both charts show systematically too small values of easterly declination between San Francisco and Honolulu by about 1 to 2 deg.

2. The latest isoclinic chart gives dips systematically too low by about 1 deg. on the average.

3. The latest chart of lines of equal horizontal intensity gives uniformly too high values on the average by about $\frac{1}{25}$th part.

At the end of the present cruise of the "Galilee," it is proposed to publish in detail the entire work and results. It may then be worth while to make corrections to the present charts, and also to make tests of the potential hypothesis—*i.e.*, of the existence of vertical electric currents for the various circuits.

Magnet Coils for Arc Lamps.—An American patent has recently been issued to Prof. Elihu Thomson for a process for insulating coils which must withstand excessive moisture and high temperature. Each coil is composed of a single helix of ribbon copper, wound edgewise with the turns close together, so that it forms a tube, the thickness of whose wall is the width of the ribbon conductor. After the coil is wound, and while there is still some space between the convolutions, it is covered by immersion with an insulating and cementing compound, consisting of kaolin and silicate of soda. The proportions of these two ingredients is such that the mixture is a viscous liquid, like a water varnish, which will soak into all crevices and form a thin layer between the metal coils. The entire coil is then closed together to form a rigid structure, and is subjected to a low red heat, until the insulating compound is vitrified into an insoluble moisture-proof cement which binds the coils together without permitting contact between its turns. This insulation is a double silicate of aluminium and sodium, and is refractory, being incapable of complete fusion except at a temperature which would melt the copper.

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In his presidential address to the American Institute of Electrical Engineers Dr. S. S. WHEELER departed from purely engineering topics, and dealt with the subject of Professional Honour, summing up the question in the following words of FRANCIS BACON:—"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavour themselves by way of amends to be a help or ornament thereunto." Dr. WHEELER divides the moral duties of an engineer into three parts—first, duty to the client; second, duty to the public; third, duty to the engineering societies.

The first of these is generally well recognised in some form or another. From this point of view we may class engineers roughly as manufacturers, contractors (or both), consulting engineers and assistants. Of these the assistant is necessarily the most numerous, and his employer must be regarded as his client. The identification by an assistant of his employer's interests with his own is essential for the success of the assistant; and though also of great importance to the employer, it is not always so well recognised by reward as it should be. But the duty of the manufacturer or of the contractor (by which we mean those persons who hold responsible positions in manufacturing or contracting firms) is to the proprietor or shareholder; and duty to the client is not so important, because it is generally a question of dealing with others who have engineering knowledge. Moreover, the giving of satisfaction to engineering clients is *commercially* important, and brings its own reward. It therefore happens that when the subject of Professional Honour is mentioned, it is generally taken to refer to the consulting engineer, and to no other class. In many ways this is as it should be, for the consultant is employed to look after the interests of those who have not sufficient engineering knowledge to handle such work themselves. He must be above

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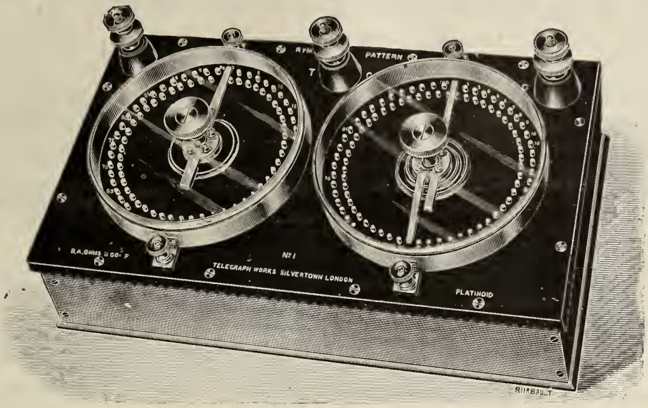

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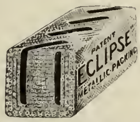

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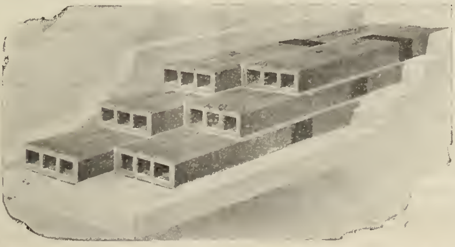

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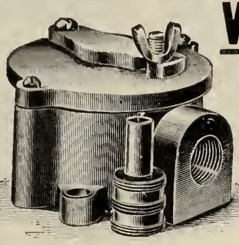

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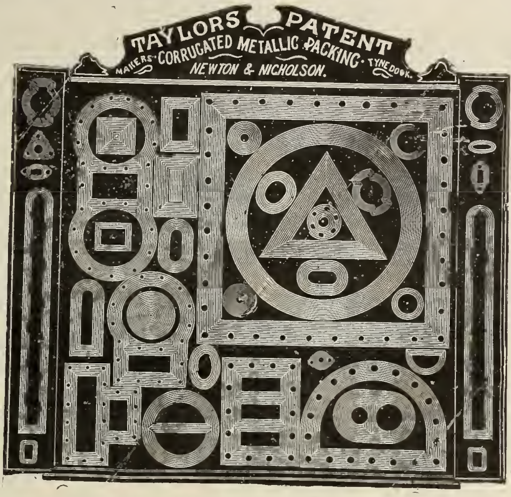

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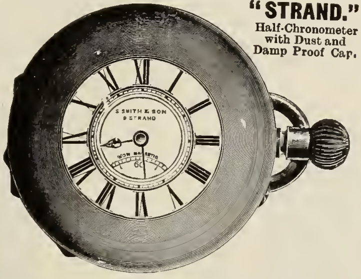

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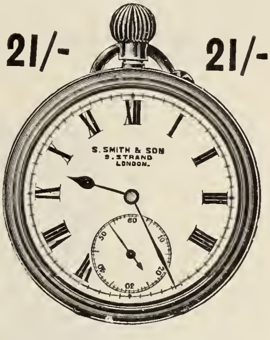

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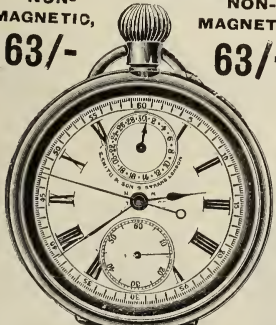

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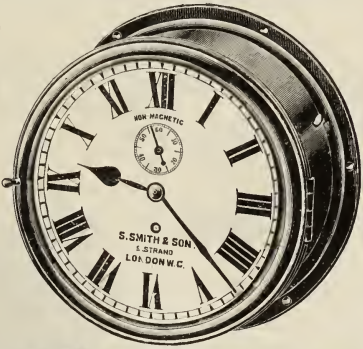

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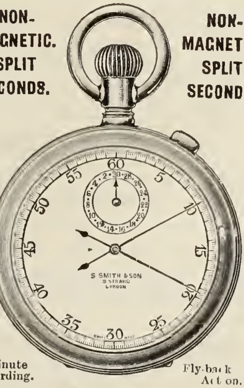

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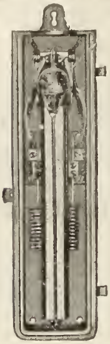

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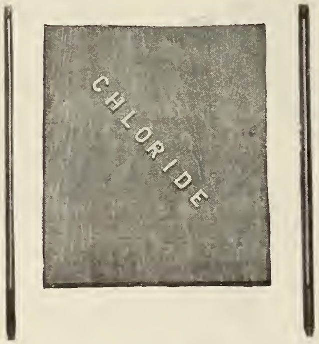

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suspicion, must regard his client's interests above his own, must have no personal interest in the plant recommended to his client, and must not seek work by any form of advertisement. Not only so, but a consultant is not permitted to engage in work as a contractor. There is, of course, no possible justification for the acceptance by a consultant of a manufacturer's discount in addition to a fee from the client who is the purchaser of the manufacturer's goods; but it is noticeable that whereas the consultant is hedged about by rules of professional honour, and may not act as an agent for any manufacturer, the contractor is free to act, not merely as a contractor, but also as a consultant without any restrictions whatever.

The duty of the engineer to the public is less easily defined. Dr. WHEELER is of the opinion that every engineer should instruct individual members of the public whenever appealed to, and give a simple explanation. It is not enough for the engineer to say briefly that such-and-such a statement is absurd. Some explanation should be given as to where the absurdity comes in. This is philanthropic, but does not sound very promising. Most of the absurdities which the public are always ready to believe originate in, and are supported by, the daily press; and so long as the daily press is keen on the marvellous and avoids having responsible engineers upon its staff, so long will the public swallow the absurd and will regard the average engineer as a dull-witted individual in comparison with the crank.

Dr. WHEELER insists strongly on the third duty, or duty to the professional society, and regards this as a duty almost self-evident. "Yet there are those who pay no attention to the official society representing the profession to which they belong. Rare and peculiar birds." He remarks that, unfortunately, some societies at times are not well run, the meetings are sometimes monotonous, the groups of men are not well balanced; but none of these things is an excuse. There is a good deal of truth in such a view. The least difficult period for running a professional society is when an industry is young and is progressing rapidly. There is then more enthusiasm, opinions are more readily expressed, and discussions are more alive. But when the industry settles down, when methods and apparatus become standardised, there is less to record and fewer possibilities to discuss. Then it is that Papers are less spontaneous, and the member who pays his subscription considers that he has done enough. There is, however, a class of member who criticises his society, who is never tired of finding fault with it, but who resolutely abstains from giving any assistance whatever and from improving that of which he complains. Such members are by no means restricted to our cousins across the water; indeed, the Institution of Electrical Engineers in this country would gain much by the hearty co-operation of all its members, or even by that mere attitude of approval advocated by Dr. WHEELER.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Modern Polyphase Machinery. By ANDREW STUART. (London: S. Rentell & Co.) 5s. net.

The object of this manual is to present a survey of the principles and construction of modern polyphase plant without the use of mathematics, with the result that it is neither suited to the needs of the designer nor the student who is about to become a designer. A good deal of general information on the subject is, however, collected together, and a number of illustrations are given of typical machines. After some introductory matter, including notes on the magnetic properties of iron and behaviour of insulating materials, the general principles of the alternating-current generator are dealt with in an elementary way. The treatment is necessarily clumsy on account of even trigonometrical symbols being rigidly excluded. The succeeding portion of the more mechanical aspects of the design is more satisfactory and the brief surveys of methods of excitation and compounding and the factors which influence output are suggestive but somewhat incomplete. The chapter, however, on the determination of characteristics is hardly on the lines of recent developments in that direction, still sticking to the somewhat meaningless expression "synchronous impedance." A short description is then given of the usual methods of synchronising, including the recently introduced Westinghouse automatic synchroniser. The first half of the book concludes with descriptions of some well-known types of alternators, the most interesting part of which is that devoted to modern forms of turbo-alternator, showing the wide differences in constructive methods employed by different designers. A few words on synchronous motors follow, and a brief note on what are described with due deference to a well-known author as *rotatory* converters. The last portion of the book, which forms about one-third of the whole, is devoted to induction motors, and except for a similar clumsiness to that referred to above, due to the absence of anything but the simplest mathematical notation, is perhaps the best part of the book. Such algebraical expressions as are used, however, are not particularly happy in their choice of symbols. The illustrations are plentiful, but more care might have been taken in the preparation of the line blocks, which are very poor.

The Practical Testing of Dynamos and Motors. By CHARLES F. SMITH. (Manchester: The Scientific Publishing Co.) 5s. net.

The second edition of this handbook of continuous-current machine testing contains several additions to its original form, principally in the way of tests, the utility of which has been recognised since the original edition made its appearance. The general scheme of the book is the giving of instructions for the carrying out of a progressive series of about 30 experiments upon dynamos and motors, these instructions being for the most part prefaced by introductory explanations. Thus, for example, in the chapter on magnetic circuits, the predetermination of the open circuit characteristic is fully explained and a numerical example worked out before the instructions are given for determining it experimentally for a given machine. The diagrams of connections are clear, and in many cases typical curves are given to show the sort of result to be expected. One of the additions to the chapter on efficiency tests of dynamos since the former edition is the method of testing two similar machines, originally proposed by Mr. M. B. Field in connection with traction motors, in which the excitation of the two machines can be kept equal. The succeeding section sets forth the more usual methods of separating out the different losses of dynamos and motors, and the next chapter deals with miscellaneous tests, such as the determination of leakage coefficients and the voltage curve around the commutator. Last of all are a few short notes on the testing of balancers, boosters and motor-generators in general. The work is practical in the best sense of the word and should prove of use to those for whom it is intended.

The Manufacture of Lubricants, Shoe Polishes and Leather Dressings. By R. BRUNNER, translated from the German by C. SALTER. (London: Scott, Greenwood & Son.) 7s. 6d.

This book consists principally of instructions and recipes for the preparation of various kinds of lubricants, including greases for axles and other machinery, special oils for lubricating different classes of moving machinery, mineral lubricating oils, clockmakers' oils, as well as shoe polishes, blackings and varnishes and dressings for all kinds of leather. Lubricants which are quasi solid at ordinary temperatures are first discussed and afterwards the refining and preparation of animal and vegetable oils of different varieties is gone into at some length. Mineral lubricating oils are shortly dealt with and after a collection of recipes for special lubricants for particular purposes, some practical notes are given on the use of lubricants, but on the whole the work is intended for the manufacturer of lubricating materials rather than for the user. The second part deals with the manufacture of shoe polishes and leather softening preparations.

GLASGOW CORPORATION TRAMWAYS.

The annual report and accounts issued by the Tramways committee of the Corporation of Glasgow for the year ending May 31, 1906, show a decrease in the net balance on the year's working, notwithstanding an increase in the total revenue. As will be seen below, the average revenue per car-mile has increased, but there has also been an increase in the working expenses per car-mile, mainly due to the extra cost of maintaining the permanent way.

Some 6¾ miles of new route have been opened during the year, which brings up to total length of tramway route owned and leased by the Corporation to 80½ miles, which all except a few furlongs is of double track. Some extensions to car depots, &c., have been made, during the year and oil switches have been installed at Dalhousie sub-station.

The number of cars in stock is now 783, and the following table gives comparative figures for traffic, &c., for the last three years:—

Year ending May 31st.	1904.	1905.	1906.
Lines open for traffic (single track)	140	147½	160¾
Car-mileage	16,291,082	17,943,595	18,886,910
Passengers carried	188,962,610	195,767,519	208,059,833
Receipts	£717,893	£756,480	£813,769
Average receipts per car-mile	10 58d.	10 12d.	10·34d.

In addition to generating current at their own stations for traction purposes, the tramways department have also sold 1,405,843 units to the electricity department through Whitevale sub-station.

A summary of expenses expressed in pence per car-mile over the year's working is given in the following table:—

COSTS PER CAR-MILE.	Year ending May 31, 1905.	Year ending May 31, 1906.
TRAFFIC EXPENSES.		
Salaries and wages	2·34d.	2·31d.
Cleaning cars and depot expenses	0·27d.	0·32d.
Cleaning, salting and sanding track	0·05d.	0·05d.
Ticket check	0·12d.	0·12d.
Uniforms	0 09d.	0 13d.
Miscellaneous	0·04d.	0·03d.
Total traffic expenses	2·91d.	2·96d.
GENERAL EXPENSES.		
Salaries and wages	0·09d.	0·09d.
Rents, rates and taxes	0 57d.	0·60d.
Insurance	0·27d.	0·29d.
Law and Parliamentary expenses	0·01d.	0 01d.
Printing, stationery and miscellaneous	0·07d.	0·06d.
Total general expenses	1·01d.	1·05d.
REPAIRS AND MAINTENANCE.		
Permanent way	0·33d.	0·84d.
Electric equipment of line	0·08d.	0·09d.
Buildings	0 06d.	0·07d.
Cars	0·23d.	0·23d.
Electric equipment of cars	0·18d.	0·16d.
Miscellaneous	0·04d.	0·05d.
Total repairs and maintenance	0·92d.	1·44d.
POWER EXPENSES.		
Salaries and wages	0·12d.	0·12d.
Fuel	0·13d.	0·14d.
Oil, water and waste	0·02d.	0·01d.
Repairs	0 06d.	0·07d.
Miscellaneous	0·01d.	0·01d.
Total power expenses	0·34d.	0·35d.
TOTAL WORKING EXPENSES (excluding capital charges)	**5·18d.**	**5·80d.**
CAPITAL CHARGES, &c.		
Rental of leased lines	0 08d.	0·12d.
Interest	0·67d.	0·70d.
Sinking fund	0 63d.	0 61d.
Income tax	0 07d.	0·16d.
Proportion of Parliamentary expenses written off	0·01d.	0 01d.
Payment to "Common Good" fund of Glasgow Corporation	0 33d.	0·32d.
Depreciation and permanent way renewals funds	2·05d.	2·03d.
Total capital charges	3·84d.	3·98d.
TOTAL EXPENSES (including capital charges)	**9·02d.**	**9·78d.**

The total receipts during the year amounted to £820,939, and the working expenses, as analysed above, came to £456,269. From the balance of £364,670 the following items were deducted: interest £54,788, sinking fund £48,327, income tax £12,423, rental of leased lines, &c., £9,716, depreciation and renewals £169,887, Parliamentary expenses £2,858, and payment to "Common Good" under terms of arrangement £25,000. Interest on surplus revenue amounted to £4,745, so that the final excess of income over expenditure came to £46,418. Of this, £10,000 was made over as an additional payment to the "Common Good," and the remaining £36,418 was carried to the general reserve fund.

The following table shows the total capital expenditure up to May 31st under various headings:—

Account.	Expenditure to May 31, 1906.	Per cent. of total.
Permanent way	£905,990	30 4
Electrical equipment of line	587,870	19·8
Land	136,222	4 6
Buildings, &c.	426,122	14·3
Generating plant	388,036	13 1
Workshop, tools and plant	25,814	0 9
Cars	264,232	8 9
Electrical equipment of cars	195,275	6·6
Other rolling stock	7,576	0·3
Miscellaneous equipment	18,090	0 6
Office furniture	5,163	0·2
Lease of Govan and Ibrox Tramways	4,057	0·1
Parliamentary expenses	6,902	0·2
Total	£2,971,349	100·0

The total units generated amounted to 25,370,859, of which, as stated above, 1,405,843 units were sold to the electricity department and 19,820,686 were issued for traction load at the sub-station 'bus bars. The maximum load on the power station was 8,033 kw. The average car-miles per day per car were 99·91, and the average speed 7·42 miles per hour.

A NEW METHOD OF ASSORTING INCANDESCENT LAMPS ACCORDING TO AGE.*

BY DR. CLAYTON H. SHARP.

To all electric lighting companies practising the system of free replacements of incandescent lamps, the proper assorting of the lamps which are returned from their lines is of considerable importance. Experience shows that if all returned lamps were reckoned as useless the companies would suffer material losses by destroying lamps entirely suitable for further useful service.

The assorting may be planned simply to show whether or not a lamp should be returned to the lines for normal service, or it may be more discriminating. It may divide the lamps into classes, such as (1) those suitable for further service under normal conditions; (2) those which have decreased further in candle-power, but which are still useful for certain purposes where high candle-power is not of first importance—*e.g.*, their bulbs may be coloured; (3) those which have so nearly finished their useful life that it is not desirable to make further use of them.

The proper and best way to assort these returned lamps is to instal a photometer and to measure each lamp, classifying the lamps according to their candle-power. In this operation the initial candle-power and voltage of the lamp must be taken into account. All this involves investment in a photometer with the necessary instruments, rheostats, &c.

A suitable space must be set aside for the photometer and at least two people should be trained as a photometer team to operate it A storage battery to supply steady voltage is a very desirable adjunct. Standard lamps must be provided and carefully watched, instruments checked and kept in order and insidious errors to which photometry is particularly liable must be guarded against. This demands a certain amount of time and attention on the part of a skilled man who understands such work. It is a troublesome, and, at first sight, a comparatively unimportant detail of central station operation. There is a strong temptation to neglect it altogether. Too often it is neglected, especially by smaller companies. If, however, 10 per cent. of the returned lamps are capable of further useful service, it needs no great amount of arithmetic to show that such neglect is costly. It is, of course, bad policy to reissue lamps with blackened bulbs or in which the candle-power has deteriorated considerably; but it is found that many of the lamps returned from customers' premises have never been used, and others have had only slight use and are still in condition for useful service. It is for the purpose of separating these lamps, which are still good, from those which have depreciated preventing their reissue, that methods of assorting are useful to the lighting companies. There is evidently a place for a method which is free from the difficulties and the complications of the photometer method; which requires no special apparatus or skill, and which is speedy and sufficiently exact. The method which is herewith submitted is believed to fulfil these requirements.

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* From the *Electrical World*.

The Electrical Testing Laboratories follow the long established practice of estimating the degree of blackening of the bulbs of lamps which have undergone life test. For purpose of estimation an arbitrary scale of bulb blackening has been established on a system somewhat resembling the hardness scale used by mineralogists. A series of lamps having all degrees of blackening, from the faintest to the densest, was selected. These were designated by the numbers up to nine. The blackening of any lamp is determined by locating it in this series, and is designated accordingly.

To facilitate this determination the scale lamps are placed upright in front of a ground glass screen which is uniformly illuminated from behind. Spaces are left between the scale lamps so that an unknown lamp can be interpolated anywhere in the series. By comparing this lamp with the lamps on either side it is easy to determine whether its proper position in the series has been found.

About a year ago some 300 lamps were tested to determine their ultimate limit of life, *i.e.*, all these lamps were left on life test until they burnt out. After burning out the degree of blackening of their bulbs was estimated. The life of these lamps extended over all periods from 50 hours for the earliest burnt-out to 2,868 hours for the last. The bulb blackenings ranged all the way from zero to 9 on the scale.

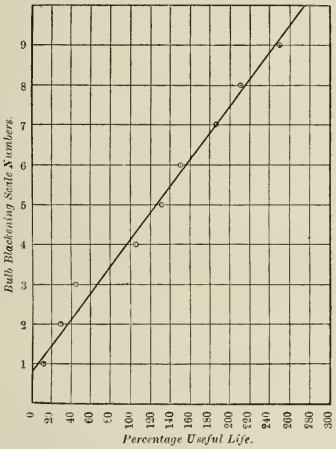

Fig. 1.—Curve showing Relation between Hours Life to Burn Out and Bulb Blackening.

These results were discussed by plotting a curve showing the relation between hours life to burn out and bulb blackening. This curve, which is shown in Fig. 1, came out a straight line, the points being quite close to it in every case. Considering that the scale of blackening is an arbitrary one, selected without the aid of measurements of the actual absorption, that is somewhat remarkable. It is noticeable that the intercept of the curve on the axis falls at the point at which the lamp, after having risen and passed its peak, has fallen to its original candle-power. The bulb blackening does not begin to be perceptible until then. The conclusion is inevitable that, at least in the case of lamps burned until they fail, the final degree of blackening as measured on this scale, is proportional to the time that they have burned. It would seem not warrantable to assume that this blackening progresses more or less uniformly during the life of the lamps and is not deposited at the moment of their destruction. If this is correct, it should be possible to estimate with a fair degree of accuracy what point any lamp has reached in its life history by determining the degree of blackening of its bulb.

To test the accuracy of this assumption, life test lamps when they were taken off the racks to be photometered, were examined for bulb backening also. To make this examination closer, the steps in the lower part of the blackening scale were made finer by the introduction of standards representing discolouration of ½, 1½, 2½, 3½ and 4½. These tests were made on several successive days and the results were plotted out. Special care was taken to determine the degree of blackening corresponding to the 80 per cent. point in candle-power—the blackening at the end of the useful life of the lamp. For this purpose a large number of "finals" were examined, and this point was quite definitely located. All the curves so obtained were straight lines and coincided quite closely with the upper part of the curve of Fig. 1.

In this way it was demonstrated that the degree of blackening constitutes a fairly reliable criterion for the depreciation of a lamp. Moreover, it is a criterion which is independent of the candle-power of the lamp. To locate by means of a photometer the position of a returned lamp on its life curve requires a knowledge of its initial candle power and voltage rating.

The bulb blackening gives directly the percentage of its useful life which a lamp has spent. It is also independent of the efficiency at which the lamp has been operated. The lamp alone tells its own complete story without reference to initial or intermediate conditions.

The next step was to find out whether this criterion can be used practically in assorting the lamps actually returned to a lighting company. Through the courtesy of two lighting companies this has been possible. The first of these companies assorts its returned lamps into three groups—those above 15 c.p., those between 15 c.p. and 14 c.p., and those below 14 c.p. This is done with a photometer. Standards of bulb blackening corresponding to the above stages of life were prepared, and a simple arrangement was constructed for matching the returned lamps. The lamps were assorted into the above groups by the bulb-blackening method, and then the lamps in each group were photometered by the lighting company's force, as usual Accepting the photometrical values as correct, the number of errors made by the bulb blackening method was ascertained. Two different trials of this sort were made, the results of which are incorporated in the accompanying table :--

Table I.—*Classification into Groups by Bulb Blackening.*

	First day.	Second day.
Number of 16 c.p. lamps inspected	368 lamps	.. 432 lamps.
Classified in Group No. 1 above 15 c.p. ..	180 ,,	.. 242 ,,
Classified in Group No. 2 15 c.p. to 14 c.p	100 ,,	.. 100 ,,
Classified in Group No. 3 below 14 c.p. ..	88 ,,	.. 80 ,,

Erroneously Classified, as Indicated by Subsequent Photometry.

	First day.	Second day.
Group No. 1	8 lamps or 4·5%	.. 24 lamps or 10%
Group No. 2	29 ,, ,, 29%	.. 31 ,, ,, 31%
Group No. 3	6 ,, ,, 6·8%	.. 31 ,, ,, 2·5%
Total errors..........	43 ,, ,, 12%	.. 57 ,, ,, 13%

Assuming that the test had been made with a view to separating the lamps into high and low groups only, taking 14 c.p. as the dividing line, Table II. was compiled.

Table II.—*Assorted into High and Low Groups.*

	First day.	Second day.
Errors	High, 12·3% Low, 3·7%	.. High, 5·1% .. Low, 7·2%

It will be seen that the results are quite satisfactory as far as selecting lamps above 15 c.p. and below 14 c.p. is concerned. A much larger percentage of errors was made in 15-14 c.p. group. This corresponds to the greater difficulty in discriminating between such small differences in bulb blackening as correspond to a drop of only 1 c.p. in the life of the lamp. Even so, the method is by no means a total failure, since 70 per cent. of these lamps were correctly classified The results of even this considerable percentage of errors could not be very serious. The small percentage of errors made in discriminating between lamps above 14 c.p. and those below that point shows that the method meets fairly well the requirements of practice for this method of assorting.

A notable advantage of the method is the quickness with which the work can be done. In photmetering the above lamps the labour of two operators during four hours was required, while in making the bulb inspection one operator with the simplest possible equipment accomplished the same work in three hours, hence with three-eighths of the labour cost. The time of the bulb inspector included that necessary for cleaning the bulbs, a duty of which he relieved the photometer operator.

An inspection of 950 lamps returned to the other company showed that in assorting into classes above and below 13 c.p. about 5 per cent. of errors was made.

The bulb blackening method is useful for other purposes than merely separating lamps into high and low groups. A company in possession of a set of blackening or discolouration standards is in a position to investigate its returned lamps and to determine whether lamps are, in general, returned too early or too late in their lives. It makes it easy to obtain valuable information as to the operation of the free replacement system. For instance, an inspection of some 1,300 lamps returned to a lighting company showed an average bulb blackening of 3·4, indicating that the average period of use had exceeded the period of useful life by 20 per cent. The classification made of these lamps is shown in Table III.

Table III.

Bulb discolouration.	No. of lamps.	Proportion of total No. inspected.	Proportion of average effective life indicated.
1	206	15·4 per cent.	45 per cent.
2	187	13·9 ,,	80 ,,
3	321	23·9 ,,	115 ,,
4	365	22·8 ,,	130 ,,
5	186	13·9 ,,	165 ,,
6	72	5·4 ,,	200 ,,
7	39	2·9 ,,	235 ,,
8	24	1·8 ,,	250 ,,

It is of interest to know what the different steps in this blackening scale are numerically equal to. To determine this the percentage of light absorbed was measured on a photometer. Several sets of lamps corresponding to the steps of the blackening scale were selected. Each of these was placed in the photometer rotator with a tubular lamp behind it The percentage of light transmitted was thus determined. Similar measurements were made on new lamps to determine what portion of this light was intercepted by the clear glass and what portion by the carbon coating. After this had been done the bases were removed from these lamps, and the absorption of one thickness of the lamp wall was measured by putting the miniature lamp inside the empty bulb. The results of preliminary measurements are shown in the curve of Fig. 2. It will be seen that this curve is nearly a straight line for the lower numbers which cover the ordinary range of returned lamps. These results are subject to revision.

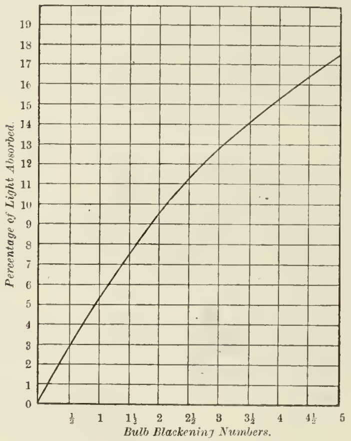

Fig. 2.—Curve showing Percentage of Light Absorbed to Blackened Bulbs.

An interesting conclusion from the above is that in round numbers 50 per cent. of the decrease in candle-power of a lamp is produced by bulb blackening and 50 per cent. by changes in the filament.

A POLYPHASE TRACTION SYSTEM FOR ELECTRIC RAILWAYS.*

BY DR. W. KUMMER.

The system described below, which has been patented in Germany,† contains several novel features. Motors are mounted so as to drive most of the axles along the train, and in this way a high rate of acceleration is obtained. The motors are of the polyphase induction type with short-circuited rotors. They are driven through a converter, the form of which depends on whether the overhead line supplies continuous or alternating current. Suppose the line to be supplied with high-tension continuous current at a pressure between 2,000 and 5,000 volts. In this case the converter would assume the form of a motor-generator, the continuous-current motor being excited from a separate source, which is controlled by resistances, and the polyphase generator being driven by the motor and excited by a constant field. This excitation can be provided by a battery or by a special exciter, which would also provide current for lighting and for working the air compressors, &c The controller itself merely regulates the low-voltage excitation circuit, and is therefore safe and simple in operation. The first five positions of the controller regulate the speed of the motor generator until the desired frequency on the polyphase side is reached, and the next three positions also serve for further regulation; if used in the inverse direction, they tend to decrease the speed, and exert a recuperative effect on the supply network. After switching on, the motor-generator runs unloaded until it reaches a frequency on the alternating side at which the turning moment of the polyphase motors, allowing for 100 per cent. slip, is sufficient to start the train. After this the slip decreases with the increasing frequency, until it reaches its normal value, when the controller is in its fifth position; the turning moment of the polyphase motors, however, remains constant, and by means of regulation of the starting resistances, the primary current can be maintained constant also. Further regulation of the speed is effected by the insertion of resistances into the field circuit of the continuous current motor which causes a decrease of the turning moment and also of the slip, in spite of the increase of speed. A recuperative effect can be obtained by an increase of the exciting current of the continuous-current machine, which causes this to have a higher potential than the network supplying it, the motion of the train being converted by means of the motors acting as asynchronous generators into energy which is returned to the line. The electric brake can be applied by switching the continuous-current portion of the motor-generator on the starting resistances in four separate stages, the train being finally brought to rest by the application of the ordinary compressed air brake.

It may also be pointed out that the above system can be used with alternating current supplied from the overhead conductor. In this case the continuous-current portion of the motor-generator is replaced by an alternating current commutator motor. With this system, the use of transformers is possible, and this adds to the flexibility of the arrangement. Still, with continuous currents, voltages up to 5,000 are safe and practicable, and should suffice both for suburban and main lines, for which this system is principally intended.

The Oerlikon Company of Zurich have acquired the author's patent, and carried out a series of careful tests with a view to ensuring the satisfactory working of the various details in actual operation. So far no actual working tes's have been made on a railway, but by means of electrical and mechanical tests it has been shown that the system is capable of dealing with the problem which railway work is likely to present.

The advantages of this form of equipment are as follows. In the first place, a high rate of acceleration is obtained at the start. This has hitherto been best obtained by the use of multiple unit systems, in which motors are installed so as to drive many of the axles on the train. In this case each motor car has its own subsidiary control apparatus, whereas in the system described above all the separate control apparatus is replaced by the one motor-generator arranged to give a secondary polyphase current of variable frequency, to which the primaries of the motors along the train are permanently connected in parallel. It is evident that this arrangement admits of great simplicity in the matter of collection and transformation of current, seeing that the control apparatus can be centralised at one point, and the use of high tension current tends to cheapen the cost of feeders and overhead wires. The weight of the equipment will, however, be greater, while its cost per ton will be less. On the carriages themselves only the actual traction motors would be carried; all other apparatus for the purpose of regulation, transformation and conversion of the current would be carried on a motor-driven car of the nature of a locomotive.

With a view to estimating the weight of the equipment, a comparison is made on the basis of an article by S. G. Freund on "The Carriages of the New York Underground Railway," which has recently appeared in a contemporary. The weight of the train is to be 187 tons, and the length of track 730 metres. According to the schedule, a speed of 31 km. per hour is to be reached with a nearly constant acceleration of about 6·6 metres per second per second, rising then to 43 km. per hour with a decreased acceleration. At the start the motors must give a nearly constant pull of 12,000 kg. at the circumference of the car wheels, which at 31 km. per hour means 1,375 H.P. on the axles. Assuming the diameter of the wheels to be 860 mm., and the gearing in the ratio of 1 : 3·3, the speed of the axles will be 630 revs. per min. The train would have 10 polyphase motors, each with eight poles; allowing for a 5 per cent. slip at full load, the periodicity would be 44. Allowing for the usual efficiency of gearing, &c., the full-load output of the secondary of the motor generator would be 1,500 H.P., and of the primary 1,700 H.P. Supposing the converter to be supplied with high-tension continuous-current on the primary side, and to give polyphase current of variable periodicity on the secondary side, the primary would probably be designed with six poles and the secondary with eight poles for a speed of 660 revs. per min. Taking all figures into account, the construction of the converter would probably require a bore of 1,200 mm. for the primary and secondary sides, and a length of 400 mm. for the primary armature and of 600 mm. for the secondary. The weight of such a converter, including casing, would be about 20·5 tons; the weight of the framework of the locomotive with two bogies and two driver's platforms would be 19·5 tons; and including the other necessary accessories the total weight of the locomotive would be 47 tons. Therefore, out of the total of 187 tons, 140 tons would represent the weight of the train proper. Seeing that the electrical equipment of the carriages themselves would be somewhat lighter than on the multiple unit system, the weight of the locomotive must be considered to be reduced by about 20 or 30 per cent. in order to make the comparison on a reasonable basis.

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* Condensed from *Elektrische Bahnen und Betriebe*, June 13, 1906,

† D.R.P. 157,769 (1902).

CORRESPONDENCE.

STANDARDISING RUBBER-COVERED CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to draw your attention to a statement made in Mr. John Langan's Paper on "Standardising Rubber-covered Wires and Cables," published in the *Proceedings* of the American Institute of Electrical Engineers, Vol. XXV., No. 4, April 1906, which I think needs some modification. A short abstract of this Paper was given under "American Cable Practice" in your issue of May 18th last.

In referring to the amount of resinous matter contained in fine Para rubber, Mr. Langan states that it seldom exceeds 1 per cent. Now, as a rubber chemist of many years' experience, and from the results of scores of analyses, I beg to say that no sample of Para rubber has yet come under my notice with so low a percentage of resinous matter. As a matter of fact, the amount of resinous matter contained in pure Para rubber, washed and dried as it would be used in the manufacture of rubber-insulated wires, varies from 2 per cent. to as much as 5 per cent.

I should feel obliged by your inserting the above note in your valuable journal at an early opportunity, as Mr. Langan's figure may be misleading to consulting engineers and electricians who have to draw up specifications.—Yours, &c.,

Woolwich, July 26. W. F. EICHENAUER.

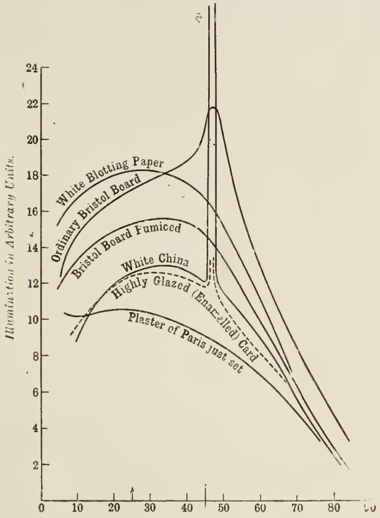
SOME CAUSES OF ERROR IN PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. L. W. Wild's article on p. 529 usefully calls attention to certain errors which may arise through neglect of angular adjustments, but he illustrates his subject by reference to ill-designed and ill-made apparatus, and he alludes to the "Trotter screen." I would not have complained had he not used this again, in his letter to you on p. 589, as a shocking example. If Mr. Wild has found an instrument with a side shake amounting to 1 deg., and with screens on which the light is incident at an angle of 60 deg., I must beg him not to call it a "Trotter screen." I have designed several kinds of photometers for different purposes, and the particular pattern which Mr. Wild probably had in his mind was briefly described in the *Proceedings* of the Physical Society of London, Vol. XII., December, 1893, pp. 345-360, and in *Phil. Mag.*, July, 1893. That paper described two kinds of screens, one with two lozenge-shaped holes, one over the other, and one with a long grid, specially intended for work with rapidly fluctuating lights. "The screens were held in a frame capable of rotation round a vertical axis through a small angle, for the purpose of producing small and rapid variations." The simple form was more fully described in the *Journal* Inst. Elec. Eng., Vol. XXXII., pp. 188-189. There is so little new in the principle of this that I have never claimed it as the "Trotter photometer."

In a Paper read on the same day (June 9, 1893), Prof. S. P. Thompson referred to the use of two opaque screens by Sir John Conroy in 1883. Those screens were inclined at about 60 deg. to one another—that is, an angle of incidence of 30 deg. "He found, as I did," wrote Prof. S. P. Thompson, "that 90 deg. is too large a dihedral angle for exact work." The Thompson-Starling photometer described in that Paper has two surfaces meeting at an angle of about 70 deg.

I made some experiments on this point in 1895, but the records have been mislaid, and I have never had opportunity to go on with the work. On October 31, 1895, I wrote to Messrs. Nalder Bros., who were making what they called the Trotter bar photometer (as distinguished from the illumination photometer): "I enclose a few curves forming part of a research on which I have done but little as yet. The angles refer to the position of the back screen of a photometer, the front one remaining fixed. The vertical scale is read directly off the photometer bar. The two lights were equal, and when the photometer reads 10, the angles being the same, the balance is the same, and the reflecting powers of the screens are the same. If the screens are not made of the same material, *or* if the angles are not the same, and the photometer reads, say, 5, the brilliance of one screen is therefore half the brilliance of the other. I only trouble you with this in order to show that 35 deg. (or as marked here 25 deg.) is on the flat of most of the curves. This means that a trifling error in the angles of the screens will not affect the truth of the photometer, and, what is more important, a deviation of the position of the light from the true axis does not matter."



Angle of Incidence of Light on Back Screen or of Line of Sight with Back Screen.

I cannot remember why I called attention to 25 deg., but the general results show that if anyone is so foolish as to use an angle of incidence of 60 deg. he would be liable to such an error as Mr. Wild discusses, and that with an angle between 30 deg. and 40 deg. such an error may be eliminated. The curves are traced from the rather blotted copy in my letter book, and I regret that I cannot indicate the observed points on them.—Yours &c., A. P. TROTTER.

Whitehall, S W., July 31.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Mr. Wild's letter of the 27th ult. in reply to mine in the same issue. I cannot, however, agree with him that it is *impossible* to avoid errors of the magnitude of 3 per cent. due to want of alignment of lights. In the first place, if he will refer again to my letter, he will observe that the one case mentioned by me—viz., that of the street-lighting photometer—will not be affected in this manner, since the distance between the lamp tested and the photometer head is very much greater; and in the other case, of the central-station photometer (and, by the way, the photometer head under discussion was the "Flicker" and not the "Trotter"), the error due to the special case of accidental bending of filament can, with similar lamps—*i.e.*, lamps of the same make and shape of filament—be compensated for very largely by viewing in the vertical plane. This exceptional case, I think, is a little far-fetched, although in the exact circumstances that he mentions it is sound enough, since in the case of important work, where such errors as 3 per cent. are of moment, such defective lamps would be discarded. The method of viewing in the vertical plane is, of course, subject to alignment errors of the same order where the lamps are of different heights; but, in any case, it is fair to assume that in such work some care is taken to ensure that the C.G. of the filament is in the correct position. When it comes to heterochromatic photometry, the colour errors, due to the use of the "Trotter" screen, will quite swamp the alignment errors, and therefore the latter are of small importance.

At the same time, I should like again to say that articles discussing the possibilities of such errors are extremely valuable and are much appreciated by manufacturers.—Yours, &c.,

Westminster, S.W., Aug. 1. G. J. LEMMENS.

PARALLEL RUNNING OF GAS-DRIVEN ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am sure that, with your usual courtesy, you will gladly permit me to attempt to remove a misconception that obviously pervades your brief editorial comment on the three Papers dealing with high-power gas engines (and read at the last meeting of the Iron and Steel Institute)—namely, that gas engines are not suitable for driving electrical machinery running in parallel. This misconception, although, unfortunately, common amongst some engineers in this country, has now no existence in Germany.

The misconception had its origin in the difficulty experienced with the engines of the early Otto-cycle design—having a single acting piston, driven by town gas or other fuel having a high proportion of hydrogen or of hydro-carbon as part of its chemical constitution and having a thermal value of at least 150 B.Th.U. per cubic foot. Now, Sir, the successful use (established for several years) of power gases of low calorific value, 80 to 110 B.Th.U., and having a hydrogen content of not more than 5 per cent. (volumetric), driving pairs of double-acting Otto-cycle engines (a pair of double-acting cylinders being arranged on each side of flywheel alternator) has removed all doubts as to the possibility of employing this highly efficient thermo-dynamic instrument, the gas engine, up to almost any desired power capacity, and for driving electrical machinery running in parallel—in fact, my list of makers capable of specifying and guaranteeing engines to run with remarkable cyclical uniformity is growing larger every year.

Compared with the reciprocating engine, steam or gas, the turbine will always have the unchallenged claim of cyclical perfection, but on this point I may justly hold that so long as the gas engine drives with the desired steadiness to keep in step no more is required. The objection to the gas engine because it will not give the steadiness of the turbine is not retarding the application of this economic instrument on the Continent, and it will not do so here or elsewhere.—*Abusus non tollit usum.*

I am satisfied, Sir, that, with the rapidly widening and splendid facilities provided by the modern electrical power transmitting and distributing agencies, many of us will live to see the practical consummation of the idea I have so long worked for, namely, the *centralisation on the coal fields*, as far as practicable, of all our land power-generating agencies; the suppression of steam and its displacement by gas as the medium of power generation; and the recovery of valuable nitrogenous and hydro-carbonaceous residuals from the coals that now merely pollute our atmosphere, add to the cost, and reduce the enjoyment of our daily lives.—Yours, &c.,

Westminster, S.W., July 30. B. H. THWAITE.

N.B.—Close on 500,000 H.P. of large furnace gas engines, with unit capacities varying between 500 E.H.P. and 3,000 E.H.P., have been built within the last few years.

[In the editorial note referred to we did not imply that gas-driven alternators could not be run in parallel, but merely stated that the problem of driving alternators is more difficult than that of making gas-driven blowing engines. We think this view is generally recognised. We might also point out that the mere steadiness necessary for running in step is not all that is required.—ED. *E.*]

PARLIAMENTARY INTELLIGENCE.

MISCELLANEOUS.

The Kent Electric Power Bill was read a third time in the House of Commons on Thursday last week. In the House Lords, the South Wales Electrical Power Distribution Bill, the Macclesfield and District Tramways Bill, the North-West London Railway Bill and the Watford and Edgware Railway Bill was read a third time and passed.

The St. Pancras Electricity Bill and the Hackney Electricity Bill were read a third time in the House of Lords and passed on Friday of last week.

The Corporation of London (Blackfriars and other Bridges) Bill and the London County Council Tramways and Improvements Bill have been returned to the House of Lords from the House of Commons agreed to, and now await only the Royal Assent to become law.

LEGAL INTELLIGENCE.

Attorney-General v. Great Northern, Piccadilly & Brompton Railway Co.

On Monday, before Mr. Justice Walton, the Attorney-General (for the Crown) sought to recover from defendants £13,200, in respect of penalties under sec. 113 of the Stamp Act, for failure to state an increase of the nominal capital of the company.

The SOLICITOR-GENERAL (Sir W. Robson) said the sum was really the amount of duty due on increased capital of the company. In 1899 an act was passed incorporating the Great Northern and Strand Railway Co. with a capital of £2,400,000. Though that capital was not issued, duty was paid on it. Another company had been incorporated, two years before that time, called the Brompton & Piccadilly Circus Railway Co., and in 1902 acts were passed uniting the two companies under the title of the Great Northern, Piccadilly & Brompton Railway Co., and the Solicitor-General argued that the unissued capital now became the capital of the new company, and, as such, was liable to duty.

Mr. LUSH, K.C., for defendants, said the Brompton Co., by the Act of 1902, became clothed with the identity of the Strand Co., and was substituted for that company, assuming all its liabilities and enjoying all its immunities. He could not think that the Court would assist the Crown to obtain two duties in respect of the same authority to issue the same capital.

In delivering judgment, his LORDSHIP said that he agreed that the charge which was imposed by sec. 113 of the Stamp Act was really a charge upon a grant of power to do certain things and to raise certain capital. If that grant were revoked, or repealed, or had expired, the same powers might be granted to another company, or, indeed, to the same company, if it remained in existence. Then there would be a new grant, and a new duty would become payable, although duty had been paid under the original grant. The Solicitor-General maintained that the grant made to one company in that case had been afterwards given to another, and that, although the first company had paid the duty and never exercised their powers, the second company upon the grant to it must again pay the duty. After reviewing the facts he decided that the view taken by the Solicitor-General was not the correct one. He thought the capital of £2,400,000 which the Brompton Co. were authorised to raise would be raised, if at all, under the Act of 1899, and not under any power given by the 1902 Act, so that there was no new act or grant upon which the duty should be made payable. Judgment would be for defendants, with costs.

Hawkes v. Electrical Corpn. (Ltd.) and Bauer.

This case came before the Lord Chief Justice and a special jury last week. Plaintiff (Mr. O. C. Hawkes, of Birmingham), sought to rescind contracts dated Dec. 8, 1904, to take 6,500 shares in the Electrical Corpn. (Ltd.) and to rectify the register of the corporation by removing plaintiffs' name therefrom. He also claimed repayment of £4,000 as against each of the defendants (the Electrical Corpn. and Mr. J. A. Bauer). It was alleged [that Bauer promoted in 1899 the defendant company, of which he was a director. On Dec. 2, 1904, Bauer orally agreed with plaintiff that he would assign the defendant company his patents in the Pluto electric heating and cooking apparatus for £5,000 (£4,500 in shares and £500 in cash), and that plaintiff should have the option for 11 days to purchase half of the 13,000 £1 shares standing in Bauer's name on the register of the company for £6,500. This agreement was subsequently reduced to writing, and plaintiff entered into an agreement in writing with Bauer and the company to apply for and accept allotment of 6,500 shares of £1 each in defendant company. On Dec. 14 the company allotted the shares, and plaintiff paid £3,250 by cheque on account. On May 25, 1905, plaintiff paid by cheque to the company another £750. Plaintiff alleged that he was induced to enter into the contract and to pay the sums referred to by false and fraudulent representations made by Bauer on his own behalf and on behalf of the company.

DEFENDANTS admitted the representations, but said that, so far as the representations were matters of opinion, Bauer honestly entertained such opinion, and so far as they were matters of fact, it was not admitted that they were in any material respect untrue. As to the claim for rescinding the contract, defendants pleaded that plaintiff did not repudiate the agreements within a reasonable time, and that after full knowledge of all material facts plaintiff ratified and confirmed the agreements. The defendants also said it was a term of the agreement that defendant company should employ O. C. Hawkes (Ltd.), of which plaintiff was managing director, to manufacture certain articles, and the taking of shares in defendant company formed the consideration for that clause. In pursuance of it, O. C. Hawkes (Ltd.) had been employed, and had been paid £700 in respect of goods manufactured by them.

Mr LUSH, K.C., said plaintiff was a man of position and influence in Birmingham, and Mr. Bauer, who had invented an electric heating stove, which he called the Pluto, was anxious to get hold of Mr. Hawkes, and seemed not to have hesitated what representation he made. Among statements made to induce plaintiff to throw in his lot with the company was that his father and brother held high positions, that his father was a director of the General Electric Co. and that they were of good social rank; but these statements were untrue, the fact being that his father was a baker in a small street in St. Luke's, London. His brother was said to be a distinguished physician in Harley-street, whereas he kept a beershop. Mr. Hawkes was (said counsel) much impressed by these representations, thinking he was dealing with a well-connected person. Other representations of alleged facts which were equally imaginary were that he had had several offers from syndicates and electrical companies to purchase the Pluto patents; that he had bona-fide orders for considerable quantities of heaters; that there was a considerable demand for them; and that they had been mainly instrumental in his obtaining the first diploma and gold medal at the Bath electrical exhibition in 1904. He alleged that Bauer got up an ocular demonstration of the powers of the Pluto heater at his office for the benefit of Mr. Hawkes. A kettle was placed on the heater, the current was switched on, and lo! the water was boiling in two or three minutes. But it was all a trick—the water had been heated nearly to the boiling point beforehand, and, moreover, it was not a Pluto heater that was used.

Mr. O. C. HAWKES gave evidence in support of counsel's statements. He said he had been in business for 35 years, and had been pretty successful.

In reply to a question whether he had not gone into the electrical heating business himself since severing his connection with defendant company, witness said he had patented a heater to place in the cases which they had manufactured for the Pluto and had not been paid for. It was not true to say that the heater was an imitation of the Pluto stove.

Mr. RUFUS ISAACS (for defendant) subsequently announced that the parties had come to terms. If the case had gone on there was a great body of evidence that would have to be called and he was glad the parties had been able to come to a settlement.

The LORD CHIEF JUSTICE: I think it is a very proper conclusion.

A juror was then withdrawn, and the proceedings terminated.

Westlake and Others v. St. Pancras Borough Council.

This case came before Mr. Justice Neville last week.

Mr. JENKINS, K.C., for plaintiffs, said his clients sought to restrain defendants from carrying on certain works in such a way as to create a nuisance. Plaintiffs also claimed damages for past acts of defendants. The alleged nuisance was caused by vibration, set up by the engines at defendants' electricity generating station opposite plaintiffs' premises. Plaintiffs alleged that the vibration was of such a nature as to make their houses less comfortable, and at times it was really intolerable. The nuisance was something more than temporary, and the vibration caused injury to plaintiffs' premises structurally. Plaintiffs also alleged that in connection with defendants' dust destructor works, which were on the same site, a sort of grit or dust issued from the chimney shaft and covered plaintiffs' premises when the wind was in a certain direction. Plaintiffs further complained of nuisance by smell caused by the burning of the refuse and also by a process of what was called "damping down" the clinkers. After working for some time (counsel continued), in 1902 defendants decided to largely increase their station equipment, and in May, 1903, they put in three engines of from 700 H.P. to 900 H.P. each. The effect of that addition was to set up vibration. In 1904 Mr. Westlake (one of the plaintiffs) complained in writing, and in November, 1903, the owners of certain houses in Great College-street brought an action against defendants, and an injunction was granted, but a stay was allowed on the footing that within a certain time defendants would balance the engines properly and then there would be no nuisance. The present plaintiffs were awaiting the result of that action. Defendants having got the stay occupied the six months in trying to improve the balancing of their engines and also in buying out the plaintiffs in the first action. Defendants did not then worry any more about the injunction, and ultimately, after complaints had been made, the present action was commenced on Dec. 30, 1905.

Mr. J. J. BOURNE, M.Inst.C.E., said he went over the King's-road electricity works in connection with the previous action against the Council. The engines then there were about 750 H.P. Since the beginning of March, 1906, he had probably visited Mr. Westlake's premises about 50 times. Each time he noticed vibration, sometimes periodical, sometimes continuous. The vibration was not due to tramways or other traffic, but was caused by vibrating engines at the generating station. Vehicular vibration had not the same character of continuity and had not the recurrence of beat as that caused by synchronising engines. He was speaking of the combined effect of the engines. He noticed the works chimney vomited out sparks and dirt, and when he left the premises his hands were very dirty from the dirt from the works. He obtained vibration records by means of experiments with instruments independently of his senses. He produced a vibration recording instrument which he had used on plaintiffs' premises, and explained the records obtained.

Capt. H. R. SANKEY, R.E. (ret.) said that on April 8 he visited plaintiffs' premises and made experiments several times On April 11, in company with Mr. Bourne, he went over the houses, and saw several vibration testers. There were visual signs of vibration in the living rooms. In his judgment the vibration recording machine produced was a perfect instruments for its purposes. The vibrations were, in his judgment, caused by running machinery not perfectly balanced. He had no doubt the vibration came from the electricity station. The question of the balancing of the engines was of very great importance. Unbalancing was caused by what were called the inertia forces not balancing among themselves. Six engines could be balanced, but not three. He would attribute what he observed to the steam turbines. Vibration was ordinarily produced by two or more engines running out of step. The recording instrument did not record the actual vibration, it magnified it 200 times probably. He knew great efforts had been made to balance the engines. There was a vertical deep well steam pump at Idris's, opposite the power station. Pump power was frequently unbalanced. The 140 H.P. horizontal engine at Idris's works would not produce the vibration he observed at plaintiff's premises. It was impossible to dogmatise about vibration without an accurate knowledge of the subsoil. The principle of Prof. Dalby's balancing device was to introduce bog weights to put the inertia forces in opposition to the piston.

A mass of further evidence having been given of the usual character in such cases, and rebutting evidence having been submitted for the defence,

Mr. Justice NEVILLE delivered judgment. He said that lapse of time before action brought in the case of a legal nuisance would not prevent the right to an injunction if the nuisance alleged was proved to exist. But in such cases the Court must take into consideration the fact that since 1894 plaintiffs had done nothing in respect to the nuisance alleged to arise from the dust destructor, and it was not alleged that the nuisance was an increasing nuisance, but that it had existed since the destructor was started. In his opinion, plaintiffs' evidence on that point was vague, inaccurate and somewhat exaggerated, and he held that they had failed to prove any nuisance from the dust destructor. As to the vibration alleged to be caused by defendants' electric generating plant, a great deal of the evidence was directed to the question whether there was vibration on plaintiffs' premises, but the question was not whether there was vibration, but whether vibration existed so as to be an actionable nuisance. It was common ground that periodic vibrations had existed since 1903. The evidence on both sides showed, in his opinion, that the working of defendants' No. 3 engine led to vibration which Col. Crompton (defendant's principal expert witness) said might be acknowledged to be a nuisance. Taking that admission with plaintiffs' expert evidence, he thought a legal nuisance existed at the date of the writ. It was true defendants had discontinued the use of No. 3 engine since February, 1906, and they had stated that that engine would not be used again, but as the nuisance existed at the date of the writ, he thought plaintiffs were entitled to an injunction restraining defendants from working No. 3 engine or any other engine so as to cause a nuisance to plaintiffs. That entitled plaintiffs to the costs of the action except so far as they had been increased by their claim for an injunction in respect of the dust destructor, and there would be a set-off of those costs against the costs of the action, and defendants would pay the balance of the costs.

Mayor, &c., of Southampton v. Courtenay.

The hearing of this case was concluded on Monday before Mr. Justice Phillimore and a special jury.

Mr. LOWE, K.C. (for plaintiffs), said the Corporation on June 24, 1905, contracted with defendant giving him the sole right of advertising in all their regularly running electric tramcars for five years at £25 per car per annum, and plaintiffs now sought to recover £918 15s. alleged to be due under the contract. Defendant contended that "regular running" cars excluded cars which from time to time might be held in reserve as supplementary cars for special journeys or for special exigencies, but he (counsel) stated that the Corporation had no reserve or supplementary cars. They had 49 cars, of which 45 ran every day. Plaintiffs did not object to defendant's exclusion of supplementary and reserve cars, but they could not admit that defendant should have his advertisement free on cars that for any reason did not run for a whole working day.

In the result the case was settled, the parties agreeing to a formula which had been prepared, recognising that 45 out of the 49 cars owned by the Corporation should be taken as the number of "regular running" cars both for the purposes of the action and as a basis for the future in the event of the number of cars being increased.

His LORDSHIP thought the settlement a proper one, and the jury found for plaintiffs for the amount claimed, with interest.

Judgment accordingly, with costs.

The King v. Mountford (ex parte London United Tramways (1901), Ltd.

A Divisional Court (Mr. Justice Darling and Mr. Justice Phillimore) delivered a reserved judgment on Saturday in this case. The London United Tramways Co. had obtained a rule nisi calling upon Mr. Mountford to show cause why an inquisition verdict and judgment taken before the Sheriff of Surrey, on Feb. 26, should not be quashed on the ground of excess of jurisdiction. The facts were as follows: Mr. Mountford practised as a dentist in a house at Kingston, which for many years had been associated with a dentist's practice, and he held the house on lease for a term of years. The company wishing to widen the street gave him the statutory notice to treat for a strip of land (about 10 ft. wide by 170 ft. long). Mr. Mountford originally claimed for compensation (1 the value of the land taken and compensation for damage done to his business while the works were being executed; (2) for injury done to his premises and the goodwill of his business by reason of depriving the house to a certain extent of its approach; (3) for injury to the stable and for depreciation of goodwill in consequence of the alteration of the character of the neighbourhood by the Company constructing their tramways. The Company alleged that the notice to treat was served in pursuance of their powers, and that no compensation could be awarded for laying down and opening authorised tramways.

Mr. Justice DARLING said the Lands Clauses Consolidation Act, 1845, sec. 63, ensured that in estimating the purchase money of land or compensation to be paid for the taking of it regard should be had not only to the value of the land to be purchased or taken but also to the damage, if any, to be sustained by the owner of the lands taken from the other lands of such owner, or otherwise injuriously affecting such other lands by the exercise of the purchase powers. His Lordship said that in the Sheriff's Court the jury awarded Mr. Mountford £360 in respect of the land taken and £400 in respect of the injurious affection of the remainder of Mr. Mountford's premises, including loss of goodwill. That sum was arrived at by considering the injury likely to be done to Mr. Mountford's other land and to his practice by the Company's legal order of the tramway laid upon land which had never been his. Whether that was a matter entitling Mr. Mountford to compensation in that respect was the question they had to decide. That he would have been entitled to such compensation had the tramway been laid and worked upon the land taken from him appeared to be indisputable and to follow from the decisions in the cases cited. Yet, even so, it seemed to him that a person whose land was taken and paid for at its full value and more received some advantages over others equally inconvenienced with himself. Mr. Mountford suffered no more from the running of the trams than did his neighbour on the apposite side of the road. For the taking of his land Mr. Mountford had been paid £360 and that sum included damages for the diminished value of the land left to him and also further damages for the use of that taken owing to the passing over it near Mr. Mountford's house of the public and the ordinary traffic of the street. More than that, he could not satisfy himself he was entitled to. He could not veto the making of the tramway along the public highway nor the working of it. He thought the rule should be made absolute.

Mr. Justice PHILLIMORE concurred, and the rule was accordingly made absolute with costs.

Mr. GORDON, on behalf of the claimant, elected to have the whole verdict quashed and to have a fresh inquisition.

Order accordingly.

Dunphy v. Montreal Light, Heat & Power Co.

Last week the Judicial Committee of the Privy Council (Lords Macnaghten and Atkinson and Sir Arthur Wilson, Sir E. Taschereau and Sir Alfred Wills) granted the petitioner special leave to appeal in forma pauperis from a judgment of the Court of King's Bench for Quebec of Nov., 25, 1905. Petitioner's husband was killed by a shock sustained through contact with an overhead electric wire erected by respondents, and a jury awarded her $3,000 and her children $5,000. The Court of Review affirmed that result and allowed interest and costs, but on appeal the Court of King's Bench reversed the decision and dismissed petitioner's action on the ground that the company were entitled under their charter to erect overhead wires, although that method was dangerous, and that the verdict as to negligence was against the weight of evidence. Petitioner now sought leave to appeal, the question at issue being whether the King's Bench Court could properly set aside a verdict on a question of fact.

Meadows v. L. & Y. Railway Co.

At Liverpool Assizes on Saturday, before Mr. Justice Bray and a special jury, plaintiff sought to recover damages for injuries inflicted in the disaster which occurred at the Hall-road Station of the Lancashire and Yorkshire Electric Railway, a year ago. A verdict was taken by consent for £1,250 and taxed costs.

Stephens v. Sheffield Corporation.

At West Riding Assizes at Leeds, on Monday, plaintiff sought to recover £500 damages for personal injuries alleged to have been caused by the negligent driving of one of the City tramcars. Plaintiff was a passenger on a car on the Attercliffe route on Jan. 3 when a collision occurred with a cart, the shaft of which penetrated the car, and knocked plaintiff off his seat and seriously injured him.

It was contended that the driver should have stopped his car and not gone on when there was likelihood of a collision.

For the defence it was stated that the horse swerved after coming out from behind a dray, and that it was impossible to avoid a collision.

The jury found for plaintiff, with £200 damages.

Workmen's Compensation.

In the City of London Court on Wednesday Judge Lumley-Smith, K.C., delivered a reserved judgment on a novel point raised under the Workmen's Compensation Acts.

The widow of an employé (named Deacon) of the National Telephone Co. sought to recover £250 damages for the death of her husband, and a claim was also put forward on behalf of a child. In April Deakin was working on one of the company's poles effecting repairs, when he fell a distance of over 50 ft. and was killed. Defendants were said to have been negligent in supplying defective appliances for doing the work, and it was alleged that if the company had adopted up-to-date methods, such as those employed in America, Deakin would still be alive. He earned 32s. per week. A claim at common law had been disallowed, and it was then contended that the plaintiff could recover under the Workmen's Compensation Act, and that a telephone pole with 400 or 500 wires on it was a "building" within the meaning of the act.

Judge LUMLEY-SMITH now said he did not think the claim had been made out. The pole, though connected to the telephone exchange by wires, was no part of the building and no scaffolding was employed. He decided that the accident did not happen during the repair of a building, and plaintiff, therefore, had no case, though he gave the decision with regret.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Erith Urban District Council require an assistant electrical engineer, who must have had a sound mechanical training. Preference will be given to one with practical experience in the working of a three-phase system. Salary £150. Application to the chief electrical engineer (Mr. Geo. E Heath), High-street, Erith, by 10 a.m. Monday, Aug. 20. See also an advertisement.

Barrow-in-Furness Corporation invite applications for the appointment of mains superintendent at a salary of £135 per annum. Applications (addressed to the Chairman of the Electricity committee), to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, Aug. 20. See also an advertisement.

A vacancy occurs for a premium pupil at Whitby District Council's electricity works. Particulars from the electrical engineer, Mr. L. H. King. See an advertisement.

The Newcastle upon-Tyne Electric Supply Co. require for overhead distribution work an assistant with experience. Applications to Construction Department of the Company, Carville Power Station, Wallsend-on Tyne. See an advertisement.

A leading driver, accustomed to Belliss engines, condensing plant, &c.; also leading stoker accustomed to Babcock marine-type boilers and chain grate stokers, are required for a large central station in the south of England. See an advertisement.

A charge electrical engineer is required at East Sussex County Asylum, Hellingly, to act under the resident engineer and take charge of the central station plant. Applications to the resident engineer at the asylum. See an advertisement.

Several jointers are required for jointing e.h.t. and l.t. lead-covered and vulcanised bitumen cables. See an advertisement.

A manager is wanted for west-end showrooms, electric light fittings and metal work generally. See an advertisement.

The Council of the University of Leeds invite applications for the appointment of assistant lecturer and demonstrator in electrical engineering, to date from Sept 1. Salary £175. Applications by Aug. 1 to the Registrar.

Glasgow Corporation require an inspector of lighting, at a salary up to £400 per annum. Applicants must have experience in street lighting by electricity and gas. Applications by Aug. 13.

Ebbw Vale Council require a resident electrical engineer. Applications by Aug. 10.

Birmingham Corporation have appointed Mr. C. W. Hill, chief assistant to the tramways manager (Mr. A. Baker) at £300 per annum, increasing by annual increments of £50 to £400. Mr. S. B. N. Marsh has been appointed accountant and cashier of the department at £200 per annum.

Woolwich (London) Council have appointed Mr. F. H. Edwards station engineer in the electricity department at a commencing salary of £180 per annum, and Mr. S. P. Ives installation engineer on probation for six months at £150 per annum.

Mr. W. Willox, district engineer of the London, Brighton & South Coast Railway Co., has been appointed engineer of the Metropolitan Railway Co.

Mr. W. Robinson will shortly retire from the position of chief goods manager of the N.E. Railway, after nearly 50 years' service, and the directors have appointed Mr. E. C. Geddes, commercial and claims agent, to be also deputy chief goods manager.

Walthamstow Council have appointed Mr. H Hanbury, Ilford, chief clerk at the electricity works at £100 per annum.

Mr. B. Sankey, chief assistant electrical engineer at Mansfield, has been appointed (out of 248 applicants) borough electrical engineer at Whitehaven at £250 per annum.

EDUCATIONAL NOTICES.

University of Birmingham.—The 1906-7 session commences on Monday, Oct. 1. The full course in the department of engineering extends over four years. The technical engineering classes include lectures on the strength of materials, the theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing the course includes the design of tools, prime motors, dynamos and other forms of machinery. The engineering laboratory course includes determination of strength of materials, experimental study of the steam engine and boiler, frictional efficiency tests, the flow of water over weirs, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work includes the testing of continuous and alternating-current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing work. The courses also include mathematics, physics, chemistry, geology and metallurgy. Detailed syllabus can be obtained from the secretary.

University of Liverpool.—The 1906-7 session commences on Oct. 9. The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng. (or the certificate in engineering) are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are also afforded for postgraduate work and research. Prospectuses may be obtained from the Registrar.

University of Manchester.—Prospectuses containing particulars of the lecture, laboratory and drawing courses in the engineering department, also the course in physics, mathematics and chemistry (qualifying for the degrees in engineering and the engineering certificate) can be obtained from the Registrar.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Cooper's Hill College.—This college ceases to exist this week, but the engineering and electrical testing work hitherto carried on at the college for the Indian Public Works Department in connection with railway irrigation and other public undertakings, will be carried out by the National Physical Laboratory. The scientific equipment of Cooper's Hill College has already been transferred to Bushey.

Aberdeen.—The Gas and Electric Lighting committee have appointed a sub-committee to consider the question of extending the electric lighting area so as to cover the whole of gas lighting area.

Argentina.—The "Review of the River Plate" says that Messrs. Treman & Acevedo have obtained a concession from the provincial government for the construction of electric or other light railways around Rosario, and that Belgian capital will be employed.

Mr. Delfin Vieyra has applied for a concession for an electric railway from Cordoba to Rosario, and proposes to take power from the San Roque dam, Cordoba.

Australasia.—The tramway revenue of the New South Wales railways and tramways department for the past year was £851,483, compared with £813,589. Expenditure was £665,083, against £685,682.

The "Australian Mining Standard" reports that at a recent meeting Launceston (Tasmania) Municipal Council rejected a motion to ask Noyes Bros. to prepare estimates of expenditure and revenue for the proposed electric tramways. The meeting was in favour of the general principle of constructing tramways, but some members thought the city surveyor (Mr. St. John David) competent to prepare the report.

Kalgoorlie (W.A.) municipal electrical engineer (Mr. D. Curle Smith) has prepared an estimate for electricity works for Leonora Council. He estimates that, on the basis of a demand for 800 16 c.p. lamps and a consumption of 57,000 units per annum, the cost of generation would be 6·6d. per unit, and if the price charged were 8d. the gross profit would be £283, and a tax of 10s. per annum on every inhabitant would be necessary to redeem the capital (about £5,000) in 10 years. Further information is to be obtained.

Melbourne Council are borrowing £250,000, of which £140,000 is required for extensions of buildings and plant at the electricity works.

Barking.—To encourage the use of electric energy for lighting power and heating an exhibition of motors, fittings, and domestic appliances will be held by the Council in September.

Application is being made to the L.G. Board and the Board of Trade for power to let electrical fittings, &c., on hire by the Council.

Bristol.—An inquiry was held on Friday last into the application of the Corporation to borrow £103,554 for the extension of the electricity supply undertaking.

The assistant town clerk (Mr. Wise) explained that the application for a new loan was caused by the growth of the electrical undertaking.

The inspector (Mr. H. R. Hooper) mentioned that the application was divided into four separate parts—the Temple Back works £10,400, Avonbank station £37,100, distribution system £40,799. 11s. 10d. and adjustment on loans £4,745. 11s. 10d.

Replying to questions by the inspector, the borough electrical engineer (Mr. H. Faraday Proctor) stated that the amount received from the insurance offices in respect of the fire at Temple Back station in 1903 was £8,200. The debt outstanding upon that station was £30,000, and it was being wiped out by half-yearly instalments.

The Inspector said after the fire there was certain plant which ceased to earn revenue. He asked the value of that plant, the amount of outstanding debt on it, and what had been done to meet that outstanding debt.

Upon these and other points in regard to the loan for Temple Back information could not be given then, and this portion of the inquiry was adjourned.

The second portion of the loan (£57,100 for Avonbank) was then taken. £12,200 was required for superstructure, £32,130 for engine room plant, £9,682 for boiler house plant and £3,039 for contingencies. Mr. Proctor was examined at some length upon the details of the various requirements.

Proceeding to deal with the distribution system for which £40,799 was asked, the Inspector inquired whether the work of laying the cables, &c., was carried out by contract or by direct labour.

Mr. Proctor replied that the work had been done partly by both methods.

The Inspector said he could not accept the mere totals; he would require the number of lineal yards for each street and other details.

Mr. Proctor explained that their idea was to carry out the work when occasion required. It would extend over about two years. After the adjustment of loans had been considered, the Inspector said they would have to meet again, and was decided to resume the inquiry on Sept. 20.

Camberwell (London).—A special meeting of the Council will be held on Sept. 19 to consider the question of applying for a provisional electric lighting order. The County of London Electric Supply Co., the London Electric Supply Corpn. and the South London Electric Supply Corpn. already possess orders for the district, and the Council have on two previous occasions made unsuccessful attempts to obtain electricity supply powers.

Denmark.—Our Copenhagen correspondent informs us that not only is the consumption of electrical energy rapidly increasing in Copenhagen, but outlying districts are establishing their own electricity works. The municipality of Sölleröd intend to establish two generating stations, one for the western or inland district and one for the eastern district on the Sound.

A special Danish Railway Commission which has nearly completed its work recommends amongst other proposed lines an electric railway between Aarhus and Randers. It is also probable that an electric line will be constructed to connect Frederiksvärd, Roskiede, Ringsted, Nestold and Karreböksmunde.

Derby.—The Tramways committee have increased the salary of the tramways manager (Mr. F. Harding) to £275, and that of the car shed superintendent (Mr. C. Beach) to £150 per annum.

Ealing.—The charge for electric current for street lighting has been reduced to 2d. per unit.

Eastbourne.—The Council decided on Wednesday to apply for sanction to a loan of £11,269 for electricity supply as follows: Expenditure already incurred £6,726, estimated probable expenditure during ensuing twelve months £4,093, money payable for electric light cables in parish of Willingdon £450.

Edinburgh.—The Tramways committee will confer with Leith Council and other interested parties as to the steps to be taken with regard to the equipment of the Broughton-street tramway for electric traction.

Some time ago we described the electrical installation at the handsome new buildings of the *Scotsman* at Edinburgh. The owners, Messrs. John Ritchie & Co., have had prepared an interesting description of the complete buildings, exterior and interior, accompanied by some fine photographs of the interiors.

Egypt.—An article on the growth of German commercial competition in Egypt which appears in the "Journal" of the British Chamber of Commerce of Egypt states that some of the large German electrical firms have recently established branch offices in Egypt, and are actively canvassing for business, especially in connection with large electrical installations.

Electric Cargo Transporter.—An innovation has been successfully introduced at the London Docks in the form of a set of electrically-operated continuous rollers upon which chests of tea, &c., are transferred from ship to shed. The Harrison liner "Huntsman" satisfactorily discharged her cargo of tea by means of this contrivance on Wednesday. The apparatus reduces breakages of chests to a minimum, and permits the number of hands employed to be materially reduced.

Electricity and Hours of Labour.—In a memorandum explaining recent and impending changes in the administration of dockyards, issued on Wednesday by the Admiralty, it is stated that the introduction of electric lighting has made it possible to establish a uniform 48-hour week instead of long days in summer and short days in winter.

Electro-Medical Quack.—At Staffordshire Assizes on Saturday, after a trial extending over three days, the notorious "Professor" Richard was sentenced to 12 months' imprisonment without hard labour for obtaining by false pretences various sums of money from credulous people, whom he claimed to be able to cure by electrical treatment.

A number of witnesses (including several victims of prisoner's treatment) were called.

One victim, a servant, said she took her sister, who was totally blind, to see the "Professor" at Nottingham. He told her sister that her nerves were dormant, and wanted waking up with electricity. On his undertaking to restore her sight she paid him 26 guineas. His treatment did her sister no good.

Medical evidence was also called, and Dr. Hall Edwards said in certain nervous cases any treatment which appealed to the imagination might do good temporarily.

Mr. Avory, K.C. (for the defence): Is not electricity often beneficially used in cases of deafness?

Witness: Deafness is a regular hunting ground for quacks, but I have not known of one case in a thousand in which electricity can do even the slightest good.

Dr. Campbell, Professor of Forensic Medicine at Leeds University, said in some cases prisoner's treatment might be of temporary benefit, but in most it could do no good. Any treatment which inspired faith might do good, but the effect soon passed away.

Dr. Codd, of Wolverhampton, said there was nothing novel in the construction of prisoner's electric chair. The current which it gave out was never used by medical specialists, because of the pain it produced compared with the physiological effect obtained. Constant-current apparatus was more costly, but more efficacious.

Detective Lewis said that prisoner called at the police office and said: "If you will not make the case worse than you can help I will give you £100."

Mr. Avory submitted that there was no evidence that prisoner guaranteed to cure his patients.

Several witnesses were called for the defence; but the jury, after a minute's absence, found prisoner guilty.

Evidence was then given that he was born in Alsace. He was expelled from Belgium by Royal Decree in 1873, and was cancelled from the register of population in Havre. He was subsequently authorised to return to Antwerp, and again expelled for misconduct in 1876.

Mr. Justice Bigham, in sentencing him to 12 months' imprisonment, without hard labour, on account of his health, said that the prisoner was a dangerous person, and he hoped that this exposure would destroy his career in this direction.

Exhibition.—At a manufacturers' and industrial exhibition at the Drill Hall, Bristol, from Sept. 24 to Oct. 20 next, a display of apparatus connected with the production and applications of electricity will be included.

Faroe Islands Cable.—The Great Northern Telegraph Co. notify that their new cable to the Faroe Islands (Thorshavn) was opened for traffic on Aug. 1, the rate for telegrams from any office in the United Kingdom being fixed at 5½d. per word. Telegrams to other places in the Faroe Islands will be sent by post from Thorshavn.

Fatality.—An accident occurred on Monday at Messrs. Kitson & Son's Airedal Foundry, Hunslet, Leeds. An electrician named Holmes (in the employ of Wilson Hartnell & Co.), while connecting up an electric motor, slipped, and in trying to save himself came in contact with a live wire and was killed.

At the inquest on Wednesday it was stated that deceased was engaged in fixing a new starting switch when he slipped. Medical evidence showed that deceased had a persistent gland in the neck which rendered him liable to death from a slight shock.

The jury returned a verdict of "Accidental death," and added a rider recommending the placing of temporary guards over "live" wires.

Greenwich (London).—On Wednesday the Council decided to obtain the opinion of an expert as to the desirability and probable cost of introducing ozone (electrically produced) into the sewers in the district, and to ensure movement of the air therein by means of electric fans.

Hastings.—The electors have declared by a vote of nearly two to one in favour of Sunday tramways. The route from the Front up London-road to Silverhill was opened for traffic on Saturday.

Hertfordshire Tramways.—From Whetstone, on the border of Middlesex and Hertfordshire, the electric tramway service of the Metropolitan Electric Tramways Co. (as lessees of Middlesex and Hertfordshire County Councils) to High Barnet will be opened for traffic on Monday next. This is the first electric tramway service in Hertfordshire, and represents, with a change at the Archway Tavern, Highgate-hill, a complete tramway service from Moorgate-st. (City) to Barnet (Herts).

Highgate Hill Cable Tramway.—London County Council propose to acquire the cable tramway from the Archway Tavern to the top of Highgate Hill, which will constitute the new terminus of the L.C.C. tramways.

Islington (London).—At this (Friday) evening's meeting the Council will be recommended to confirm the following re-arrangement of the staff of the electricity works:—

Mr. M. J. Allward, station superintendent, to be chief assistant and works manager on probation for 12 months at £225 a year, to be increased to £250 at the end of that period, if the arrangement proves satisfactory. Mr. T. A. G. Margary, mains superintendent, to be distributing engineer on probation for 12 months at £225 per annum, to be increased to £250. Mr. M. H. Adams to be constructional and maintenance engineer at his present salary of £160 per annum, to be increased to £200, in two annual increments of £20. Mr. R. Lund and Mr. J. J. Hargreaves, mains engineers, to be district mains engineers, with salaries of £3 and £2. 10s. per week respectively. Mr. C. H. Higgins, shift engineer, to be senior shift engineer at £3 per week. Mr. C. F. Wade, shift engineer, to have his salary increased from £2. 5s. to £2. 10s. per week. Mr. E. T. Gifford, junior shift engineer, to be shift engineer on probation for six months at present salary. Mr. T. Simmonds to be rectifier attendant on probation for six months at £2 per week.

Johannesburg.—The Rand Central Electric Works contemplate putting down additional generating plant.

L.C.C. Tramways.—The official inspection of the reconstructed tramways in York-road, Wandsworth, and the new lines in Red Lion-street, South-street and Garrett-lane to the existing tramways in Defoe-road, Tooting, took place this week.

London County Council.—At Tuesday's meeting (the last before the recess) the estimate of £96,500 for the construction of the tramway lines over Westminster Bridge and along the Embankment was accepted.

The Highways committee presented a recommendation that the conduit system of electric traction should be adopted on the tramways from the Tottenham Court-road end of Hampstead-road to High-street, Camden Town, and the overhead system between the junction at High-street, Camden Town, on to Finsbury Park, and from the junction at High-street, Camden Town, on to the Hampstead terminus.

Mr. Allen Baker, M.P., warned the Council that a mixture of the two systems might lead to considerable confusion and heavy expense.

After a lengthy discussion, the Committee's recommendation was approved.

The same committee reported that the Board of Trade had approved of the conduit system of electric traction for the line from the Angel at Islington, to Highbury station

The supplemental estimate of expenditure on capital account of £14,500 in respect of cables and cable ducts for the northern system was approved and a tender amounting to £23,628. 16s. 3d. for the supply of low-tension cables, feeder pillars, &c., from W. T. Henley's Telegraph Works Co. was accepted. Additional expenditure of £7,350 was sanctioned for track work for the tramways on the Aldwych-Angel route.

Lothians Electric Power Scheme.—Dalkeith Council have approved the Lothians Electric Power Co.'s proposals for laying electricity supply mains in a portion of Dalkeith.

The company's area of supply embraces the whole of the County of Mid-Lothian (with the exception of Edinburgh and Leith and the parishes of Stow, Heriot, and Fala and Soutra), and also portions of Haddingtonshire. Apart from power, the Company can only supply electrical energy to authorised undertakers and in certain cases for lighting to those already supplied with power.

Luton.—The salary of the borough electrical engineer (Mr. W. H. Cooke) has been increased to £300 per annum.

The tramway provisional order has been extended for a year.

Sanction has been received to a loan of £7,000 for electricity supply extensions.

Malvern.—The Council are applying for sanction to a loan of £2,000 for extensions of the electricity works.

Manchester.—The arbitrator (Mr. G. R. Askwith, K.C.) in the dispute between the Corporation and their tramways employés has issued his award, which is in favour of the Corporation. Mr. Askwith finds "that the claim to payment at the rate of time and a-half for all Sunday labour cannot justfiably be granted."

The new tramway route to Sale was opened for traffic on Saturday.

Marylebone (London).—From end of Sept., 1906, the following charges for current come into force:—

Lighting, 8d. per unit for equivalent of 500 hours' maximum demand, and 1d. per unit after. Power and heating, 2d. per unit for 125 hours' maximum demand in each quarter, and 1d. per unit after. Basement lighting, flat rate of 2d. per unit. Meter rent, 10s. per annum for equivalent of 50 c.p. lamps installed. Additional rentals are to be charged for separate meters required for special power or basements. Consumers are to be allowed 25 per cent. discount off excess of each quarter's account above £50 if accounts are settled within 30 days and outstanding claims against the Council on account of change of pressure are withdrawn. Consumers supplied previous to August, 1905, may remain on their present scale of charge until Sept., 1907.

The Council will instal and supply (through wiring contractors) not less than two pairs of 50-watt lamps to any new and approved consumer for an inclusive charge of 20s. per 50-watt lamp per annum to cover use of the wiring and supply of current up to 1,500 hours a year, all new lamps to be paid for by consumer and current consumed in excess of above quantity to be paid for 1d. per unit.

Middlesbro'.—The Corporation have decided to grant a reduction of ½d. per unit to consumers of over 1,000 units of electric current per quarter.

Motor 'Buses as Tramway Feeders.—Westminster Council have declined to support the proposal of Islington (London) Council to request the L.C.C. to promote legislation next session to run a municipal motor 'bus service as feeders to the L.C.C. tramways.

Municipal Telephony.—As announced in our last issue (p. 566), Brighton Town Council decided on Thursday of last week to dispose of their telephone undertaking to the Postmaster-General for £49,000.

The report of the Telephone committee gave a résume of the negotiations between the parties. The original offer of the Post Office (made in February last) was £41,200, exclusive of the central exchange, which was held not to be suitable for permanent use. Prolonged negotiations (in which the local M.P.s assisted) resulted in the the Post Office offer being increased to £49,000, which the committee recommended the Council to accept. The total expenditure on the undertaking was £56,147, including £500 to be paid to Hove to release the Council from the agreement by which the telephone ducts in Hove became the property of Hove Council. As £3,816 had been paid to the sinking fund, the net debt was £52,327, so that after receipt of the £49,000 the deficiency would be £3,327. Of that amount the committee said £1,878 was paid out of the current rate in 1904-5, and towards meeting the remainder the Corporation had in hand accumulated profits from the undertaking to the amount of £877. Consequently the deficiency remaining to be provided for would be £572.

The Chairman of the committee (Councillor Lintott) in moving the adoption of the report, said the committee did not receive a definite statement from the Postmaster-General until 12:30 the previous night. They had considered what would be the probable effect, not only of selling to the Post Office, but also to the National Telephone Co. They also considered the advisibility and possibility of carrying on the undertaking until the expiration of the license, and he had no hesitation in saying that, with uniformity of feeling in the committee, the support and confidence of the Council, the loyalty of the ratepayers, the continued interest of the officials of the undertaking, and fair treatment at the hands of the Government, it might have been carried on to the benefit of the town. But that was a combination of conditions which the committee could hardly expect. Their position was not due to any lack of interest on the part of the committee, nor to a lack of energy in the staff, but simply and solely to the shuttlecock policy of the Government. They felt that it was in the interests of the telephone users and the ratepayers that the course recommended should be adopted. The Postmaster-General would be able to compel the National Co. to agree to a subscription inter-communication, and so do away with a duplicated system, and the subscribers would be better able to bring pressure to bear on the Postmaster-General than on the National Co. in the case of excessive charges or inefficient service. Although the committee felt very reluctantly compelled to recommend the Council to accept the Postmaster-General's offer, yet in the circumstances it was in the best interests of the users and the ratepayers that the offer should be accepted.

Councillor Tozer seconded, and inquired if the National Telephone Co. had made an offer for the undertaking?

Councillor Galpin asked that the consideration of the report might be postponed for a fortnight and that negotiations be at once opened with the National Co. He (Councillor Galpin) had written to Mr. Gaine asking if his company was willing to purchase the Corporation system of telephones, and also if it was true that in Glasgow their offer for the municipal system was £20,000 more than that of the Post Office. Mr. Gaine replied: "Whether the company would be prepared now to negotiate for the purchase of the Brighton Corporation telephone undertaking, I do not know, but the company is not prepared to open any negotiation unless invited to do so. With regard to the case of Glasgow, negotiation did take place last year, but it was agreed that the terms discussed should be treated as confidential, and, moreover, the negotiation fell through and was not reopened."

Councillor Jarvis moved an amendment that the question be deferred until the September meeting.

Ald. Blaker said the committee had a direct mandate to open up negotiations with the Postmaster-General. If the committee had had reasonable assistance from the Council they would have made the undertaking a profitable concern. In spite of all that they had to contend with, they had paid interest and redemption and carried the undertaking on in a manner upon which they were to be complimented. They had all to gain by selling to the Post Office. There would probably be a working agreement between the Post Office and the National Co. If they sold to the National Co. there would be no competition and no interchange of communication.

Councillor Black said the Government's change of policy had largely minimised the necessity for their continuing, inasmuch as they could see before them now public ownership of telephones and not ownership by a company whose interest was the interest of all. The competition that the undertaking had had to face from the very beginning was not foreseen by those who started the scheme. There was an impression very largely held by members of the Council that the minimum figure was then being charged by the National Co., and that if they started a rival undertaking they would be assured that the lower rate they offered could not be met by the National Co. by reason of their agreements with other towns. That seemed to have largely arisen through a misunderstanding of the words of the manager of the company, who said it was impossible for his company to give unlimited users at a lower price than was charged, although he did not say that practically an unlimited user could not be introduced. Another reason which had militated against the success of the Corporation undertaking was that (in his opinion) £5. 10s. for an unlimited service was lower than prudence would suggest. The sale would involve a loss of a little over £2,000. That was to say they had paid off already out of the rates during the first year, when the income was not sufficient for expenses, and while the undertaking was in process of formation, £1,878. That left a still further deficit of £570. They had the assurance that the enhanced value of the stocks of the Corporation now as against the time when the borrowing of the money took place would fully repay them that £570, so he was confident that if they sold the undertaking to the Postmaster-General on the terms named, no further charge would fall upon the rates, and they would have a further off-set in the value of the building at the Pavilion, which would, for the present, bring in a rental of £100 per annum. To hold up the Telephone Service as being on its last legs was to grossly misrepresent an undertaking which had been very carefully nurtured, and which, but for the change of policy by the Government, would have been successful, and of great service to the ratepayers. They had asked that the whole of the staff should be retained, on terms as favourable as at present, and that had been agreed and no injustice would therefore be done to their servants. It was useless to look for better consideration from the National Co. than from the Government.

The Town Clerk at this juncture announced that he had received a telephone message stating that the Postmaster-General had stated that the rent of the building at the Pavilion must be £60, and not £100 as had been stated.

After further discussion the amendment was rejected by 31 votes to 11, and the sale was then approved, only three members opposing.

It was also agreed, in consideration of Hove Council transferring to the Postmaster-General their property in the telephone ducts in Hove, to pay Hove Council £500 as compensation.

Newquay.—The electricity works will commence supply of current to-day (Friday).

P.O. Fire Alarm Telephones.—Manchester Watch committee has made an arrangement with the G.P.O. for the provision and maintenance of a new system of telephonic fire alarms in connection with the new central fire station, London-road, where there will be several switchboards and up-to-date telephone apparatus, while it is proposed to place at various points in the streets 200 Nonpariel succession fire alarm signal boxes affixed on iron pedestals. For an annual rental of £490 the G.P.O. will provide a staff of specially-trained officers to maintain the installation. The annual rental for wire will be at the rate of £4 a mile for about 150 miles, equal £600.

Provisional Order Transfer.—Rawmarsh Council propose, with the consent of the Board of Trade, to transfer their provisional electric lighting order to the Mexborough & Swinton Tramways Co. for 42 years.

Scandinavia.—Our Copenhagen correspondent states that a Swedish engineer has recently prepared statistics showing that water power is available to the extent of 10,000,000 H.P. in Sweden, 28,000,000 H.P. in Norway and 4,000,000 H.P. in Finland, or, leaving out of the question water-power in out-of-the-way or inconvenient places, the figures are approximately 3,800,000 H.P., 4,800,000 H.P. and 500,000 H.P. respectively. It is suggested that this power might be utilised in Sweden in the manufacture of chemical manures, paper, &c., in ore smelting and other industries and that imports of coal would thereby be greatly reduced. It is also estimated that as a result of the utilisation of the available water power a reduction of 60,000,000 kr. a year in Sweden's imports might be effected and her exports increased by about twice that amount.

South Wales Electric Power Scheme.—On Monday the committee of colliery owners who are customers of the South Wales Electrical Power Distribution Co., considered the proposed new scale of charges suggested by Mr. Merz, technical adviser to the debenture-holders of the company, and the following resolution was passed:—

"This meeting, having heard Mr. Chamen's explanation of the method of ascertaining the maximum horse-power for the quarter under Mr. Merz's scale, is of opinion that the scale is a reasonable one, and, subject to a satisfactory agreement as to detail terms, the meeting is favourably disposed to support the company's scheme, and requests Mr. Chamen to obtain from the various consumers the horse-power they are likely to require and guarantee."

Southport.—The Council have always realised the importance of good illumination of the streets of the town, and for the last 11 years have employed arc lamps for the lighting of the main thoroughfares and the promenade. Early last year it was decided to make an extensive experiment with improved arc lamps, and the whole of Lord-street (one of the finest thoroughfares in England) was lighted with "Excello" flame arc lamps.

There were two interlacing circuits, each of 15 12-ampere lamps in series on 750 volts supplied from a constant pressure transformer, which gave every satisfaction. It was therefore decided this spring, after a year's practical trial, to replace all the old 15-ampere arcs by Excello lamps. The original open-type white arc lamps were supplied in series with rectified current from a constant current transformer, but as with Excellos there is no gain in illuminating effect by rectification of the current (due to the fact that both the crater tips project downwards), it was decided to remove the rectifier and supply the new circuits through the constant-current transformers. The new installation, which includes circuits of 36 Excellos in series, was put to work on Friday last, and from that date the Promenade, Lord-street, Eastbank-street, Church-street, &c., have been entirely lighted with Excello arcs. The economy of the new method of lighting is considerable. A circuit of 36 Excellos of 12-ampere capacity, complete with safety coils coupled in parallel to each lamp, took, under careful test, only 19·25 kw. of energy, or slightly less than 540 watts per lamp. This is the first installation of Excello arc lamps run on this principle, and the entirely satisfactory results prove the care and forethought exercised by Mr. R. S. Downe, the borough electrical engineer at Southport, who designed the installation which the Union Electric Co. were called upon to carry out.

Spain.—The "Madrid Gazette" for July 22 states that a decree has been issued authorising the Barcelona Tramway Co. to appropriate water from the harbour for the production of electric power.

Stepney (London).—At the meeting of the Council on Wednesday the Electric Lighting committee reported that they had considered the resolution passed by the Council in June asking them to ascertain whether the engagement of the consulting electrical engineer (Mr. Arthur Wright) might be advantageously terminated.

The committee report that if the undertaking continues to develop at the same rate as at present, the maximum load capacity of the station would be reached in 1907. The Council would, therefore, soon have to consider the question of adopting one of the following two expedients—viz., taking steps to erect a second station, or taking a bulk supply. Assuming that it was decided to erect a station at Blyth's Wharf, the local authority would doubtless require the services of a consulting electrical engineer to advise them upon the utilisation to the best advantage of that part of the site which had been allocated for the second station. In this event the Council could not, in view of past experience, do better than avail themselves of the advice and expert assistance of the present consulting engineer, to whose sound judgment and unique experience the progress of the undertaking largely attributed. Moreover, the method of remunerating the consulting engineer is unquestionably most advantageous and economical and tends to the removal of temptations to unduly inflate the capital expenditure of the undertaking. Even assuming the Council took bulk supply, they would require technical advice of the highest order. Under the circumstances the Council would recognise that the present was not an opportune time to terminate the engagement, especially bearing in mind the fact that should the L.C.C. obtain powers in the next session of Parliament to supply undertakers with electricity in bulk, it was doubtful whether they would be able to do so when the Council would require it. In conclusion, the committee state that they were unanimously of opinion that the engagement of the consulting engineer could not now be advantageously terminated.

The report was referred back.

Stourbridge.—The Board of Trade have deferred the revocation of the Council's provisional electric order (1899) pending submission of the draft deed for transferring the order.

Street Work.—Westminster City Council have replied to a communication from London County Council in regard to the proposed legislation to compel companies having power to break up streets to execute work at certain specified periods of the year, that if their proposal were confined to making regulations the City Council would raise no objection, provided the administration of the regulations were left entirely to the discretion of the borough councils and were approved by a majority of the councils.

Sunderland.—The Electricity and Lighting committee anticipate a gross profit of £13,930 and a net deficit of £124 on the current half-year's working of the electricity undertaking, but it is hoped that the second half of the year will make amends for this deficit, which is the result of a substantial reduction in charge for current.

The committee propose to take steps to appoint a successor to Mr. J. F. C. Snell, borough electrical and tramways engineer, whose agreement with the Corporation expires shortly.

Swinton and Pendlebury.—The revised agreement between the Council and the Lancashire Electric Power Co. in regard to the supply of electricity in bulk by the company has been approved by the Council.

The agreement is for five years, and the company will supply electrical energy at £6 per annum per kilowatt for a demand of 100 kw.; £5 for each further kilowatt up to 200; £4. 10s. from 200 to 300; £3. 10s. from 300 to 500; and £3 above 500, with a charge of 0·45d. for each unit of current supplied. These charges are for a three-phase alternating-current service at 400 and 230 volts pressure, but if the Council demand direct-current supply, the above prices will be increased by 10 per cent. per annum. The company are empowered to supply direct from their own mains high-tension current to individual consumers of over 25 kw. outside a $\frac{1}{4}$ mile radius from the sub-station. The company can enter into contracts with individual consumers for supplying high-tension current within the Council's area of supply for 10 years. At the expiration of nine years, if the Council are desirous of themselves supplying electrical energy to individual consumers previously supplied by the company, 12 months' notice is to be given by the Council that they will take over the contracts. In the event of the Council ceasing to take a supply in bulk from the company after five years, the company will pay the Council $2\frac{1}{2}$ per cent. on all moneys received from consumers supplied direct by the company. The Council will provide, equip and maintain proper and efficient transforming and distributing stations. All electrical energy required by the Council is to be supplied by the company, to whom a quarterly statement is to be furnished setting forth the number of lamps, motors, &c., which are connected to the Council's distributing mains, the company undertaking to supply and instal the necessary electrical apparatus, transforming plant, &c. The company agrees to indemnify the Council against loss in the event of any default in supply of energy, and they may terminate the agreement should the company become insolvent. In case the company at any time grant to any other corporation or company more favourable terms for the supply of electricity, under similar conditions, than the terms provided in this agreement, the Council become entitled to the benefit of such terms.

Telegraph Reform in Spain.—The King signed on Monday a decree creating a committee empowered to undertake the reform of the telegraph administration, and fixing a term of three months for the organisation of a new telephone service.

The Manufacture of Liquid Air on a Commercial Scale.—The Liquid Air Power & Automobile Co. of Great Britain (Ltd.) gave a demonstration on Wednesday of their process of manufacturing liquid air on the occasion of the formal opening of their new works at Church-road, Battersea, by Major Baden-Powell. The company employ Knudsen's system, which is a simple regenerative method with a three-stage intercooled compressor working up to 2,500 lb. per sq. in., and not employing auxiliary working fluids in cascade. Special precautions are taken for purification, and a feature of the system is the use of that part of the air which does not liquefy on leaving the expansion valve to drive a small turbine, the liquefaction being completed by the work so done. The company state they are able to produce 700 gallons of liquid air per day with a 250 H.P. plant, and can retail the fluid at 5s. per gallon. The commercial uses to which the company look forward to create the demand which they are now prepared to supply are:—

1. The production of oxygen by separating out the nitrogen from air at a price considerably less than can be done by processes used at present.
2. The production of a safety explosive for blasting purposes.
3. Various applications in the chemical industries.
4. The maturing of liquors and preservation of milk by extreme cold.

The company does not at present intend to proceed with the application of liquid air for the production of power, but will confine its operations to the branches of the business indicated above, which will probably prove more profitable.

Walthamstow.—The Board of Trade has approved the construction of additional loops on the tramway routes. The Council have applied for sanction to a loan of £16,775 for additional plant at the electricity works, including £3,150 for boilers, £140 for steam dynamo, £650 for switchboard extension, £515 for purifying plant, £515 for grease extracting plant, £800 for buildings and £350 for steam piping. The balance will be employed in main extensions, &c.

Willesden.—The annual report of the Electricity committee states that there was a loss of £860 on the working of the electricity supply undertaking during 1905.

Woolwich.—On the recommendation of the Electricity committee the Council have engaged Sir A. B. W. Kennedy to report upon the present position of the electricity undertaking, at a fee of 200 guineas.

The Electricity committee have decided to instal the electric light at Plumstead baths "on the prime cost system, but conditionally upon the cost not exceeding £678."

Zanzibar.—The Zanzibar Railroad Co., an American concern, is about to build a light railway from the town to the north end of the island, where the chief plantations are situate. The line is to be 3 ft. gauge, and has been already partly opened for traffic. The same company is constructing a tramway service to make a complete circuit of the town. The motive power for the railway is at present steam, and the tramways are mule-drawn, but it is proposed eventually to adopt electricity for both lines. The same American company has secured a concession for the electric lighting of the public thoroughfares and of the Sultan's Palace, having purchased the installation formerly utilised for the latter purpose. Kerosene is the illuminating agent at present for the street lighting. A complete project for telephoning the town is also under contemplation.

It is stated that three different British syndicates had the opportunity of securing the above concessions but were not sufficiently impressed with the possibilities of the venture to proceed with the matter.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Birkenhead.—On the presentation of the annual report of the tramways manager at the Council meeting on Wednesday Mr. Dodds drew the attention of the chairman of the Tramways committee to the fact that, although there was an increase in the present year as compared with 1903 of 661,129 persons carried, yet the property was going down.

He thought that within a reasonable time some policy ought to be forthcoming which would show that the tramways could be made profitable. They were now practically on the rates. The time had come when the routes which inflicted a great loss upon the ratepayers ought to be discontinued or modified.

Blackburn.—For the year ended March 25 the total income of the electricity department was £29,946. 12s. 2d.

The total expenses were £14,376, leaving a gross profit of £15,571. After paying interest and sinking fund the net profit (£276. 13s. 2d.) has been transferred to reserve. 3,917,723 units were generated, 282,611 were supplied to the public lamps, 1,290,872 were sold to private consumers for lighting and power and 1,757,974 for traction. The total maximum supply demanded was 2,270 kw. The capital expended is £245,591, an increase of £9,887 on the year.

Bristol.—The annual report of the electrical committee was adopted by the Corporation on Tuesday.

The report stated that the question of the financial position of the electrical undertaking in regard to the renewal of depreciated assets has engaged the attention of the committee during the year, and they had consulted Prof. L. R. Dicksee, C.A , and Sir William Preece on the matter. The committee were pleased to find from the report of Prof. Dicksee (founded on Sir William Preece's estimate of the life of the various assets) that although, apart from the statutory repayments of principal no systematic provision for renewing depreciated assets has been made in the past, the balances of the reserve and depreciation and contingency accounts at March 25, 1905, amounted to more than a sum which would have accumulated at compound interest by that date had such systematic provision been made, and which, in consequence of the equated terms for loans, the committee are advised will be required. apart from the amount annually paid off loans to meet renewals of short-lived assets before the period for re-borrowing (*i.e.*, the total repayment of the loan) has arrived. With the view of meeting all future claims for renewals, whether arising from ordinary wear and tear, obsolescence or otherwise, which may arise before such period has arrived, the committee have created a "Reserved (for renewals) Fund," and transferred thereto the balances before referred to and a portion of the profits of the past year. The balance of this account it is intended to invest outside the undertaking and to make systematic contributions of such further annual sums as may be advised.

The number of consumers on March 25 last was 2,827, an increase of 150 during the year, representing total connections of 302,846 30-watt lamps (compared with 274,166 last year). The number of units sold for private lighting was 2,793,993, power 2,183,373, public lighting 833,602, total 5,810,968, an aggregate increase of 593,440. The gross receipts amounted to £70,664. 8s. 4d., and the expenditure to £30,784. 18s. 3d., leaving gross profit £39,879. 10s. 1d., which, with interest, &c., leaves £41,291. 1s. 10d. available towards dividends on stock, interest on loans (£20,015. 5s. 1d.), repayment of money borrowed (£13,749. 3s. 2d.), reserve for renewals (£2,500), or a total of £36,264. 8s. 3d., showing net profit £5,026. 13s. 7d., or with £951. 16s. 3d. from last account, £5,978. 9s. 8d., and this has been carried forward.

The Chairman of the Electrical committee (Ald. Pearson) moved the adoption of the report, and alluded to the L.G. Board inquiry (reported on another page). He said he had been connected with the public life of Bristol for 30 years, and now found himself treated as if he was an unmitigated scamp seeking to impose upon the L.G. Board. He ventured to say that they could not reasonably hope that during the coming year they would be able to show the same rate of increase in lamps and profits as they had shown in the past year. In the meantime a very important question had been discussed not only in relation to them but also in relation of every electrical undertaking of the country, whether they as municipalities were trading on proper lines and making adequate and proper provision for reserve and depreciation, and whether some day they would have an exceedingly rude awakening to the fact that the concerns which they believed to be sound were really frauds. He pointed out how they might pay to a sinking fund for machinery which had gone out of existence. The committee felt that that course was wrong, and on that point the accountant was with them. The accountant had suggested that the various sums that had been put by year after year, should be brought back again to be used year by year, and pay once and for all for machinery during its life. Their electricity undertaking made a profit and continued to provide ample funds to enable them to meet any responsibilities. In the previous year the receipts amounted to over £69,000, the gross profit being about £37,000, and this year the figures were £70,664 and £39,879. 10s. 1d., so that the reduction in price had lessened the income by £4,500. Various sums had been put aside for sinking fund and additional reserve, and over £5,000 was carried forward. He believed that the next year's trading would be better than the past.

Burnley.—For the year ended March 31 the net income of the electricity department from the sale of current, &c. was £19,301. 11s. 10d.

Works costs were £6,138. 6s. 6d., and total costs £8,164. 12s. 5d. An extraordinary expenditure of £1,045. 7s. 7d. was incurred on two spare armatures, milking booster, &c. (this item being disallowed by the L.G. Board on capital account) and the gross profit was £10,155. 7s. 11d. Interest and sinking fund absorbed £4,958. 8s. 8d., and after placing £1,001. 13s. 7d. to depreciation, the balance (£4,188) was transferred to the borough fund. The total capital expenditure is £91,300. 3s. 6d., an increase of £3,534. 4s. 11d. on the year. There are 581 consumers representing the equivalent of 44,962 8 c.p. (including 246 B.H.P. in motors) connected, against 530 and 40,879 8 c.p. in 1905. The percentage of gross profit to capital outlay is 11·1, against 14·9, the percentage of net profit being 5·7, against 9·46. The capacity of the plant at the station is 1,990 kw. and the maximum load was 1,475 kw., the load factor being 20·85 per cent. against 22·54 per cent. 2,693,974 units were sold (552,445 for private lighting and power, 12,367 for street lighting and 2,129,162 for traction), against 2,642,541. The works costs per unit sold were 0·547d., against 0·563d., and the total costs (including extraordinary expenditure) 0·820d., against 0·741d.

An interesting report and analysis of the figures of the year's working by the borough electrical engineer (Mr. Jas. E. Starkie) accompanies the accounts. The rental of motors and arc lamps was reduced on April 1 of last year to less than the amount of depreciation, but by setting the profit on work done together with the rentals against depreciation the account shows a profit of 19s. The reserve fund of the department now stands at £7,957. Mr. Starkie, after dealing with the working of the generating plant during the year, recommends the provision of a mechanics' shop to do small repairs, &c. The scheme of dividing the lighting mains into sections by means of fuse boxes and pillars is being proceeded with.

Coventry.—The gross profit on the past year's working of the electricity department is £11,973, against £8,216. Interest and sinking fund amount to £9,480, against £8,628, and the net profit is £2,603, against a loss last year of £228 and a profit of £775 in 1903-4. The capital expended during the year was £18,182, bringing the total to £152,685.

Croydon.—The annual report and accounts of the ninth year's working of the electricity department were approved by the Council on Monday.

The chairman of the Lighting and Electricity committee (Ald. Miller) said that the works costs showed a slight increase over last year, and several items, such as rates, &c., showed a considerable rise. The revenue was £52,446, against £49,675, and the units sold 4,245,434, against 3,917,939. The total expenses were £27,266, leaving a gross profit of £25,181. After paying interest and sinking fund, the net profit was £4,087. The reserve fund was now £13,900, and the balance in hand £4,000. Since the commencement of the undertaking there had been a profit of £61,000. They had given £6,000 to the rates and £2,500 towards establishment expenses. The total capital expended is £313,348. 8s. 9d., an increase of £13,153 on the year. 5,170,572 units were generated, 1,867,017 units were sold to private consumers, 1,693,741 supplied for traction and 684,676 to the public lamps. The total maximum supply demanded was 2,655 kw.

Glasgow.—Last week in moving the approval of the accounts of the tramways department for the past year (set out on p. 624 of our present issue),

The convener (Mr. Hugh Alexander) stated that the outstanding feature was the increase of revenue by £57,000, while the net surplus had decreased by £37,000. That was due largely to the fact that the maintenance of the track had cost £66,000 against £24,000, the highest previous amount spent on maintenance. He did not know that he could give any sufficient reason for the increased outlay on maintenance of track. Interest on capital had been £5,000 more, notwithstanding that their debt was a little less. The sinking fund rose automatically every year. Last year they paid £48,300. The Income-tax Commissioners had claimed £12,422 against £5,400 in the previous year. He could not promise that the surplus would be any better next year, and he reminded the Council that he had warned them for several years that it would be a mistake to look forward to a surplus from £90,000 to £100,000. They had written off depreciation on the ordinary lines. For the renewal of track they had laid aside £500 per mile, against £450 two years ago. Then it was proposed to increase the sum to be handed over to the Common Good from £25,000 to £35,000, making the total payment to that fund during the past 12 years £191,000.

Mr. J. M'Farlane considered they were perfectly safe in allowing 8 per cent. for the renewal of permanent way and for repair. As far as depreciation was concerned, they were also, he thought, proceeding on safe lines. For electrical equipment they allowed 3 per cent., for stations 5 per cent., and for cars 7½ per cent.

Treasurer Stevenson thought that next year an account should be inserted showing the actual cost of each part of the system and the actual amount written off, so that it could be seen what had been spent altogether and what had been written off.

After further discussion the accounts were adopted.

Liverpool.—The auditors of the tramways department have issued their report on the accounts for 1905:—

Car receipts were £550,083, an increase on the previous year of £9,223, and the passengers carried numbered 119,123,644, increase 2,480,981. The mileage run was 12,066,963, a decrease of 99,456. The passenger receipts per car-mile averaged 10·940d., against 10·669d. The surplus was £175,677, leaving, after payment of sinking fund and interest, a net profit of £75,959. Of this, two-thirds was placed to reserve and the balance was voted to relief of rates. The amount set aside for renewals and depreciation (£88,814) is equal to 7·68 per cent. on capital expended, and the reserve stands at £214,398.

St. Annes-on-the Sea.—The capital expended on the electricity undertaking for the year ended March was £1,829. 11s. 1d., making a total of £40,435. 5s. 2½d.

The annual income was £8,085. 0s. 4d. The gross profit was £3,858. 10s. 7½d., and after paying interest and sinking fund the net profit was £1,243. 14s. 6½d. 703,661 units were generated, 355,298 were sold by contract, 178,903 to private consumers and 81,850 to the public lamps. The total maximum supply demanded was 336 kw. for traction and 219 kw. for lighting. Working expenses per unit were 1·390d., against 1·331d. in 1904-5. There are 418 private consumers (against 321).

Southampton.—The income of the tramways department for the past year was £51,025. 3s. 8d.

The traffic expenses were £14,204. 14s. 5d., general expenses £4,379. 8s. 7d., repairs and maintenance £5,703. 12s. 6d., and energy for traction and lighting of cars (1,338,710 units at 2d. per unit, less discount, &c.) cost £10,826. 7s. 9d. Interest absorbed £6,087. 16s. 1d., income tax £353. 3s. 10d., and sinking fund charges £5,189. 9s. The balance (£4,126. 11s. 2d.) has been carried to depreciation and renewals fund. The expenditure on renewal of permanent way was £4,485. 16s 10d., and the balance forward of the tramways depreciation and renewals fund account is £528, against £887. 5s. 8d. last year. Capital expenditure is £199,031. 6s. 6d., an increase of £101. 14s. 8d. during the year. 9,420,013 passengers were carried, and 1,156,783 car miles run; the receipts per car mile were 10·20d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Coventry Corporation invite tenders for supply and laying of 10,000 yds. of high-tension twin-concentric cable. Specifications from the City treasurer, Little Park-street, Coventry. Tenders to the town clerk (Mr. Geo. Sutton), 10, Hay-lane, by 10 a.m , Aug. 8. See also an advertisement.

Greenock Corporation invite tenders for the following contracts for the year ending June 30, 1907 : (1) Steam coal (washed singles and doubles), (2) oil and engine room stores, and (3) consumers' electricity meters. Tenders to the town clerk, Mr. C. MacCulloch, Municipal-buildings, Greenock, by 10 a.m. Aug. 7.

Manchester Tramways committee invite tenders for supply of electric tramcar bodies, electrical equipments for cars and tramcar trucks. Specifications, &c., from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester. Tenders to Chairman of Tramways committee by 5 p.m. Aug. 6.

Dudley Electricity committee invite tenders for supplying and laying feeder and distributor cables. Specifications, &c., from the consulting engineer, Mr. Reginald P. Wilson, 66, Victoria-street, Westminster. Tenders to Chairman of committee, Town Hall, Dudley, by noon Aug. 13.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of certain ports. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17–19, Bedford-street, London, W.C.

Gloucester Light Railways committee invite tenders for stores for the 16 months ending Dec. 31, 1906, including vulcanised rubber cables, insulating materials, ironmongery, paints, general stores, oil, incandescent lamps, car-wheel tyres, &c. Tenders to chairman by Aug. 9.

Leeds Electricity committee invite tenders for steam, feed-water, exhaust, overflow, blow-off and other pipes, valves, &c. Tenders to the Town Clerk, by 10 a.m. Aug. 15.

Stockport Electricity committee invite tenders for a water-tube boiler, with superheater and stoker. Tenders to Chairman by noon Aug. 11.

Dublin Markets committee want tenders by noon Aug. 13 for electric lighting of the fish and vegetable markets and the weights and measures offices. Specifications from the City Electrical Engineer, Fleet-street, Dublin.

Brentford Guardians want tenders by 10 a.m. Aug. 8 for wiring and telephone and bell installation at their new buildings at Isleworth Further information from Mr. W. H. Ward, Paradise-street, Birmingham.

Walthamstow Council require tenders by Aug. 31 for alterations and additions to permanent way of light railways. Specification from Mr. G. W. Holmes, Town Hall, Walthamstow.

Bolton Electricity committee invite tenders for two Lancashire boilers. Tenders to Chairman by noon Aug. 9.

Portsmouth Tramways committee invite tenders for best Welsh steam coal. Tenders by noon Aug. 6.

Tenders are to be invited from selected firms for installing internal telephones in the Town Hall, *Paddington* (London).

TENDERS RECEIVED AND ACCEPTED.

Islington (London) Lighting committee has received the following tenders for 250 end sealing boxes for concentric cable :—

British Insulated & Helsby Cables (*prov. accepted*), **8s. 3d.** each ; Berry, Skinner & Co., 8s. 3d. ; Rumney & Rumney, 8s. 3d. ; J. A. Cross, 10s. ; Westminster Engineering Co., 10s. 6d. ; Universal Electrical Mfg. Co., 10s. 6d. ; E. F. Moy, 11s. ; Sowden & Sons, 12s. ; W. T. Glover & Co., 14s. ; W. Lucy & Co., 14s. 6d. ; Imperial Construction Co., 17s. ; Callender's Co., 15s. 10d. ; Howard Davies, 15s. 6d. ; Reason Mfg. Co., 17s. 6d. ; W. T. Henley's Co., 17s. 6d.

The following tenders were received for 230 isolating switches :—Universal Electrical Mfg. Co. (*prov. accepted*) **11s.** each ; E. F. Moy, 12s. ; General Electric Co., 12s. 3d. ; Veritys Limited, 12s. 9d. ; Oliver & Co., 14s. ; Reason Mfg. Co., 14s. 6d. ; J. E. Spagnoletti & Co., 15s. ; Drake & Gorham, 18s. 9d. ; Union Electric Co., 19s. ; Johnson & Phillips, 22s. 3d. ; Crompton & Co., 27s. ; Brush Co., 29s.

The following tenders were received for 5,000 yds. of troughing and 13,500 brick covers:—Leeds Fireclay Co. (*prov. accepted*), **£111. 11s. 8d.** ; Doulton & Co., £121. 1s. 10d. ; J. Knowles & Co., £156. 19s. 7d. ; Albion Clay Co., £164. 1s. 4d.

The Electric Lighting committee of Sydney (N.S.W.) Council recommend for acceptance the tenders of the British Insulated & Helsby Cables for cables at £9,535. 8s. 4d. ; that of Dick, Kerr & Co. for generating plant at £20,145 ; that of the Australian General Electric Co. for static transformers and switchboards at £6,069 ; and that of the Stirling Boiler Co. for boilers and pipework at £11,640 Two tenders of equal amount were received for bitumen and their consideration is postponed.

For constructing railways Nos. 1 and 2 (under the Waltham Cross and Enfield Light Railway Order, 1906) Middlesex County Council have placed the contract with Dick, Kerr & Co., at the same prices and under the same schedule at which they constructed the section of railway from Edgware-road to Willesden-green. The firm have also been requested to allow their offer for the construction of the railway under the Waltham Cross and Enfield Order to remain open.

The construction of part of railway No. 7, from the termination of railway No. 2 in High-road, Southgate, up to the bridge north of New Southgate station has been placed with Wimpey & Co. at an advance of 7½ per cent. on the schedule of prices at which they are constructing railway No. 2.

King's Norton and Northfield Council received the following tenders for the overhead equipment of the tramway between Moseley and King's Heath and the extension to Alcester Lanes End :—

Brush Co. (*accepted*)	**£4,115**	**5**	**6**	Dick, Kerr & Co.....	£4,695	4	0
H. J. McCormick ..	6,432	8	7	Brit. Elec. Equip. Co.	4,158	11	10

For constructing the light railway between Green Lanes, Wood Green and Southgate Middlesex County Council received 16 tenders (varying from £63,314. 11s. 2d. to £134,892 15s.), and that of Dick, Kerr & Co , at £65,910. 2s. 2d. (the lowest tender but one), was accepted. The county engineer's estimate was £68,411. 11s. 9d.

Stepney (London) Council have accepted the following tenders : W. Badger, meter cases at £104. 9s. 2d. ; J. & W. Shale tendered at £118. 17s. 6d. and Buck & Hickman at £133. 13s. 9d. For wiring two underground conveniences, the tender of W. Palmer, at £23. 8s., was accepted. There were 10 tenders, varying from the accepted to £65.

Walthamstow Council have accepted the tender of Callender's Co. for feeder pillars at £17 each, that of Oliver & Co. for nine spare arc lamps at £32. 12s. 6d., and that of Reavell & Co. for an air compressor at £96.

Bolton Tramways' committee have accepted the tender of the Milnes-Daimler Co. for a motor tower waggon chassis, and the Electricity committee have placed an order with J. Musgrave & Sons for steam pipework.

Maidstone Council received the following tenders for condensing plant :—

Mirrlees-Watson Co. (*accepted*)	**£977**	**0**	**0**	W.H. Allen, Son & Co.	£1,232	10	0
				Babcock & Wilcox ..	1,100	0	0
Davey Paxman & Co.	1,322	10	0	G. & J. Weir.. ..	1,080	0	0

Bristol Electrical committee have accepted the following tenders : H. Tuchman, arc lamp carbons, £362. 3s. 3d. ; Richard Woods & Co. and A. E. Brook (Ltd.), a.c. motors, £134. 9s ; Morris Hawkins Electrical Co., d.c. motors, £496. 12s.

Millar's Karri & Jarrah Co. have received from the Posmaster-General's department (Perth, W. Australia) an order for 700 jarrah telegraph and telephone poles at £518. 15s.

Birmingham Corporation have placed the contract for 12 months' supply of 3 H.P. and 7½ H.P. motors with the Rhodes Electrical Mfg. Co., Bradford and London.

Hull Electricity committee have accepted the tender of Thos. Parker (Ltd.) for two 90 kw. transformers at £1,642, and that of the Lahmeyer Electrical Co. for one 200 kw. transformer at £1,536. 10s.

Bolton Corporation have accepted the tender of the Adams Manufacturing Co. for the supply of motor starting rheostats up to March 31st next.

Dublin City Council have accepted the tender of Wm Coates & Son for wiring the libraries at Thomas street, Capel-street and Charleville Mall.

An order has been placed by Stepney (London) Council with Babcock and Wilcox for a steel coal bunker for the generating station at £265.

The Argentine Government have accepted the tender of C. Beffa for the erection of electricity works at La Plata port at $62,175 m/n.

Croydon Council have accepted the tender of Griffiths & Millington for the right of advertising on the tramcars for seven years at £31. 10s. per car per annum.

Lancaster Council have placed an order with the British Insulated & Helsby Cables for 1,150 yards of pilot wire at £59.

Chelmsford Joint Hospital Board have accepted the tender of F. H. Dennis for installation of telephones at the hospital.

Woolwich Council have accepted the tender of the Electricity committee for wiring Plumstead Baths and Wash-houses at £678.

Quick Cable-laying Work.—The British Insulated & Helsby Cables have just completed an important cable-laying contract for the North Metropolitan Electric Power Supply Co. with remarkable dispatch :—

> On June 14 last the North Metropolitan placed an order with the contractors to supply and lay trunk cables to connect their Hendon and Finchley sub-stations, to enable their transmission system to be supplied from either their Brimsdown or Willesden (Taylor's-lane) power station. The order was for 9¼ miles of 0·1 e.h.t. three-core 11,000 volt cable, and 4⅝ miles of eight-core telephone cable, the cables in both cases being plain lead-covered, and 4⅝ miles of trench work and temporary reinstatement, of which about 95 per cent. was under road surfaces. The e.h.t. cable was to be laid in a ¾ in. socketted glazed earthenware trough, and the telephone cable in tarred wooden troughing. A portion of the earthenware troughing and tile covers were obtained from various makers' stocks, but the remainder and all wooden troughing had to be built. Different thicknesses of tile covers were used, so as to clearly distinguish one cable from another at any point of the route. All the cables had to be built, and the despatch of the e.h.t. and telephone cable was made from Prescot exactly 14 days after receipt of order. Laying commenced on July 3, and, being favoured with good weather from start to finish, the work was completed ready for testing by the evening of July 27—*i.e.*, six weeks and one day after receipt of order. The cables were ready for and were actually put under working pressure on July 28. The number of men employed on the work was approximately 230, divided into two gangs. Overtime was worked when necessary, but there was practically no night work, except keeping the jointers through the night on two occasions only.

Gas Engine Plant.—What will eventually develop into perhaps the largest gas power plant in the world has its inception in an important contract for eight large gas-driven blowing engines to be installed in the steel plant of the Indiana Steel Co., Gary, U.S.A. The machines will be uniform in size and capacity. Each gas engine as an electric unit will have a rated capacity on blast furnace gas of nearly 3,000 H.P., corresponding to a rating of 4,000 H.P. on natural gas. The unit will be arranged in twin tandem fashion, each side consisting of two double acting gas cylinders, and one blowing cylinder in the opposed or vis-à-vis arrangement. The power cylinders are 42 in., and the air cylinders 68 in. in diameter, with a common stroke of 54 in., the unit running at a maximum speed of 75 revs. per min. for blowing and 84 revs. per min. for electric work. The capacity of air delivery at this speed will be 33,000 cubic ft. of free air per minute at 28 lb. pressure, with a maximum pressure delivery of 30 lb. per square inch. This type of engine will not only be used for blowing but also for electric generation. In all sizes a resemblance to the horizontal tandem heavy duty steam engine design is strong. The general design conforms closely to that of similar machinery installed for the Carnegie Steel Co.'s plant (U.S. Steel Corpn.) at Bessemer, near Pittsburg. The Westinghouse Machine Co. are the contractors in both cases.

Mill Lighting.—The Rochdale Electric Co. have secured the contract for the electric lighting of the new Crest Mill at Rochdale. The company have also in hand similar contracts for the Clover and Croft mills. The dynamos and motors (which will aggregate over 500 H.P) will be made at the company's works at Shawclough, Rochdale.

BUSINESS NOTICES.

Evershed & Vignoles, Acton-lane works, Chiswick, W., have appointed Mr. James Ferguson, 61, Pollok street, Pollokshaws, Glasgow, their agent for Soctland. The firm have also appointed C. H. B. Forbes & Co., of Bombay, their agents for the city and presidency of Bombay.

Mr. Henry M. Sayers, M.I.E.E., has removed from 36 to 39, Victoria-street, Westminster, S.W.

The works of the Rhodes Electrical Mfg. Co. (Sunbridge-road, Bradford) will be closed for the summer holidays for the week commencing Aug 6, and unless special arrangements are made, no goods will delivered or received by the works during that period.

The Marconi Wireless Telegraph Co. will close their Chelmsford works on the 11th inst. The company's new works are at Dalston, London, N.E.

The officers of the electricity department of Acton District Council have removed to 130, Churchfield-road, Acton. Telephone 360 P.O., Chiswick.

BANKRUPTCIES, LIQUIDATIONS, &c.

August 14 is the last day for receiving proofs in the bankruptcy of Wm. Leslie, electrical engineer, H.M. Prison, Brixton, S.W., and Alice Frances Cheesman, H.M. Prison, Holloway, N., both late of Putney, London, S.W.

A receiving order has been made against Lazarus Blumenthal, electrical merchant, 78, Queen Victoria-street, E.C. First meeting of creditors Aug. 13 (public examination Sept. 11) at Bankruptcy-buildings, Carey-street, W.C.

A receiving order has been made against Harry Jones, electrical engineer (lately trading in co-partnership as H. Jones & Co.), 44, hurch street, Longton.

A meeting will be held on Aug. 29 at 79, Queen-street, London, E.C., to receive an account of the winding up of the National Electric Traction Co. (Ltd.).

A meeting will be held on Sept. 5, at 14, Victoria-street, London, S.W., to receive an account of the winding up of the Yorkshire Electric Tramways Construction Synd. (Ltd.).

Winding-up Petition.—A petition by O. C. Hawkes (Ltd.) for the winding-up of the Electrical Corpn. (Ltd.) will be heard in the High Court on Aug. 7.

Sale by Auction—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, Aug. 23 (by order of the Secretary of State for War), at 11 a.m., some unserviceable and obsolete stores, including lead and founders' ashes, broken crucibles, cast and wrought iron and steel, copper, gun metal, brass, electric cable, telegraph and telephone instruments, engines, engineers' tools, &c. Catalogues from the War Office, Pall Mall, S.W.; Ordnance Office, Tower, E.C.; and the Ordnance Office, Royal Arsenal, Woolwich, S.E. Further particulars are given in an advertisement.

Heyland's Three-Phase Generators.—Notwithstanding the undoubted advantages offered by polyphase over continuous current for the transmission of energy to great distances, and its greater suitability for feeding simple and cheap motors, statistics have shown that thus far for smaller generating stations the preference has generally been given to the continuous-current system. One of the principal reasons for this is to be found in the fact that hitherto a separate direct-current excitation is indispensable for every polyphase plant, and this involves certain complication. Another difficulty which militated against the application of polyphase-current for smaller plants was that the maintenance of a constant voltage under fluctuating loads either required constant regulation by the attendant or the use of rather complicated adjusting devices, which naturally rendered the working of the entire plant more difficult and expensive. A notable improvement in the direction of simplicity and more satisfactory operation has recently been made by the introduction of the "Heyland" three-phase dynamo by the Lahmeyer Electrical Co., 109–111, New Oxford-street, London, W.C. As these machines are self-exciting they do not require a continuous-current dynamo. Moreover, on account of the special winding of this machine it has not to be continuously adjusted by hand, but regulates and automatically responds instantly to every variation of voltage. Other distinguishing features of the machine are the small floor space covered and its lightness, rendering heavy foundations unnecessary. These dynamos are built for an output up to 75 H.P., so that even small isolated concerns can reap the advantage of three-phase current, which hitherto has not been utilisable for small plants.

Catalogues.—A good example of the lever type of totally-enclosed motor starter, specially designed to meet the demand for a thoroughly good starter for use in places where there is an unusual accumulation of dust or where the atmosphere is likely to be of an explosive nature, is described in pamphlet sheet No. 34 issued by A. Reyrolle & Co., Hebburn-on-Tyne. The workmanship and general appearance of these starters were very favourably commented upon by visitors to Messrs. Reyrolle's stand at the late electrical exhibition at Olympia. The particular type of starter here listed includes a special resistance, by means of which the motor starts at all loads, whilst the handle is held at the first stud. For use in mines and other dangerous situations, the starter can be made perfectly gas-tight.

On the subject of electrical power in the Clyde Valley the British Westinghouse Co. have prepared for publication an interesting pamphlet. The frontispiece shows the power station of the Clyde Valley Electrical Power Co. at Yoker, and a second illustration the Motherwell station. A number of good interior views of both stations are also given.

The Westinghouse Co. have also issued an instructive pamphlet dealing with the Metropolitan Railway from its inauguration in 1863 to its electrification in 1906. Both sections of the pamphlet contain much interesting matter.

"Technical Thermometry" and the large range of instruments and apparatus which are required in electrical research work are succinctly dealt with in the catalogue which has been prepared for publication by the Cambridge Scientific Instrument Co. (list No. 39). It is pointed out that great progress has been made in the science of thermometry and the Cambridge Scientific Instrument Co. rightly claim that they have kept well to the front in designing, manufacturing and supplying instruments needed for this branch of work. This publication is outside the ordinary range of catalogues and price lists in the fact that the descriptions of the apparatus listed are exhaustive. There are a number of excellent photographic illustrations, as well as illustrations showing the actual instruments and, in some cases, diagrammatic sketches of connections, &c. In an appendix the subjects of electrical resistance thermometry and thermoelectric thermometry are briefly dealt with. We have selected for brief mention several items: Fig. 1 shows a resistance thermometer connected to a Whipple patent temperature indicator. By depressing the contact key F and by turning the milled head H the resistance of the indicator is made to equal that of the thermometer, the galvanometer needle at B showing when balance is obtained. The required temperature in degrees C. or F. can at once be read off on the scale at A. The indicator need not be near the thermometer, but may be a considerable distance from it without affecting the accuracy of the readings. Fig. 2 shows a spring-suspended table for supporting galvanometers where these instruments would otherwise be subjected to vibration. Fig. 3 shows the Féry radiation pyrometer telescope. For this instrument the Cambridge Co. are sole agents in the British Empire and many other places. The complete outfit of the Féry radiation pyrometer consists of a telescope and a galvanometer. Fixed within the telescope, at a point upon its optic axis, is the junction of a copper constantan thermo-couple arranged in the form of a cross. The two wires are attached to the two brass strips D and R, which are attached to the terminals shown at *bb'*. The terminals are connected by leads to the galvanometer. In use an adjustable diaphragm is fitted in front of the telescope in order that the amount of radiation falling on the thermo-couple may be varied. Fig. 4 is a Collins patent mercury contact. These contacts are fitted to the Callendar & Griffiths self-testing bridges made by the company, and combine the advantages of both plug and mercury contacts without their disadvantages. The act of inserting the heavy plug D depresses the spring A, forcing the copper link B into the mercury cups C and C_2. When the plug D is removed the spring lifts the link out of the mercury cups and the small plate E is lifted by the helical spring F against the opening G, thus preventing dust from entering the box. The cover of the box is so arranged that with the most ordinary care it is impossible for the mercury to escape. Fig. 5 shows a Griffiths thermoelectric key. When a platinum thermometer is used for accurate work thermoelectric effects sufficient to affect the accuracy of the observation constantly present themselves. By means of this key the balance shown by the galvanometer is independent of all such causes of disturbance.

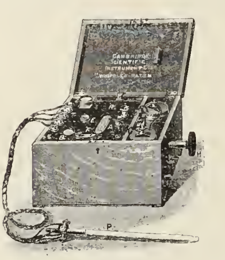


FIG. 1.

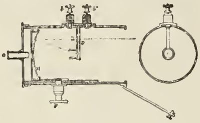


FIG. 3.

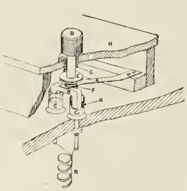


FIG. 4.

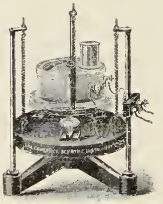


FIG. 2.

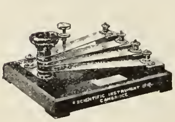


FIG. 5.

Pamphlet No. 16, issued by Bruce Peebles & Co., East Pilton, Edinburgh, and 1, London Wall-buildings, London, E.C., describes the latest type of this firm's induction motor. In preparing this list for publication Messrs. Bruce Peebles have chosen, under expert advice, a range of motor varying from 1 to 100 H.P., for each of which the designs are complete, and all parts are held in stock only awaiting assembly, so that, so far as these machines are concerned, almost immediate delivery can be given. Where strictly standard machines are ordered special discounts are offered off list prices. One of the illustations shows a fine example of a 250 H.P. totally-enclosed colliery motor.

Messrs. Crosier, Stephens & Co, 2, Collingwood street, Newcastle-on-Tyne, are issuing an admirably-arranged circular dealing with power plant for colliery working and for large installations generally.

"**The Journal.**"—Part 178 of the Journal of the Institution of Electrical Engineers is now ready, price 5s. Particulars of contents are given in an advertisement.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery, which is not separately specified) from July 25 to 31, with the ports of destination :—

Africa—Alexandria, £147 (including £82 telegraph material); Cape Town, £204; Chinde, £50; Durban, £786; Port Elizabeth, £74 (telegraph material); Quilimane, £66. *Argentina*—Buenos Aires, £2,264 (including £573 telegraph material). *Australasia*—Adelaide, £118; Auckland, £60; Brisbane, £107; Melbourne, £1,988 (including £1,780 telegraph cable); Napier, £12; Perth, £91; Sydney, £1,155; Wellington, £35. *Azores*, £10 (telegraph material). *Belgium*—Antwerp, £150; Brussels, £24; Ostend, £116. *Brazil*—Rio Janeiro, £4,786 (including £4,741 telegraph material and apparatus). *Burma*—Rangoon, £187. *Canada*—Montreal, £24. *Ceylon*—Colombo, £580. *China*—Foochow, £14 (telegraph material); Shanghai, £40. *Denmark*—Copenhagen, £740 (including £30 telegraph material). *Faroe Islands*, £33,650 (telegraph cable). *France*—Boulogne, £12. *Gibraltar*, £14 (telegraph material). *Holland*—Amsterdam, £96 (including £20 telegraph material); Rotterdam, £10. *Hong Kong*, £218. *India*—Bombay, £1,100 (including £421 telegraph material); Calcutta, £2,168 (including £38 telegraph material); Madras, £108. *Italy*—Genoa, £50. *Japan*—Kobe, £2,220; Tokio, £37; Yokohama, £99 (telegraph material). *Portugal*—Lisbon, £162 (including £50 telegraph material). *Russia*—St. Petersburg, £265 (including £225 telegraph material). *Siam*—Bangkok, £122. *Spain*—Gerada, £40. *Straits Settlements*—Penang, £176; Singapore, £156. *Sweden*—Gothenburg, £20; Stockholm, £120 (telegraph material). *Uruguay*—Monte Video, £6,490 (telegraph cable). *West Indies*—St. Lucia, £17 (telegraph material). Total £61,178, against £48,360 in the corresponding week last year (July 26 to Aug. 1).

COMPANIES' MEETINGS AND REPORTS.

City & South London Railway Co.

The forty-fourth ordinary general meeting was held on Tuesday, the Right Hon. C. B. STUART-WORTLEY, K.C., M P., presiding.

Mr. W. F. KNIGHT (the Secretary) read the notice convening the meeting.

The CHAIRMAN said : It is a matter of great satisfaction to me that I am in a position to congratulate you upon a considerable increase in passenger and general receipts for the half-year, amounting to £1,232, which, with a decrease in working expenses of £353, makes a net increased profit of £1,585. The result is that £42,614 has to be carried to net revenue account, against £41,029 last year. Now, if you will turn to the net revenue account, you will see that there is £83 less brought forward from the previous half-year, but against that there is an increase of £1,286 in interest and discounts, making, therefore, a total balance available for dividend, after the payment of £11,225 interest on debenture stock and after placing, as usual, the sum of £1,500 to renewal fund, of £32,987. That will admit, after payment of dividend on the preference stocks for the half-year, of the payment of a dividend upon the consolidated ordinary stock at the rate of 2¼ per cent. per annum for the past half-year, as compared with one at the rate of 2 per cent. for the corresponding period of the previous year, leaving us a balance to carry forward of £1,871, as against £1,041 for the corresponding period of last year. This result is due mainly to the fact that we have carried 383,532 more passengers, and have received £1,561 more in money. There is, it is true, a slight decrease in the amount which we have received for season tickets of £910, but this, however, is accounted for by the fact, as I explained to you at the last half-yearly meeting, that the previous holders of season tickets seem to have preferred to take our ordinary 6d. return tickets. Now, with regard to the receipts I may tell you that in the miscellaneous receipts we show an increase of a small amount in parcels of £9, in rents and way-leaves an increase of £549, and in sundry receipts of £17, showing a net increase in the total receipts for the half-year of £1,232, and it is very gratifying to note that our total expenses continue to decrease. For although in maintenance there is an increase of £17, and in law charges of £11, there are decreases in the items of locomotive and generating power of £31, carriage repairs £34, traffic expenses £169, general charges £23, and passenger duty £80. I will now call your attention to what I may term the statistical results of the half-year's working, and you will find that the receipts per train are 16s. 0·40d., against 16s. 3·70d., and the receipts per train mile are 2s. 7·41d., against 2s. 7·95d., and per passenger 1·80d., against 1·84d., but in connection with this decrease it must be borne in mind that from May 1, 1905, we reduced our fares, and as, therefore, the first four months of the half-year now under review had the full effect of that reduction a comparison cannot fairly be made. It is gratifying to note that the percentage of working expenses continues very low, being at the rate of 44·94 per cent., against 46·13 per cent. for the corresponding half of the previous year, while the expenses per train-mile are 1s. 3·08d., against 1s. 3·63d. a year ago. The locomotive charges per train-mile have amounted to 4·62d., as compared with 4·75d. a year ago, and the traffic expenses have been 6·60d., against 6·68d. So much for the working of the half year ; and now, ladies and gentlemen, to turn to the future, I am very glad to be able to tell you that the execution of the contract of our great works in connection with the extension to Euston continues to progress satisfactorily. I told you when I addressed you six months ago what progress had been made. Some delay has occurred owing to the whole of the works west of King's Cross and west of St. Pancras having to be carried out under compressed air. In addition, we have had a certain amount of rock to contend with in the tunnels, and we have therefore suffered a delay in the completion of that portion of the line by several weeks, but as this delay ran concurrently with the compressed air works, it will not, in itself, effect the date of the opening. I think that I ought to tell you that both the tunnels have been driven under the great roof of St. Pancras station without the slightest damage to that structure, and that the exchange passages with the Great Northern Railway at King's Cross and the Midland Railway at St. Pancras, and also those with the London & North-Western Railway at Euston are being carried out. I think it is a very satisfactory fact that the whole length of the main running tunnels have been completed now with the exception of only 140 yds. You will, I am sure, appreciate how much nearer we are to the realisation of the great possibilities which I foreshadowed when I last had the pleasure of addressing you. I now turn to a very interesting matter, which is our new connection with the Baker Street & Waterloo Railway Co. at our Elephant & Castle station. There is not much that I need add to what has already been stated in the printed report which has been circulated amongst you. I am in the happy position of being able to tell you that the opening will take place actually so soon as next Sunday. That means a great deal for us, because it takes less than a minute to walk from our platforms to those of the Baker Street & Waterloo Railway Co., and our line will be, as we consider it, the newest and quickest railway route from the Angel, Finsbury-park, Moorgate-street, and the City in the north and east, and from Clapham Common and our other South London stations, on the other hand, to such places as Waterloo Station—where passengers will ascend in lifts right on to the platforms of the London and South-Western Railway Co.—to Westminster Bridge-road (formerly Kennington-road)—to "Embankment" near Charing Cross, where the Baker Street line taps the District Railway—to Trafalgar Square, Piccadilly Circus, and all the district which those stations serve, and as passengers will be able to book through, very good results are anticipated by your Directors to follow therefrom. Moreover, I am glad to tell you that our relations with the Baker Street & Waterloo Railway Co. are most friendly, and we have every reason to hope that everything will be done by both companies to fairly and fully develop this new traffic. I have now to refer to a very important matter in connection with our Stockwell installation. For a period of 16 years we have been very badly off in the way of taking our trains out of the tunnels for the purposes of cleaning and repairs. I may say that the only means we have hitherto had is by a siding or tunnel which goes up a very steep incline and has a rise of 1 ft. in 3½ ft. It is very awkward with difficult curves, and whenever it has been necessary to take up a train or a locomotive we have had to draw it up by a steel wire rope either for purposes of repairs or cleaning, and we had to stop the traffic upon the down road with, of course, the consequent undesirable delay. Well, we have now set about making two siding tunnels right under our depot at Stockwell, and on the same level as our underground station at Stockwell, and we are sinking a large shaft some 20 ft. by 40 ft. in which will be installed an electric lift sufficiently large to raise a carriage right up into the depot. By this means we hope to overhaul and clean our carriages in the open a little oftener than has hitherto been the case, and as far as the cost goes I am advised that the Company will have this extra accommodation without practically any additional expense, as the whole process of hauling the trains and locomotives up to the surface was not only expensive but otherwise very inconvenient. Before I conclude, I may just say that as regards the future we have begun the new half-year with unusually good traffics. I now move the adoption of the report and accounts.

Mr. CHAS. SEYMOUR GRENFELL seconded the motion.

Mr. ANDREWS: I would just like to ask whether the very gratifying increases in our traffic receipts for the last few weeks are due to any particular cause. They usually go down in the fine weather, and when it turns wet the decrease ceases and they go up again.

The CHAIRMAN: In regard to this increase of traffic, as compared with the corresponding period of the previous year, that it is a very satisfactory comparison, and some of it seems of a permanent character. It is perfectly true that we have had some advantage in the traffic receipts during the current half-year from the fact that these northern tramways from Moorgate-street here have been under reconstruction and that has led to us getting some increase, but the increase is not only at those stations, and this by no means accounts for the whole of the increase which we have had.

The motion was then carried unanimously, as was a resolution approving the dividends as set out in the report.

There being no further business, a cordial vote of thanks to the Chairman, Directors and staff terminated the proceedings.

BOMBAY ELECTRIC SUPPLY AND TRAMWAYS CO. (LTD.)—At the first ordinary general meeting on Tuesday, Sir E. Sassoon, Bart., M.P., said that some difficulties inherent to the novelty of the work, its surroundings and the somewhat variable climatic conditions of Bombay had had to be encountered, but those were being successfully surmounted. Some delays had prevented their making as fast progress with laying the new track, installing the overhead equipment and other matters connected with electrification as they could have wished, but they were satisfied that everything that was possible to be done was being done in the direction of exploiting the various features of the undertaking. The balance standing to credit of profit and loss (£19,121) enabled them to pay their debenture interest, the cumulative dividend on the preference shares and to carry forward £3,163. That was the result of the working from Aug. 2, 1905, to Dec. 31 last. The directors considered that a very encouraging position, as the tramways had not yet been electrified and the electric lighting and supply department of their business was still in its infancy. The company acquired (under agreement with the British Electric Traction Co.) the horse tramways in Bombay, with horses, cars, plant, &c., together with a power house containing about 1,000 H.P. of plant, mains, &c., for £950,000, payable as to £225,000 in cash, £600,000 by the allotment of that amount of 4½ per cent. debenture stock and £125,000 by the allotment of 12,500 fully paid ordinary shares of £10 each. This price included the completion of certain specified works and buildings in connection with the supply of electricity, the cost of obtaining the traction license and the costs in connection with the formation and registration of the company. Since Aug. 2, 1905, £27,788 further had been spent on the power and lighting section of the undertaking and on the electrification and reconstruction of the tramways. The directors had not considered it necessary to make any provision for depreciation during the period of conversion and reconstruction of the tramway system to electric traction. When the lines had been reconstructed that would have to be provided for. The issued capital at Dec. 31st last was £600,000 4½ per cent. debenture stock; £600,000 preference shares (£4 called up) and 14,507 ordinary shares (fully paid). The Government had undertaken to grant to the company the electric traction license required under the Indian Electricity Act, and it was anticipated that that would be issued very shortly. The work of electrifying the tramways was being energetically proceeded with, and it was anticipated that about seven route miles of double track would be in operation early next year. Messrs. J. G. White & Co. were carrying out (as sub-contractors) the reconstruction of the tramways, and the Brush Company were supplying the electrical plant and machinery for the power station. The Callender Co. were supplying the cables. The electricity supply license was granted on June 7, 1905, and a continuous supply was commenced in November. This business was developing very satisfactorily. The equivalent of 36,071 8 c.p. lamps was connected up to June, and several important installations would shortly be connected, while the company was in negotiation for lighting the docks and many other public institutions. The company had at present installed in their generating station plant of 1,800 kw. capacity, and further plant of 2,000 kw. capacity was on its way to Bombay. An application had recently been made to the Government of Bombay by Messrs. Tata (of Bombay) for the issue of a licence entitled the Bombay Hydro-Electric Licence, for the supply of electrical energy to the city and island of Bombay. The area of supply under that license was identical with that for which the Government had issued a license to their company. and the directors were taking steps to oppose the grant of a license to Messrs. Tata. Bombay Municipality, under the terms of the concession to their company, bound itself to take all proper steps and use its best endeavours to prevent competition in any area to which the company's license might extend, and the company had called upon the Bombay Municipality to give effect to the terms of that engagement.

CENTRAL LONDON RAILWAY CO.—At the meeting on Wednesday the chairman (Sir H. Oakley) said that the only material item of expenditure was £11,000 spent on a new sub-station to ensure the continuity of their work and to provide a substitute in case of the temporary failure of any one of their sub-stations. They would probably have to spend a further sum in additional machinery at Shepherd's Bush, because they found their working there was running very nearly to their margin of power. He had been asked to account for the reduction of passengers (700,000) carried. The total decrease was only about 3 per cent., and nearly one-half of that was in Sunday traffic. At some of the stations there was a greater proportionate decrease, due, as they thought, to the improved condition of their competitors and also to the advent and inroads of the motor 'bus. When the Metropolitan & District Railways had put themselves more nearly on an equal footing with the company, a proportionate amount of traffic had gone back to them, in addition to which the omnibuses and the motor 'buses had picked up passengers who rode for short distances only. They did not think that it was expedient, for the moment, to enter into competition with 'buses for that class of traffic by any alteration of fares, and they had, therefore, maintained their 2d. fare consistently from end to end, and they thought they saw that there was now a gradual return of many of the passengers who had left them, because they found that they could always rely upon a train, and that they were carried quickly, cleanly and comfortably. Their energies were bent towards a reduction of expenses, and they had been enabled to economise the loss of £5,600 by reducing working expenses by £2,800. Rates and taxes increased by £1,400, and the payment on that item amounted to something like 18 per cent. of net revenue.

CONSOLIDATED ELECTRICAL CO. (LTD.)—At the meeting last week Mr. H. Allen said he thought that was the first time for a great number of years, either in the history of the company or its predecessor, that the auditors had given them a clean certificate. The report and accounts having been adopted, the Chairman made a statement as to the position of the company. They retained (he said) their Coventry freeholds (standing in the books at £1,500), when disposing of the rest of their property to the Consolidated Supply Co. In regard to the investment in the Anglo-Portuguese Telephone Co. they held some 70,000 shares out of a total of 100,000. He also gave particulars of their interest in the Supply Co. The latter company had been successful in placing some of its shares at par. Their preference dividend arrears had been cleared off, and the 3 per cent. dividend on the ordinary shares would absorb £3,300, leaving a balance on the year's operations of £8,479. Making allowance for exceptional circumstances, they had now attained a position which removed the main ground for anxiety and assured a certain and steadily-increasing return upon their capital. Subsequently it was resolved to present the chairman with 500 guineas in consideration of exceptional services rendered to the company.

CROMPTON & CO. (LTD.)—The report for the year ended March 31 states that the contract department has again made a satisfactory profit, and the directors report that, although selling prices are still low and competition keen, the results of the year's working at the Chelmsford works show a marked improvement. During the financial year an extension to the lamp shop has been completed and equipped with necessary machine tools. The economies at the works referred to in last year's report, improvements in manufacture and an increased output, aided by this extension, have all contributed to a better result. The net profit for the year is £20,060. 6s. 4d., compared with £9,128. 10s. 7d. in the preceding year. After providing debenture interest, &c., there remains (with amount from last year) an available balance of £13,372. 15s. 11d. The directors propose a dividend of $2\frac{1}{2}$ per cent. for the year, to place £1,500 to reserve for doubtful debts and contingencies and to carry forward £5,816. 10s. 11d. The company has transferred to the Madras Electric Supply Corpn. the licence obtained for electric lighting in that town, and a contract has been secured from the corporation for the complete equipment of their undertaking in Madras for £174,534. The amount of work in hand at the commencement of the current financial year is largely in excess of the figures for any previous year, and the prospects of the company may therefore, be considered satisfactory.

GREAT NORTHERN & CITY RAILWAY CO.—The total revenue receipts for the six months ended June 30 were £49,390. 8s. 9d., against £46,239. 14s. 10d. for the corresponding period last year. The passengers carried (excluding season ticket holders) were 6,852,233 and 6,391,574 respectively. The number of local season tickets issued during the half-year was 3,131, against 2,913, and the number of three route season ticket holders using the line during the half-year was 2,697.

LONDON & SOUTH-WESTERN RAILWAY CO.—In the directors' report for the June half-year it is stated that at the conclusion of the forthcoming general meeting the shareholders will be asked to sanction the creation and issue of stock to provide for the purchase of the undertaking of the Waterloo and City Railway Co.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—At the meeting on Wednesday the chairman (Lord Cottesloe) said that the competition of tramways in the suburban districts served by the company was still felt, and accounted for a large part of the diminution in passenger receipts. The enlargement and improvement of Victoria station had involved the complete alteration of the signalling arrangements, and the opportunity had been taken to establish an entirely new system, partly electrical and partly mechanical, which, when in full working order, would prove very advantageous and much more expeditious than the old arrangement. At the last meeting the proprietors were told that a contract for the equipment for electrical working of the South London Railway from London Bridge to Victoria was being negotiated with the Allgemeine Electricitäts Gesellschaft, of Berlin. The contract had now been signed, as well as a contract for the supply of the electrical energy by the London Electric Supply Corpn. The preliminary work connected with the equipment was already in hand. In reply to questions as to the alleged failure so far of the electrification of the Metropolitan Railway, Lord Cottesloe said it must be remembered, on the other hand, that the North-Eastern and the Lancashire & Yorkshire Co s had both electrified certain portions of their systems with extremely satisfactory results, and they themselves must hope that their own experiment would turn out well.

In our issues of Dec. 15 and 22 we gave some particulars of the contract entered into by the company with the A.E.G. for the electrification of a portion of their suburban lines, and it is now stated that everything except the motor equipments are to be British manufacture. The subcontractors for the overhead work, feeder cables and section cabins are R. W. Blackwell & Co., and they have sub-let the switchboards for the section cabins to the British Thomson-Houston Co. The trucks are being manufactured by the Leeds Forge Co. Eight trains (of three coaches each) are on order, and there will be a 10 minutes' service between Victoria and London Bridge. As already announced, a seven years' contract has been entered into with the London Electric Supply Corpn. for supply of power with a minimum of 4,000,000 units per annum. The Corporation will lay duplicate mains from their power station at Deptford to Queen's-road station, Peckham, and from this station the railway company will lay two mains to Denmark Hill, which is the main distributing centre for the South London lines to be converted to electric traction.

METROPOLITAN RAILWAY CO.—At the meeting last week the chairman (Sir Chas. McLaren, M.P.) explained the causes of the decreased receipts. In consequence of the expensive buildings and plant they had had to erect in connection with their electrification, their assessments at Neasden and elsewhere were being put up, and they could not but regard that as very unfair, seeing that what they had done simply constituted a change from one mode of locomotion to another. Then the electrification of the Hammersmith and City Railway had taken longer than was expected, and the contractors for the rolling stock were also behind in the delivery of the trains for that service. The delay in getting rid of steam was not through any fault of theirs. The beneficial results of electrification could not appear until steam trains were removed entirely, and they were still hopeful that when that was accomplished a very great difference in their traffic returns would be shown. They had had a large number of breakdowns of the electric trains, especially during the earlier months of the half-year. The fault lay entirely with the equipment of the cars, for which the contractors (the British Westinghouse Co.) were responsible, the equipments being still in their hands, as the board had not up to now been sufficiently satisfied with them to take them over. The main fault lay in the character of the controllers provided on the motor-cars. At the time they placed the order they were assured that similar controllers had been working satisfactorily on important lines in America and elsewhere, and there was apparently no reason why they should not do equally well here. However, it proved not to be so, and the contractors were still engaged in taking all these controllers out and replacing them by those of a new design, which they were advised was superior and better adapted for the conditions of their system. The controllers had been changed on about one-third of the trains and the Westinghouse Co. estimated that within two or three months the work would be completed.

WATERLOO & CITY RAILWAY CO.—The gross receipts (less Government duty) for the June half-year were £17,367. 14s. 3d., and the working expenses £7,815. 9s. 5d., compared with £17,577. 0s. 11d. and £7,974. 18s. 4d. respectively for the corresponding period of 1905. The balance available for dividend, after providing for debenture interest, is £8,838. 7s. 11d., and a dividend at the rate of 3 per cent. on the ordinary stock will absorb £8,100, leaving £738. 7s. 11d. to be carried forward. The number of passengers (exclusive of season tickets) was 2,181,068, against 2,206,695 and 2,219,143 in the December and June half-years of 1905. At the meeting yesterday (Thursday) the report and accounts were adopted.

NEW COMPANIES REGISTERED.

LLANDUDNO AND DISTRICT ELECTRIC TRAMWAY CONSTRUCTION CO. (LTD.) (89,639).—Reg. July 25, capital £100,000 in £100 shares, to adopt agreements with the Carnarvonshire Electric Traction Synd. (Ltd.) relating to the acquisition of certain light railway orders authorising the construction of electric light railways between Colwyn Bay, Llandudno and Deganwy, together with the undertaking of the Llandudno and Colwyn Bay Electric Traction Co. (Ltd.) and with Bruce Peebles & Co. (Ltd.) relating to the completion of the construction and equipment of the said light railways or part thereof, and to carry on the business of tramway, railway, omnibus and electrical, electricians, &c.

VICTOR ARC LAMP CO. (LTD.) (89,571.)—Reg. July 19, capital £3,000 in £1 shares, to acquire the patents granted to V. W. Riley and H. W. Rowing in an invention for an improvement in connection with electric arc lamps, and to carry on the business of arc lamp manufacturers, electrical and general engineers, &c. First directors, R. P. Sims, E. J. Stevenson, A. C. G. Smith, H. Noakes, V. W. Riley and H. W. Rowing. Reg. office, 6, Holborn-viaduct, London, E.C.

CITY NOTES.

MEMORANDA (Aug. 2).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $29\frac{15}{16}$d. per oz. Consols $87\frac{7}{16}$—$87\frac{9}{16}$ for money, $87\frac{5}{8}$—$87\frac{3}{4}$ for account; $2\frac{1}{2}$ per cent. annuities $86\frac{1}{4}$—$86\frac{3}{4}$. Consols Pay Day, Sept. 3; Stocks and Shares Continuation Day, Aug. 13; Ticket Day, Aug. 14; Pay Day, Aug. 15; Mining Share Carry-over Day, Aug. 10.

BAKER STREET & WATERLOO RAILWAYS.—Mr. E. B. Read, who has been secretary of the company since its formation, has resigned.

BLACKPOOL & FLEETWOOD TRAMROADS CO.—The revenue for the half-year ended June 30 was £11,204, out of which the directors recommend a dividend at the rate of 4 per cent. for the half-year; £500 is placed to depreciation reserve and £560 to general reserve. 877,825 passengers were carried.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—Interim dividends on the first and second preference shares, and at the rate of 5 per cent. on the ordinary shares for the half-year ended June 30 have been declared.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—The directors have declared an interim dividend to June 30 at the rate of $8\frac{1}{2}$ per cent.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim ordinary dividend for the half-year ended June 30 at the rate of 9 per cent.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 5 per cent. for the half-year ended June 30.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—The directors have declared a dividend of 1s. 3d. per share (less tax) for the quarter ended June 30.

CLEVELAND & DURHAM ELECTRIC POWER (LTD.)—Letters of allotment for the recent issue of shares have been posted.

ELECTRIC LANDAULET CO. (LTD.)—The directors have declared an interim dividend for the half-year to June 30 at the rate of 5 per cent.

IMPERIAL TRAMWAYS CO. (LTD.)—The directors have declared an interim dividend to June 30 at the rate of 8 per cent.

LLANDUDNO & DISTRICT ELECTRIC TRAMWAYS CONSTRUCTION CO. (LTD.)—This company has issued a prospectus inviting subscriptions to an issue of 775 shares of £100 each at par.

LONDON UNITED TRAMWAYS (1901) (LTD.)—The directors have declared an ordinary dividend for the half-year ended June 30 at the rate of 3 per cent., the same rate as for the year 1905.

METROPOLITAN DISTRICT RAILWAY CO.—The directors recommend a dividend on the 4 per cent. guaranteed stock for the six months to June 30 at the rate of $1\frac{1}{2}$ per cent., the same rate as last year.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend of 4s. per share on the ordinary shares, being at the rate of 8 per cent., against 10 per cent. for the corresponding period last year.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared an interim dividend for the half-year to June 30 at the rate of 11 per cent., compared with 13 per cent. last year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 25	1,858	+ 251	8	13,225	− 162
Airdrie	,, 20	185	− 12	29	6,360	+ 605
Anglo-Argentine	,, 29	13,503	+ 811	30	442,009	+ 46,279
Ashton-under-Lyne Corp.	...	...	...	...	...	...
Ayr Corporation	,, 21 ,, 28	943 512	+ 77 + 1	11	4,404	− 75
Baker St. & Waterloo Ry.	,, 28	1,151	...	4	5,4[illegible]0	...
Barnsley	,, 20	159	− 3	29	4,639	+ 80
Barrow	,, 20	208	+ 8	29	6,988	+ 337
Bath Electric Trams, Ltd	,, 25	959	+ 191	30	23,156	+ 3,680
Birkenhead Corporation	,, 20	1,089	− 70	...	...	...
*Birmingham Corporation	,, 28	1,379	+ 1,016	17	13,181	+ 7,072
Birmingham & Mid.	,, 20	9,983	− 601	29	294,123	+ 18,786
Blackburn Corporation	,, 25	1,093	+ 120	¶17	18,735	+ 1,099
Blackpool Corporation	,, 26	2,019	+ 257	16	19,821	+ 674
Blackpool and Fleetwood	,, 28	1,307	+ 307	4	4,507	+ 282
Blackp'l, St. Anne's & Lytham	,, 26	863	+ 140	§28	12,072	+ 1,309
*Bolton Corporation	,, 29	2,251	+ 102	17	37,379	+ 2,351
Bournemouth Corporation	,, 25	1,752	+ 185	†17	27,592	+ 6,114
Bradford Corporation	,, 28	4,925	+ 395	17	72,870	+ 3,223
Brighton Corporation	,, 29	1,145	− 63	17	17,074	− 1,002
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 27	5,433	− 8	24	1[illegible]0,9[illegible]5	+ 3,611
Buenos Ayres & Belgrano	,, 29	3,294	− 32	30	106,591	+ 6,054
Buenos Ayres Elec. Trms	June 30	1,157	+ 133	26	35,846	+ 6,840
Burnley Corporation	July 28	1,159	+ 127	17	19,881	+ 860
Burton Corporation	,, 29	319	− 27	§17	5,260	− 369
Bury Corporation	,, 22	1,039	...	16	16,231	...
Calcutta Tramways Co.	,, 28	a42,969	+ a6,939	4	a176,000	+ R10,540
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 21	2,108	− 103	16	33,533	− 1,170
Cavehill	,, 20	152	+ 101	29	2,434	+ 856
Central London Railway	,, 28	5,596	− 91	4	25,370	− 673
Chatham & Dist. Lt. Rys.	,, 26	753	− 222	†30	19,044	− 431
City & South London Rly.	,, 29	2,704	+ 431	4	10,117	+ 1,061
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	,, 28	692	− 2	30	14,017	− 395
Croydon Corporation	,, 27	1,571	+ 67	8	13,296	+ 937
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Tram	,, 20	622	...	29	12,803	− 403
Dover Corporation	,, 28	310	+ 63	17	4,495	+ 610
‖Dublin & Lucan Railway	,, 27	146	+ 6	§4	636	− 44
‡Dublin United	,, 27	5,619	+ 174	‡4	21,412	435
‖Dundee Corporation	,, 25	1,332	+ 206	§17	11,316	+ 2,315
East Ham Council	,, 25	959	+ 99	17	16,213	+ 1,538
Exeter Corporation	,, 27	332	+ 3	17	4,975	− 451
Falkirk and District	...	...	...	..	...	...
Gateshead & Dist. Trams	,, 20	893	+ 40	29	27,648	+ 1,575
Glasgow Corporation	,, 25	14,849	+ 1,342	9	139,425	+ 8,699
Glossop	..	...	...	...	...	...
Gloucester Corporation	...	...	...	..	...	...
Gravesend—Northfleet	,, 2	273	− 7	29	6,876	+ 263
Gt. Northern & City Rly.	,, 28	1,574	+ 110	4	6,489	+ 617
Greenock & Port Glasgow	,, 20	653	− 116	29	18,757	+ 668
Halifax Corporation	,, 25	1,770	+ 41	17	28,937	+ 1,188
Hartlepool Tramways	,, 20	351	+ 38	29	8,265	+ 858
Hastings Elec. Trams Co.	,, 26	830	...	4	3,250	...
Huddersfield	,, 28	1,536	+ 89	17	26,383	+ 2,554
Hull Corporation	,, 28	2,355	− 117	17	38,513	+ 1,116
Ilford Dist. Coun.	,, 25	524	+ 11	17	8,767	+ 118
Ilkeston Dist. Council	,, 25	1[illegible]2	+ 16	17	2,258	+ 101
Ipswich Corporation	,, 25	513	+ 12	17	7,631	− 211
Isle of Thanet Co.	,, 28	1,313	− 30	42	19,480	− 1,310
Keighley Corporation	,, 26	164	+ 1	4	588	− 14
Kidderminster & District	,, 20	167	− 2	29	3,795	− 54
Kilmarnock Corporation	,, 25	270	− 6	11	1,820	− 84
Kirkcaldy Corporation	,, 25	318	− 2	4	1,087	+ 26
Lanarkshire Trams Co.	,, 26	794	+ 74	†30	25,920	+ 5,683
Leamington	,, 20	199	− 5	29	4,981	+ 2,815
Leeds Corporation	,, 28	6,748	+ 843	17	10[illegible],701	+ 6,223
Leicester Corporation	,, 30	2,150	+ 23	4	9,426	− 5
Leith Corporation	...	...	...	...	...	...
Liverpool Overhead Rly.	,, 2[illegible]	1,551	− 79	4	6,273	− 236
Liverpool Corporation	,, 21	17,106	− 295	29	308,141	+ 5,541
*London County Council	,, 21	26,162	+ 9,70[illegible]	16	425,590	+ 184,320
London United	,, 27	7,502	+ 611	†10	181,[illegible]03	+ 10,248
Lowestoft	,, 21 ,, 28	268 305	− 87 − 2	44	6,380	− 528
Maidstone Corporation	,, 21	122	− 32	16	1,863	− 203
Manchester Corporation	,, 25	13,951	+ 724	17	233,608	+ 8,742
Mersey Railway	,, 28	1,605	+ 114	4	6,467	+ 541
Merthyr	,, 20	193	+ 6	29	5,507	+ 52
Metropolitan Dist. Railway	,, 29	7,528	+ 1,739	4	31,377	+ 4,557
*Metropolitan Elec. Trams	,, 29	3,751	+ 179	29	[illegible]5,638	+ 25,639
Middleton	,, 2[illegible]	398	− 12	29	9,985	+ 239
Nelson Corporation	,, 25	152	+ 1[illegible]	18	2,608	+ 219
Newcastle-on-Tyne Corp.	,, 26	4,[illegible]5[illegible]	+ 45	17	7[illegible],6[illegible]	+ 4,839
Newport (Mon.)	,, 2[illegible]	6[illegible]5	+ 34	17	1[illegible],[illegible]31	+ 656
Northampton Corporation	,, 27	4[illegible]9	+ 6	17	[illegible],7[illegible]0	+ 33
Oldham, Ashton & Hyde	,, 20	595	− 16	29	1[illegible],121	+ 480
Oldham Corporation	,, 29	1,913	+ 221	18	3[illegible],[illegible]59	+ 2,675
Perth (N.B.) Corporation	...	...	...	..	...	...
Perth (W. A.) Elec. Trams	,, 27	1,[illegible]59	+ 95	30	41,681	+ 2,653
Peterborough	,, 20	146	− 16	29	3,537	− 321
Pontypridd District Coun.	...	...	...	..	...	...
Portsmouth Corporation	,, 28	2,528	+ 162	17	35,517	− 82
Potteries	,, 20	1,724	+ 17	29	50,968	+ 2,651
Preston Corporation	..	...	...	...	...	...
Reading Corporation	,, 28	719	+ 34	4	2,071	− 91
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 26	515	+ 72	17	8,391	+ 728
Rothesay	,, 20	969	− 178	29	5,373	+ 1,079
Salford Corporation	,, 30	4,650	+ 236	17	79,169	+ 424
Sheerness	,, 18	68	− 25	29	1,563	− 8[illegible]2
Sheffield Corporation	,, 29	5,425	+ 415	18	95,236	+ 4,919
Singapore Trams	,, 28	$7,620	...	5	$29,371	...
Southampton Corporation	,, 25	1,113	+ 24	†17	16,401	+ 18
Southend Corporation	,, 25	529	− 13	17	6,708	+ 112
Southport Tramways	,, 20	432	− 3	29	8,715	+ 111

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Stalyb'dge, Hyde, &c., Jt Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	...	...
Sunderland Corpn.	July 25	499	..	30	11,455	...
Sunderland & District	...	...	...	...	...	..
Swansea Trams	,, 20	916	+ 30	29	22,957	+ 4,381
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 20	51	− 6	29	1,265	− 107
Tynemouth and District	,, 20	372	− 77	29	6,827	− 256
Tyneside Trams Co.	,, 11 ,, 18 ,, 25	506 445 490	+ 56 − 26 + 35	20	18,442	+ 855
Wallasey District Council	,, 28	947	+ 37	17	14,148	+ 677
Walsall Corporation	,, 28	559	+ 37	27	15,937	+ 849
Warrington Corporation	,, 26	391	+ 19	17	6,336	+ 569
West Ham Corporation	,, 26	2,357	+ 634	17	39,410	+ 12,240
Weston-super-Mare	,, 18	317	− 9	29	3,040	+ 121
Wolverhampton Corpn.	,, 26	841	...	4	3,552	...
*Worcester	,, 20	336	− 30	29	7,816	− 709
Wrexham	,, 20	112	− 1	29	2,861	− 12
Yorkshire W.R. Trams	,, 29	884	+ 59	30	24,312	...
Yorkshire Woollen District	,, 20	934	+ 147	29	25,546	+ 7,461

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Aug. 1.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Aug. 1. Highest.	Business, Week to Aug. 1. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	6 13/16—7 1/16	5 13 6	Ap, Oct	7 1/16	6 15/16
5	2/9	Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	6	5 31/32
St.	6%	Do. Permanent 6% Deb. Stock	13[illegible]—141	4 5 0	—	140¼	140
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102—104	4 16 3	—	102½	—
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—4⅝	5 10 0	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99—104	4 6 6	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117—120	5 0 0	—	118½	..
St.	5%	Do. Pref. Ord. Stk	107—110	4 11 0	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock	105—108	4 13 0	—	106¼	..
4	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	101%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	101—104	4 6 0	—	..	—
[illegible]	8/0	Buenos Ayres and Belgrano Ord.	8¼—8¾	5 0 0	—	..	..
[illegible]	8/0	Do. 6 per Cent. "A" Cm. Pref.	5¼—5¾	5 4 0	—	..	..
1	8/0	Do. "B"	4⅞—5⅜	5 9 0	—	5⅛	—
St.	5%	Do. 5 per Cent. Debs.	104—106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102—105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	98—10[illegible]	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101—105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102—107	5 12 0	..	..	..
[illegible]	4/6	Calcutta Tramways (Nos. 1 to 105)	8—8½	4 15 0	—	8 1/16	8⅛
5	2/6	Do. Nos. 105,001 to 137,610	7¾—8¼	4 17 0	—	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103—108	4 5 0	—	..	..
[illegible]	[illegible]/6	Cape Electric Tram Shares	1 9/16—1 13/16	6 3 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100—102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94—96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92—94	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	88—93	6 9 0	..	..	..
[illegible]	1/0	Lisbon Elec. Trams Ord.	1⅜—1 9/16	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	10[illegible]—113	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100—103	4 7 6	Ja, Jul	..	..
100	4½%	†Montreal St. Ry. Sterling 4½% Debs. (1922)	102—104	4 6 6	—	103	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104—106	4 14 8	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	140—142	5 2 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	98	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu.Pr.	4¾—5¼	5 14 6	..	..	..
5	5/[illegible]	Calcutta Elec. (1-30,000)	7⅞—8⅛	5 2 6	..	8	..
50	[illegible]%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48—50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92—94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	85—89	5 12 4	—	..	..
St.	6	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	1[illegible]0—113	5 6 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	6 18 0	—	..	..
1	1/6	Rand Electric	1 5/16—1 7/16	..	—	—	..
1	..	River Plate Electricity Co. Ord.	7/16—9/16	..	..	..	..
1	1/2[illegible]	Do. 6% Non. Cum. Pref	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99—102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	5⅝—5⅞	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb.	99—102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99—101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Aug. 1.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 1. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10½–11½	6 3 6	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10⅛–10⅝	4 5 3	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11 –12	5 0 0	..	–	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛–8⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	101½	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8 –9	5 11 6	–	.	..
5	8/6	Do. 7 per Cent. Pref.	7¾–8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	8 17 9	–	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 –5	5 0 0	Feb, Aug	.	..
5	2/3	Do. 4½ per Cent. Pref.	4⅛–4⅝	4 17 0	Feb, Aug	4¼	4
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	8 18 3	–	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾–4¼	5 6 0	–	..	..
5	2/3	Do. Do. (1903)	3¾–4¼	5 6 0	..	..	..
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	..	.
10	5/0	City of London Electric Lighting Ord.	10 –10¾	5 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122 –125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –103	4 7 6	..	.	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	[illegible]	8 19 10	April, Oct	.	..
5	5%	Do. Do. 5% non cum. pref.	[illegible]	4 5 3	April, Oct	.	..
10	6/0	County of London Elec. Supply Ord.	7¾–8¾	5 14 0	–	8⅜	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¼–12¼	4 18 0	Mar, Sept	11⁵⁄₁₆	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106 –109	4 2 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	8/6	Folkestone Electricity Supply Co. Ord.	5⅜–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	–	..
5	5/0	Hove Electric Lighting Ord.	7⅝–8⅛	5 10 0	–	7⁵⁄₁₆	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	2/6	†Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	† Do. 4 per Cent. Deb. Stock (red.)	97 –100	4 0 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	8 17 6	–	..	..
8	2/4½	London Electric Supply Ord.	2 –2½	4 0 0	–	2	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5¼	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	98¾	..
5	10%	Metropolitan Electric Sup. Ord.	8 –9	5 10 0	April, Oct	8¼	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⁵⁄₁₆–5⁹⁄₁₆	4 1 0	Jan. July	.	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	110¾	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	94 –96	3 13 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	99½	..
10	7½%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10¾–11	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 1 3	Feb, Aug	..	–
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾–5⅞	4 5 1	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1¼–1⁹⁄₃₂	2 7 4	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 8 7	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	–
5	4/6	Oxford Electric Ord.	6⅜–6⅞	4 17 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97 –99	4 1 0	–	..	..
5	5/0	†St. James' & Pall Mall Elec. Ord.	10¼–11¼	5 11 1	Feb, Aug	10⁵⁄₁₆	..
5	3/6	† Do. 7 per Cent. Pref.	6¾–7¾	4 10 4	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	2½–3	6 13 0	..	..	..
1	0/3	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	–	..	..	–
1	0/8¾	Do. 7% Cum. Pref.	1⅛–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3½ 4	6 10 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4¼–4¾	5 5 0	–	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100 –102	4 8 0	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	10 –11	6 2 0	Mar, Sept	10³⁄₁₆	10⅛
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5⁷⁄₁₆	[illegible]
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	..	..	..
1	1/0	Beth Elec. Trams Pref. Ord.	¹⁵⁄₁₆–1¹⁄₃₂	4 14 0	..	¹⁵⁄₁₆	..
1	0/6	Do. 5% Cum. Pref.	¹⁵⁄₁₆–1¹⁄₁₆	4 9 0	..	–	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	–	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	9½%	Bristol Tramways and Carriage Ord.	15¼–15¾	5 8 0	Feb, Aug	..	–
10	4%	Do. Cum. Pref. (fully paid)	9⅞–10⅛	3 19 0	..	..	–
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	9⅜–9⅞	5 2 0	–	9⁷⁄₁₆	..
10	6/0	Do. 6 per Cent. Cum. Pref.	8⅝–9⅛	6 11 0	Feb, Aug	9⅛	8¾
St.	5%	Do. 5 per Cent. Perpetual Debs	109 –112	4 9 3	..	111¾	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	89 –92	4 19 0	..	90½	..
St.	4%	Central London Ordinary Stock	85 –87	4 12 0	June, Dec	86¾	86
St.	4%	Do. 4 per Cent. Pref. Stock	99 –101	3 19 0	..	100¼	..
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	74½	..
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	–	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs	100 –103	3 17 6	..	.	..
St.	2¼%	City and South London Rly. Con. Ord.	46 –48	4 8 0	Feb, Aug	47½	43
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120 –123	4 1 4	Feb, Aug	–	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	.	..
St.	5%	Do. (1901)	114 –117	4 5 3	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	.	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord.	14¼–15¼	3 8 6	..	.	..
10	6/0	† Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	†Gt. Northern & City Rly. Prf. Ord. (4%)	8¼–8¾	10 13 4	..	[illegible]	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	.	..
10	9%	‡ Imperial Tramways Ord	15 –16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8⅛–8⅜	8 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¼–8¾	5 14 0	–	8¼	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 3	–	93¾	93
St.	..	Mersey Con. Ord. Stock	4 –6	–	–	.	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–¼	..	–	⅛	..
1	0/6	Do. 5% Cum. Pref.	¹³⁄₁₆–¹⁵⁄₁₆	5 9 0	–	[illegible]	[illegible]
St.	4½%	Do. 4½% Deb. Stock	100 –102	4 8 3	–	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	[illegible]–1⅛	..	May —	1⅛	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¼	5 5 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½–8½	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 – 92	5 8 8	–	..	..
St.	3½%	Waterloo and City Ord.	100 –103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	–	–	..
St.	4½%	Do. 4½% 1st Debs.	93 –96	4 14 9	..	..	–

Shre.	Last Dividend	Name.	Price Wed., Aug. 1.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 1. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	1⁷⁄₁₆–1⁹⁄₁₆	..	–	..	..
1	2/4½	Babcock & Wilcox Ord	3¾–4	4 14 0	..	3¹⁵⁄₁₆	3⅞
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	–
1	4/0	British Insulated & Helsby Cables Ord.	6⅜–6⅞	5 18 0	July, Feb	6⁹⁄₁₆	..
1	3/0	† Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
1	..	British Westinghouse 6% Pref.	1½–2	..	..	.	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	78	77½
1	1/0	Brush Electrical Engineering	⅝–⅞	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1¾	6 17 0	Mar, Sept	..	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	83½	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	10¹⁵⁄₁₆	10⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	109½	..
1	[illegible]	Castner-Kellner Alkali Co.	1¹⁄₃₂–1⁵⁄₃₂	5 4 6	..	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	–	..	–
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1³⁄₁₆–1⁵⁄₁₆	7 10 0	–	.	–
1	7½d.	Do 6% Cum. Pref.	1¹⁄₁₆–1³⁄₁₆	5 8 0	..	..	–
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾–2	3 12 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–98%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	[illegible]	5 12 0	Sept —	..	..
5	3/0	Do. 6% Cum. Pref.	[illegible]	4 5 0	Sept —	..	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	4 5 6	Feb, Aug	1⅝	..
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	..	..	..
5	1/6	†Edmundson's Elec. Corp. Ord.	3¼–3¾	9 12 0	H'lf-yearly	1¾	3⁷⁄₁₆
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅝–5⅛	5 17 6	..	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	..	..
2	1/7½	Electric Construction Co.	[illegible]–⅝	11 4 0	July —	..	..
2	2/2½	† Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July	2	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	86 –89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 8	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –97	4 2 6	–	..	..
5	10/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	12¾	12⅝
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 1 6	Feb, Aug	..	–
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	108½	107
St.	22/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wks.	17 –18	2 17 2	Feb, Aug	17⅝	..
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	–
1	1/2½	Richardsons, Westgarth & Co., Ltd. Ord.	²⁹⁄₃₂–³¹⁄₃₂	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	¹⁵⁄₁₆–1¹⁄₁₆	5 1 6	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	86 –89	4 11 0	..	[illegible]	..
12	12/0	Telegraph Construction & Mainten'ce.	32½–34½	6 1 6	Mar, July	33⅝	33
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	..
1	1/0	†Vickers, Sons & Maxim, Ltd., Ord.	2⅜–2½	6 0 0	..	2½	2¹³⁄₃₂
1	6d.	† Do. 5% Non-Cum. Preference	1¹⁄₁₆–1³⁄₁₆	4 12 0	..	1⅛	1⁵⁄₃₂
St.	5%	Do. 5% Non-Cum. Preferred	112 – 115	4 7 0	–	114½	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 –105	3 16 0	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	..	106¼	106¼
5	–	Willans and Robinson Ord.	1 –1½	–	Apr, Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	5¾–6¼	–	Apr. Oct	8	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	79⅞	78⅝
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½–4	..	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	84 –89	5 12 0	..	..	..
St.	15/0	†Anglo-American	65 –67	4 17 0	F, My, Ag, N	65	..
St.	30/0	† Do. Preferred	111 –112	5 9 0	F, My, Ag, N	112¼	111
St.	10/0	Do. Deferred	21⅝–21⅞	2 9 0	F, My Ag, N	21⅝	21⅝
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–98½	4 0 6	Jn Ap, Jy, O	98¼	98
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb. Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent Deb.	98%–101%	3 19 0	Jan, July	..	..
20	6/3	Direct United States Cable xd & bonus	15½–16	4 13 6	Ja, Ap, Jy, O	16⅛	16
100	4½%	Direct West India Cable 4½% Reg. Db. (rd.)	99½–101½	4 8 9	Jn, Dec ..	..	..
St.	66/0	Eastern Ordinary xd & bonus	142 –145	4 16 6	Ja, Ap, Jy, O	144½	142½
St.	17/6	Do. 3½ per Cent. Pref. Stock	89 –91	3 17 0	Ja, Ap, Jy, O	90⅞	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	.	..
10	2/6	Eastern Extension	14 –14½	4 16 6	Ja, Ap, Jy, O	14¼	14¹⁄₁₆
St.	4%	† Do. 4 per Cent. Deb. Stock	104½–106½	3 15 0	Feb, Aug	..	..
100	4%	†Eastern & S. African 4% Mrt. Deb. 1909	99 –101	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	38 – 40	5 18 0	Jan, July	38¾	38½
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½–101½	4 8 9	June, Dec	..	..
25	12/6	Indo-European	58 – 60	5 8 4	May, Nov	59¾	58¾
100	4%	Mackay Companies Common	[illegible]	5 3 0	Jan, July	–	..
100	4%	Do. Preference	[illegible]	5 6 0	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	¹⁵⁄₁₆–1³⁄₁₆	..	..	1	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	–
5⅓	–	West Coast of America	¾–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100 –103	3 17 6	Jan, July	101	..
10	–	West India and Panama	⅜–½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6 – 7	8 11 4	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14½	..
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	103⅞	..
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	5/0	†Chili Telephone (fully paid)	7⅜–7⅞	4 18 0	August —	..	–
1	0/4½	Monte Video Telephone Ord.	¹⁵⁄₁₆–1¹⁄₁₆	3 15 8	–	–	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock xd & rights	107 –109	5 10 1	–	108½	107
St.	6%	Do. Def. Stock xd & rights	107 –109	4 11 0	–	111	107⅝
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	10 –12	5 0 0	Feb, Aug	..	..
5	2/6	‡ Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼–5¾	4 7 0	Feb, Aug	5½	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	98¼	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 17 0	–	103⅛	..
1	[illegible]	Oriental	1¹⁄₁₆–1³⁄₁₆	4 3 6	April, Oct	1¹⁄₁₆	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1¹⁄₁₆–1³⁄₁₆	4 11 0	–	..	..
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	100 –103	4 7 6	..	..	..
5	8/0	United River Plate	7 –7½	5 6 8	July —	7³⁄₃₂	7
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	108½ 111½	4 9 9	June, Dec	.	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	..	.	.
10	2/0	†Globe Telegraph and Trust	10½–11	5 0 0	Ja Ap, Jy O	10⅞	10¾
10	3/0	† Do. 6 per Cent. Pref	14½–14¾	4 1 6	Ja Ap, Jy, O	14⅞	14⅝
10	6%	Submarine Cables Trust (Cert.)	108 – 111	4 11 6	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE sectional addresses of the British Association are in some degree a measure of the value of the meeting. Of numerous excellent sectional addresses—many of more than ordinary merit—probably that which will be remembered longest by those who are physically inclined is the address of Prof. EWING to Section G. This address was devoted to propounding a theory of crystallisation in special relation to the problems of the effects of stress in metals. Its purpose is to give to the student of the strength of materials a method of picturing the ultramicroscopic occurrences following the forces he applies; to do for the man interested in elasticity just what its author has already done for the man of magnetism. Though its conception of hard, round, smooth molecules provided symmetrically with three positive and three negative poles may appear highly artificial, yet on further thought the idea is redeemed by the consideration that it could be founded on very possible attributes of the electronic atom. This, however, is one of those hypotheses whose only test and only justification lies in the success with which it fits known facts, and suggests new experiments or new methods to the experimentalists in this field.

◆

IN the opening paragraph of his Presidential Address to Section A of the British Association Principal GRIFFITHS struck a note of regret—if we may be allowed to read between the lines—that he is no longer joining in the fray with those who are extending the limits of our knowledge. Those who are in the fray will be equally sorry. We cannot help feeling that it is a pity that ability for undertaking original work—by which we mean work that is really of an original kind as distinct from routine measurements—should be occupied chiefly with administrative work which does not as a rule call for the same qualities. It is sometimes said that students suffer on account of the original work of the professor taking a predominant position. There is, however, a happy mean; and so long as the main object of an institution is kept in sight there is nothing more stimulating to the student than original work. To some extent, no doubt, it is a question of financial considerations. Administrative work is a necessity, and any board of management will pay a certain figure for such work; but original research, on the face of it, is not so necessary; it may appear to have only an indirect value, and, its valuation being difficult, it is often left out of account.

◆

Prof. WYNDHAM DUNSTAN, in his Address to the Chemical Section of the British Association, remarked that the production of rubber by chemical means had been virtually accomplished by its formation from isoprene. So far, the exact nature of the change has not been determined, but the solution of the problem seems to be only a question of time. Nevertheless, Prof. DUNSTAN has no wish to discourage the great extension of rubber planting that is now taking place, and he apparently thinks that the cost of raw rubber may go down sufficiently to make the artificial production of rubber unprofitable, in the same way that it is not worth while to produce quinine synthetically though practically possible.

◆

IN his Paper on "Glow Lamps," which we reproduce on another page, Sir WILLIAM PREECE calls for further standardisation, in compliance with the pressures of 110 volts and 220 volts adopted by the Engineering Standards Committee. There certainly is an advantage in standardising electrical machinery for such pressures as far as possible, but we doubt if this is the case with glow lamps. A glow lamp is not manufactured by any exact mechanical process, but depends very much on the judgment of the operative. It is therefore to the advantage of the lamp maker to have a certain range of pressures over which his lamps may be utilised, so that if a lamp is unsuitable for, say, 220 volts, it may be used on some other pressure, and the number of useless lamps thereby reduced to a minimum. As for our manufacturers Sir William Preece has not a good word to say. He asks why the Nernst lamp, the Welsbach mantle, tantalum, osmium and zircon glow lamps, flame arcs, &c., are all importations, and he finally remarks that the term "Made in England" is becoming a reproach to us. Perhaps our manufacturers will take up this challenge.

◆

As pointed out by Prof. Silvanus Thompson, it is just possible that the carbon filament is no longer worth troubling about. The metallic filament has much in its favour. The efficiency is higher, though poor nevertheless, and, what is most important to the central station engineer, the resistance of a metal increases with temperature, whereas that of carbon decreases, though indeed graphitised carbon filaments are apparently an exception. The metal filament lamp is, therefore, much less sensitive to changes of pressure, with the result that mains for such lamps might be laid out to better advantage. We doubt, however, if the days of the carbon lamp are numbered as yet.

◆

We regret to note that the Trustees of the British Museum are seeing fit to dispense with the services of Prof. Ray Lankester, relying upon the age limit of 60 as the ground of their dismissal. As to the pros and cons of the case, as far as service is concerned, we prefer not to express an opinion, since only one side has been put forward; but there can be no question that employment by the Civil Service of scientific men after thay have reached a position of eminence should be coupled with some assurance that their services will not be summarily terminated without some adequate pension. Otherwise no one is likely in future to give up a University appointment of any importance for a position in the Civil Service, however lucrative in appearance.

Baker Street and Waterloo Railway.—The extension of the Baker-street & Waterloo Railway to the Elephant and Castle was opened for traffic at the beginning of the week, and through bookings are in operation with the City & South London Railway. The stations of the two lines at the Elephant and Castle are connected by a covered passage.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906	—
Bolama—Bissao	July 24, 1906	Aug. 3, 1906

Thunderstorms.—During the storm on Thursday night of last week, which was accompanied by one of the most vivid and continuous displays of lightning which has been seen in London during recent years, the conduits of the London County Council South London tramway system were so seriously flooded that traffic had to be suspended on the entire system for 40 minutes. Considerable damage both by lightning and floods is reported from various parts of the country.

Technical Schools in Germany.—According to the *Daily Telegraph*, the building of the new intermediate technical school in Berlin have now been completed. The new school, which is said to be the largest of its kind in the world, is midway in position between the ordinary grade schools and the famous Hochschule at Charlottenburg. The institution will have accommodation for 2,000 students, and the laboratories are on an unusually large scale. The cost of the building and equipment has exceeded three million marks, and the fees charged will place the curriculum within reach of the humblest.

Electrically-propelled Fire Engines in Berlin.—The *Centralblatt für Accumulatoren* states that the new fire station in Suarezstrasse at Charlottenburg has been provided with a complete electrically-propelled fire-extinguishing equipment. The turn-out consists, as is usual in Berlin, of three vehicles, the first carrying the officers and men, the second the steam fire engine and the third auxiliary apparatus. All three are driven from accumulators, and a charging plant is provided in the fire station. Arrangements are made so that the batteries can be changed on the road if necessary. The maximum speed is about 18½ miles per hour.

Tantalum Lamps.—A prolonged series of tests seems to indicate that with the improvements which have recently been made in the manufacture of tantalum lamps, the average useful life may now be taken on continuous-current circuits as 800 hours, or about the same as most carbon filament lamps. Taking the cost of a 23 c.p. 110 volt tantalum lamp as 2s. 9d. and that of a carbon filament lamp of the same candle-power and voltage as 9d., and the watts consumed as 40 and 92 respectively, there is a considerable saving shown in favour of the tantalum lamp, even taking lamp renewals into account. Thus for current at 4d. per B.T.U. the cost of energy and lamp renewals for the carbon lamp would amount to 31s. 7d. per 1,000 hours and that of the tantalum lamp to only 16s. 7d. The saving is, of course, less marked with current at lower rates, but with a price as low as 1d. per unit there is still a saving of 1s. 10d. per 1,000 hours. Messrs. Siemens Bros. Dynamo Works (Ltd.), who send us these figures, state that a series of photometric tests show that a much better distribution of light is obtained from these lamps if the half of the bulb away from the holder is obscured, and they intend to adopt this as their standard practice.

Electric Traction on the Midland Railway.—No very definite information is at present available regarding the details of the proposed scheme of electric traction on the Midland Railway to which we briefly referred in a note in our last issue, but we understand that it has been decided to electrically equip the 8 miles, or thereabouts, of line between Heysham Harbour, Morecambe, Lancaster Green, Ayre and Lancaster Castle. The line will be worked on the single-phase system, and the existing Heysham Harbour power station will be utilised for the supply of power, single-phase current being obtained from motor-generators. Overhead construction of the single catenary type is to be used, and the line voltage is fixed at 3,300 volts, 25 cycles. Only the local service will be worked electrically, and it is anticipated that three motor cars and four trailers will be provided at first, the trains in the summer months consisting of a motor car and two trailers. It is intended to fit two motors to each motor car, and the control will be of the multiple unit type. No great traffic developments are expected on this section of the line, and the scheme is purely an experimental one, though an appreciable economy is anticipated in the working of the projected service as against its present cost.

Petrol-Electric Omnibuses.—The *Engineering Review* describes two types of petrol-electric omnibus which are now running in the streets of Paris, neither of which depends on accumulators for its operation. One of these is the Krieger omnibus, in which a 24 H.P. petrol engine running at 1,200 revs. per min. is direct coupled to a six-pole generator. The excitation of this machine is effected by three different windings: (*a*) the usual shunt winding from the brushes of the machine, (*b*) a separate winding supplied from a small battery, and (*c*) a series winding connected to be in opposition to the other two. The effect of this differential excitation is to lower the voltage automatically when there is a great demand for current while maintaining the engine speed and power output constant over a large range of speed of the vehicle.

The motors, of which there are two, are geared to the back wheels and are compound wound. The De Dion petrol electric omnibus is somewhat similar, but employs a 30 H.P. petrol engine running at 1,400 revs. per min. direct coupled to a compound-wound generator of practically constant voltage. Only one motor is employed, and this has two commutators, which are placed in series or parallel by the controller.

Recent Developments in Steel Manufacture.—In the manufacture of special alloy steels, the element which is intended to give special properties to the steel is introduced into the metal either in form of the pure metal or of a ferro alloy. According to the *Electrical World* the pure metals used for such work, like chromium, tungsten, &c., are generally produced by the aluminothermic reaction; their advantage is that they are free from carbon, so that by introducing the metal into the steel bath no carbon is included. The ferro-alloys are mostly made in the electric furnace, especially the high-percentage ferro-alloys; the lower the percentage of iron in the alloy, the less is its content of carbon and the smaller, therefore, the danger of introducing a prohibitive amount of carbon into the metallic bath. The advantage of the use of ferro-alloys over that of pure metals is that the former has a lower melting point, so that the alloying process does not require a specially high temperature. The manufacture of ferro-alloys, which is in principle very simple, is essentially the same as was used many years ago in the experiments of the brothers Cowles for making alloys in the electric furnace. For making, for instance, ferro-silicon, a mixture of iron (or iron oxide), silica and carbon represents the charge and the chemical reaction in the furnace is simply the reduction of the oxides by means of the carbon resulting in the production of an alloy of iron and silicon. This reduction requires a high temperature, and on account of this high temperature the electric furnace is specially suitable. Mr. A. J. Rossi has recently patented a process for making titanium steel, the special feature of which is that he does not first produce ferro-titanium. He feeds into an electric furnace an ascertained quantity of pig iron containing a definite quantity of carbon and then adds a predetermined quantity of granulated oxides of titanium calculated to be sufficient to decarburise the pig iron to the required extent. He raises the temperature to 3,200°F. or 3,500°F., which is sufficient for the reduction of the oxide of iron and of the titanic acid by the carbon of the pig iron. The advantage of this method is that by introducing the titanium into the steel he does not increase the carbon content in the steel, but on the contrary diminishes it. On the other hand the evident disadvantage of this process (compared with the use of ferro-titanium) is that the whole steel bath must be raised to the reduction temperature of titanic oxide.

Postmaster-General's Report.—The fifty-second annual report of the Postmaster-General has just been issued, and gives an account of the business carried on by the Post Office during the year ending March 31, 1906.

During the year 89,478,000 telegrams passed over the Post Office wires, as compared with 88,969,000 in 1904-5. The receipts, however, have decreased from £2,755,485 to £2,743,186. The estimated value of the railway free telegrams is £59,000, against £55,800 in 1904-5; that of the Government free telegrams £18,500, against £22,800 in 1904-5. The decrease in press telegrams is striking. But the press telegraphy at the time of the general election was enormous, the amount dealt with at the Central Telegraph Office on the night of Jan. 15-16, having only been exceeded on three occasions, and those 20 years ago. During the year the telegraph has been extended to 240 offices in country districts and in the surburban areas of the larger towns. Guarantees have been given for 147 of the new telegraph offices, 76 by local authorities, and 71 by private persons. There are now in the United Kingdom 10,372 telegraph offices and post offices and 2,394 at railway stations and other public places. A revision of the charge made for delivering a telegram at an address more than 3 miles from a telegraph office was brought into operation on January 1st. The charge is now reckoned at 3d. a mile on the distance beyond the 3-mile limit, instead of on the distance from the office of delivery. The intercommunication switch in the Central Telegraph Office has been considerably extended. Telegrams can now be signalled directly between 200 metropolitan offices without retransmission. The use on a few circuits of high-speed automatic typewriting telegraph instruments has been fairly successful, but these instruments can scarcely be said to have passed as yet much beyond the experimental stage. The underground line of telegraph from London to Glasgow, which was begun in 1896-7, has now been completed. At Warrington it effects a junction with another underground line from Liverpool, which passes through Manchester and Bradford to Leeds. During the year under review the underground line from London to Chatham has also been laid, and the underground line from London to the West has been completed to Slough, pipes having been laid as far as Reading.

The number of foreign telegrams sent to and from the United Kingdom during the year was 8,796,000, an increase of 457,000 on the number sent during the preceding year. Arrangements have been made to provide additional telegraphic facilities between London and Paris and London and Antwerp by the use of improved apparatus. No new Government cables from the United Kingdom have been laid during the year; but the Commercial Cable Co. have provided an additional cable between Waterville (Ireland) and Canso (Nova Scotia); and the cable of the Great Northern Telegraph Co. between the Shetland Islands and Iceland, via the Faroe Islands, is about to be laid. Several reductions in the rates charged for telegraphic communication between the United Kingdom and places abroad have been made during the year by the cable companies concerned, the most important being a reduction from 1s. 5d. to 1s. per word in the rate to Egypt, a reduction from 2s. 6d. to 2s. in the rate to India, and a reduction in the rate to Japan by the lines of the Eastern Telegraph Co. from 5s. 8d. to 4s. 10d.

The Wireless Telegraphy Act, 1904—of which the objects were (1) To place wireless telegraphy under governmental control for strategic purposes; (2) to enable the Government to carry out the decisions of an International Congress; (3) to regulate the erection of stations, so as to prevent the mutual interference of neighbouring installations—has worked satisfactorily. Its duration was limited to two years, but an Act extending it until December, 1909, has been passed this session. The Post Office has continued during the year to collect and deliver the Marconi Company's telegrams to and from ships at sea. The total number of outward telegrams dealt with during the year was 558, and of inward telegrams 11,094. With a view to test the capabilities of wireless telegraphy for ordinary telegraphic purposes in cases where its use seems to offer special advantages, the P.M.-G. has, after inviting tenders from all the principal wireless telegraph companies, placed contracts with the Marconi and the British De Forest Companies for installations between Tobermory and Loch Boisdale (Hebrides) and between Hunstanton and Skegness respectively. These are now in course of erection. His Majesty's Government have accepted an invitation from the German Government to take part in an International Conference on wireless telegraphy, which is to meet at Berlin on October 3rd next.

The number of trunk wire telephone centres open on March 31st last was 487, an increase of 44 in the year. The new trunk circuits provided during the year numbered 151, and the total number in use was 1,755, as compared with 1,604 in the preceding year. The total length of the trunk circuits in use was about 64,000 miles, containing about 128,000 miles of wire. The capital expenditure on the purchase and development of the trunk-wire system up to March 31st last was £2,897,503, including an expenditure during the year of £360,215. The total number of conversations over the trunk wires during the year was 17,974,000. Compared with the corresponding number for the previous year, this shows an increase at the rate of 16·2 per cent. The gross revenue derived from the trunk service was £449,004, as compared with £381,967 in 1904-5. The average value of each conversation increased very slightly, from 5·90d. to 5 97d. The Anglo-French and Anglo-Belgian telephone services have been extended to a few more provincial towns during the year. 55 provincial telephone exchanges have been opened by the Post Office during the year. New switchboards of the latest type have been installed at Cardiff and Newcastle; and several other large provincial trunk-wire exchanges are being reconstructed so as to secure greater efficiency. The total number of subscribers to the Post Office provincial telephone exchanges on March 31st was 8,425, as compared with 6,854 on March 31st, 1905; and the number of telephones rented increased during the year from 8,644 to 10,380. The sum received as rental in respect of private wires was £177,111, as compared with £172,953 for the previous year. The number of telephones in connection with the Post Office London telephone system increased during the year from 24,351 to 32,879. New exchanges at Epsom and Ealing were opened early in the year. The new City Exchange, which is equipped for 15,300 subscribers' lines, and has a maximum capacity of about 18,000 lines, is at present being used as a substitute for the Central exchange, which is in process of rearrangement on the most modern principles, and is as far as possible being made fireproof. When this work is complete the two exchanges will together possess a maximum capacity of 32,000 lines. Some of the apparatus which is being removed from the Central Exchange will be available as a reserve switchboard in case of the destruction by fire of a Post Office exchange. There were on March 31st 314 Post Office call offices open in the London area. Of these 187 were opened during the year. The length of the underground pipes which had been laid in the Metropolitan area on March 31st last was 1,606 miles, 355 miles of which were laid during the year. Cables containing 208,968 miles of wire have been provided, including 49,250 miles rented by the National Telephone Co. The lines of the present subscribers and the junction lines connecting exchanges amount to 90,785 miles; and 68,933 miles of wire remain available for the future development of the system. In the Metropolitan area the average cost of constructing an exchange circuit (including the installation of telephone instruments and of exchange apparatus, but excluding the provision of spare plant) has been £35. 13s. 10d., as compared with £38. 18s. 9d. in the previous year. Taking into account the whole system, including spare plant of all kinds, the capital expenditure per station (*i.e.*, per telephone connected with an exchange) stands now at less than £54, as against £64 in 1904-5, and £73 in 1903-4. The amount of royalty received during the year from the National Telephone Co. was £217,905, and from other licencees £9,303.

MANCHESTER CORPORATION TRAMWAYS.

The annual report of the Manchester Corporation Tramways committee records extensions amounting to about $5\frac{1}{4}$ miles of single track, which brings up the total length of single track open for traffic to about $151\frac{1}{2}$ miles. The following figures taken from the report will serve to show the increase of traffic as compared with the previous year, and other details :—

—	1904–5.	1905–6.
Car-miles run	14,123,124	14,655,908
Passengers carried	126,900,875	133,923,932
Total number of units used	18,854,240	22,164,445
Units used per car-mile	1·33	1·53
Average revenue per car-mile	10·68d.	10·84d.
Average journeys per head of population	169	178

The table below gives the expenses under various headings expressed as pence per car-mile :—

COSTS PER CAR-MILE.	Year ending Mar. 31, 1905.	Year ending Mar. 31, 1906.
TRAFFIC EXPENSES.		
Salaries and wages	2·36d.	2·36d.
Cleaning cars, depot expenses, &c.	0·46d.	0·44d.
Cleaning, salting and sanding track	0·05d.	0·04d.
Ticket check	0·17d.	0·17d.
Uniforms	0·07d.	0·06d.
Miscellaneous	0·02d.	0·02d.
Total traffic expenses	3·13d.	3·09d.
GENERAL EXPENSES.		
Salaries and wages	0·18d.	0·19d.
Rents, rates and taxes	0·49d.	0·53d.
Printing, stationery and office expenses	0·06d.	0·04d.
Legal expenses, compensation, &c.	0·19d.	0 15d.
Insurance	0·01d.	0·01d.
Miscellaneous	0·07d.	0·08d.
Total general expenses	1·00d.	1·00d.
REPAIRS AND MAINTENANCE.		
Permanent way	0·16d.	0·17d.
Electric equipment of line	0·10d.	0·10d.
Buildings	0·01d.	0·03d.
Cars (including electric equipment)	0·57d.	0·58d.
Miscellaneous	0·03d.	0·03d.
Total repairs and maintenance	0·87d.	0·91d.
POWER EXPENSES.		
Current at 1·385d. per unit	1·99d.	2·10d.
TOTAL COSTS (not including capital charges)	6·99d.	7·10d.
Interest	0·89d.	0·80d.
Income tax	0·05d.	0·11d.
Rent of leased lines	0·17d.	0·28d.
Proportion written off leaseholds	0·01d.	0·01d.
Sinking fund	0·60d.	0·63d.
Renewals and depreciation	1·20d.	1·15d.
TOTAL COSTS (including capital charges)	9·91d.	10·08d.

The total working expenses, which we have analysed above, amounted to £433,561 and the total receipts were £663,707. From the balance of £230,146 the following charges were met:—Interest £48,732, redemption of debt £38,595, rental of leased lines £17,250, proportion written off leaseholds £931, income tax £6,418. In addition to these charges, £70,082 was carried to renewals and depreciation account. Deducting these items £48,138 is left, to which must be added £1,952, produced by bank interest, giving finally £50,090, of which £46,000 was contributed in aid of the rates, and £4,090 was appropriated for street improvements.

The following table shows the capital expenditure :—

Account.	Total up to March 31, 1906.	Per cent. of total.
Permanent way	£566,561	33·8
Overhead equipment	160,705	9·6
Depots and offices	292,397	17·5
Electric cars	318,377	19 0
Sundry vehicles	5,678	0·3
Machinery and plant	9,566	0 6
Office furniture	5,570	0·3
Purchase of Carriage Company's undertaking	273,402	16·3
Parliamentary and preliminary expenses	43,555	2·6
Total	£1,675,811	100·0

SOME NOTES ON THE MECHANICAL DESIGN OF ELECTRICAL GENERATORS.*

BY R. LIVINGSTONE.

(Continued from page 571.)

As torsion is of so little account in shafts for electrical generators the keys used can be made very much smaller than they are made in shafting in which torsion is of primary importance. In fact the dimensions of the keys used are fixed not by the output of the machine but by such mechanical considerations, as handling in shop, stiffness for driving into place, &c. Proportions such as are given in Fig. 4 will be found suitable in most cases.

The following table of dimensions is based on the proportions given and is added for convenience.

d. In.	*b.* In.	*t.* In.	*d.* In.	*b.* In.	*t.* In.	*d.* In.	*b.* In.	*t.* In.
1	$\frac{1}{4}$	$\frac{3}{16}$	$4\frac{1}{4}$	$\frac{21}{32}$	$\frac{1}{2}$	$7\frac{1}{2}$	$1\frac{1}{16}$	$\frac{13}{16}$
$1\frac{1}{4}$	$\frac{9}{32}$	$\frac{7}{32}$	$4\frac{1}{2}$	$\frac{11}{16}$	$\frac{17}{32}$	$7\frac{3}{4}$	$1\frac{3}{32}$	$\frac{27}{32}$
$1\frac{1}{2}$	$\frac{5}{16}$	$\frac{1}{4}$	$4\frac{3}{4}$	$\frac{23}{32}$	$\frac{9}{16}$	8	$1\frac{1}{8}$	$\frac{27}{32}$
$1\frac{3}{4}$	$\frac{11}{32}$	$\frac{9}{32}$	5	$\frac{3}{4}$	$\frac{9}{16}$	$8\frac{1}{4}$	$1\frac{5}{32}$	$\frac{7}{8}$
2	$\frac{3}{8}$	$\frac{9}{32}$	$5\frac{1}{4}$	$\frac{25}{32}$	$\frac{19}{32}$	$8\frac{1}{2}$	$1\frac{3}{16}$	$\frac{29}{32}$
$2\frac{1}{4}$	$\frac{13}{32}$	$\frac{5}{16}$	$5\frac{1}{2}$	$\frac{13}{16}$	$\frac{5}{8}$	$8\frac{3}{4}$	$1\frac{7}{32}$	$\frac{15}{16}$
$2\frac{1}{2}$	$\frac{7}{16}$	$\frac{11}{32}$	$5\frac{3}{4}$	$\frac{27}{32}$	$\frac{21}{32}$	9	$1\frac{1}{4}$	$\frac{15}{16}$
$2\frac{3}{4}$	$\frac{15}{32}$	$\frac{3}{8}$	6	$\frac{7}{8}$	$\frac{21}{32}$	$9\frac{1}{2}$	$1\frac{5}{16}$	1
3	$\frac{1}{2}$	$\frac{3}{8}$	$6\frac{1}{4}$	$\frac{29}{32}$	$\frac{11}{16}$	10	$1\frac{3}{8}$	$1\frac{1}{32}$
$3\frac{1}{4}$	$\frac{17}{32}$	$\frac{13}{32}$	$6\frac{1}{2}$	$\frac{15}{16}$	$\frac{23}{32}$	$10\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{3}{32}$
$3\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	$6\frac{3}{4}$	$\frac{31}{32}$	$\frac{3}{4}$	11	$1\frac{1}{2}$	$1\frac{1}{8}$
$3\frac{3}{4}$	$\frac{19}{32}$	$\frac{15}{32}$	7	1	$\frac{3}{4}$	$11\frac{1}{2}$	$1\frac{9}{16}$	$1\frac{3}{16}$
4	$\frac{5}{8}$	$\frac{15}{32}$	$7\frac{1}{4}$	$1\frac{1}{32}$	$\frac{25}{32}$	12	$1\frac{5}{8}$	$1\frac{7}{32}$

Unbalanced magnetic pull is a factor which is very often neglected in shaft calculations. Now when the rotor is displaced by an amount equal to 10 per cent. of the air gap, the unbalanced pull in many generators amounts to three-quarters of the weight of the rotor, and in a few cases to *as much as* the weight of the rotor. It is evident then that this unbalanced magnetic pull is of considerable importance; certainly of as much importance as the weight of rotor.

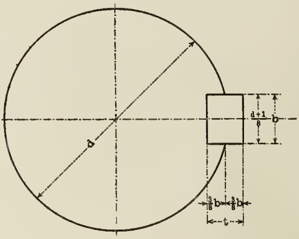

FIG. 4.

Mr. J. K. Sumec† gives the following formula for the unbalanced pull on a rotor due to eccentricity

$$P=\frac{B^2}{8\pi}\cdot S\cdot\frac{\epsilon}{\delta}\cdot\frac{1}{\left\{1-\left(\frac{\epsilon}{\delta}\right)^2\right\}^{\frac{3}{2}}},$$

where P = pull in dynes, B^2 = mean square of magnetic induction around rotor periphery, assuming the rotor to be perfectly concentric, S = total cylindrical surface of rotor, δ = (single) air gap, and ϵ = eccentricity of rotor.

Assuming a mean square of density at 20×10^6 and a displacement of the rotor of 10 per cent. of the air gap, then

$$P=1{\cdot}16S \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where P = pull in pounds and S = surface of rotor in square inches. The above simple formula will be found very useful for approximate calculations of unbalanced magnetic pull and also for checking more accurate working.

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* Based on a Paper read before the Dick Kerr Engineering Society.

† *Zeitschrift für Elektrotechnik*, Wien, 22, pp. 727-728, December 18, 1904. Also *l'Eclairage Electrique*, 38, pp. 281-285, February 20, 1904, and 41, pp. 257-260, November 12, 1904. *Zeitschrift für Elektrotechnik*, Wien, 23, pp. 421-422, July 9, 1905.

Hollow Shafts.—There is very little gain in making shafts hollow when the outside diameter is less than 20 in. The extra cost of forging or boring is greater than the saving in material. If, however, in calculating the diameter of a shaft for a generator we arrive at a diameter of over 15 in. it is advisable to assume that we are dealing with a hollow shaft with, say, 3 in. bore in the centre, as in shafts of this size, it is difficult to make a forging which is perfectly sound in the centre. It would seem from the above that shafts above 15 in. diameter should be made hollow, but, as I have already pointed out, it is more economical to leave the useless centre portion in, until sufficient metal can be removed to pay for the additional labour. Of course, by using a hollow shaft we lighten the rotor to some extent and so reduce the losses in the bearings and cost of shipment. Again, a hollow shaft is more reliable than a solid shaft, as, when the central portion of a large shaft is removed, initial strains due to cooling are done away with, and when forged hollow a more uniform forging will be obtained.

Another point to be considered is that the bearing has a larger surface for the dissipation of heat, and so will run cooler.

The material used in shaft forgings is also of great importance, and the physical properties should be as follows :—

Ultimate strength	68,000—78,000 lb. per sq. in.	
Elastic limit	38,000—48,000 ,, ,,	
Elongation	30—38 per cent.	in 2″ × ·798″ test piece
Contraction of area	30—45 ,,	

The impurities should be as follows :—

Carbon, not more than	0·22 per cent.
Sulphur ,, ,, ,,	0·07 ,,
Silicon ,, ,, ,,	0·06 ,,
Phosphorus ,, ,,	0·05 ,,
Manganese ,, ,,	0·80 ,,

Phosphorus especially is a most objectionable element, and every effort should be made to get rid of it.

(*To be continued.*)

THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.[*]

BY K. REINHARDT.

(*Continued from page 612.*)

III.—The Present Design of Large Gas Engines in Germany.

From the answers received from the ironworks and collieries to the questions, it may further be concluded that the old arrangement of the single-acting four-cycle motor, with one or more cylinders, has no longer in recent years been generally used, and that, on the other hand, double-acting four-cycle motors, mostly with tandem cylinders, are in keen competition with two-cycle motors. There is, therefore, little necessity to deal in this Paper with the obsolete single-acting four-cycle motors, which have been replaced by newer designs, particularly as many of these engines were only considered by their designers as of temporary construction, owing to the heavy demand which suddenly arose for large gas engines. To this category belong the older engines of the Gasmotorenfabrik Deutz, of the Société Cockerill, of the Körting Bros., and of the Maschinenbau-Gesellschaft Nürnberg.

Most of the new types which are now prevailing have already been described.[†] In order to institute an accurate comparison with the types since designed, it will be necessary here to recapitulate as concisely as possible the chief features of modern gas engines.

Before commencing, the fact may be recalled that the possibility of making gas engines of larger powers depended on overcoming the numerous prejudices and misconceptions of many gas-engine manufacturers. These were chiefly with reference to the idea that it was impossible to construct a stuffing box, a cooled piston-rod and a cooled piston which should be reliable in working.

Once the possibility of constructing these parts to work in a reliable manner was proved by several engines built by Körting Bros., John Cockerill, and the Maschinenbau-Gesellschaft Nürnberg, and after Körting Bros. had had a double-acting four-cycle engine running for a long time in their own works, and in the year 1902 made known their new double-acting two-cycle engine, a very rapid development took place. Many firms which had previously built single-acting four-cycle engines began to build double-acting closed cylinders and pistons working on both sides, so that in Germany at present, with the exception of the two-cycle Oechelhäuser motor, only the four-cycle Dingler engine has open cylinders.

To the best of the author's knowledge, at the present time 29 firms in Germany build large gas engines. Of these, 21 firms build double-acting four-cycle engines, five firms build two-cycle engines and three firms build both systems.

General Remarks.

(A) *Cylinder, Exhaust-Valve Chest.*—Until the year 1902 all German builders of gas motors made their single acting open four-cycle engines with cylinder ends, as used for small motors, the construction of which, owing to insufficient reliability, was the chief cause of the troubles encountered originally in the construction of large gas engines.[*]

In the year 1902 the Gasmotorenfabrik Deutz[†] first introduced a design of cylinder which avoided the old cylinder ends, and was provided with an arrangement of lift-valves similar to a lift-valve steam engine. The cylinder, which was provided with covers at both ends projecting within the cylinder in a similar manner to steam engines, stood on a support in the centre on which it could slide, and the outer mantle was, for part of its length, provided with an opening, so that the semi-circular turned support and semi-circular cover at this place rendered the mantle water-tight. This manner of constructing the cylinder should avoid the danger of initial strains in casting, and reduce the stresses caused by heat in working, and also render possible the complete removal of the core after casting, and an easy cleaning of the cooling mantle.

In examining the various designs, it will be seen that nearly all cylinders of the newer types of four-cycle engines follow the same principles as to the arrangement of the lift-valves. Most makers, however, consider that a separation of the outer casing is unnecessary, and that, for safety, it is more to the purpose to increase the height of the flanges, and thus provide a larger space between the inner and outer mantles. It is easy to understand that a larger flange is better fitted to resist the stresses due to the difference of temperature between the inner and outer covers, owing to the definite rates of expansion distributed over a greater length. On this account calculations can only be made with approximate accuracy, because the average temperatures, and, in particular, that of the inner mantle, are unknown.

Compared with the older design of cylinder heads, with a strong flange (with which both the outer and inner casings of the head were cast together, and bolted to the cylinder proper, and with the outer and inner casings rigidly connected by the branches of the valve chambers), the newer types offer, without doubt, far greater security against breakages.

In the older form of cylinder heads the stresses caused by the heat were always much higher at the portion of the head between the branches for the valves and the flange than they are in any part of the newest form of cylinders. In the first mentioned, the inner surface of the rigidly connected parts was exposed through the whole of their length to the highest temperature at each explosion, while modern cylinders are much better in this respect.

With the latter this can be explained by the fact that, because the cylinder covers project into the cylinder at both ends as far as the surface of the joint, the inner cylinder walls are cooled both from without and from within (by the cooled walls of the cylinder covers), and further, that the middle portion of the inner walls, or rather the working surfaces of the cylinder, do not generally reach these high temperatures, and the whole working surface is passed over by a cooled piston.

In this manner the average temperature of the inner wall remains considerably lower than was the case with the older cylinder heads, and the design is also much more trustworthy. Many makers have ceased to cast the valve chambers, which, with the inner cylinder, form one piece, together with the outer mantle, and thus increase the security of the construction.

This is the reason why, during the last few years, few instances of cracked cylinders have been heard of, and in exceptional cases where they have occurred those who have investigated the subject are agreed that the cause of the breakage had nothing to do with the construction, but was to be attributed to the presence of water in the cylinder, to the mantle being badly washed in the foundry and to the formation of deposits and such like causes.

The exhaust valve chambers also belong to those portions of a gas engine which, like the cylinders, cylinder covers and pistons, are exposed to dangerous stresses caused by the fluctuating temperatures of their walls, so far as the latter form a single casting. Their design requires for this reason considerable care, and, above all, a symmetrical form.

The construction of the exhaust valve chamber of the engine of the Maschinenbau-Gesellschaft Nürnberg is an improvement well adapted for its purpose (Fig. 5). It fulfils at the same time the condition that the inner portion, which carries the valve seating, can be withdrawn downwards with the valve, without disconnecting the valve chamber or its connection with the exhaust pipe.

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[*] Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on July 24th. Slightly condensed.

[†] *Stahl und Eisen*, 1902, Nos. 21, 21; 1905, Nos. 2, 3.

[*] *Stahl und Eisen*, 1902, No. 21.

[†] *Ibid.*, Plate 20.

Similar constructions are made by the Gasmotorenfabrik Deutz, by Ehrhardt & Sehmer and other makers.

With several designs it is impossible to take out the valves without unbolting the connections of the whole chamber, with the exhaust pipe, and removing the latter; for instance, the engines made by the Elsässischen Maschinenbau-Gesellschaft and the Märkischen Maschinenbau-Gesellschaft. An arrangement of the exhaust valve-chambers differing somewhat from other constructions is that of Schüchtermann and Kremer. This chamber, situated at the side of the cylinder, is so constructed that the walls are entirely protected from stresses caused by the variations of temperature. The valve with its spindle can in this case be withdrawn upwards.

The author wishes to point out that, in order to silence the exhaust, a spray of water is employed with advantage in the exhaust pipe, and the exhaust vessel is made as large as possible. In such cases the exhaust pipe must be provided with a drain pipe of sufficient dimensions to allow the water to flow off freely, so that in case of negligence in the use of the water spray—for instance, at the starting of the engine—no water can enter the cylinder through the exhaust valve, and thus occasion its destruction.

Now that the causes of the less important breakages of cylinder covers and of pistons have been found to be partly due to a faulty arrangement of ribs, these difficulties should be in the future overcome by experienced makers. These accidents are generally discovered in time, by a slight leakage of water, and consequently the failing of the ignition and the falling off of the power of the engine. It is to be hoped that most of the designs of cylinders, cylinder covers and pistons of the newer engines will prove to be permanently trustworthy.

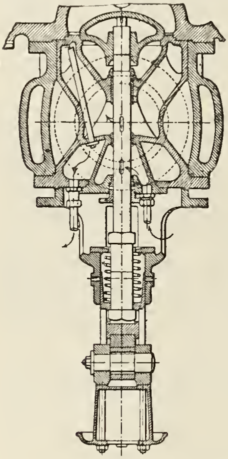

Fig. 5.

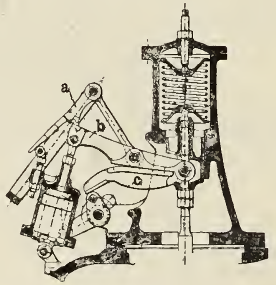

Fig. 6.

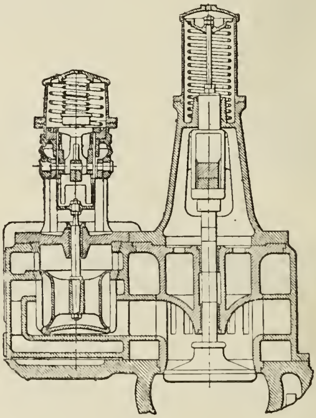

Fig. 7.

(B) *Valve Gear.*—Included in the valve gear of gas engines, in addition to the mechanism, which is arranged for the regular motion of the principal inlet and outlet valves on the cylinder, for the admission of the mixture and for the exhaust of the burnt gases respectively, are chiefly to be reckoned those parts which serve to regulate the speed, through the influence of the governor and the formation of the mixture.

The inlet valve is always cooled by the fresh mixture admitted; it therefore requires no special cooling. It is, however, absolutely necessary that the hollow exhaust valves should be water-cooled. Water is circulated through the hollow valve spindle; at the same time it must be observed that the spindle must not be rendered water-tight by a stuffing box, otherwise the valve easily hangs.

The valves are opened by an exterior mechanism driven by eccentrics or cams on a side shaft, which, in the case of four-cycle engines, runs at half the speed of the crank shaft. The eccentric rods in nearly all designs are combined with roller levers.

Thus, in spite of the unavoidable acceleration of large masses of moving rods, and in spite of the pressure on the exhaust valves when opened, the valves are lifted without shocks and the valve gear works smoothly. The valves opening inwards are closed by springs.

The idea that cams are not suitable for operating lift-valve gearing is incorrect. A large number of gas engines may be found working with valve gearing controlled by cams, and the action of the latter is smooth and unobjectionable.

It is, of course, obvious that cams must be combined with stronger springs than is necessary with eccentrics, because with the former, in addition to the valve, spindle and roller lever, the driving rod of the gearing has also, as a rule, to be accelerated or moved by springs.

The strength of these springs, however, should not be greater than necessary with regard to the acceleration of the mass; but for other reasons—*e.g.*, when the engine is working by quantity governing (and, therefore, with constant mixture and variable compression), and also if it is running without load, the springs must be of such a strength that they will prevent the opening of the valve to the partial vacuum formed at the time of the suction stroke (which amounts to about one-fourth atmosphere absolute).

By the arrangement of a double curved cam, provided with a roller and a counter roller, a constrained motion of the rod may be obtained both for opening and closing by the roller levers without the aid of spring closure, and by a suitable design of the valve gear, the constrainment can be extended just as well with cam as with eccentric, even to the valve by the introduction of buffer springs. The springs have thereby only to endure a compression of a few millimetres. This arrangement as a rule is applied only to the exhaust valve motion.

With eccentric valve motions combined with roller levers, the valve rod and the active roller lever always have to travel along in active distance, and therefore, as regards the admission valve motion, usually require a long spring, having a compressive length equal to the travel of the valve.

In view of the satisfactory results of valve motions, whether controlled by cams or by eccentrics, no general decision can be taken as to which design is the better for all cases.

The most important thing is to give the cam the correct form to assure smooth running; and makers of gas engines, guided by experience, understand quite well how to do this, even though the method adopted is said not to be in accordance with the theory of the cam.

The valve motions employed in large gas engines for the purpose of governing and forming the mixture may be divided as follows:—

(*a*) *The Quality Method of Governing*—with constant total volume admission to the cylinder at each suction stroke, and therefore with constant compression, but supplying a variable mixture. With this valve gearing the composition of the mixture with a varying load is so varied through the action of the governor that (at a smaller power than the maximum) after opening the inlet valve, air is first drawn into the cylinder and then at a certain position of the piston (depending on the momentary load on the engine and the position of the governor) the opening of the gas valve commences, and the mixture continues to enter the cylinder until the end of the suction stroke, when both the inlet and the gas valve close.

Therefore, with a smaller load, more air and less gas, but with a greater load, less air and more gas, are drawn in. The compression remains constant, but the composition of the mixture during the suction stroke is not only very variable with a varying load, but also with a constant load. Seeing that at first pure air alone is admitted, and that it is only afterwards that the gas is drawn in, the air has acquired an accelerated motion in the inlet pipe, whilst the gas, which is allowed to enter gradually, starts from rest and has to accelerate; and in addition the gas has to flow through an opening, the area of which is continually altering during the period of the opening of the gas valve. The composition of the mixture alters constantly, owing to the opposing influence of the air and gas pressures and to the alterations of the area of the gas inlet, which occur during the opening of the gas valve. The old gear, which is now rarely used, for operating the gas valve by inclined notches is somewhat upon the same principle. With the latter gear the gas valve was brought to the closing position at the end of the suction stroke, and then the trouble arose that, through throttling the gas, a still poorer mixture ensued. After the compression this was located exactly in the neigbourhood of the ignition.

To get over this difficulty the gas valve was not allowed to close till after the dead centre was reached—*i.e.*, until after the inlet valve; and so long as the inlet valve remained open the gas was not much throttled.

The principal disadvantages of the latter—viz., the weak mixtures—are: with low loads and with the engine running light, the irregular ignition caused by this, especially with varying gas pressure, and the resulting uncertainty of governing, as well as a proportionately large consumption of gas with smaller loads.

The slow consumption of the weak mixture often results in the fact that the exhausting gases, and those gases which remain behind in the cylinder at the beginning of the suction, continue to burn and thereby ignite the incoming mixture afterwards, owing to which back firing occurs in the suction passage, which unfavourably influences the governing and the regular working of the engine, especially when running without load.

A valve gear, based upon the same principles, is at the present time constructed by the Maschinenbau-Gesellschaft Nürnberg and their licencees (Figs. 6 and 7).

The gas valve is lifted by an active carrier, *a*, of a trip gear jointed to an eccentric rod and connected to an active roller lever, *b*, which lies against a passive roller lever, *c*, whose position is fixed by the governor. By this means the time of the opening of the gas valve is dependent upon the position of the governor. When the carrier *a* is tripped the gas valve falls freely and closes at each charge, immediately with or shortly after the closing of the inlet valve. This valve gear—with the exception of the exterior mechanism, which is taken from the modern steam engine, and moreover, is not free from a somewhat objectionable back pressure on the governor—is in its action only an improvement on the inclined notch gear.

The peculiarities of the quality method of governing described here induced the designer of the Nürnberg engine, Mr. Richter, to improve the valve gear, with respect to the formation of the mixture in the engines recently constructed under his direction for the firm of Thyssen & Co., Mülheim-Ruhr. As shown by Fig. 7, a balanced double-seated valve is combined with a sliding sleeve on the same spindle, which, when the gas-valve is shut, permits the admission of pure air to the inlet valve through a slit which is always open. If the gas-valve is lifted the sliding sleeve increases the area of the air passage regularly with the motion of the gas valve. The object of this valve-gear is to obtain as regular an acceleration and retardation of the air and gas columns as possible, without the partial vacuum, induced by an early cut-off, being too high. Further, as the gas-valve is double-seated, a good distribution of air and gas is obtained, and at the same time the acceleration of the air column is utilised to accelerate that of the gas column.

It is necessary first to ascertain from experience whether this formation is really an advantage, and whether this is not outbalanced by the higher vacuum produced in the cylinder during the suction stroke.

Should this arrangement of mixing valve, as opposed to the ordinary quality governing, not result in the anticipated advantage of a more regular mixture with constant pressure, the author recommends that the air-slide be made to work in an inverted manner—*i.e.*, in such a way that it opens to its farthest extent when the gas valve is shut, so that, after the gas valve has begun to lift, it reduces to some extent the area of the opening for the admission of air. By this means also the unfavourable influence of the air column first accelerated would be lessened.

The disadvantages of so-called quality governing are naturally less considerable in engines which work mostly on a load which varies little from the normal load, such as for the driving of blowing engines and pumps. But for even driving of these latter the author considers the following method of quantity governing preferable to quality governing.

(*b*) *Quantity Method of Governing, with Varying Cut-off, and therefore Varying Compression, but with Constant Mixture.*—In this method of governing it does not happen that, after the inlet valve is opened, first pure air and then a continually varying mixture flows in, but, from the very beginning of the stroke gas and air are admitted, and always in the same proportion, so that the condition of constant mixture is fulfilled—*i.e.*, if the diffusion of this with the residual gases is not taken into consideration. It is clear that this valve gear must give a more regular mixture at the normal power than the quality method of governing. For lower loads the amount of the constant mixture is diminished by the action of the governor, either by throttling throughout the whole length of the suction stroke, as in the valve gear of the Gasmotorenfabrik Deutz, or by closing earlier by a cut-off arrangement (either a valve or a slide), which enables the air and also gas to be admitted in the desired proportions from the beginning of the suction stroke. This last arrangement of quantity governing requires a special drive for this regulating valve from the valve-gear shaft, but to compensate for this the negative work with a small load is less during the period of suction than with throttling.

This manner of governing, according to Prof. Meyer,[*] gives, even with the engine running unloaded, an almost perfect and regular combustion, from which follows the possibility of obtaining effective governing when the engine is running almost without any load. The consumption of gas with small loads is also more economical than with the quality method of governing, although, as compared to the consumption with larger loads, it increases, because the compression is reduced.

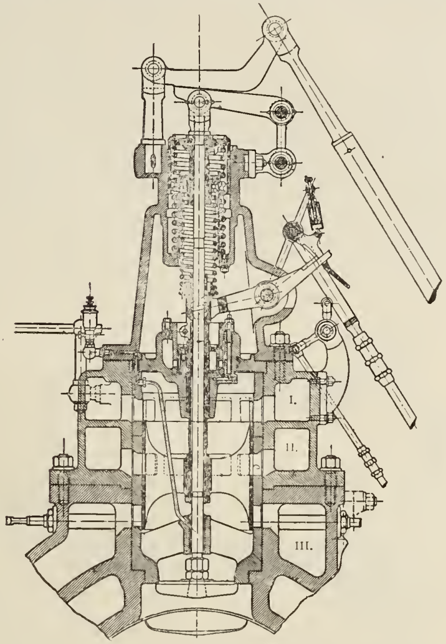

Fig. 8.

The advantages of this method of governing appear to be acknowledged by most of the older makers of gas engines, with the exception of the Maschinenbau-Gesellschaft Nürnberg and their licencees. It is employed by Deutz, Cockerill, Körting, Elsässische Maschinenbau Actiengesellschaft, Ehrhardt & Sehmer and others.

As regards the disadvantages of quantity governing, it may be stated that, owing to the reduced compression at small loads, the smooth running of the crank gear is unfavourably influenced, and the partial vacuum formed in the cylinder, when the load is taken off the engine towards the end of the suction period, necessitates the use of very strong springs to load the valves in order to prevent them from reopening and thus causing hammering and also prejudicing exact governing.

(*c*) *Combined Quantity and Quality Method of Governing.*—An example of a valve gear of this kind is that of Mr. Reichenbach, constructed by the Maschinenbau A.G. Union, Essen, and by the Maschinenbau-Anstalt of Görlitz, in which, from the maximum power, down to a certain power, only the amount of the constant mixture is varied, while from this power, down to the power when the engine is running unloaded, proportionately more air is added—

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[*] *Stahl und Eisen*, 1905, part III.

that is, the mixture is weakened, in order not to allow the compression to fall too much when running without load. In order to assure the ignition and combustion of the weaker mixture, at low powers, Reichenbach allows, with small loads, the moment of ignition to be so regulated by the governor that the ignition, from the beginning of the weakening of the mixture, with a diminishing load, takes place earlier.

By this valve gear, which will certainly prove effective, the air as well as the gas, each separately, then the mixture formed, and finally the ignition, should all be controlled by one or more governors.

(*d*) *Governing with a Constant Mixture and Constant Compression.*—A governor working in this manner has been patented by the author and constructed by Schüchtermann & Kremer (Fig. 8). It was constructed in answer to a demand by Prof. Meyer* for a method of arranging the mixture which, at constant compression, and with increasing quantity of air, renders complete combustion possible, even when the engine was running without load.

The disposition of this governor is such, that two separate air ports and a gas port lead into the cylindrical space above the inlet valve.

The inlet valve opens at the commencement of and closes at the end of the suction stroke. In the cylindrical chamber above the inlet valve, and independently of it, a slide moves in such a manner that it first keeps the gas port (I.) and then one of the air ports (II.) shut, while it allows the admission of pure air through the air port (III.) until, at a position of the piston depending on the load at that moment, influenced by the governor, it is suddenly disconnected from its outer mechanism, and through its resulting rapid downward motion suddenly closes the air port (III.), at the same time, however, opening the air port (II.) and the gas port (I.), so that both air and gas enter for the mixture, both from rest, and through areas which are of correct proportions. Only after the inlet valve is closed does the slide again move upwards.

C. *Stuffing Boxes, Cooled Pistons and Piston Rods.*—These important parts of large double-acting motors offer at the present time less difficulties than could ever have been expected.

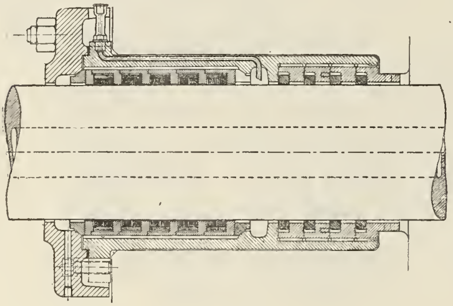

FIG. 9.

There are stuffing boxes of various constructions in use, all of which give satisfaction, and the following packings may be cited as examples: Sieger (Fig. 9), Maschinenbau-Gesellschaft, Nürnberg (Fig. 10), Elsässische Maschinenbau-Gesellschaft (Fig. 11).

The construction of these packings can be clearly seen from the figures, and requires no special description.

With several packings all the rings are made of cast iron. In a few types only those rings situated nearest to the explosion chamber are of cast iron, whilst the remaining rings are made of suitable white metal. Several packings have an extra front packing—*e.g.*, in the Howaldt packing.

Most packings permit a movement of the packing rings in a direction perpendicular to the axis of the cylinder only, a few others also allow a slightly inclined motion of the rod.

Great care must be taken that the cylinder cover is well cooled, that the packing rings are well lubricated, and that they never have to support the weight of the piston rod. This might happen, however, if in the course of time the clearance between the packing rings and the stuffing box becomes filled with burnt residues. Therefore it is necessary from time to time to remove the packing for cleaning, and for this reason it is advisable to make the stuffing box a separate and easily removable part (Fig. 9) and not continuous with the cover.

The following description of the various types of gas engines shows that the pistons, cooled through the hollow piston rods, differ in construction. They have proved very difficult to design; pistons broke both when they were made in one or more pieces and when they were low or high in tensile strength. With the thicknesses of walls, which are necessary to transmit the energy of the explosion, the initial stresses in pistons are already dangerous, wherefore it is necessary to reheat the cast-steel pistons after casting. It is, moreover, not advisable to stiffen them with ribs, as these, as is the case with cylinder heads and cylinder covers, often are the cause of fracture. With pistons divided into two parts, great attention must be given to the water-tight joint to prevent leakage of the cooling water, which is below 3 to 5 atmospheres, at the circumference of the piston, as even the smallest leakage prevents the formation of the electric spark necessary for ignition.

Finally, the fixing of the piston on the rod is a very important point.

The old-fashioned method of securing the piston to the piston rod by a screwed end and a nut may be employed if the materials of the rod and nut are of very different hardnesses; otherwise, as proved by experience, a slackening of the nut is often impossible. The most practical design for this purpose is certainly that first constructed by Cockerill, in which the two halves of the piston are pressed against a flange, forged on the piston rod by small screws which can easily be slackened.

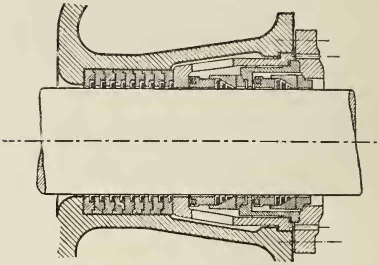

FIG. 10.

The cooling of the piston rod and of the piston is now generally so arranged that the cooling water enters the rod at one end and flows out at the other. A flowing back is avoided by a pipe being fitted in the bore of the piston rod. In tandem engines this arrangement is either on each cylinder or the cooling water is allowed to pass through both rods and both pistons, one after the other. In the first case the cooling water must be at a pressure of from 2½ to 3 atmospheres, and in the second from 4½ to 5 atmospheres. Concerning the manufacture of the piston rod, that system is naturally the best by which the axis of the piston rod, when erected and loaded with the pistons and the water they contain, is a straight line. In order to attain this end the piston rod, loaded in this manner, can be turned by keeping the rod fixed and allowing the tool to turn, or the rod is turned with the lathe centres displaced in such a manner that at the middle point of a line joining the centres of the end sections the rod has a deviation which is equal to the deflection of the rod when loaded.

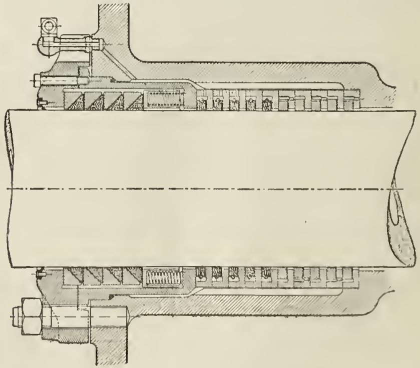

FIG. 11.

This method is not generally adopted in two-cycle engines, because the piston is too long, being equal to the stroke of the engine; it is also too heavy. The piston is allowed to rest on the cylinder at the risk of greater wear of the latter. Although it is evident that a free-bearing piston, which does not unduly load the working surfaces, and a piston rod working straight and not arched, are of great value in minimising wear of the cylinder and maintaining tightness in the stuffing boxes, yet, on the other hand, the danger of wear of the cylinder through the weight of the piston in two-cycle engines must not be exaggerated. This wear is in any case much greater at the edges of the piston rings, which often require replacing in large numbers, especially when they are made with too strong a spring than that arising from the weight of the piston. This follows also from experience which was gained with the old four-cycle motors, in which the piston at the same time formed the cross-head, and thereby, in addition to the load due to its own weight, transferred the much greater guiding pressure to the surface of the cylinder. In these engines wear was principally encountered at that part of the cylinder over which the piston rings passed and the front portion of the cylinder, but the piston itself showed hardly any signs of wear. Therefore not more piston rings should be used than are necessary to keep the long double-cycle pistons tight; moreover, it is better to distribute them at both ends of the piston.

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* *Stahl und Eisen*, 1905, part III.

The lower surface of the cylinder, which should be well lubricated, would wear better if the exhaust ports were omitted, for much of the oil blows out through them.

(*To be continued.*)

PROF. EWING'S ADDRESS TO SECTION G OF THE BRITISH ASSOCIATION.*

I intend to devote this address to considering in certain aspects the inner structure of metals and the manner in which they yield under strain. It will not be disputed that this is a primary concern of the engineer, who in all his problems of design is confronted by the limitations imposed on him by the strength and elasticity of the materials he employs. It is a leading aim with him to secure lightness and cheapness by giving to the parts such dimensions as are no larger than will secure safety, and hence it is of the first importance to know in each particular case how high a stress may be applied without risk of rupture or of permanent alteration in form. Again, the engineer recognises the merit, for structural purposes, of plasticity as well as strength, and in many of his operations he makes direct use of that property, as in the drawing of wires and tubes or the flanging of plates. He is concerned, too, with the hardening effect that occurs in such processes when work is expended on permanently deforming a metal in the cold state, and also with the restoration to the normal condition of comparative softness which can be brought about by annealing. Nor can he afford to be indifferent to the phenomena of "fatigue" in metals, which manifest themselves when a piece is subjected to repeated alternations or variations of stress—fatigue of strength and fatigue of elasticity, which, like physiological fatigue, admits under some conditions of rest-cure, inasmuch as it tends to disappear with the lapse of time. No apology need be made in selecting for a presidential address to Section G a subject that touches so many points of direct practical interest to engineers. It is a subject which has for me the additional attraction of lying in the borderland between engineering and physics—a borderland in which I have often strayed, and still love to stray, and I enter it to-day even at the risk of wandering into regions which, to engineers, may seem a little remote from home, regions where the landscape has, perhaps, a suspicious likeness to that of the country over which the learned men of Section A hold rule.

To engineers, quite as much as to physicists and chemists, we owe in recent years an immense extension of knowledge regarding the structure of metals. This has come about mainly by the intelligent use of the microscope. Take any piece of metal in the state in which an engineer makes use of it, polish and lightly etch its surface, and examine it under the microscope, and you find that it is a congerie of a multitude of grains, every one of which may be proved to be a crystal. It is true that the boundaries of each grain have none of the characteristics of geometrical regularity which one is apt to look for in a crystal, but the grain is a true crystal for all that. Its boundaries have been determined by the accident of its growth in relation to the simultaneous growth of neighbouring grains —the grains have grown, crystal fashion, until they have met and the surface of meeting, whatever shape it may happen to take, constitutes the boundary. But within each grain there is the true crystalline characteristic—a regular tactical formation of the little elements of which the crystal is built up. It is as if little fairy children had built the metal by piling brickbats in a nursery. Each child starts wherever it happens to be, placing its first brickbat at random, and then piling the others side by side with the first in geometrical regularity of orientation until the pile, or the branches it shoots out, meets the advancing pile of a neighbour; and so the structure goes on, until the whole space is entirely filled by a solid mass containing as many grains as there have been nuclei from which the growth began.

We now know that this process of crystal growth occurs not only in the solidification of a metal from the liquid state, but in many cases during cooling through a "critical" temperature when the metal is already solid. We know also that the process may in certain conditions go on slowly at very moderate temperatures. We know also that the process of annealing is essentially the raising of the metal to a temperature at which recrystallisation may take place, though the metal remains solid while this internal arrangement of its particles goes on. Whether crystallisation occurs in solidifying from the liquid or during the cooling of an already solid piece, it results in the formation of an aggregate of grains, each one of which is a true crystal. Their size may be large or small—in general, quick cooling means that crystallisation starts from many nuclei, and the resulting grains are consequently small; with very slow cooling you get a gross structure made up of grains of a much larger size.

For simplicity of statement I shall ask you in what follows to confine your attention to simple metals, omitting any reference to alloys. Alloys present many complexities, into which we need not at present enter. With simple metals every crystalline grain is made of the same substance: the elementary brickbats are all exactly alike, though there may be the widest variation from grain to grain as regards the form of the grain, and also as regards the direction in which the elementary brickbats are piled. In any one grain they are piled with perfect regularity, all facing one way, like a regiment of perfectly similar soldiers formed up in rows, where each man is equidistant from his neighbours, before and behind, as well as to right and to left. Or perhaps I might compare them to the well-drilled flowers of an early Victorian wall-paper.

It was shown by Mr. Rosenhain and myself* that when a piece of metal is strained beyond its limit of elasticity, so that permanent set is produced, the yielding takes place by means of slips between one and another portion of each crystal grain. A part of each crystal slides over another part of the same crystal, as you might slide the cards in a pack. It is as if all the soldiers to one side of a given line were to take a step forward, those on the other side remaining as they were, or as if all the men in the front rows took a step to the left, while those in the rows behind kept their places. In other words, the plasticity which a metal possesses is due to the possibility of shear on certain planes in the crystal that are called "cleavage" or "gliding" planes. Plastic yielding is due to the occurrence of this shear; it may take place in three or more directions in a single grain, corresponding to the various possible planes of cleavage, and in each direction it may happen on few or many parallel planes, according to the extent of the strain to which the piece is subjected. Examine under the microscope the polished surface of a piece of metal which has been somewhat severely strained after polishing, and you find that the occurrence of this shear or slip is manifested on the polished surface by the appearance of little steps, which show themselves as lines or narrow bands when looked at from above. To these we gave the name of slip-bands. Just as the piece of metal is an aggregate of crystal grains, the change of shape which is imposed upon it in straining is an aggregate effect of the multitude of little slips which occur in the grains of which it is made up. Each grain, of course, alters its form in the process.

Speaking broadly, this distortion of the form of any one grain by means of slips leaves it still a crystal. If part of the group of brickbats moves forward, keeping parallel to themselves and to the others, the formation remains regular, except that a step is formed on the outermost rows; the orientation of the elements continues the same throughout. Considerations which I shall mention presently lead to some qualification of this statement. I now see reason to believe that in the process of slip there is a disturbance of the elementary portions or brickbats adjoining the plane of slip, which may alter their setting, and thereby introduce to a small extent some local departure from the perfectly homogeneous orientation which is the characteristic of the true crystal. In very severe straining there may even be a wide departure from true crystalline character. We shall recur to this later; but meanwhile it will suffice to say that substantially the slip which is involved in a plastic strain of moderate amount is a bodily translation, parallel to themselves, of part of the group of elementary brickbats or molecules which build up the grain. If a crystal whose form has been altered, even largely, by such straining is cut and polished and etched it appears, under the microscope, to be to all intents and purposes as regular in the tactical grouping of its elements as any other crystal.

Further, in the process of straining we have, first, an elastic stage, extending through very small movements, in which there is no dissipation of energy and no permanent set. When this is exceeded, the slip occurs suddenly; the work done in straining is dissipated; if the straining force is removed a strain persists, forming a permanent "set"; if it continues to act it goes on (within certain limits) producing augmented strain. In general a large amount of strain may take place without the cohesion between the gliding surfaces being destroyed. Immediately after the strain has occurred there is marked fatigue, showing itself in a loss of perfect elasticity; but this will disappear with the lapse of time, and the piece will then be harder than at first. If, on the other hand, a process of alternate straining back and forth be many times repeated, the piece breaks.

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* Presidential Address delivered by Prof. J. A. Ewing, F.R.S., at York, on Thursday, August 2nd.

* Ewing and Rosenhain, "The Crystalline Structure of Metals," Bakerian Lecture, *Phil. Trans.* Roy. Soc., Vol. CXCIII. A, 1899.

These are now familiar facts. Can we attempt to explain them on the basis of a molecular theory which will at the same time offer a clue to the process of crystal-building as we find it in metals? I venture to make this Address the occasion of inviting attention to some more or less speculative considerations which may be held to go some little way towards furnishing the material for such an explanation.

At the Leeds meeting of this Association, in 1890, it was my privilege to bring forward certain contributions to the molecular theory of magnetism, and to show a model which demonstrated that the rather complex phenomena of magnetisation were explainable on the very simple assumption that the magnetic molecules are constrained by no other forces than those which they mutually exert on one another in consequence of their polarities.* From this were found to result all the chief phenomena of permeability and magnetic hysteresis. Let us attempt to-day to apply considerations of a similar character to another group of physical facts, namely, those that are associated with the crystalline structure of metals and with the manner of their yielding under strain. Just as in dealing with magnetic phenomena, I take as starting-point the idea that the stability of the structure is due to mutual forces exerted on one another by its elementary parts or molecules, and that the clue to the phenomena is to be sought in the play of these mutual forces when displacement of the molecules occurs.

Iron and most of the useful metals crystallise in the cubic system; for simplicity we may limit what has to be said to them. Imagine a molecule possessing polarity equally in three directions, defined by rectangular axes. We need not for the present purpose inquire to what the polarity along the axes is due; it will suffice to assume that the molecule has six poles, three positive and three negative, and that these repel the like and attract the unlike poles of other molecules. We may make a model by using three magnetised rods fixed at right angles to one another at their middle points. I imagine, further, that the molecule has an envelope in the shape of a sphere, which touches the spherical envelopes of its neighbours, and assume that these spheres may turn on one another without friction.†

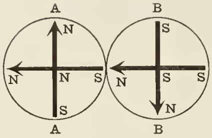

FIG. 1.

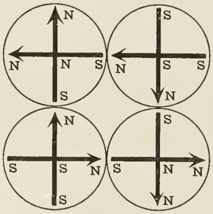

FIG. 2.

Think, now, of the process of crystal-building with a supply of such spherical molecules for brickbats. Starting with one molecule, let a second be brought up to it and allowed to take up its place under the action of the polar forces. It will have a position of stability when a positive pole in molecule A touches (or lies in juxtaposition to) a negative pole in molecule B, with the corresponding axes in line, and when the further condition is satisfied that the axes in molecule B whose poles are not touched by A are stably situated with respect to the field of force exerted by the poles of A.

In other words, we have the formation shown in Fig. 1. For convenience of representation, in the diagram the poles are distinguished by the letters N and S, but it must not be assumed that the polarities with which we are here concerned have anything to do with magnetism.

Suppose, now, that the crystal is built up by the arrival of other molecules, each of which in its turn assumes the position of maximum stability consistent with formation in cubic or normal piling. The group in that case takes an arrangement which is essentially a repetition of this quartette as shown in Fig. 2.

Along each row the polarity preserves the same direction, but the polarity of each row is opposite to that of each contiguous parallel row. This description applies equally to all three axes. The whole group (Fig. 3) consists of the quartettes of Fig. 2 piled alongside of and also on top of one another. In this way we arrive at what I take to be the simplest possible type of cubic crystal.

In this grouping each molecule has the alignment giving maximum stability, and it seems fair to assume that it will take that alignment when the crystal grain is formed under conditions of complete freedom, as in solidifying from the liquid state. As a rule, the actual process of crystal building goes on dendritically; branches shoot out, and from them other branches proceed at right angles, leaving interstices to be filled in later. We have, therefore, to conceive of the molecules as piling themselves preferably in rows rather than in blocks, though ultimately the block form is arrived at. In this position of maximum stability each molecule has its six poles touching poles of contrary name.

Now comes a point of particular importance. Imagine two neighbouring molecules in the same block to be turned round, each through one right angle, in opposite senses. They will now each have five poles touching five poles of contrary name, but the sixth pole will touch a pole of the same name as itself. They are still stably situated, but much less stably than in the original configuration, and they will revert to that configuration if set swinging through an angle sufficient to exceed the limited range within which they are stable in the new position.

Similarly we may imagine a group of three, four or more molecules, each to be turned through a right angle, thereby constituting a small group with more or less stability, but always with less than would be found if the normal configuration had been preserved. The little group in question may be made up of molecules in a row, or it may be a quartette or block, or take such a form as a T or L. A sufficient disturbance tends to resolve it into agreement with the normal tactics of the molecules which build up the rest of the grain.

It is conjecturally possible that small groups of this kind, possessing little stability, may be formed during the process of crystallisation, so that here and there in the grain we may have a tiny patch of dissenters keeping one another in countenance, but out of complete harmony with their environment.

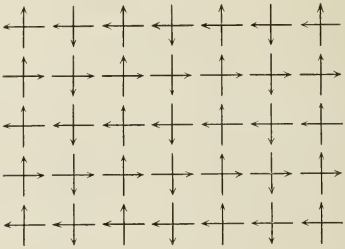

FIG. 3.

If this happens at all during crystallisation, it would seem less likely to happen in free crystallisation from a liquid state than in the more constrained process that occurs when a metal already in the solid state recrystallises at a temperature far below its melting point. Though rare or absent in the first case, it might occur frequently in the second. There are differences in the appearance of crystal grains under the microscope in metal as cast and in metal as recrystallised in the solid state, of which this may be the explanation. It may also explain a difference pointed out by Rosenhain,* that the slip lines in cast metal are straight and regular, whereas in wrought iron and other metals which have recrystallised in the solid they rarely take a straight course across the crystal, but proceed in jagged, irregular steps. These may be due to the presence here and there of small planes of weakness, resulting from the existence of what I have called dissenting groups. Again, these groups, possessing, as they do, less stability than their normal neighbours, may be conjectured to differ from the normal parts of the grain in respect of electrolytic quality, and to be more readily attached by an etching reagent. Hence, perhaps, the conspicuous isolated geometrical pits that appear on etching a polished surface of wrought iron.

It will help in making clear these points, and others that are to follow, if we study the action of a model formed by grouping a number of polarised "molecules" in one plane, supporting them on fixed centres, about which they are free to turn. In the model before you the centres are uniformly spaced in rectangular rows, and the "molecules" are + shaped pieces of hardened steel, strongly magnetised along each of the crossed axes, each having, therefore, two north poles and two south poles. The third axis is omitted in the model, the movement to be studied with the help of the model being move-

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[*] "Contributions to the Molecular Theory of Induced Magnetism," *Proc. Roy. Soc.*, Vol. XLVIII., June 19, 1890, or *Phil. Mag.*, September, 1890.

[†] Or, let the envelope be a shell of any form, inside of which the axes of polarity are free to turn as a rigid system.

[*] Rosenhain: "The Plastic Yielding of Iron and Steel," *Journal* of the Iron and Steel Institute, No. 1 for 1904, p. 335.

ment in one plane. On placing these "molecules" on their centres they readily take up the position already indicated in Fig. 3. Each one within the group has its four poles in close proximity to four poles of contrary name, and is, therefore, highly stable. If disturbed by being turned through a small angle and let go, it swings back, transmitting a wave of vibration through the group, which is reflected from the edges, and is finally damped out in the model by pivot friction and air friction. We may assume some damping action (say, by the induction of eddy currents) in the actual solid, of which the model may be taken as a very crude representation.

By turning two molecules carefully round together, each through one right angle in opposite senses, we set up a dissenting pair, whose equilibrium has feeble stability. A slight displacement, such as might be produced by the transmission of a vibrational wave, breaks them up, and they swing back to the normal configuration, giving out energy, which is taken up by the rest and is ultimately dissipated. By making the dissenting coterie consist of three or more we can give it additional strength.

An example is shown in Fig. 4, where the three molecules marked *a*, *b* and *c* are turned round in this way.

Notice that the normal molecule *d*, adjoining a line of such dissenters, is in a peculiar position. His neighbours present to him three N. poles and one S. pole. He has the choice of conforming to the majority, or of throwing in his lot with the dissenters; and he has a third possible position of equilibrium (very feeble equilibrium) which is reached when his two S. poles are turned until the one neighbouring south pole faces just between them. I have laboured these points a little because they seem important when we come to speak of the effects of strain.

Consider now the straining action, which we may imitate in the model by sliding one part of the group past the other part. For this purpose the centres are cemented to two glass plates which can slide parallel to one of the axes.

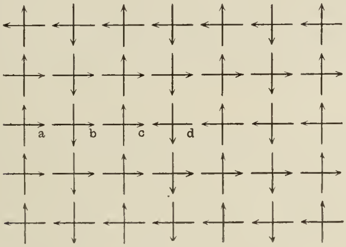

Fig. 4.

At first, when the displacement by sliding is exceedingly small, the strain is a purely elastic one. The molecules adjacent to the plane of sliding pull one another round a little, but without breaking bonds, and if in this stage the strain is removed, by letting the plate slide back to its original position, there is no dissipation of energy. The work done in displacing the molecules is recovered in the return movement. We have here a representation of what happens between each pair of adjoining rows in the elastic straining of a metal. So far the action is within the limit of elasticity; it leaves no permanent effect; it is completely reversible.

But now let the process of straining be carried further. The opposing molecules try to preserve their rows intact, but a stage is reached when their resistance is overcome; the bonds are broken, and they swing back, unable to exert further opposition to the slip. The limit of elasticity has now been passed. Energy is dissipated; set has been produced; the action is now no longer reversible. The model shows well the general disturbance that is set up in molecules adjoining the plane of slip, which we may take to account for the work that is expended in a metal in producing plastic strain.

Moreover, when the slip on any plane stops and the molecules settle down again, the chances are much against their all taking up the normal orientation which they had before the disturbance. What I have called dissenting groups or unstable coteries are formed as a result of the disturbance. Here and there like poles are found in juxtaposition. Viewed as a whole, the molecular constitution of the metal in the region adjacent to the plane of slip is now uncertain and patchy. It includes parts whose stability is much less than normal. Individual molecules or small groups in it are very feebly stable; a touch would make them tumble into positions of greater stability.

Observe how all this agrees with what we know about the nature of plastic strain through experiments on iron or other metals. Its beginning is characteristically jerky. Once the critical force is reached, which is enough to start it, there is a big yield, which will not be stopped even by reducing the amount of the straining force.

Again, we know that there is a slow creeping action that continues after the straining force has done its main work. I ascribe this to the gradual breaking up of the more unstable groups which have been formed during the subsidence of disturbance in the earlier stage of the slip.

Further, we know that overstrained iron is very imperfectly elastic until it has had a long rest, or until it has been raised for a short time to a temperature such as that of boiling water.[*] This is to be expected when we recognise the presence of unstable individuals or groups resulting from the overstrain. When the elasticity of the overstrained piece is tested by removing and reapplying the load, some of these tumble into new positions, making inversible movements, which dissipate energy and produce hysteresis in the relation of the strain to the stress although the strain is quasi-elastic. At ordinary temperatures these unstable groups are gradually becoming resolved, no doubt through the action of the molecular movements that are associated with heat, and hence the slow progressive recovery of perfect, or nearly perfect, elasticity shown by the experiments of Muir. Let the temperature be raised and they disappear much more quickly; in warm surroundings the rest-cure for elastic fatigue does not need to be nearly so long.

Rosenhain[†] has recently shown that after the slip-bands on the surface of an overstrained specimen have been obliterated by polishing, traces of them will reappear on etching if only a short interval of time is allowed to lapse since the overstraining; but if time is given for complete recovery no traces are found. This is in remarkable agreement with the view now put forward, that the layers contiguous to the surface of slip contain for a time comparatively unstable groups. They are consequently different from the normal metal until the unstable groups are resolved, and the temporary difference manifests itself on etching, provided that is done while the difference still exists.

From the engineer's point of view a much more important matter than this fatigue of elasticity is the fatigue of strength that causes fracture when a straining action is very frequently repeated. Experiments which I made with Mr. Humfrey[‡] showed that this action begins with nothing more or less than slight slip on surfaces where the strain is locally sufficient to exceed the limit of elasticity. An alternating stress, which makes the surfaces slip backwards and forwards many thousands, or it may be millions of times alternately, produces an effect which is seen on the polished surface as a development of the slip lines into actual cracks, and this soon leads to rupture.

We have, therefore, to look for an effect equivalent to an interruption of continuity across part or the whole of a surface of slip, an effect progressive in its character, becoming important after a few rubbings to and fro if the movement is violent, but only after very many rubbings if the movement is slight.

That there is a progressive action which spreads more or less into the substance of the grain on each side of the original surface of slip was clearly seen in the experiments referred to. It was found that a slip-band visible on the polished surface of the piece broadened out from a sharply defined line into a comparatively wide band with hazy edges, and this was traced to an actual heaping up of material on each side of the step which constituted the original line.

I think this suggests that under alternating stresses which cause repeated backward and forward slips, these do not occur strictly on the same surface in the successive repetitions, and hence the disturbance spreads to some extent laterally. It may be conjectured that slip on any surface leaves a more or less defective alignment of the molecular centres; that is to say, the rows on one side of the plane of slip cease to lie strictly in line with those on the other side. If this occurs over neighbouring surfaces, as a result of slips or a number of parallel planes very close together, the metal throughout the affected region loses its strictly crystalline character, and with it loses the cohesion which is due to strict alignment.

Mr. G. T. Beilby, in a very suggestive Paper,[§] has advanced grounds for believing that portions of a metal may pass from a crystalline to an amorphous formation under the mechanical influence of severe strain, as in the hammering of gold leaf or the drawing of wire, and that this occurs in the polishing of a metallic surface, and also in the internal rubbing which takes place at a surface of slip within the grain. In both cases he suggests the formation of an altered layer. When a polished metal surface is etched, the altered layer is dissolved away, and the normal structure below it is revealed.

Without accepting all Mr. Beilby's conclusions, I think the idea of an altered and more or less amorphous layer is supported by the considerations I am now putting forward. We have assumed that in normal crystallisation the intermolecular forces lead to a normal piling, in which each molecule touches six neighbours. But it may be conjectured that some of them may take up pyramidal piling

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[*] J. Muir, "On the Recovery of Iron from Overstrain," *Phil. Trans.*, Vol. CXCIII. A, 1900.

[†] *Journal* of the Iron and Steel Institute, 1906.

[‡] Ewing and Humfrey, "The Fracture of Metals under Repeated Alternations of Stress," *Phil. Trans.*, Vol. CC. A, 1902.

[§] Beilby, "The Hard and Soft States in Metals," *Phil. Mag.*, August, 1904.

(touching twelve others) under the compulsion of strong forces—such forces, for example, as act on the superficial molecules of a surface that is being polished.

If this also occurs at a surface of slip, it gives us a clue to several known facts. It at least assists in explaining the familiar result that metal is hardened by straining in the sense of being made less plastic. Again, it accounts for the general increase of density which is found to take place in such an operation as wire drawing. Further, if a local increase of density occurs in the interior of a grain through piling of some molecules in the closer manner where repeated slips are going on, the concentration of material at one place requires it to be taken from another; in other words, the closer piling tends to produce a gap or crack in the neighbourhood where it occurs. This is consistent with what we know of the development of cracks through repeated alternations of strain.

Recourse to the model shows that with pyramidal piling the polar axes point in so random a manner that the aggregate may fairly be called amorphous. To illustrate this a group is shown with centres fixed at the corners of equilateral triangles.

It is obvious that any pyramidal piling at a surface of slip tends to bar further slip at that particular surface. Hence not only the augmented hardness due to strain, but the tendency in repeated alternations to lateral spreading of the region on which slip occurs. The hardness due to straining is, of course, removed when we raise the metal to such a temperature that complete recrystallisation occurs, normal piling being then restored in the new grains.

Taking a previously unstrained piece, it is clear that the facility with which slip will occur at any particular surface of slip in any particular grain depends not only on the nature of the metal and on the orientation of the surface in question to the direction of the stress, but also on the amount of support the grain receives from its neighbours in resisting slip there. In other words, for a given orientation of surface the resistance to slip may be said to consist of two parts; one is inherent in the surface itself, and the other is derived from the position of the grain with reference to other grains.

To make this point clear, think of a grain (under stress) in which there is a gliding surface oriented in the most favourable direction for slipping. Slip on this surface can take place only when its yielding compels the neighbours (which are also under stress) to yield with it, and the surfaces in these on which slip is compelled to occur are, on the whole, less favourably situated. Hence the original grain cannot yield until the stress is considerably in excess of that which would suffice to make it yield if it stood alone, or had neighbours equally favourably inclined.

Apply this consideration to the case of steel, where there are two classes of grains: the ferrite, which is simply iron, and the pearlite, which is a harder structure. Slip on any ferrite grain is resisted partly by the strength of the surface itself, and partly by the impossibility of its yielding without forcing slip to take place on neighbouring (harder) grains. Now, suppose the structure is a very gross one, such as Mr. Stead has shown may be found in steel that is seriously overheated. On the large grains of ferrite in overheated steel the resistance to slip will be but little greater than it would be in iron, and, consequently, under an alternating stress fatigue of strength, leading to rupture, may be produced by a very moderate amount of load. Mr. Stead* has shown how the effects of overheating can be removed by the simple expedient of raising the steel to a temperature sufficient to cause recrystallisation—a homœopathic remedy that transforms the gross structure of the overheated metal into an ordinarily fine structure, where no ferrite grain can yield without compelling the yielding of many pearlite grains. Hence we find, as Rogers† has demonstrated by experiment, that steel cured by reheating from the grossness of structure previously produced by overheating has an immensely increased power to resist the deteriorating effects of often-repeated stress.

I trust you will not feel I have abused the licence of the Chair in presenting contributions to molecular theory that are for the most part in the nature of speculative suggestions, thrown out in the hope that they may some time lead to a fuller and more definite knowledge. Remote as they may seem to be from the concerns of the workaday engineer, they relate to the matter which it is his business to handle, and to the *rationale* of properties, without which that matter would be useless to serve him. We have attempted to penetrate into its very heart and substance in order the better to comprehend the qualities and functions on which the practical work of engineering relies. The man whose daily business leads him through familiar tracks in a forest does well to stray from time to time into the shady depths that lie on either hand. The eyes of his imagination will be opened. He will at least learn his own limitations, and, if he is fortunate, he may gain some clearing on a hill-top which commands a wider view than he has ever had before.

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* See especially a Paper by J. E. Stead and A. W. Richards on "The Restoration of Dangerously Crystalline Steel by Heat Treatment," *Journal* of the Iron and Steel Institute, No. 2, 1903.

† F. Rogers, "Heat Treatment and Fatigue of Steel," *Journal* of the Iron and Steel Institute, No. 1, 1905.

PRINCIPAL GRIFFITHS' ADDRESS TO SECTION A OF THE BRITISH ASSOCIATION.*

After referring to the work of Sprengel, Joly and Langley, who are among those members that the Association has lost since the last meeting, and to the bearing which researches on radium and radio-activity have upon the structure of the earth, the author discusses recent work on the determination of constants and the application of thermodynamics to osmotics as follows:—

During the past 25 years much thought has been devoted to the accurate determination of certain physical constants. This is very apparent in the case of one of the most important—namely, that commonly termed the "mechanical equivalent of heat," or, as I prefer to define it, the "thermal equivalent of energy." When Lord Kelvin addressed you in 1882, I think it probable that he would have indicated the value obtained by Joule—viz., 772·6 foot-pounds—at Manchester, as the quantity of work required to raise the temperature of 1 lb. of water through 1°F. at 62°F. It is true that the results of Rowland's classical investigation were published in 1880 and 1881, but the discrepancy between his conclusions and those of Regnault regarding the change in the specific heat of water at temperatures between 0°C. and 30°C. introduced an element of uncertainty.

As a consequence of this discrepancy much experimental work on the subject has been performed in the last quarter of a century, and I think it may be said without hesitation that the value of this important constant is now ascertained with an accuracy of about one part in 2,000. The amount of labour which has been employed in the determination of this thermal constant is extraordinary, and, as I have pointed out elsewhere, it well illustrates the cosmopolitan character of scientific investigation.

I have given reasons † for specially selecting for consideration the determinations of Rowland, of Bartoli and Stracciati, of Ludin, of Callendar and Barnes, of Schuster and Gannon, and I have ventured to add my own. Thus Baltimore, Pisa, Zurich, Montreal, Manchester and Cambridge have all contributed to the solution of the problem, and we may now with some certainty say that 777·7 foot-pounds at Greenwich are very closely the equivalent of the amount of heat required to raise 1 lb. of water through 1 deg. on the hydrogen scale at 63 5°F.

It may possibly appear that the result just quoted is a somewhat poor return for the expenditure of so much thought and labour. I would call attention, therefore, to the fact that the value of this equivalent is dependent on the measurements of many other natural constants; hence any agreement between the results obtained by the observations of Rowland and some of the other observers I have mentioned would only be possible in the absence of errors of appreciable magnitude in the determinations of mass, of change of temperature and of electrical resistance and current. Certain discrepancies have led to the discovery of hitherto unsuspected cause of inaccuracy, especially in the determination of temperature, and thus the inquiry has rendered valuable service in many branches of physical inquiry.

For example, so far back as 1893 I ventured upon a prophecy that the value assigned to the E.M.F. of a Clarke's cell was somewhat too high, and that it was possible that 1·4328 represents more truly the P.D. of a Clarke's cell at 15°C. than the ordinarily accepted value of 1·4342. In the report of the Electrical Standards Committee for 1897 will be found a discussion of this matter, and one of the consequences of the deliberations of that committee is to be seen in the ampere balance now standing in the National Physical Laboratory.

The results of the observations obtained by this instrument will, I believe, shortly be published by Prof. Ayrton and Mr. Mather, but I am at liberty to state that, so far as the observations have been reduced, they point to the conclusion that the prophecy to which I have referred is closely fulfilled. We may say, therefore, with some confidence that the values of those units which form the basis of our system of electrical measurement are not only practically determined with a high degree of accuracy, but that also our measurements of temperature and of energy are placed on a satisfactory footing.

The last few years have been fruitful in revelations which not only profoundly affect the views of students of science, but also are of such a nature as to catch the eye of the public. In some cases the applications of these discoveries to the purposes of mankind have been evident and immediate. Every well-equipped hospital possesses apparatus for the production of Röntgen rays, and I suppose that every bluejacket in the Navy has some degree of acquaintance with those applications of science which have resulted from the discovery of Hertzian waves.

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* Presidential address delivered by Principal E. H. Griffiths, Sc.D., F.R.S., at York, on August 2nd. Abbreviated.

† Griffiths, "The Thermal Measurement of Energy."

The ambition of the student is naturally fired by such examples, and there is a possible danger that the plodding but absolutely necessary work of accurate measurement may suffer by neglect. I therefore venture to repeat the well-established axiom that our advance in scientific knowledge is a function of accurate measurement, and that the student who devotes his energy to the determination of some physical constant is probably giving a "point of departure" to the pioneer. For it must ever be remembered that to the scientific investigator the rule of three has ceased to hold any significance.

When Lord Rayleigh discovered that the mean weight per litre under standard conditions of chemical nitrogen was 1·251, and that of atmospheric nitrogen was 1·257, the believer in the rule of three would have been unlikely to suspect that this difference of 0·006 would supply the clue which led Lord Rayleigh and Sir W. Ramsay to the discovery of a new element, a discovery which in its turn led to others of possibly even greater importance. For all we know the next decimal place in any hitherto accepted value may afford another example of the truth of the statement that a part may be greater than the whole.

At the time when Lord Kelvin delivered the address to which I have already referred the truth of the second law of thermodynamics was probably not so generally accepted as is the case at the present time. Each apparent example of violation of that law has on closer examination proved to be additional evidence of its validity. We seem unable to find those "sorting demons" of Maxwell's whose existence appears necessary for its violation.

Mr. Campbell recently expressed doubts as to the application of thermodynamic considerations to osmotics. He contended that the errors in the determination of osmotic pressure were greater than those which could be attributed to experimental sources. Now, the theoretical relation between osmotic pressure and the freezing point is based directly on thermodynamic considerations, and it was because I entertained a belief that the most direct evidence of this much debated matter could be obtained from the observation of the freezing point of a very dilute solution that I embarked on a series of somewhat elaborate experiments during the years 1897 to 1901. My removal from Cambridge and the death of my assistant, Mr. C. Green, compelled me to leave that inquiry in an unfinished condition. Nevertheless, I had investigated the depression of the freezing point in certain solutions varying in strength from 0·0003 to 0·025 gramme-molecule per litre.

Subsequently to my departure from Cambridge Mr. Bedford re-erected the apparatus in another building. After having surmounted great difficulties, he repeated many of my experiments, and he informs me that the numbers he has so far obtained are in almost entire agreement with those previously obtained by me. The molecular depression in the case of cane sugar I found to be 1·858, of potassium chloride 3·720, and I understand that Mr. Bedford's experiments agree with these results with a discrepancy of less than one part in 1,000. The most probable number obtained from theoretical considerations would be in the former case 1·857, in the latter 3·714. As Mr. Whetham has pointed out, unless there is some balancing of opposite errors of a very improbable nature, it is difficult to imagine a more direct vindication of the application of thermodynamic considerations to the phenomena of solution. I may add that I also examined correspondingly dilute solutions of sodium chloride, barium chloride, sulphuric acid, potassium bichromate, magnesium chloride, and potassium iodide; but, owing to the circumstances to which I have referred, I was unable to repeat these experiments in such a manner as to enable me to attach great importance to the resulting figures. Nevertheless, I obtained values which strengthened the conclusions to which I was led by the more exhaustive examination of the dilute solutions of sugar and potassium chloride.

So far back as the Liverpool Meeting of this Association I expressed a hope that the experimental difficulties of the direct measurement of osmotic pressures would be overcome, as such direct measurement would afford the most useful data by means of which to obtain further light on the much vexed question of the nature of solutions. I remember, also, that it was the general opinion of those who had given attention to this matter that the experimental difficulties were insuperable.

I am glad, therefore, to have this opportunity of stating my high appreciation of the manner in which Lord Berkeley and Mr. Hartley have grappled with the difficulties of this investigation. They have proved that the osmotic pressure obtained by direct measurement agrees with that derived from vapour-pressure observations to within less than 5 per cent.* This agreement is of great importance, as it diminishes our doubts as to the extent to which the imperfections of semi-permeable membranes may affect the validity of results dependent upon their behaviour, and points to the possibility of determining the osmotic pressures of concentrated solutions by measurement of their vapour pressures.

I trust it will not be thought out of place if I here refer to the interesting correspondence which has recently appeared in *Nature* on the thermodynamic theory of osmotic pressure, and the allied, but by no means identical, problem of the difference between electrolytic and non-electrolytic solutions.

On the one side we have Prof. Armstrong, whose chief desire appears to be the vindication of the moral character of what he terms "the poor molecule"; and Mr. Campbell, whose doubts concerning the second law of thermodynamics are closely connected with a lurking belief in the existence of Maxwell's "sorting demons"; and by way of reserves we have Prof. Kahlenberg, who contends that "thermodynamic reasoning cannot be applied to actual osmotic processes" on account of the "selective action of the membrane" and "insists that the formation of crystals from a solution or the concentration of a solution by evaporation are not osmotic processes."

On the other hand we have Mr. Whetham, who, I confess, seems to me to be capable of holding his own without need of reinforcements. He has pointed out that confusion has arisen from the use of the term "osmotic pressure" to denote the actual pressure experimentally realised in certain conditions, as well as the ideal pressure required in thermodynamic theory. With regard to the theory of electrolytic dissociation, Mr. Whetham shows that the fact that the velocities of the ions are constant in dilute solutions and decrease slowly with increasing concentration, while the conductivity of a dilute solution is at most proportional to the first power of the concentration, appears irreconcilable with any assumption as to the existence of the active part of an electrolyte in the form of combined molecules when in solution. I would here join with Mr. Whetham in the request that those who oppose the theory of ionic dissociation would state their views as to the mechanism of electrolysis, and their reasons for supposing that the application of the principles of thermodynamics to the phenomena of solution is unjustifiable.

Prof. Armstrong remarks that it is unfair to "cloak the inquiry by restricting it to thermodynamic reasoning, a favourite manœuvre with the mathematically minded." He adds that such a course may satisfy the physicist, but "is repulsive to the chemist"

The inquiry, "Why is the application of thermodynamic reasoning repulsive to the chemist?" naturally suggests itself I confess that at one time I regarded the extreme advocates of the theory of ionic dissociation with a certain amount of suspicion, but I think that most of those who have studied the evidence now at our disposal, or who have been engaged in experimental investigation into this interesting branch of physics, cannot fail to agree with Mr. Whetham that, as regards the fundamental conceptions of the theory, "the cumulative evidence seems overpowering." At all events, we may consider that the application to the phenomena of solution of reasoning based on thermodynamic considerations is justifiable until we are presented with stronger arguments than those based on the repulsiveness to certain chemists of the conclusions to which it leads or the doubt it throws upon the activities of Maxwell's demons and the selective action of semi-permeable membranes.

I will now trespass upon your forbearance and pass from the consideration of such special departments of natural science as usually engage the attention of members of this Section to some more general considerations, which naturally arise in any comparison of our knowledge of to-day with that which we possessed when we last met in this city.

It will, I think, generally be admitted that during the last 25 years the increase in our "natural knowledge" has been greater than in any previous quarter of a century.

Day by day we are adding new facts to our storehouse of information, until it has now become impossible for the individual to have more than a superficial knowledge of the contents of the building. And although this accumulation is one which we may well regard with satisfaction, it necessarily gives rise to difficulties unfelt by our predecessors.

I venture to indicate one of such difficulties, one which has been brought home to me both by my experience as an examiner and by the fact that during the past few years I have had to preside over many meetings of examiners, and to mark the effect of examinations on the teaching in our universities.

We now expect a student to acquire in a three years' course a far greater amount of information than was considered necessary, say, 25 years ago. The attention both of the teacher and of the taught is naturally directed to those extremities of the branches of science in which the growth has been most marked in recent years, and I venture to think that there is in consequence some danger of our neglecting the roots of the whole matter. Compare, for example, a final Paper in chemistry in any one of our universities with its predecessor of a quarter of a century ago.

The enormous advance of organic chemistry has necessarily reacted on the examinations, and thus the student is unable to devote

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* Concentration.	Direct O.P. at 0°C.	O.P. deduced from vapour pressure at 0°C.
540 grains per lit. solution	67·5	69·4
660 ,, ,, ,,	100·8	101·9
750 ,, ,, ,,	133·7	136·0

Proc. Roy. Soc., June, 1906.

an adequate proportion of his time and attention to the foundations of the subject. The same remark applies in the domain of physics. There is a danger, therefore, of our educational edifice becoming top-heavy.

I have heard complaints, on the one hand, from the examiners that while the candidates frequently exhibit considerable knowledge of the most recent scientific developments, they show a lamentable ignorance of the simple phenomena and the principles they illustrate. On the other hand, I have heard from candidates that many of the questions were too simple—that they were concerned with principles and facts to which their attention had not been directed since they first began the study of natural science.

My own experience has been that the simplest questions are those answered in the least effective manner. A candidate unable to give satisfactory illustrations of Newton's Laws will discourse upon the mass of an electron or the nature of the Röntgen rays, and attempt the solution of problems on such subjects as Hertzian waves and electric convection.

I hope that the attention of both examiners and teachers may be directed to the best methods of dealing with what appears to me to be not only a serious but an increasing evil.

To pass from one of the inconveniences which inevitably arise from growth, it is pleasant to dwell upon its more gratifying consequences.

Perhaps one of the most marked characteristics of the progress of science in recent times is the increasing public appreciation of the importance of original investigation and research.

The expansion of the university colleges in number and importance has greatly assisted and quickened this movement.

Twenty-five years ago there were comparatively few laboratories which held out any possibility of research to the English student. True, there were giants in those days, men, as a rule, working under difficulties greater than those encountered by their successors of to-day. The better equipment of our laboratories and the growth in the number and activity of our scientific societies have played no small part in stimulating public interest. Nevertheless, much remains to be done. Those who have read Prof. Perry's somewhat pessimistic words on England's neglect of science must admit that, however rapid our progress, the British people have not yet so fully awakened to the national importance of this question as some of our competitors.

The idea that a degree is one of the chief objects of education yet lingers amongst us. The conviction that it is a national duty to seek out and, when found, utilise the latent scientific ability of the rising generation for the purpose of adding to our stores of natural knowledge still needs to be brought home to the "man in the street." And here I would venture to indicate my personal belief in the necessity of more free communication between the laboratory and the market-place. It is possible that the language of science is becoming too technical, and that the difficulties with which scientific inquirers have been faced in past times have tended to habits of exclusiveness. For example, complaints are frequent that our manufacturers are less alert in grasping the practical applications of scientific discovery than their competitors in Germany and the United States. I confess, however, that it seems to me possible that the fault is not altogether on the side of the manufacturers. We want missionaries to preach the doctrine that one of the greatest of national assets is scientific discovery. If we can convince the men of business of this country that there are few more profitable investments than the encouragement of research, our difficulties in this matter will be at an end.

It is my lot to serve on the education committees of three county councils, and I have been much struck by the readiness of the members of those bodies to extend such encouragement whenever it has been possible to convince them that the results may conduce to the prosperity, the comfort and the safety of the community.

It has also been my privilege to address meetings of the men who work in the coalfields of South Wales. I have attempted to direct their attention to the advantages which they have derived from the labours of those who have endeavoured to probe the secrets of nature in the laboratory; I have tried to show how discoveries based upon the researches of Humphry Davy, Faraday, Joule, for example, have not only diminished the dangers to which miners are exposed, but have also, by increasing the demands upon our stores of energy given employment to thousands of their fellow-workers.

My experiences lead me to the belief that these men are ready to support the action of their representatives in extending support and encouragement to all efforts to assist the advance of scientific discovery.

It is possible that in dwelling on this matter I am trespassing on your forbearance, but I cannot resist this opportunity of pleading for the extension of your sympathies beyond the walls of the laboratory. The old toast, "Here's to science pure and undefiled; may it never do a ha'porth of good to anybody," may possibly be an excellent one in the laboratory; for, so far as I know, no great scientific principle has ever been established by labours prompted solely by desire for financial gain. Nevertheless, if we wish for the support of our fellow-countrymen, that toast is not one for public dinners. There is no scientific society which is brought into such close contact with the public as is the British Association, and affiliated with that Association are some scores of local scientific societies, containing many thousands of enthusiastic observers and inquirers. If this great organisation were seriously to take up the task of bringing home to the minds of the people of this kingdom the enormous value of the results of scientific inquiry, I believe it might be possible to change the indifference and apathy of our public bodies into active interest and encouragement. If each affiliated society would institute a series of public, non-technical lectures, of such a nature as to bring home to the minds of the hearers some comprehension of the results of the work of Faraday, of Wheatstone, of Pasteur, of Maxwell, of Lister, and of Kelvin, the change in the public attitude would be real, evident and fruitful.

In conclusion, one is tempted to seek for the underlying cause of the acceleration in the increase in the rate of advance of natural knowledge. Is it to be found in the increase in power of the human intellect, or the diversion into one particular channel of activities previously otherwise employed? It is possible that the human intellect has, by the processes of evolution, become more powerful, and that man's ability to decipher the secrets of nature has thereby increased. I think, however, that it would require a bold advocate to support this thesis. If any such mental evolution has taken place, it is strange that it should be restricted to one particular sphere of activity. Are our poets and authors of to-day greater than Homer, our statesmen than Pericles? Or, passing into the domain of science, can we say with confidence that, in pure power of reasoning, Maxwell was undoubtedly the superior of Archimedes?

I have elsewhere indicated what appears to me to explain the mystery of this acceleration—namely, *the extension of our senses* by mechanical appliances. When we supplement our eyes by the bolometer and the electric coherer, the range of our vision is augmented a thousandfold. By the use of the electroscope and the galvanometer we have extended our senses of sight and touch until we can detect the presence of an electron.

Having realised the imperfection of our faculties, we have called upon nature in all departments of science to supply our deficiencies, and are thus enabled to walk with confidence where previously all seemed dark.

From the time of Archimedes to that of Bacon we despised natural knowledge, while we deified intellect and authority; hence, for nearly two thousand years our record was one of retreat rather than advance When the philosopher left his study and applied his powers of observation to the phenomena of the universe, progress became a reality, and thenceforward the march of discovery has known no backward step. We have therefore every reason to believe that when the Association again visits this ancient city our President will be able to chronicle an increase in natural knowledge even greater than that which has been one of the distinguishing characteristics of the last quarter of a century.

GLOW LAMPS AND THE GRADING OF VOLTAGES.*

BY WILLIAM HENRY PREECE, K.C.B., F.R.S.

Twenty-five years have passed since I first brought the Edison glow lamp before the British public, and though great progress has since been made in the development of electrical industries generally, it cannot be said that much concrete improvement has been effected in the efficiency or economy of the lamp itself. Edison and Swan left little to be done. Their child left their hands well matured. Experience has brought to light minor defects and science has determined laws and economies of use and value. Rivals are, however, now springing into existence which are attracting much attention, and are stimulating the carbon interests to maintain their position, but the carbon filament glow lamp retains all the principles and conditions which startled the practical world in 1881.

Lord Avebury in his presidential address at our Jubilee Meeting in 1881, said:—

"In the electric light gas lighting has found a formidable competitor, which appears destined to take its place in public illumination and in lighting large halls, work for which purposes it combines brilliancy and freedom from obnoxious products of combustion with comparative cheapness. The electric light seems also to threaten, when employed in the manner recently devised by Edison, Swan and others, to make inroads into our dwelling houses."

It was at this meeting in Section A that Lord Kelvin showed how Faure's accumulator could assist as a storage battery towards the economy of generating stations for electric energy, and Sir Joseph Swan also exhibited and described his original incandescent lamp.

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* Paper read before the British Association (Section G) at York, August 6, 1906.

The glow lamp, with its glass bulb exhausted of air and its fine filament of hard carbon, through which electric energy flows, is familiar to every one; but the changes of form through which its glass protector has passed, the fixture of its cap which fits the lamp into the collar, the various ways in which it is made to form part of an electric circuit, the character and quality of the carbon itself, its treatment or *flashing* and the 45 operations through which it must pass from raw material to a finished exquisite article, are not so familiar to the user.

Definitions.—Energy is a term applied to that great universal and indestructible principle of nature which excites the motion of matter whether we consider the revolutions of the stars or the undulations of the atoms. Whatever stirs into action the infinitely great or the infinitely small is *energy* and its action on matter is *work* whose two factors are *force* and *motion*. The scientific unit of energy or work is the *Erg*. It is the work done by a *Dyne* in moving a gramme through a distance of one centimetre. The dyne is the unit force which, acting on a gramme, imparts to that gramme a velocity of 1 cm. per second. The erg is very small, and to make a good practical unit of work 10^7 ergs are taken and called a *Joule*. The British foot-pound, so well known in mechanics, is 1·356 joules. The unit of *power*, or the time-rate of doing work, is 1 joule acting for one second, and is called a *Watt*. There are 746 watts in a horse-power. In electrical practice the unit of power is a *kilowatt* (kw.)—*i.e.*, 1,000 watts, which is equal to 1·34 H.P.

The Board of Trade unit of energy is 1 kw. acting for one hour, and this unit is the basis of all charges for the distribution and supply of electrical energy for all purposes. It was defined by Act of Parliament in 1882. It has not yet received a name.

Electrical energy in conductors flows as a *current*, and is driven by *electromotive force* against *resistance*. By the British Association system of electrical standards resistance is measured in *Ohms*, electromotive force in *Volts*, and current in *Amperes*. The general use of these names during the past 30 years has done much to establish the correct conception of electrical terms in the minds of the public generally. Indeed, it has established a new universal international language, because the British Association units are employed throughout the whole world.

The unit of light in this country established by Act of Parliament is that given by the British candle—a spermaceti candle ⅞ in. in diameter (6 to the pound) burning 120 grains per minute. The light emitted by this candle is, however, not steady or constant enough for photometric work generally. The 10 candle-power Pentane burner of Mr. Vernon Harcourt, which has a steady and uniform conical flame emitting a whiter and better light than the sperm candle, is therefore generally employed for photometry in the United Kingdom. Carbon filament glow lamps properly selected and gauged are of great service as secondary standards for general use in factory tests and can be compared periodically with the primary standard on account of their portability. The more modern metallic filament glow lamps may possibly make even better secondary standards.

The glowing carbon filament emits its light in consequence of the energy contained in the current doing work upon its molecules. The result of this work done is *temperature*, and the consequent rapid oscillation of the molecules of carbon excites those undulations of the *æther* which fills all space called *luminous waves*. These when falling upon the retina of the eye produce the sensation called *light*. The amount of heat generated in a second, and therefore the temperature excited, depends on the character of the carbon filament, its hardness, its purity, its density, and its uniformity of structure. There is a fixed temperature—Draper's critical point—525°C.,* at which all matter commences to emit luminous waves—the first perceptible dark red rays—and as the temperature rises to 1,160°C., all the prismatic colours are emitted, until finally the very bright white rays are accompanied by the dissociation of the solid carbon and it is broken. Although this effect of temperature tends to reduce the resistance of the carbon the loss of carbon particles by dissociation reduces the diameter of the filament, its resistance increases, the current is diminished, the glass bulb blackens by the deposition upon it of the ejected carbon, and again light is lost. Thus too great an increase of temperature is very injurious.†

Since light is the consequence of work done, the *efficiency* of the carbon filament is measured by the number of watts required to generate the light of a candle—*i.e.*, the watts per candle-power. It is quite an empirical unit but an extremely useful one. A dull red light given by an ordinary flashed carbon filament means a comparatively low temperature; this cannot be expressed in terms of watts per candle-power for the candle-power is hardly measurable. Approximately, 3·8 watts per candle power, acting on the carbon filament, means a good reading light, 3·1 watts per candle-power means an excellent light and 3·0 to 2·5 watts per candle-power means a very bright light verging on the critical point of dissociation which has to be avoided. The behaviour of a lamp under increasing voltage is shown by Fig. 1, where we see the energy expend d in watts in raising the temperature of the carbon from its normal condition to that of luminosity and of useful incandescence.

Efficiency.—The relative life value of all lamps is practically the same at whatever efficiency they are tested This was a deduction from some excellent tests made by Mr. Upton in Mr. Edison's laboratory in 1893 when I visited New York. I verified this principle at home, and in 1896 introduced a life test by which the efficiency was rapidly and conveniently measured by gradually raising the normal voltage of 100 to 170 volts. This test has continued in use to the present day at the General Post Office, but in America it has been modified by starting the lamps on test at 3·1 watts per candle-power and recording the number of hours until the candle power has fallen to 80 per cent. of the standard value.

There is no reason why this shortened life test should not be carried out at even a higher efficiency such as 2·5, 2·75 or 3 watts per candle on circuits with a virtually constant voltage. It is a better test than my original one, in which the voltage is raised to breaking point in 2½ minutes. There is an advantage in maintaining a constant voltage. The American consumer is supplied with lamps to a strict specification. Hence lamp makers are forced to select their lamps accurately as to rating. How different it is with us. The Admiralty, the War Office and the General Post Office alone do this and have done so for the past 10 years They get the best of the lamps and those alone which are carefully selected as to rating

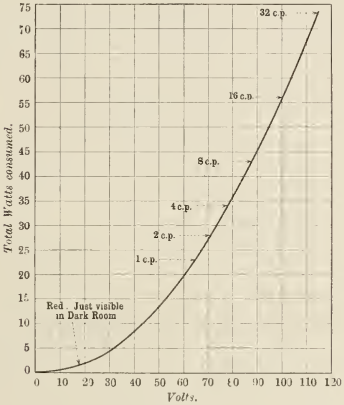

FIG. 1.

By treatment in the very high temperatures of the electric furnace of the order of 3,500°C. the ordinary flashed carbon filament has recently been completely changed in its physical character. All impurities have been driven out of it, and it has become pure graphite, with a grey colour and a greasy feel. Its electric resistance coefficient has changed its sign. The ohms *increase* instead of fall with heat. It behaves like a metal. Its density is much higher. It blackens the bulb much less during incandescence and it has a much longer useful life. It is economical, for it can be worked at an efficiency of 2·5 watts per candle. This new American lamp is not on the British market yet except for street lighting. It will tend to maintain the pre-eminence of the carbon filament, now being so vigorously assailed.

The new street lamp is supplied in three sizes :—

Watts.	Diffused Candle-Power.
125	70
187	105
250	140

This works out at 1·8 watts per candle power.

Nernst Lamp.—But we are not entirely dependent on carbon. Prof. Nernst, of Göttingen, in 1898, found that filaments of pipeclay, alumina, zirconia, &c., insulators when cold, become conductors when red hot and when carrying a current gave a brilliant light at a much better efficiency than carbon. Lamps have been made on this principle, and although they may not have, as yet, come into very general use continuous progress is being made in improving them. They are somewhat deficient in reliability and durability and are sensitive to changes in voltage. They are admirable for magic-lantern purposes and should be extremely valuable for street lighting where ordinary glow lamps are a distinct failure. I prefer the incandescent gas mantle to the ordinary glow lamp for streets but the Nernst lamp ought to be superior to both, and indeed it has been found so in practice. A special form of Nernst lamp fitted with a reflector for street lighting on a 200 volt circuit and taking 51·2 watts gave a mean hemispherical candle-power of 38·6 or 1·325 watts per candle which was an excellent result [*]

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* Draper's law is true only when expressed in terms of absolute temperatures when the radiating surface is black and the absorbing surface is at absolute zero. It also excludes effects due to conduction and convection. The uniformity of this critical point in all matter is not confirmed.

† The carbon must be uniform both in structure, form and surface. Want of uniformity and the presence of spots are shown by difference in light emissivity, and this can be seen through smoked glass. The advent of rupture can be detected by the appearance of a bright spot and prevented by removal of the lamp.

The filament or *glower* of this type of lamp has first to be heated. This is done electrically by means of an electromagnetic device automatic in its action switching the current from the *heater* to the glower. The glower itself is exposed to the air, but a fine iron wire which increases in resistance as the temperature rises is employed as a balancer and is contained in an exhausted glass bulb. These lamps apparently work equally well on either a direct or alternating system, but the frequency of the latter system should certainly be below 50.

Osmium.—D. Auer von Welsbach, the inventor of the gas mantle, has invented an osmium lamp which gives a very white light, and has a very good efficiency—*i.e.*, 1·5 watts per candle-power.

Osmium is very scarce, but it is the most refractory metal known. It is too brittle to be drawn into wire. For this purpose it is made into a paste with organic material and squirted into a solid cylinder through jewelled dies. The foreign matter is then expelled by heat. There remains a filament porous and rough but bright, giving better light efficiency. It is brittle when cold but soft when incandescent, requiring support. 9 in. (280 mm.) of this filament 0·087 mm. in diameter gives, at 37 volts, 22 c.p., with an efficiency of 1·5 watts per candle-power. The candle-power is wonderfully constant, and the actual life 2,000 hours. The bulb is said not to blacken. At present, however, they are expensive in prime cost and renewals. They would make excellent secondary standards of light.

The rare metals have the great advantage that their resistance increases with their temperature, differing from the ordinary carbon, the resistance of which decreases under the same circumstances. This makes variation of voltage with them less harmful than with carbon for they become self-regulating. They also emit a whiter light and have a higher efficiency. The energy they consume is less, so that for annual cost they make for economy.

Tantalum.—Messrs. Siemens Bros. have introduced tantalum for the filament. It is another rare metal of extraordinary hardness and of considerable ductility—a strange combination. Its melting point ranges between 2,250°C. and 2,300°C. It gives a very steady white light. In a test of 12 lamps the mean absolute life was 1,104 hours, and the mean useful life 500 hours. The filament is 650 mm. long and 0·05 mm. in diameter. The current it takes at 110 volts is 0·3654 ampere. The total watts are thus 40·19, and a mean efficiency of 2·1 watts per candle, the initial efficiency being 1·5 watts per candle.

They work best on direct-current circuits, and they blacken in horizontal belts with age. They blacken more and have a shorter life on an alternating current circuit, but this depends much on the frequency. With frequencies below 50 the difference in behaviour on a direct or alternating circuit is scarcely noticeable. Blackening increases also with any abnormal increase of voltage. The wire roughens with age and breaks without warning and with great suddenness. It is a very promising lamp and is quite in its infancy.

Zirconium, also a rare metal, has been worked up with cellulose into a filament, and has given satisfactory effects, but recently it has been combined with tungsten, wolfram, and some other rare metals to make a new filament called the zircon or "Z" lamp. The initial efficiency of this lamp is 1·07 watts per candle, and the normal candle power 50. It was first made to work with 37 volts, but now the lamps are manufactured to work with 110 volts and even 220 volts. I have in one of my rooms some of these 110 volt lamps. They give a brilliant light, but they have yet to pass through the ordeal of a practical trial and exhaustive testing. They blacken with age. They will work on alternating as well as direct-current circuits.

Mercury.—The mercury vapour lamps of Hewitt and of Bastian scarcely come within the class of glow lamps for they depend upon the irradiation of vacuum tubes and are therefore more allied to arc lamps, but they are very permanent, and though the light emitted in the Hewitt lamp is very deficient in the red rays, Mr. Bastian has remedied this defect by supplementing the mercury rays with those of a carbon filament suspended below a circular glass tube filled with the mercury vapour. The effect is quite that of daylight. I have had one of these lamps in my own office for some time and it has given great satisfaction. The latest improvement emanating from Germany is in the use of an amalgam of cadmium for the electrodes and also an amalgam of mercury, zinc, sodium and bismuth, which are said to give a light comparable with that of a flame arc. I have not seen them.

For the rest of the Paper I will confine myself to the carbon filament alone.

Life.—The life of a glow lamp is dependent entirely upon the voltage that maintains it alight. If a lamp be specified to give 16 c.p. with 110 volts at an efficiency of 3·5 watts per candle it may give this result at starting, but surely and certainly by the various causes enumerated, it will give less and less light however constant the voltage may be. It will deteriorate more rapidly if the voltage be variable, especially if it exceeds the standard 110 volt pressure. I mention particularly the 110 volt. The other standard pressure is 220 volts, but manufacturers have not yet introduced a 220 as good as the 110 volt lamp. The latter requires quite 20 per cent. more energy for the same light than the former, and it would be decidedly economical to fix 110 volt lamps—2 in series—on 220 volt circuits. I am doing this on my own installation in Wimbledon. In fact, it has been proved in America that the 110 volt lamp has three times the useful life of the American 220 volt lamp, and that 110 volt lamps at 3·1 watts per candle and 220 volt lamps of 3·8 watts per candle have equally useful lives. The former will absorb 30·4, the latter 24·6 units, the difference being 5·8. If we take the mean price per unit at 3½d., it indicates that the 220-volt lamp costs 10d. more every 500 hours than does the 110-volt lamp which is more than the cost of the lamp. The reason for the difference between the two lamps is the impossibility of "flashing" the fine filament of the 220 volt lamp. The consequence is that the lamps have to be worked at a lower temperature.

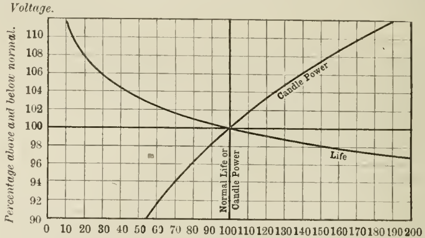

Fig. 2.

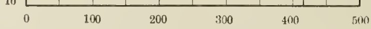

Fig. 2a.—Life Test.

Lamps may last alight for many hundred hours. I have known lamps that have endured through 6,000 hours, but it is quite certain and easily proved that after a lamp has dropped from 16 c.p. to 12·8 cp. it is wiser and cheaper to remove it and replace it with a new lamp. The *useful life* of a glow lamp is defined as the time taken for the M.H.C.P. to drop 20 per cent. from the standard value. The relation between life and candle-power with varying voltage is well shown by Fig. 2, and between life, candle-power and resistance by Fig. 2a. They show why voltage regulation is so important.

Blackening.—This loss of light is due as much to the blackening of the bulb as to the increase of the resistance of the lamp. The blackening is so regular in its growth through age, when the voltage is maintained constant, that Dr. Clayton Sharp proposes to classify used lamps by comparison with a scale of standard lamps artificially aged. This simplifies the assortment of played out lamps immensely. It is quite easy to determine the point when the lamp has reached the end of its useful life. Indeed, the bulb blackening gives directly the percentage of its useful life. It is a test independent of candle-power and of efficiency and very quick. The lamp tells its own story.

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[*] It is comparatively easy to test the mean horizontal candle-power (M.H.C.P.) of the carbon filament glow lamp, but it is not so easy to do so in the case of the Nernst lamp. The former is rotated at a uniform rate about a vertical axis, and gives a good average result; the latter must, however, as it cannot resist centrifugal force, be measured by the more complicated and tedious process of obtaining the mean hemispherical candle-power. As a rule all new kinds of lamps should be tested for mean spherical and mean horizontal candle-power, and the ratio $\frac{\text{MSCP}}{\text{MHCP}}$ determined. This gives the *reduction factor* which for carbon lamps is about 0·80 and for tantalum lamps 0 726.

The useful life of a lamp, as already mentioned, is defined as the number of hours it takes for the candle-power to fall 20 per cent. from its standard intensity. The *absolute life* is the period in hours it takes to expire by rupture of the filament. These hours may be continuous or intermittent. My experiments of 1894-5 showed that interruptions in lighting made no difference if the voltage remained constant. Messrs. Ayrton and Perry proved that it made no difference whether the currents were continuous or alternating, but subsequent experience has shown that on both systems *variation* of voltage has a deleterious influence.

Standards.—The following candle-powers are recognised as standards 8, 16, 32 M.H.C.P. It is proposed to add to them 12 c.p. and 25 c.p. The Continental standards are 10, 20, 30 candle-power.

It is impossible to tell how far lamps comply with specified standards unless they are tested on purchase and tested periodically during life. It is impractical to expect that any users other than the very large ones would undertake this duty. Hence, if testing is to be done effectually it must be done by the authorised distributors. There is no difficulty in doing this when the local authority is the distributor, for several borough councils are by Parliamentary authority agents for maintaining the accuracy of the National Weights and Measures under the Board of Trade. Some of them have already seen the necessity of testing, and have established their local laboratories. The true solution is for the distributors to supply the lamps free and to maintain them. Some do this, but it is against clause 18 of the Act of 1882. This clause is virtually a dead letter, and it should certainly be repealed or modified, for it stands in the way of a great public economical reform.

18. The undertakers shall not be entitled to prescribe any special form of lamp or burner to be used by any company or person, or in any way to control or interfere with the manner in which electricity supplied by them under this Act, and any license, order or special act is used: Provided always that no local authority, company or person shall be at liberty to use any form of lamp or burner or to use the electricity supplied to them for any purposes, or to deal with it in any manner so as to unduly or improperly interfere with the supply of electricity supplied to any other local authority, company or person by the undertakers, and if any dispute or difference arises between the undertakers and any local authority, company or person entitled to be supplied with electricity under this Act, or any license, order or special act, as to the matters aforesaid, such dispute or difference shall be determined by arbitration.

The Acts of 1882, 1888 and 1889 are Power Bills pure and simple, but they are generally called the Electric Lighting Acts, giving the impression that the undertakers under those acts do not supply power. This strange error has led to the removal of conditions most detrimental to the operations and interests of those authorities who are acting under the restricted statutory powers of the former Acts, and Parliament fails to move in the matter.

Voltage Variation.—The most serious disturbance in our systems of distribution of electrical energy and a prolific source of decay and destruction of our glow lamps is the variation of voltage, not only from our specified standard pressures, but in any one system, from the individual pressure adopted in the network of that system. This latter variation is an evil, not only in the feeders but in the service lines, and frequently in the internal circuits of lamp installations. No serious attempt has yet been made to secure uniform pressure throughout the network of distribution systems by introducing voltage regulators.

The departure from the standard pressures of 110 volts and 220 volts adopted by the Engineering Standards Committee is shown by the following table:—

Voltage of circuit.	Lighting kw.	Number of generating stations.
100	72,701	54
102	463	1
103	160	1
104	2,824	1
105	7,308	6
107	3,567	1
110	7,523	11
115	5,103	3
120	120	1
150	2,379	3
200	129,690	81
204	16,603	2
205	3,112	1
210	21,361	26
214	3,568	1
215	479	1
220	66,935	82
225	144	6
230	104,720	122
235	88	1
240	45,389	57
250	18,249	10
	512,516	472

In 472 systems only 11 adopt *110* and 82 *220* volts, while 122 employ *230*. Most of these, however, were established before the Standards Committee was formed, but many have been established since. The whole object of a standardised system of pressures is to secure uniformity of lamps and a reduction of the very numerous processes in factories, so as to reduce their prime cost. Standardisation thoroughly carried out means economy, cheaper manufacture to the maker, lower price to the user.

Fig. 3 gives an excellent idea of this unequal distribution of voltages. It shows approximately how 512,516 kw. (683,355 H.P.) are distributed over this country to supply electrical energy for lighting only, and how indifferently they comply with standardisation. It shows that there is a great deal too much technical individualism about and that the time has come for the Incorporated Municipal Electrical Association and the chairmen of Electric Light committees to take some steps to secure uniformity of practice. This is necessary for the benefit of the public, for greater uniformity tends to greater economy. The ruling force is £ s. d. and not mere fad. The great and rapid growth of the power demand adduces an additional reason why standardisation should be enforced. It is of even more consequence with motors than with lamps.

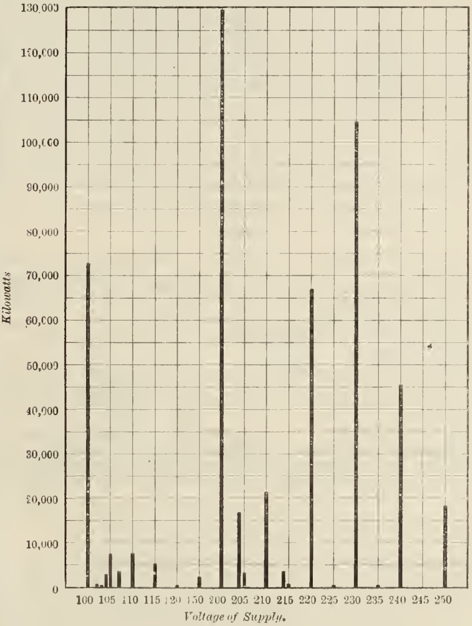


FIG. 3.

The variation of pressure in the network of a system is therefore a serious evil, for it affects not only the life but the efficiency and candle-power of the lamps, and especially of the high efficiency lamps which we hope standardisation will secure in the future. Mr. Wilkinson of Harrogate says: "Many lighting circuits are unfit to supply any lamps of higher efficiency than 'Traction' lamps, while numbers of supply networks are badly laid out and so stinted of copper that it is necessary to maintain abnormal pressure at the feeding centres during heavy loads in order to produce a satisfactory light in the remote districts" (Inst. of E.E., February, 1906).

Voltage Regulation.—Voltage regulation makes for increased and greater uniformity of light. There are several excellent systems of voltage regulators which automatically maintain the pressure constant to within a small percentage for both continuous and alternating systems, but the main difficulty is in the original design of the network when fear of financial failure demanded low estimates of cost to secure the support of timid councils.

Batteries are most effective regulators for continuous-current systems, especially at sub-stations, but a good practical method is to regulate the current in the field exciter circuits of large dynamos, while small dynamos, if not compounded, are regulated by resistance thrown in or out by relays.

Alternating-current systems are also regulated by varying the exciter current and by varying the induction ratio of static transformers.

Grading Voltages.—One of the most serious evils brought out by the enquiries of the Standardisation Committee has been the very faulty rating of the lamps by the majority of the British makers. I know of a case where a householder could not get his servants to use 8 candle lamps because they gave "so poor a light." He got the manufacturer to mark them as 16 candle lamps and all grumbling ceased, though the light remained the same. A large number of 220 volt and 110 volt 16 c.p. lamps were purchased in the open British market and sent over to New York to be compared with the American-made lamp. They were tested. Their performance was extremely wretched. They agreed neither with their marked voltage candle-power nor efficiency. They showed a miserable absence of uniformity. They averaged out 13·2 candle-power and 4·51 watts per candle. The American lamps averaged 16·2 candles and 3·83 watts per candle with great uniformity.

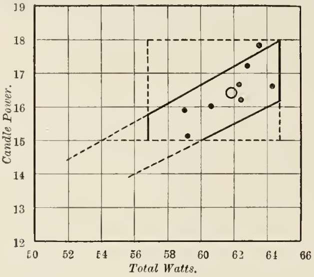


Fig. 4.

Both sets of lamps were subjected to the American rapid life test. They were set up at 3·1 watt per candle. The English lamps averaged a life of 82 hours, the American 156 hours—a superiority nearly twice as good!

But this result was also obtained that the American 220 volt lamp has five times the useful life of the English-made lamp of similar voltage!!

This experiment was repeated at home. Lamps were purchased in the open market in London and sent to the National Physical Laboratory. The results confirms in many respects the American figures.

The target diagram is a very convenient way of showing graphically the result of tests. Figs. 4 and 5 show the total watts as abscissæ, the candle-power as ordinates, the limits allowed on a rectangle and the efficiency as diagonal lines through the rectangle.

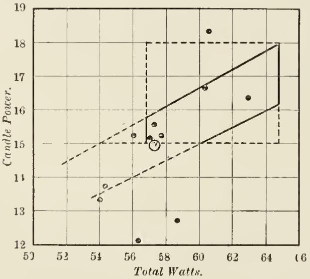
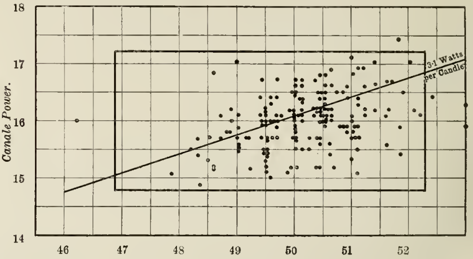


Fig. 5.

They show the care bestowed by the manufacturer in rating and selecting the lamps by their clustering about the average point within the rectangle.

The standard adopted in this country for pressures allows a variation of 10 per cent. on either side. This means a wide margin of from 99 to 121 volts in the one class and from 208 to 242 volts in the other. Hence lamps may be made and supplied of any voltage within these wide limits. Since the pressures are so ill selected, and manufacturers can find a market for virtually all that they make, owing to the callousness of users, no care is taken to select and stock lamps in their various grades, or to make them of uniform structure. Moreover, the absence of specification and of tests has encouraged great looseness of practice in the users, who buy, as well as in the tradesmen, who sell. The result has been faulty rating, poor efficiency, nasty lamps and great waste. The rejected cheap lamps of the Continent have been dumped down in this country and their marking neglected. Experience shows that the cheap lamp proves to be a swallower of energy and a costly agent. I have heard of a case where Continental made lamps absorbed 9·14 watts per candle. The user gives attention to his quarterly bill only, and when he finds his bill increasing per lamp, as it invariably does with time, he does not attribute it, as he should, to the inefficiency, gradual and natural deterioration of the lamp with use, the diminution of light and the waste of energy, but to the wiles of the authorised distributor. He often blames the system and returns to gas. The persistent use of an inefficient lamp is senseless and extravagant. Many a user is paying for twice as much energy as he needs. No wonder that the gas interest rejoices. There is distinct room for the expert illuminating engineer who can test pressure candle-power differences *in situ* and who can advise the user on novelties and economies.



Representative Target Diagram of Edison 3·1 Watts per Candle Lamps. Tested by the Electrical Testing Laboratories. May, 1905.

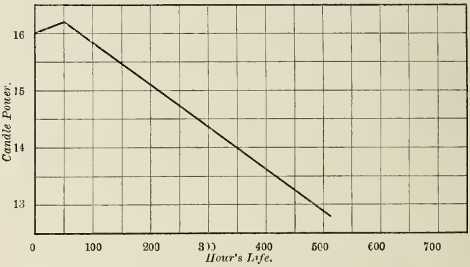


Fig. 6.—Average of 5,483 16 c.p. Edison Lamps 3·14 Watts per Candle. Tested by the Electrical Testing Laboratories. May, 1904.

The chief remedy is to make the correct rating of lamps imperative. Specification and testing will be beneficial, and will tend to secure more care in selection and better efficiency. Greater regulation of pressure would facilitate the grading of lamps into groups and enforce the similar grading of our networks into zones of pressure. But falsification of brands must be made illegal. Lamps should be grouped in classes to meet this point somewhat in the following way :—

110 volt lamps	....	100	105	110	115	120
220 ,, ,,	....	200	210	220	230	240

No others should be sold, and authorised distributors should district their systems and regulate their pressures so as to maintain pressure constant in each district. There is no fear of disturbing the price. In fact, manufacturers assure me that such a grading would so improve their own output of lamps and reduce their cost of manufacture that with a good specification they would be able not only to supply better lamps, but cheaper ones. This is found to be the case in America where voltages are graded to suit the output of the makers, and users find their lamps much more uniform in performance.

It must be remembered that a recent act of Parliament allows a committee or body of people to hold a trade mark provided they inspect. The National Physical Laboratory has its own mark and inspects and is therefore in a position to use such a mark, and so also could local authorities as authorised distributors as soon as they were in a position to inspect.

Tests.—Testing is thus the climax of all that has been said, and it is the only means that we possess to secure efficiency and prevent fraud. Moreover, it gives the right to any public body to possess a trade mark under the Trades Mark Act and to prosecute infringements as ordinary cases of fraud. With great care, much consideration and a mass of evidence and experience the Engineering Standards committee have prepared but have not finally settled a specification which will run the risk of becoming a dead letter unless some arrangements are made for branding the lamps purporting to be to standard specification. Local authorities are already inspectors of weights and measures, and they can all become so for electric lamps if they establish a testing laboratory—a by no means expensive undertaking.

The testing of candle-power, voltage, efficiency, and life is a simple matter. The National Physical Laboratory is already an inspecting institution. There is no reason why the Incorporated Municipal Electrical Association should not become one. The former institution would then become the authority possessing and dealing with prime standards, but the latter authority must necessarily deal with the user who is its client. Hence the local authority would receive secondary standards from the National Physical Laboratory who would periodically compare and certify their accuracy. Every authorised distributor who can afford it should contribute towards the maintenance of a well-equipped lamp-testing laboratory established on a commercial basis for testing and certifying all the lamps purchased under the new specification. It is for them to show the consumer how to check and prevent waste.

If the actual standards are left in the care and under the control of the National Physical Laboratory they will be reliable, and manufacturers and consumers will have confidence in their readings. If, moreover, the local inspectors maintain their secondary standards in good order by periodical examinations and renewed certificates they will be equally satisfactory, but it must be clearly understood that pentane standard lamps and secondary glow lamps can only retain confidence if they are controlled and calibrated in properly-equipped laboratories under the management of statutory authorities. Consumers cannot do their own testing effectively legally. The duty must be relegated to a properly legalised Testing Institution. Nothing can surpass the engineering of our central stations in England, for the quality and design of our plant remains a pattern to the world, but nothing can equal our internal commercial management and the financial conduct of the business, for as a rule management and control are lamentably wanting. The lamp—the aim of the capital sunk—is outside their business, and the light for which payment is made is beyond their jurisdiction. Lamps must be renewed at proper intervals. It is barbaric to let them break. Lamp control is almost universal in the U.S.A.

The gas people in the United Kingdom are wiser. They are now undertaking the supervision and maintenance of mantles for a small annual charge. It is done in York for 3d. per burner per month; in Ipswich for 3d. per burner per quarter.

It is somewhat humiliating and certainly should excite earnest thought that nearly all the recent advances in developing the electric and gas light in this country have emanated from Germany or America. The Nernst lamp, the Welsbach mantle, tantalum, osmium, zircon glow lamps, flaming arcs, &c., are all importations Is the Lion asleep? Are we wasting our energies in religious discussions? Is the spirit of enterprise abroad? Is our abundant money poured into less profitable undertakings? Are we checked by grandmotherly legislation? Something is wrong somewhere. The one thing I wish this Paper to expose is the shocking technical ignorance of the ordinary householder, the absence of any legal power to protect the user in the quality of his electrical apparatus purchased on the open market, and the apparent growing decay of honour amongst our manufacturers. "Made in England" is becoming a reproach to us.

A SUBMARINE TORPEDO BOAT CONTROLLED BY HERTZ WAVES.*

BY M. DEVAUX.

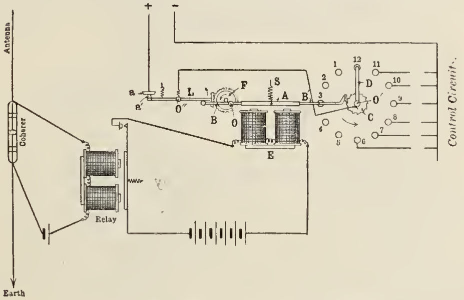
In this system a single coherer is used on board the boat working in conjunction with a relay, and the following arrangement is provided to enable any one of 12 control circuits to be selected and energised.

The essential organs of the apparatus are: (1) A distributor which moves over a series of contacts connected to the various control circuits; and (2) a main control contact device which only allows a current to be sent into the control circuits when the distributor has selected the circuit which it is desired to energise.

In order to accomplish this two-fold action an electromagnet is provided, through which a current is sent by means of a relay in the coherer circuit in the usual manner whenever a wave impulse is sent from the transmitting station on shore. This electromagnet acts upon an armature, A, normally held away from it by the spring S and carried by a lever, BB′, pivoted at O. The lever arm B′ carries a pawl engaging in a ratchet wheel, C, which carries the distributor arm D, so that each time the armature is attracted the distributor arm is caused to move one step forward. The other arm B presses against and lifts the lever L pivoted at O″, and causes it to interrupt the main control contact *aa′*. This lever carries at the other end a small rack engaging with teeth on a weighted wheel, F. The form of these teeth is such that the rack only engages with the wheel when moving in the downward direction, and the object of the arrangement is to introduce a time lag into the return motion of the lever L owing to the inertia of the weighted wheel F, which has to be started into motion whenever the lever descends. This device prevents the contact *aa′* closing while the rapidly succeeding impulses are carrying the distributor from point to point, and only allows it to complete the circuit when the distributor contact arm has reached its desired position and come to rest. Thus, in order to energise any particular control circuit, or to return the distributor to the "off" position, all that is necessary is to send the requisite number of wave impulses in rapid succession, and then pause.

In the actual submarine with which trials have recently been made, the control circuits actuated relay switches which effected the following actions: (1) Starting of propelling motor in forward direction, (2) starting propelling motor in reverse direction, (3) stopping of propelling motor, (4) movement of rudder to left, (5) movement of rudder to right, (6) stopping of steering motor, (7) lighting up of forward signal lamp, (8) lighting up of rear signal lamp, (9) discharge of the torpedo. The distributor had in all 12 positions; the three remaining points were "off" positions, and in order to avoid always having to traverse the entire circle, these were spaced at equal intervals. A complete revolution of the distributor could be made in 2 seconds.

Energy was supplied from a battery of Fulmen cells with a capacity of 450 ampere-hours and a maximum discharge rate of 100 amperes, but the number of cells is not stated. The capacity of the battery is sufficient to run the apparatus for about four hours.



General Scheme of Control Apparatus.

The hull, which displaced about 6·7 tons, was composed of two parallel sheet iron cylinders with pointed ends, strongly braced together by cross pieces. The upper cylinder, 9 metres in length and of a diameter of 45 cm., acts as a float and carries two small masts, one of which supports the receiving antenna, composed of five strands and 3 metres high. Each mast also carries a signal lamp, by which the position and direction of the boat can be observed when required at night. The main part of the vessel, the lower cylinder, was 11 metres in length with a diameter of 1 metre, and contained the torpedo-launching apparatus for a 450 mm. Whitehead torpedo, the accumulator battery and the propelling and steering motors with their accessories. The control apparatus will ultimately be placed in this portion so as to be submerged about 2 metres below the water line, but for convenient accessibility during the trials, it was contained in a case mounted on the upper cylinder.

The shore station was provided with an antenna 15 metres high composed of a group of five wires, and satisfactory evolutions were carried out last January at distances ranging from 400 to 1,800 metres. The latter distance has been exceeded more recently with a slightly modified form of apparatus of which details, however, cannot yet be published.

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* Abstract of a Paper read before the Société Internationale des Electriciens, and appearing in the *Bulletin* of the Society, June, 1906.

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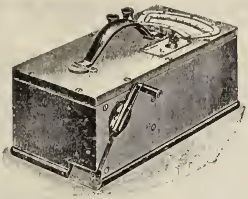

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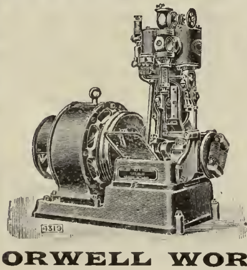

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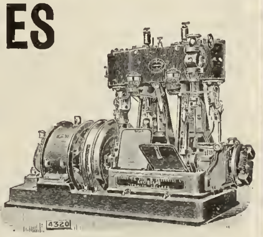

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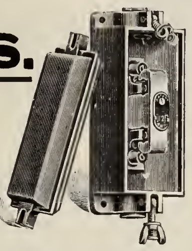

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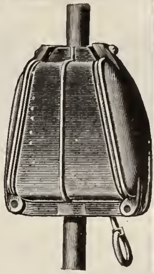

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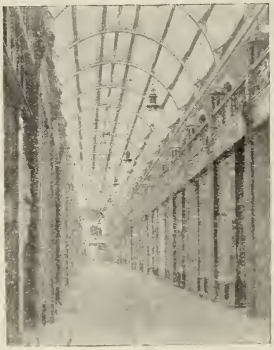
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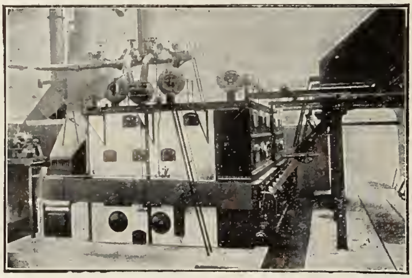

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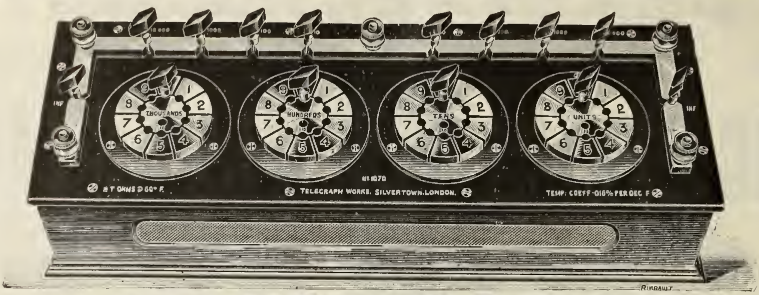
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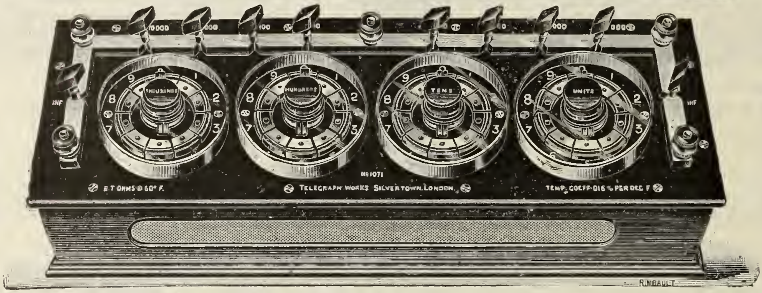
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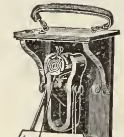

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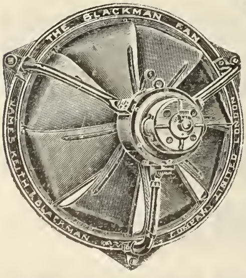
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of men of science in any excursions for public sympathy or for public enlightenment. And in the belief that Prof. **Ray Lankester's** vigorous thrust at the ruling powers quite satisfies the condition just laid down, we express our gratification that he has been bold enough to utilise his opportunity fully. To those who are over-fearful we would say that, even if any good that accrues comes slowly, no harm is done by disturbing the placid waters of officialdom.

The man of science—a term embracing the engineer—as contrasted with the rest of the world, measures the success of a British Association meeting by its Papers. On the present occasion, we think the Papers have been, especially in Section G, above the average in quality, and have been, in the main, of the right kind. Most of them had been conceived in a broad spirit, and were, therefore, of interest to all. Others, more specialised in appearance, yet proved in the reading of potential value to all. As Col. **Crompton** remarked during the discussion of one such Paper, no one engaged in developing any line of engineering practice could afford to be ignorant of the matter of that Paper. And the same remark could have been made many times at this year's meeting of Section G.

As for the operations of Section A, they were fully maintained at the high standard of excellence we have been accustomed to during the past three or four years. On radio-activity—that most attractive subject to the physicist and the general member alike—there were several exciting debates, which will be found epitomised in our diary. No doubt these matters continue to fascinate the layman, largely because of the ease with which the subject is followed. A smattering of electricity and chemistry is sufficient.

To the electrician, however, the discussions are useful for their annual dose of up-to-date information; or, if he be very well read on these subjects, they establish new connections between different portions of his stock of knowledge—connections that help to fix, and give shape to, the whole. This year's discussions and Papers, in fact, threaded the whole mass of radio-active science in many directions.

We fear, however, that this attractiveness for the initiated and the uninitiated alike must by contrast prove somewhat discouraging to the researchers in more everyday branches of physics. Humdrum but valuable work appears thrust into the shade by this more glittering and conquering progress of radio-activity. We trust that the more sober—and more necessary—branches of research will not be retarded in development by the flow of worshippers towards the radiant rival goddess.

THE BRITISH ASSOCIATION AT YORK.

Thursday, August 2nd.

Active work began in all the sections to-day and was in most cases inaugurated by the delivery of the presidential addresses. Principal Griffith's address to Section A (Physics) and Prof. Ewing's address to Section G (Engineering) are given in another part of this issue. The times of delivery were, as is customary, so arranged that those interested in the work of both sections could attend the two functions in turn; and in spite of the very considerable distance between the places of meeting of Sections A and G, a large number of members listened to both addresses. This matter of ease of transition from Section A to Section G and vice versa seems, by the way, to have received rather scant attention at the hands of those who allot rooms to the various sections. However, the present arrangement—nearly 10 minutes' walk between A and G—is an improvement on that originally planned, where these two closely-related sections were actually given two rooms separated almost as far as was possible! The new position of A is, sad to say, the greatest possible distance from the seat of the Chemistry Section B—a fact that promises to give chemists interested in radio-activity very considerable, yet withal beneficial, walking exercise. To return to the A and G presidential addresses. Both were very well received and, indeed, worthy of the speakers. That of Prof. Ewing received special distinction at the hands of Sir Benjamin Baker, who moved the vote of thanks. He said it was the most excellent address that had ever been given to the Engineering Section, and went on to emphasise the practical importance to the working engineer of Prof. Ewing's new-born method of picturing the causes of strength and weakness in, and the effects of heat treatment on, the materials on which the engineer had to rely.

The annual report of the Council, issued to-day after the General committee meeting, mentions Sir David Gill, H.M. astronomer at the Cape, as President-elect for the Leicester meeting next year. The report urges the desirability of joining up the triangulation north and south of the Zambesi, and sets aside £300 from the special South African Fund for connecting the Rhodesian and Transvaal triangulations; and, besides, suggests to the Cape Government the carrying forward of a magnetic survey. The balance-sheet shows that last year the receipts were nearly £4,900 and the expenditure £2,900, of which nearly £900 went in grants in aid of research.

A Paper of considerable electrical interest was being read in the Chemistry Section while the presidential addresses were being listened to in Sections A and G. This was a Paper by S. Leetham and W. Cramp on the application of the gases produced by the electrical discharge in air to bleaching and sterilising purposes. Since 1904 the authors have been engaged in developing an apparatus for the production of a peculiarly active gas discovered by Mr. Leetham in 1903, and now much used for flour-bleaching purposes. The apparatus consists essentially of an alternator, transformer, ozoniser and spark-box, the two latter being in series on the high-tension side of the transformer. A current of air is caused to pass through these while they are excited, the general result being an extremely active modification of the air supplied. Lantern slides, showing the apparatus as now used and the variations introduced by different conditions, were exhibited. The authors have found that all the types of electric discharge behave similarly and need similar means for rendering them steady, and, besides, that with a properly arranged circuit any desired type of discharge may be obtained and, by regulation, caused to pass gradually to any other type. The effect of increasing the number of spark-points in series is to raise the pressure necessary, but not proportionally to the number of sparks; and a similar rule holds for an increase of length of spark-gap. High air-speed also raised the pressure and set up violent oscillations in the circuit. It was found that when the air resistance was high ozone was the chief product; that then the ionisation was less marked; and that ozone and oxides of nitrogen, contrary to many authorities, may exist together without mutual destruction. Further, the bleaching action of the gas appears to be due to oxidation. Figures were given by the authors showing the degree of sterilisation produced by the gas. In the discussion Dr. Armstrong suggested that the coexistence of the mutually destructive gases was due to the very dilute condition of the mixture. He did not think it simply a case of ionisation—a thing nobody understood. Gaseous electrolysis would account for all the effects observed. Prof. Pope suggested a liquid air test for examining into the coexistence of the gases, and Dr. Hartog remarked upon the curious partiality displayed by the gas. In reply, Mr. Cramp accepted Dr. Armstrong's explanation of a hitherto obscure phenomenon.

Friday, August 3rd.

Section A.

The promise of a discussion on the "Evolution of the Elements" drew a very big audience to the Friends' Meeting House. The discussion was opened by Mr. Frederick Soddy, who entered upon his task by making a broad survey of all past thought on this matter, a survey that embraced the dreams of the Greeks, the aspirations of the alchemists, the new scientific spirit of the eighteenth century chemists, and the rigorous establishment of the atomic theory during the past 100 years. In this last epoch the absolute uniformity of the atoms of any one substance became recognised, which seemed to preclude the possiblity of a gradual change of one element into another. "No theory of evolution," said Maxwell in 1873, "can be formed to account for the similarity of atoms, for evolution necessarily implies continuous change, and the atom is incapable of growth or decay, of generation or destruction." But the discovery of the Periodic Law, together with further insight into the meaning of the spectrum, led to the view that the elements must possess similar structures in which the constituent stuff is the same, and only quantity and arrangement different in each kind of atom. Then came the brilliant researches of J. J. Thomson, when the negative corpuscle or electron was isolated, measured up, and found to possess a mass that is but a fraction of that of the smallest atom. Only four years ago Rutherford and Soddy framed a disintegration hypothesis to account for radio-active phenomena. This hypothesis, now widely accepted, easily explains the principal facts of radioactivity. It was at first put forward upon evidence gained by the experimental methods peculiar to radio-active research; but when Ramsay and Soddy proved by familiar physical methods that helium was produced from radium, then the fact of the gradual evolution of one element into others passed beyond doubt, and the new methods of investigation received the support of the old in a case where it was found possible to examine the process from both points of view.

Evolution of the radio-active type is in several features quite distinct from the old conception of the evolution of the elements. First, according to the new view, the change, though of any degree of slowness in the mass, is sudden for the individual atom; there is no gradual alteration in properties of one element's atom as it passes into another, and in this way the doctrine of the impossibility of gradual transition, deduced from nineteenth-century chemistry, remains unchallenged. Slight as this addition is to make the requirements of chemistry and spectroscopy conform to that of continuous evolution, yet the words of Maxwell clearly show how small a step the most brilliant imagination unaided is able to take. The second distinguishing feature is that the evolution proceeds from the complex to the simple. In all previous ideas evolution implied a building up. Again, this evolution we have found is actually proceeding under our eyes, a happening never dreamt of. And the last, but greatest difference between new and old, is that in the new view the energy changes are the dominant phenomena while in the old view they were never considered. Herein lies the explanation of the successful resistance of the elements to all attempts to change them. The abundant energy that emerges from a breaking atom helped, when within it, to mould its history and to make it indifferent to our puny efforts. The alchemist of old can never by any chance have transformed a single atom.

Atomic disintegration may take place without a display of rays; perhaps Nature in hiding this secret of evolution overlooked those displays that have given us the clue. Rayless changes are easily detected, however, if their products change radio-actively. Besides this class of transmuting atoms, another class, with rays of too small velocity for detection, is known. Thus, in seeking evidence of the transmutation of the common elements, some means of detecting these changes has to be invented. The radium clock, which operates by perceiving the loss of charge due to escaping particles, might be useful; but, unfortunately, as Mr. Soddy has himself recently shown, the carrying away of positive electricity by the α-particles may be regarded as accidental, as these particles are not charged at the moment of their expulsion from the atom. New methods must thus be invented or the investigator will be forced back to the spectroscope.

A single lifetime seems too short to give positive evidence of evolution of the ordinary elements. Hence Mr. Soddy has been examining old coins and ornaments, dated by antiquarians, for helium and similar gases. There is tolerable certainty that the metal was melted at the date assigned and not heated since. Others have utilised the principle that if two elements occur associated in Nature in invariable proportions, then they are parent and offspring, and the proportions are those of their lives, provided always that the parent is the longer-lived element. The case has been thus proved for uranium and radium, and for radium and polonium. But this method is likely to be of limited application, because the parent is of necessity of greater atomic weight than the child, and the heavier element is, it is presumed, usually the more unstable. Thus mere constancy of association in Nature, apart from the quantitative aspect, has to be considered. This gave the clue correctly in the radium to helium case, but no other conclusion can yet safely be drawn. Another phase of this question is seen in an element having a constant degree of rarity in Nature. Here Mr. Soddy digressed into certain economic properties of the gold standard. Resuming, he said that there is no evidence whatever that any of the known radio-active processes can in any way be artificially influenced. But he threw out the suggestion that the well-known disappearance of the gas in a Röntgen-ray bulb, occurring as it does just where intense energy is operating on small masses, is a hopeful line of research.

The Hon. R. J. Strutt took up the discussion and endeavoured to smooth out the apparent contradiction in terms which presents itself in the phrase "splitting up an *atom*." The matter is at bottom an etymological one and reminded him, he said, of those who advocated compulsory Greek at the Universities on the score of its usefulness to men of science. It would, however, appear in this case that the less we knew of Greek the better. Turning to the question of the disintegration of the ordinary elements, and looking especially at Mr. Soddy's proposal for detecting the process by loss of charge, even when there is no ionisation, he thought the prospects of success very small, for the reasons stated by Mr. Soddy himself. But another method is possible—namely, the measurement of the rate of heat production which must accompany every disintegration. Since the heating consequent upon the self-bombardment of a mass of radium had been measured, similar measurements had been successfully carried out on uranium and thorium. Of course, in those elements whose radio activity is slight, the heat production is correspondingly small—that is, the elevation in temperature of a mass of common metal above its surroundings must be very minute. Again, as regards the possibility of a transmutation of elements occurring in vacuum tubes, a series of unpublished experiments carried out by Prof. J. J. Thomson at the Cavendish Laboratory were witnessed by the speaker some years ago. Two taps were sealed close together on the stem of a Röntgen tube to provide for the admission of small quantities of gas into the bulb. During three weeks the tube was vigorously sparked and successive doses of gas admitted till as much as 10 cubic cm. had disappeared into nothingness. The gas did not escape, for the weight of the tube was found to have increased by the weight of gas admitted. Mr. Strutt suggested that any future experimenter should dissolve the inside surface of glass by hydrofluoric acid and examine the solution.

Mr. Strutt then considered the reasoning that had made the occurrence of helium in radio-active minerals suggest the transmutation of radium into that element. Now helium occurs in the atmosphere along with a number of other very inert gases of similar character. Argon is, however, hundreds of times more abundant than helium in the air; whereas helium is more abundant than argon in minerals. Why, then, does helium preponderate in minerals and argon in the atmosphere? As regards the second part of this question the kinetic theory affords a possible answer. For if the escape of gases from our atmosphere into outer space is possible, then the kinetic theory at once shows that helium might escape freely and argon but slowly. Thus the disproportion of argon and helium in our atmosphere does not in any way preclude the possibility of argon and helium, and the other members of their family, being ultimately derived from the disintegration of the heavy elements in radio-active minerals. But in effect the first part of the above question asks: Are the other inert gases of the atmosphere to be found in minerals, and what proportions do they bear to helium? He had himself, he said, been making measurements in this direction, but at present the results were not sufficiently mature for publication. He had extracted as much as half a litre of the inert gases from a mass of active mineral, and passed this mixture of gases over charcoal cooled in liquid air. Only helium escaped absorption. He found that the charcoal when heated yielded about $\frac{1}{5}$ cubic cm. of a gas, mostly argon.

Dr. Richardson pointed out that there is some evidence encouraging us to seek for a method of tapping the internal energy of the atom, since Lenard's experiments with ultra-violet light and Barkla's experiments with Röntgen rays showed that these agents merely pulled a trigger and did not supply with energy the corpuscles detached from atoms. Such a transmutation as that of lead into gold, however, required a supplying of energy in quantities costing many times the value of the gold produced.

Prof. Tilden, speaking, as he said, for the ordinary chemist, thought that if the common elements were really disintegrating, then the inert gases, such as argon, would have been much more common. As for the inferences to be drawn from the association in Nature of elements, he felt that great care was here necessary, for nearly allied elements often have compounds of about the same densities and are deposited together in the sorting out by geological processes. As for the conception of a common building material of all the atoms, he usually looked upon it as subject matter for private meditation, and had always felt that if there were any one fundamental substance there must be another, simply because the elements fall into the two classes—electro-positive and electro-negative. On the whole, he was sure that more evidence must be offered before it could be accepted that the ordinary elements are disintegrating.

Prof. Schuster added to the discussion a statement that in his laboratory Mr. Makower had, by observations at 1,000°C., noted a change in the rate of transformation of certain radium products, and he remarked that he himself had caused observations (with, as yet, negative results) to be made on radium submitted to pressures as high as 2,000 atmospheres.

Two other pieces of negative information were offered. Mr. Cortie said that the only cosmical evidence of radio-activity was merely the presence of helium in the solar spectrum, and Prof. S. P. Thompson mentioned that the anti-cathodes of Röntgen tubes never showed any radio-activity that was consequent upon the cathodic bombardment, though he had tried many materials, including radio-active elements. Thus, he said, even in the vacuum tube, where intense energy is displayed, there seems no prospect of adding to the internal energy of the atom. Prof. Thompson very usefully reminded the audience that the mystery of the disappearance of gas in a vacuum tube was probed by Villar, who found that little bubbles of gas developed in the glass of an old tube when it was heated strongly.

One or two others spoke, and Mr. Soddy replied briefly, and then it was discovered that there was no time to read the 11 Papers which, in all innocence, the committee had put down on the day's programme between Mr. Soddy's discussion and a discussion on the Notation and Use of Vectors, to be opened by Prof. Henrici at 12:15. This second discussion was therefore begun immediately. Prof. Henrici started by exhibiting nearly a dozen current notations for vector and scalar products, and proceeded to show, by working through a number of analytical theorems, how his bracket notation appealed to the eye.

On the matter of notations he confessed that every vectorist seemed to invent his own notation, and to stick to it grimly. Then Prof. Knott, mounted on quaternions and armed with the Hamiltonian notation, pranced fiercely into the debate. He denounced the vectorists and all their works, lock, stock and barrel, his principal point being an alleged fallaciousness resident in the vector product, proved, he declared, by the evident indeterminateness of either factor of a product of two vectors when the other factor and the product are given. Perfection, he claimed, in method and in notation was only to be found in quaternions. To this spirited attack Prof. Henrici replied with a remarkable burst of eloquence, and showed how easy it was to descend to the quaternionic method, and, in fact, fully express any given quaternion in any particular vector notation. This discussion, though almost too exciting for the mathematics section, was greatly appreciated; but it leaves us exactly where we stood before, and gave not the faintest suggestion of any scheme of bringing uniformity into the notation of vector algebra.

SECTION G.

A good audience gathered at 9:30 and listened to a Paper by Messrs. S. H. Davies and F. G. Fryer, of Rowntree's mechanical staff, on "The Removal of Dust and Smoke from Chimney Gases." The plant at Rowntree's works consists of six Lancashire boilers, about 30 ft. by 8 ft., supplying steam for power and heating purposes at 100 lb. per square inch, and fitted with Bennis sprinkling stokers and coal-feeding elevators. McPhail and Simpson's superheaters in the downtake of each boiler raise the steam temperature to 520°F. Green type economisers make the flue gases escaping at 20 ft. a second about 320°F. About 310 tons of dusty pea slack (40 per cent. dust and smudge and 10 per cent. ash) is consumed per week. The smoke-washing chamber is of brick, 37 ft. by 14 ft. by 17 ft. high, and the gases are drawn through by a special fan 8 ft. 6 in. diameter, and delivered to a 50 ft. by 7 ft. steel chimney. The water gauge reads about $\frac{1}{2}$ in. in the main flue. In the washer are four vertical cast-iron baffles, two fixed above and two below. Water is supplied through seven Harrison's spraying nozzles and also in the form of continuous sheets of falling water. The floor slopes to a water seal and is flushed automatically.

In the first section of the washer—*i.e.*, up to the first baffle, the speed of the gas is reduced and a lot of water is taken up, while heavy grit is dropped. In the next section the gases are cooled, and much of the water is condensed, and carries down dust and acid fumes. Careful observations show that the application of steam and hot water in the first section give much better results than the application of cold water sprays at this point; the cold water is best in the second and third sections. Also, the application of sheets of water is an extravagant method; but the walls and floor must be kept wet. Usually the exit gases are about 130°F., while the waste water is about 110°F. The minimum of water to deal with $2\frac{1}{2}$ million cubic feet of hot gases per hour is about 8,000 gallons, of which more than 6,000 gallons is fed to the sprays. It is found that the whole of the grit and dust, and practically the whole of the smoke and sulphur acids, are removed in the smoke washer.

The Paper concluded with a note on the supposed elimination of sulphur dioxide from chimney gases by treating the fuel with lime or lime water. The authors state that this has been recommended by several authorities, notably by Dr. T. E. Thorpe, of Somerset House. The conclusion, from careful experiments by the authors, is, however, that the variation in the amount of sulphur acids in the flue bears no relation to the application of milk of lime.

Mr. Robert Hammond, in discussing the Paper, remarked that this smoke and acid question was a pressing one all over the country. The solution offered by the authors was an excellent one where water is cheap—obtained, for example, as by Rowntree's, at the mere cost of pumping. But it would be impracticable in Johannesburg, where water is 3s. 6d. per thousand gallons. He was pleased to note their settlement of the lime-water question.

Prof. Hele Shaw then rose to put on record the pious hope that domestic chimneys might come within the scope of the smoke washer.

The next Paper was by Sir John Wolfe Barry, on "Standardisation in British Engineering Practice." It gives the history of the Engineering Standards Committee and an account of its financial affairs, and of its constitution and procedure, together with some account of the benefits it has already brought about. In the discussion the President remarked that the standardising of English things tended to hold English engineers out of touch with Continental and American practice, and he hoped that the work of the committee would not interfere with the coming of the kilogramme. Prof. Dalby told a story about the Admiralty, on a certain occasion, having rolls cut to roll a few hundred yards of an odd size of rail that they had formerly had supplied by some manufacturer; and Sir William White trusted that standardisation would never be attempted in any branch till full development had been attained there. Of Sir John Wolfe Barry's reply the most interesting point was his statement that he was not in favour of the metric or a decimal system.

Mr. W. Taylor, of Leicester, then read a Paper on "A Magnetic Indicator of Temperature for use in Hardening Steel." In his first experiments the steel bar to be hardened was part of a magnetic circuit energised by an alternating current coil on the yoke. Another bar, outside the furnace for heating the bar to be hardened, was in magnetic parallel with the steel bar. Each of these bars in parallel are surrounded by what may be called secondary coils, connected in series so that the currents induced in them are in opposition; the coils being such that, when the bars are cold, the induced currents are equal and opposite, and therefore no sound is perceptible in a telephone kept in the electric circuit. Now since, for the purpose of hardening, steel has to be raised to about the temperature at which it loses most of its permeability, and since the loss of permeability by the heated steel destroys the balance of the induced currents described above, therefore the appearance of sound in the telephone gives notice of the moment for quenching the steel. A rougher form of apparatus, which has been in daily use in the tool-room for about four months, was described by the author. In this a permanent magnet produces a flux through a good magnetic circuit that includes the steel to be hardened. An alternative path is offered to the flux, but this path contains normally a small air-gap, which, however, can be closed by the rocking of an iron lever pivoted at its centre at one end of the permanent magnet. Each half of the rocking lever is part of the two magnetic circuits mentioned. When the steel is heated till it loses its permeability the flux through the alternative path becomes big enough to rock the lever, and this rings a bell to notify the workman. There was no discussion on this ingenious and, no doubt, useful device.

At the meeting of the General committee this afternoon Sir David Gill was elected president of the Leicester meeting, and July 31st was fixed as the date of the commencement of the meeting. Dublin was chosen as the city to be visited in 1908, and, after some discussion, it was decided by an emphatic majority to hold the meeting in 1909 at Winnipeg.

Saturday, August 4th.

There being no section meetings to day, the members scattered in all directions, a great many taking advantage of a very well organised series of excursions. The Engineering Section had, however, a treat to itself in the shape of a visit to the new waterworks of Harrogate, by invitation of the Corporation. The journey between Masham and the works was accomplished on the light railway owned by the Corporation, and the visit concluded with a tea given by Col. and Mrs. Crompton.

In the evening Prof. S. P. Thompson gave a lecture to between two and three thousand members of the operative classes on "The Manufacture of Light." The professor, as a native of York, was enthusiastically received. He explained how science was seeking, for reasons of economy, to find ways of getting artificial light unaccompanied by undue amounts of heat. By means of a lucid exposition of the spectral analysis of light from different sources, he enabled his audience to understand wherein the waste lay in our method of getting light by raising solid bodies to incandescence; he showed that polished platinum, because it radiated a greater proportion of the right kind of rays, was a more economical light-giver than a perfectly black body. But perfection in economy was at present seen only in the fire-fly, and in the glow of a Crookes tube. If it be remembered that between ten and twenty millions sterling is expended annually in Great Britain in obtaining artificial light, of which some 99 per cent. is wasted, there is great incentive to improvement. After the vote of thanks the professor remarked that to produce one candle-power by the phosphoric stimulation of willemite by radium would require £40 worth of radium, and interest on this capital would amount, he said, to something like ¼d. per hour—a tallow candle would be cheaper.

Monday, August 6th.

SECTION A.

Bank Holiday did not affect attendances at the section meetings; there seemed to be good audiences everywhere. The gathering in Section A was large and attentive when Mr. Strutt rose to open a discussion on the bearing of "Radioactivity on the Internal Structure of the Earth." Mr. Strutt began by sketching the measurements he has carried out to obtain the proportion of radium in the principal rock formations of the earth's crust. In deciding what rocks should be examined for radium he had been guided, he said, by the consideration that as most sedimentary rocks have been formed by the weathering and disintegration of igneous rocks, it should be sufficient to examine the latter class of rocks only. A great many samples of igneous rock have therefore been examined. The rock had first to be dissolved and the solution then examined by ordinary leakage methods for the emanation of radium. Solution is, of course, a great difficulty; but granite, for example, is managed by heating with an excess of carbonate of soda. He found that in the ordinary rocks of the crust there is on the average 10^{-11} gramme of radium per cubic centimetre. Now Rutherford has shown that the outflow of heat from the surface of the earth—computed from the heat-gradient and the conductivity near the surface—could be completely accounted for by supposing that every cubic centimetre of the solid sphere contained 10^{-13} gramme of radium per cubic centimetre. The amount actually found is greater than this; in fact, it would imply a temperature gradient in the surface strata of 1°F. per foot, instead of the usual 1 deg. per 60 ft. There are two alternatives, the speaker said: either the activity of radium is suspended in the deep layers of high temperature and pressure or the element radium occurs only in the skin of the globe. To the former alternative there is the objection that though radium has been examined at high temperatures and at high pressures no great change of its activity has been established. But, as regards the second alternative, there is nothing incredible, nothing new even, in proposing that the interior of the earth is different in constitution from the crust. Geologists require, in fact, a crust of only 20 miles thickness. Now, if the distributed radium is confined to the crust, computation shows that a shell of 45 miles thickness is necessary and sufficient.

Prof. J. Milne, the seismologist, took up the discussion. He described the seismographic record of a model earthquake. It shows three sets of vibrations, technically known as phase P_1, phase P_2 and phase P_3, recorded in this order in time. Phase P_1 comes through the body of the globe, and is distinct when the arcual distance between the source and the recorder is greater than 30 deg. Phase P_3 is the record of waves propagated round the earth along the crust. The fact that P_1 becomes distinct when the above-mentioned arc is exceeded indicates that below a depth of 20 or 30 miles there is a homogeneous mass filling the interior of the globe.

Prof. Gregory explained that among geologists there are two hypotheses current: the compression theory and the segregation theory, the second being the more favoured. The first attributes to pressure that great difference which, it is felt, exists between the properties of deep and of surface rocks. The segregation theory, roughly put, assumes that the earth is mainly a globe of, say, nickel-iron, with a coating of slag. The conclusion reached by Mr. Strutt deals a great blow at the old geological idea that the folding of strata has been produced by contraction due to cooling—an idea already almost abandoned by the modern geologist, and now replaced by the view that vertical movements are of truer importance. Arrhenius' theory of an interior made gaseous by the enormous temperature ruling there can now be ignored. Geology, in fact, never pointed to extremely high temperatures. The speaker concluded by suggesting an exhaustive radio-active survey of some complex geological region.

Sir William Crookes concentrated attention on whether environment can influence the rate of heat-production by radium. He suggested that radium locked up might be in a state of suspended animation and thought that, for example, in a mass of pitch blende the activity at the surface might be greater than that in the interior. He described an experiment made by himself some years ago and written up for the Royal Society but withdrawn before publication on the advice of the secretary. The experiment consisted in filling two precisely similar brass boxes with radium bromide and silica respectively, 50 milligrammes of each, and placing them in equal holes in a large block of ice. They were adjusted to the same level by a cathetometer and the whole left in an ice-cold room. At the end of 24 hours the expected sinking of the radium-filled-box through the ice had *not* occurred; which seems to show that no heat was given out by the radium. He still awaited an explanation of this behaviour of radium under these circumstances.

Sir George Darwin now drew attention to Airy's theory, deduced from measurements of the variations of gravity, that great mountain ranges are afloat like icebergs amid lighter strata than themselves. This theory, applied to the United States pendulum survey results, had shown that the facts could be tolerably represented by assuming a homogeneous core, surrounded by a crust of rather greater thickness than that deduced from the considerations of radio-activity. The most noteworthy result of the advent of radio-activity into these speculations was the nullification of all the estimates of the age of the earth based on the temperature gradient in the surface layers.

Sir William Ramsay suggested that if metallic meteorites contained no radium, that fact afforded strong presumption that the core of the earth was of similar character. He added that it was not certain that all the energy of the α particles of radium is converted to heat whatever the surrounding medium and conditions. Then Mr. Oldham explained how his calculations on data supplied by the speed of earthquake waves, calculations that allowed for the refraction of the waves in passing through layers of increasing density, led him to the conclusion that the earth has a central core nearly half the diameter of the earth, surrounded by a thick homogeneous shell and finally by the comparatively thin crust.

Mr. Soddy next pointed out that Strutt in his calculations had assumed that radium was the only radio-active element at work. If its products were taken into full account, and to that result the effect of the widely-distributed element thorium added, then the correction reduced the estimated crust thickness considerably. He also proposed to add to Strutt's two alternatives, set out at the beginning of the discussion, another possibility—namely, that there may be a building-up of heavier elements going on in the exceptional circumstances in the interior, with, of course, absorption of energy. There are sound reasons for believing that such a process must depend on concentration and on environment. Two other speakers followed with brief remarks, one of them suggesting that the frequent occurrence together of light and heavy metals in certain granites shadowed a possibility of the absorption of energy by transmutation.

Mr. Strutt, in his reply, showed that against the nickel-iron core hypothesis there stands the fact that the earth's mean density is only about $5\frac{1}{2}$. Regarding Mr. Soddy's suggested correction for radio-active substances ignored, it was providential that a mistake of Rutherford's in measuring the heat emission of radium, corrected by Rutherford himself since Strutt's calculations, practically set the old figure right. This explanation rounded off the proceedings, which had been followed by a large audience, drawn from many different sections, with the keenest interest.

A short note of some topical interest was read by Prof. Turner, of Oxford, on a "Possible Effect of Vibration on Zenith Distance Observations, with special reference to the tremors that threaten the Royal Observatory at Greenwich." It put on record, merely, the fact that the tremors of a passing train had been known to alter the reading of the circles of a clamped instrument in an observatory. It was stated that the committee who were considering the matter of the Greenwich Observatory were endeavouring to arrange periods when observations might be taken under normal conditions, at any rate for ten years.

In the evening Dr. A. D. Waller delivered before a large audience of members a lecture on the phenomena accompanying the electrical stimulus of living tissue, which he has made so well-known under the name of "blaze-currents."

SECTION G.

The proceedings were opened at the hour of 9:30 with a Paper by Prof. Hudson Beare on the new engineering laboratories of Edinburgh University and their equipment. Prof. Beare has been hampered in the laying out of the laboratories by having to fit them into old walls never intended for their present contents, and by having none too much money available. This last hardship has proved a healthy one, however, for, as the series of lantern-slides exhibited showed, thrift and forethought have joined hands to prevent lavish crowding of the laboratories with expensive machines and so left means and room for the equipment to grow and vary with the advance of engineering science. Both the President and Prof. Unwin remarked on these matters, the latter especially laying stress on the disadvantages of too elaborate equipment.

A Paper entitled "Glow Lamps Up-to-date, and the Grading of Voltages," which is given elsewhere in this issue, was then read by Sir William Preece. The Paper urges the adoption of rigorous standardisation of glow lamps, the establishment of a properly-legalised testing institution, and consequently a measure of legal protection for the user of glow lamps purchased in the open market. Prof. S. P. Thompson started the discussion by raising the whole question of the future of the glow lamp. He contrasted the performance of the modern metal-filament lamps with that of the carbon-filament lamps, greatly to the disadvantage of the latter. In fact, he indicated that serviceable metal-filament lamps with three or four times the efficiency of the carbon lamp would shortly drive the latter out of the field. Why, then, said he, waste all that human energy involved in carrying out Sir William Preece's proposals and in the fine grading of voltages when the carbon lamp is about to disappear and when metal-filament lamps, that can be manufactured exactly to any required voltage, are coming? Incidentally, Prof. Thompson went into the science of this matter of the superiority of the metal-filament lamp, and showed, by means of radiation curves from black bodies and from a polished body, that the latter gave, under similar circumstances, a greater proportion of its radiant energy within the visible spectrum.

Col. Crompton, however, disagreed with Prof. Thompson's discouragement of the work of the Standardising Committee; he did not think we were yet in touch with the new lamps. As regards the author's praise of American methods in this grading of glow-lamp voltages, American conditions were very different from ours. Here the small consumer was the dominating consumer. He thought the large variety of supply voltages in this country, experimental voltages they may be called, quite unavoidable in a progressive industry such as ours. Again, correcting Sir William's statement of the committee's reasons for standardising 110 and 220 as supply voltages, the real reason was to make provision for the power industry—*e.g.*, a motor built for 110 volts could be used on 100 or 120 volt circuits, then both common. Regarding the fine grading of voltages, he thought that in England, where lighting is the principal load, the switchboard difficulties in keeping the volts steady would be against the proposal. As for Prof. Thompson's explanation of the superiority of the metal-filament lamp, based on its getting hotter and radiating shorter waves than the carbon lamp, how was the luminous efficiency of the flame arc to be accounted for, which—so said Col. Crompton—is colder than the crater? The area that was luminous was, in his opinion, the principal thing to look at. He had just come from the bedside of Blondel, who was at present developing a luminous cloud method of illumination which promised an efficiency of $\frac{1}{6}$ watt per candle. Mr. Hammond's contribution to the discussion took the form of a tale of Mr. Swinburne's struggles on behalf of a certain syndicate to bring the glow lamp on the market. After long delay and expense the directors sent for Mr. Swinburne and asked when he would be ready to manufacture. In about two weeks, said he. A year went by, says Mr. Hammond, and the chafing directorate sent again and asked the old question. Well, said he, quite unabashed, I have now had another year's experience of the making of glow lamps, so I should now say three weeks. Mr. Hammond agreed that all lamps should be marked with volts, efficiency and candle-power and be brought under the Weights and Measures Acts.

The next Paper was by Mr. C. F. Jenkin, and was entitled "The Advent of Single-phase Electric Traction," part of which is reprinted in another column. The Paper is a very well-reasoned and convincing résumé of the advantages of electric traction in general, the matter being looked at from a great variety of points of view. Then the advantages of high-tension single-phase over low-tension continuous distribution methods were handled broadly, the main point being that any amount of power can be taken in the former case. But it is not possible to do justice to the Paper in this space.

In the afternoon many of the members visited, by invitation of the directors, the Cargo Fleet Ironworks near Middlesbrough.

Mr. A. J. Martin read a Paper entitled "A General Supply of Gas for Light, Heat and Power Production." He revived the old proposal for generating gas at the pit-mouth, and its conveyance by pipes to great consuming centres. He pointed out that though regarded as impracticable a few years ago, the feat of conveying gas long distances under high pressure had been successfully accomplished in America; both natural gas and coal gas having been piped, the former to distances of 200 miles.

Tuesday, August 7th.

SECTION A.

So great a congestion of postponed Papers had developed that the section was divided into three sub-sections, sitting simultaneously. In the sub-section devoted to general physics the first Paper was read by Mr. C. E. S. Phillips, on a glass of low resistivity. Our readers will remember that Mr. Phillips first drew attention to this glass in our Correspondence columns some months ago. To-day he gave the results of a number of measurements of the constants of the material. Mr. Rosenhain mentioned that some pottery glazes had a very similar composition, might serve as well and would be easily obtainable; and he elicited from Mr. Phillips that the method of measurement of the resistivity was to silver-plate both sides of a slab of glass and measure the leakage.

Next came a discussion on the nature of the radiation from incandescent mantles, which was planned to be opened by Mr. Swinburne. Unfortunately, Mr. Swinburne was absent, but his manuscript was read in the right spirit and with excellent effect by Prof. Porter, one of the secretaries of the section. Unhappily the Swinburnian style of humour cannot be reproduced in abstract. The writer really advocated the theory that the mantle radiates a great many luminous rays because, being a bad radiator, it nearly attains the high temperature of the Bunsen flame. The addition to thoria of a better radiator like ceria causes a greater output, but for that reason lowers the temperature, and therefore the added ceria must be kept small. A theory opposed by Mr. Swinburne is that of "selective" radiation, which he interprets to mean that these rare earths are assumed to send out a larger proportion of energy in the form of light than do ordinary hot bodies. Still another theory, also opposed by Mr. Swinburne, is the "catalytic," in which ceria is vaguely supposed to wobble between two states of oxidation, and so, somehow, to produce in the thoria radiations of higher frequency than usual.

Dr. H. Rubens brought to the discussion a mass of experimental evidence that shows once and for all that the simple high temperature theory is correct. Selective emission appears to this extent, that the oxide of thorium radiates as well as a black body (but no better) at the blue end of the spectrum and not nearly so well as a black body in the infra-red. This point was admirably demonstrated by using the principle that good radiators are good absorbers—*i.e.*, bad reflectors. The blue light reflected from a cold mantle was thrown on the screen; now, when the mantle was heated (in the ordinary way) the screen darkened because less blue light was reflected. Then, when hot, a mantle behaves as a black body for blue rays. Again, by knowing just when the mantle is behaving as a black body, its temperature can be measured by a radiation pyrometer. The highest temperature so far recorded is 1,590°C. The above facts were emphasised by a series of charts of bolometric measurements of the spectra of various mantles. These curves show that 1 per cent. of ceria is as much as should be added to a thoria mantle. Prof. S. P. Thompson, Lord Rayleigh and Sir W. Ramsay made remarks and put a number of general questions to Dr. Rubens. Prof. Porter summed up one phase of the difference between the purely physical and the chemical schools of opinion by saying that adherents of the former school suppose the radiation from a mantle to be exactly the sum of that from the thoria and that from the ceria, while the others think the total radiation of any wave-length is greater than that sum.

Finally the president, amid great laughter, read Mr. Swinburne's replies to the comments that might have been made by various speakers. Some of these replies are noteworthy: To Prof. Armstrong—electrolysis has nothing to do with it; to Prof. Larmor—it is always safe to agree with Prof. Larmor, whether you understand him or not; to Dr. Rubens—there are now so many experimental results that abundant support can be selected for any theory.

Prof. Trouton read an excellent little Paper, by Mr. Whiteside, on the rate of decay of the phosphorescence of Balmain's luminous paint. The experiments show that the phosphorescence falls off according to a hyperbolic law, just as does fatigue in overstrained solids—a suggestive similarity.

Sir W. Ramsay and Dr. J. F. Spencer described in a long Paper the results of experiments on "Chemical and Electrical Charges induced by Ultra-violet Light." A great many elements in the form of plates were submitted to ultra-violet light, and the well-known discharging properties of the rays shot off from the elements examined accurately in regard to their power of discharging an electroscope. The rays have considerable penetrating properties; for example, they will just pass through aluminium leaf, but they discharge positively and not negatively electrified electroscopes. The most important point elucidated was in connection with the fatigue exhibited by the plates. It was found that the curve of discharge and time of exposure consisted of rising straight lines interrupted by horizontal portions, the sloping parts having all approximately the same gradient. It appears that for dyad metals these curves present two horizontal portions, while for tetrad metals there were four. The explanation offered by the authors was clearly the offspring of chemical minds and did not appear to appeal to the physicists they were addressed to. Sir William Ramsay, in elaborating the account of his position, stated that he agreed with the views now spreading that, namely, a metal as we know it is a compound of an electron and a metallic ion. When it loses an electron, a metal does not necessarily become positively charged, but becomes something else. In reply to suggestions that chemical surface actions might have something to do with the fatigue discovered, the authors believed that the vigorous polishing before each experiment must have exposed a fresh surface; the fatigue arose through the interior metal being robbed of electrons.

Mr. Soddy then gave a remarkable Paper on the positive charge of α-particle carried by radium C, a great-grandson of the radium emanation. He began with the alarming suggestion that perhaps the law of the equivalence of positive and negative electricity is not true, at any rate when considerable in quantities of electronic order. For instance, radium emanation shoots off positive particles and yet is not left negatively charged. But, as he proceeded to show, this is probably due to a fact now demonstrated that the α-particle steals its charge from the first atom it meets after beginning its fast career. It has been proved, said Mr. Soddy, that the α-particle goes right through any atom it encounters, somewhat as one planetary system may be conceived to penetrate another; in the passage it usually acquires a positive charge. Now Mr. Soddy has examined the α-particle in the interval of time between its creation and its first atomic encounter. He has done this by depositing in a definite length of an extremely minute capillary tube a layer one atom thick of radium—C—a feat made possible by knowing the decay constants of the emanation first passed into the tube. Of course, only those α-particles projected at grazing incidence from the thin radio-active layer, fly along the tube and escape from its end. To remove gas atoms from the reach of the α-particle the whole space of the experiment must be exhausted to the extreme. Then, after weeks of failure, it was at last found that α-particles can be obtained which are quite undeflectable in a strong magnetic field—that is, which are quite unchanged. The extreme delicacy of this piece of work is indicated by the fact that the gradual corrosion of the glass surface during the disintegration of the radium C, of atomic dimensions though it is, spoils the shooting of the α particles and gives them obstructions from which they gather a positive charge. Both Lord Rayleigh and the President paid high tribute to this "almost incredible" result of experimental skill.

There remained so many Papers to be dealt with that the section met in the afternoon in five sub-sections. The only items that need be recorded here are the delivery of the report of the Falmouth Observatory committee, the report on the magnetic survey in South Africa, and the report of the Electrical Standards committee.

SECTION G.

At 10 o'clock Prof. Dalby gave a small lecture on the balancing of engines, illustrating his points and conclusions by means of some excellent models. It would be unprofitable to attempt here, without illustrations, any summary of the lecture. In a Paper by Mr. Gerald Stoney, recent advances in steam turbines were discussed. His remarks mainly referred to the recent development of the turbine blowing engine, for use chiefly with blast furnaces. It appears that during the past three or four years a number of these blowing engines have been delivered to iron smelters, the usual size taking 20,000 cubic ft. of air per minute and delivering it at 10 lb. pressure. The pressure can be raised, however, in these plants, as high as 16 lb. or 17 lb. The other development dealt with by the author is the adaptation of the steam turbine to utilise the exhaust from reciprocating engines. It is expected soon to put this application into considerable use on tramp steamers, where, it is believed, there will be a net economy of 15 to 25 per cent. on the coal bill. In the discussion Mr. Hammond called attention to the possibility of diminished efficiency arising from increased clearance caused by wear; and other speakers asked the perennial questions about adapting the turbine to internal combustion, or applying it to locomotives and motor cars. In his reply Mr. Stoney stated that the change in clearance due to wear had very little effect on efficiency.

Wednesday, August 8th.

SECTION G.

Although this is the last day of the meeting, and though several sections finished off their work yesterday, there was a very good gathering in the Engineering Section. Dr. Henderson's Paper on the measurement of temperature by radiation methods, which we hope to reproduce in full in our next issue, was received with great attention. The principal comments on the Paper fell from Dr. Harker, of the National Physical Laboratory. He referred first to the difficulty of exciting a standard radiating surface of known temperature—a necessity for calibrating pyrometers; and he detailed the difficulties that arise in the use of the hot fire-clay or carbon tube whose heated interior yields the at present most perfect approach to the radiation of a perfect black body. A principal difficulty in connection with the Féry radiation pyrometer had been to fill the mirror with the legitimately available beam from the tube furnace; but in modern instruments the addition of an adjustable and calibrated diaphragm had helped greatly.

A Paper by Mr. S. Cowper-Coles on "Electro-positive Coatings for the Protection of Iron and Steel from Corrosion," was then given. The coating, say with zinc, is effected by rolling the iron objects among zinc-dust in a drum heated by Dowson gas to comparatively low temperatures. It is best, but not necessary, to exhaust the drum and to add carbon to the zinc-dust, to prevent oxidation. The coating action takes place below 300°F, though it is quicker at higher temperatures of course; and thus the method may be applied to steel spring without drawing the temper. The physical explanation of the process is that the zinc vapour penetrates the outer layers of iron and forms an alloy. Microsections were exhibited showing that coming outwards through the skin of coated iron the proportion of zinc in the alloy grew till practically pure zinc appears. Other metals than zinc such as copper, antimony and bismuth can be deposited; and aluminium can be coated and so render soldering possible. The author showed that inlaying of metals can be carried out successfully in the most ornamental designs.

The president elicited the fact that the temperature of treatment need not exceed that of the eutectic alloy of the melting metals, and remarked that Roberts-Austen had shown the possibility of diffusion of one metal into another even at ordinary temperatures.

In reply to Mr. Hawksley it was stated that zinc-coating such small things as nuts and bolts cost about 25s. per ton, the chief cost arising in the pickling process and in the handling. Mr. Cowper-Coles, in his reply, mentioned that the process had been useful in hardening surfaces. Copper, for example, can have its surface converted to brass, and aluminium can be greatly hardened similarly.

The proceedings terminated after the reading of a Paper by Prof. Dalby on "Suction Gas Engine Plants," and of one by Mr. Douglas Mackenzie on "Waterproof Roads as a Solution of the Dust Problem."

CORRESPONDENCE.

SOME CAUSES OF ERROR IN PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest Mr. Trotter's letter in your last issue on the subject of angularity errors in photometry. I must apologise to Mr. Trotter for having unintentionally libelled him in christening after him a form of photometer in which the rays strike the screens at an angle of 60 deg. I do not, however, regret the offence, since my indiscretion has called forth from Mr. Trotter a set of very interesting curves, showing the effect of angular displacement when both angle of incidence and angle of view are simultaneously varied. This is a manner of displacement which I did not go into in my article. I am, however, interested to note that at the angle which Mr. Trotter suggests—namely, 35 deg.—the error due to displacement of angle of incidence is largely compensated for by the error due to change of view angle. If the view angle were to remain fixed, the error due to change of angle of incidence would be 2½ per cent. for 1 deg. of angular side play of carriage, as against 6 per cent. for a normal angle of incidence of 60 deg.

In reply to Mr. Lemmens, I would say that I did not in my last letter reply to his remarks on street photometers, as I do not take street photometry very seriously. The conditions in street photometry are such that any errors due to incorrectness of angle are entirely swamped by the very much larger errors due to fluctuations of light. I do not, however, see how the greater distance met with between the light and the screen can in any way facilitate the exact measurement of the angle of incidence. Turning to test-room photometers, I cannot see that viewing the screen vertically can make the correct alignment of lights any the easier, as then the lights must be very accurately adjusted vertically, and it is a very difficult matter to ascertain correctly the centre of gravity of a filament consisting of, say, three turns and two long legs.—Yours, &c.,

Westminster, S.W., Aug. 8. LANCELOT W. WILD.

THE PACIFIC CABLE.

The annual Parliamentary return has just been issued, giving the accounts relating to the working of the Pacific Cable during the year ended March 31, 1906. In presenting this return, Sir Spencer Walpole, K.C.B., Chairman of the Pacific Cable Board, makes the following observations:—

1. Throughout the year 1905-6 the cable was maintained and continued in efficient working order. I am glad to be able to report that no interruption of any kind occurred on any of its sections. The Board's ship, buildings, electrical apparatus and plant at all stations are also in good order.

2. The gross message revenue received during the year amounted to £94,456. 9s. 6d., against £84,301. 9s. 1d. in the previous year. From the gross revenue, however, £2,642. 0s. 7d. has to be deducted, on account

of payments made to the Atlantic and Canadian Pacific Telegraph Co's. for transmitting between Vancouver and Europe, or vice versa, the date and time of filing of all messages between Australasia and the United Kingdom, the Continent, &c., and for delivering messages in duplicate in London and some other large centres in the United Kingdom, these payments being necessary to give to the customers of the Pacific Cable the same facilities that are afforded by the Eastern Co.'s route. With this deduction the net message revenue amounted to £91,814. 8s. 11d., against £82,188. 1s. 5d., and, including a small sum received as interest on balances, the entire revenue reached £91,952. 13s. 3d., against £87,446. 10s. 8d. in the preceding year.

3. The message revenue during 1905-6 was increased from the decision of the Government of the Commonwealth of Australia to pay over to the Board the whole of the receipts in Australia up to December 31, 1905. In previous years the Government had only transferred the receipts, before the close of the financial year, up to November 30th. The message revenue therefore, for 1905-6 contains the receipts in Australia for 13 months.

4. The actual expenditure of the Board on the service of the cable during the 12 months ending March 31, 1906 (including the sum of £34,000 set aside for the renewal account), amounted to £86,963. 17s., against £85,751. 11s. 2d. in the previous year, and subtracting this sum from the amount of the revenue, there remains a surplus of £4,988. 16s. 3d. The Board, however, had to provide a sum of £77,544. 18s. for interest and sinking fund. This sinking fund will extinguish in 50 years from its institution the entire capital expenditure. Adding this payment to the expenditure, the deficiency on the year's operations amounts to £72,566. 1s. 9d., against £75,849. 18s. 6d. in the previous year. This deficiency has to be made good by the contributing Governments.

The financial results of the year 1905-6 are set forth in the following statement :—

Receipts.

Traffic receipts	£94,456 9 6	
Less "Date and Time," &c., payments	2,642 0 7	
		£91,814 8 11
Interests on deposits		138 4 4
Deficiency recoverable in the following proportions:		
England	20,154 9 4	
Canada	20,154 9 5	
Australia	24,185 7 3	
New Zealand	8,061 15 9	
		72,556 1 9
		£164,508 15 0

Expenditure.

Third annuity payment	£77,544 18 0
Head office (salaries and expenses)	4,916 11 4
Head office (advertising, canvassing, engineers' fees, royalties and cost of remitting money home)	1,400 2 3
Stations (salaries and expenses)	29,697 18 3
Ship (salaries and expenses)	15,338 17 3
Provident fund	1,359 5 5
Renewal account	34,000 0 0
Expenses in connection with the opening of new offices in Australia	251 2 6
	£164,508 15 0

5. The renewal fund, including interest, amounted on March 31 last to £125,158. 3s. 1d. £12,500 of this sum was held in spare cable. The amount of £109,907. 10s. 7d. was invested in Home and Colonial securities as shown in Statement VI., while a balance of £2,750. 12s. 6d. was in hand, and has since been invested. All interest earned on the investments is added annually to the fund, and is not treated as part of the revenue of the year.

6. The Board's forecast of its probable revenue and expenditure during the year 1906-7, as submitted to their lordships on December 30th last, is as follows :—

Traffic revenue	£88,600	Annuity	£77,545
Estimated deficit	87,006	Renewal fund	33,000
		Working expenses *	65,061
	£175,606		£175,606

7. The land-line services in Canada, Australia and New Zealand in connection with the cable have been generally well maintained by the Governments concerned and by the Canadian Pacific Railway. The Atlantic companies have afforded uninterrupted cable communication throughout the year and a rapid and efficient service.

8. The Board is glad to be able to acknowledge the consistently good and loyal services rendered by their staff throughout the year. The health of the staff has been generally satisfactory and the Board is glad to report no serious illness has occurred.

9. Under Capt. Sharp the efficiency of the Board's repairing vessel and the discipline of the ship's company have been well maintained. In deference to the wishes of the Australian and New Zealand Governments, the Chinese stokers have been replaced by natives of Norfolk Island, who have, so far, given satisfaction.

10. In accordance with the recommendations contained in the report of the conference of the various Governments concerned, which was issued in July, 1905, and in consequence of the negotiations with the Eastern Extension Co. having fallen through, the Board despatched their general manager, Mr. Reynolds, to Australia to initiate active competition in that colony. The company having refused to accept the Commonwealth agreement as defined by the Conference, the Commonwealth Government at once withdrew the privileges provisionally extended to the company in Melbourne, and accorded to the Board facilities in Sydney similar to those enjoyed by the company under the New South Wales agreement. Advices from Mr. Reynolds indicate the early opening of the Board's offices in the latter city.

11. The attached statement may be of interest as showing the progress of the traffic since the opening of the cable.

Number of International Messages and Words.

—	Messages.				Words.			
	Ord.	Govt.	Press.	Total.	Ord.	Govt.	Press.	Total.
1902-3	18,494	915	35	19,444	202,313	24,210	1,831	228,354
1903-4	64,595	3,128	890*	68,613	744,034	83,116	37,819*	864,969
1904-5	67,677	3,018	387	71,082	781,028	71,575	19,110	871,713
1905-6 (approx.)	..	..	..	81,130	..	..	..	917,281

* Cricket.

The capital expenditure on the Pacific Cable undertaking up to March 31, 1906, was £1,997,707. 18s. 6d. (of which £3,774. 4s. 2d. has been expended during the financial year) :—

Details of expenditure.	In period ended March 31, 1905	Year ended Mar. 31, '06.	Total to March 31, 1906.
Head office (furniture, &c.)	£411 6 10	£5 15 0	£417 1 10
Stations—Buildings	63,799 17 10	2,206 0 8	66,005 18 6
Accessories	17,581 17 3	874 7 11	18,456 5 2
Cable—Contract	1,790,687 15 6	..	1,790,687 15 6
Accessories	335 15 0	..	335 15 0
Instruments	28,100 4 3	688 0 7	28,788 4 10
Ship—Contract	65,910 0 0	..	65,910 0 0
Accessories	6,971 8 1	..	6,971 8 1
Engineers' fees & expenses	20,135 9 7	..	20,135 9 7
	1,993,933 14 4	3,774 4 2	1,997,707 18 6

PARLIAMENTARY INTELLIGENCE.

Royal Assent.—The following Acts of Parliament have received the Royal Assent :—

Electric Lighting Orders Confirmation (Nos. 3, 4 and 7), Tramways Orders Confirmation, Ascot District Gas and Electricity, Derbyshire and Nottinghamshire Electric Power, West Yorkshire Tramways, London County Council (General Powers), London United Tramways, Twickenham and Teddington Electric Supply Co.'s, Newcastle-upon-Tyne Electric Supply Co.'s, Baker Street and Waterloo Railway, Southport and Lytham Tramroad, Wallasey Tramways and Improvements, Kent Electric Power, Folkestone Sandgate and Hythe Tramways, Bacup Corporation, County Council of Middlesex (General Powers), Macclesfield and District Tramways, Corporation of London (Blackfriars and other Bridges), London County Council (Tramways and Improvements), County of Durham Electric Power Supply, Shropshire, Worcestershire and Staffordshire Electric Power, Hackney Electricity, North-West London Railway, St. Pancras Electricity, South Wales Electrical Power Distribution Co., and Lancashire Electric Power.

LEGAL INTELLIGENCE.

Dudley, Stourbridge & District Electric Traction Co. (Ltd.) v. Dudley Corporation.

This case came before the Court of Appeal again yesterday. The question was as to the basis on which valuation was to be made of a light railway which was being taken over by the Corporation from the Company—whether the Light Railways Act or the Tramways Act should apply ?

The case had stood over in order that the sanction of the Board of Trade might be obtained to the appointment of an arbitrator. This sanction having been given, Mr. CRIPPS, K.C., for the appellants (plaintiffs), contended that the decision of Mr. Justice Swinfen Eady was wrong.

The Court intimated that they were not satisfied with the case as presented to them, and suggested that the arbitrator should be asked to state in his own language what led him to accept the particular figure which had been presented to the Court.

The appeal was accordingly directed to stand over.

National Telephone Co. v. Wakefield & District Tramways Co.

Before Mr. Justice Swinfen Eady on Friday plaintiffs applied for an interim injunction.

Mr. EVE, K.C., for plaintiffs, said a large mass of evidence had been filed, and as defendants desired an adjournment he could not oppose.

The motion stood over until Wednesday, when Mr. EVE said there was a direct conflict of evidence as to the respective rights of the parties to use the highway, and the matter could not be disposed of on motion. He therefore asked that it stand over until the trial of the action.

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* Including £8,000 for expenses in connection with opening offices and competitive tactics in Australia.

Mr. MACNAGHTEN, K.C., for defendants, said the case raised an important question of the construction of an Act of Parliament. The light railway company were putting up standards for electric traction, and the telephone company had their wires adjoining. The trams would be running in about three weeks.

His LORDSHIP acceded to Mr. Eve's application, reserving the question of costs.

In re Electrical Corpn. (Ltd.)—Mr. Justice Buckley on Tuesday allowed the petition of O. C. Hawkes (Ltd.) for the compulsory liquidation of the Electrical Corpn. (Ltd.) to stand till next sittings, the corporation having passed a resolution for voluntary winding up.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Sunderland Corporation require an electrical engineer to take complete control of the Municipal electrical undertaking. Candidates must be not more than 40 years of age, must have had a thorough training as mechanical and electrical engineers in some recognised works, also in a recognised technical college or similar institution, have had actual experience in high-tension alternating (preferably three-phase) supply, and be M.I.E.E. Preference will be given to one who has previously held with merit the position of electrical engineer of a borough or well-known supply company, and had experience in designing and controlling extensions; also to one holding the Diploma of the I.C.E. Salary, £800 per annum, increasing £50 yearly to £1,000. Applications to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon, Aug. 29. Further particulars are set out in an advertisement.

Barrow-in-Furness Corporation invite applications for the appointment of mains superintendent at a salary of £135 per annum. Applications (addressed to the Chairman of the Electricity committee), to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, Aug. 20. See also an advertisement.

Erith Urban District Council require an assistant electrical engineer, who must have had a sound mechanical training. Preference will be given to one with practical experience in the working of a three-phase system. Salary £150. Application to the chief electrical engineer (Mr. Geo. E Heath), High-street, Erith, by 10 a.m. Monday, Aug 20.

A resident engineer and manager is required at once for a combined electric tramway and lighting undertaking in India. See also an advertisement.

A traveller is wanted for abroad with good electrical training and fluent French and German. See an advertisement.

Glasgow Corporation require an inspector of lighting, at a salary up to £400 per annum. Applicants must have experience in street lighting by electricity and gas. Applications by Aug. 13.

Mr. C. W. Shepherd, traffic superintendent of the Edinburgh & District Tramways Co., has been appointed general manager in succession to Mr. J. E. Pitcairn, who has retired.

Salford Council have appointed Mr. Romers chief assistant to the mains superintendent at £156 per annum.

Hanley Council have appointed Mr. W. Pryor canvasser of the electric light department.

Mr. R. Barry, of Preston, has been appointed shift engineer at Leicester tramway power station.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 18 and ends on March 28. Students in the engineering and naval architecture departments usually spend the summer months in practical work. Prospectuses of the courses for the B.Sc. and D.Sc. degrees and syllabus of classes from Prof. Barr, James Watt Engineering Laboratories, The University, Glasgow.

University of Manchester..—Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. This subject may be taken as part of the courses for the B.Sc. degree in both the honours schools of engineering and physics. A special course has also been arranged extending over three years and preparing for a certificate in electrical engineering. The session commences on Oct. 2. Prospectuses from the registrar. Prospectuses containing particulars of the lecture, laboratory and drawing courses in the engineering department, also the course in physics, mathematics and chemistry (qualifying for the degrees in engineering and the engineering certificate) can be obtained from the Registrar.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Glasgow and West of Scotland Technical College.—The next session begins on Tuesday, Sept. 25, in the new buildings. The diploma of the college is granted in electrical, civil and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed University classes. There are new and well equipped laboratories in the departments of physics, electrical engineering, mechanics, technical chemistry, &c. The preliminary examination for candidates for the diploma begins on Sept. 17, and names of candidates must be lodged by Sept. 14. Prospectuses from the Secretary.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

London Trade Schools.—Acting on the recommendation of the special committee on the Apprenticeship question, the London County Council opened certain trade schools for girls at Easter, and it is now proposed to extend similar benefits to boys.

The Council have arranged to open trade schools for boys, the aim of which will be to give the scholars leaving the ordinary schools at the age of 14 to 16 a thorough preliminary training for certain trades, while at the same time continuing their general education. It is proposed to open the following schools in September:—

Poplar School of Engineering and Navigation.

School of Engineering, at L.C.C. Paddington Technical Institute.

School of Silversmithing at the L.C.C. Central School of Arts and Crafts, Regent-street, W.

At the last meeting of the Council it was decided to offer a number of scholarships, tenable at the above schools, for competition after the summer holidays. The scholarships are to be open to boys between the ages of 14 and 16, who are resident in London, and whose parents' incomes do not exceed £160 a year; they are to be tenable for two years, and, in addition to free education in general subjects and in the trade chosen, carry maintenance grants of £10 the first year and £15 for the second. The scholarships will be awarded on the result of an examination in arithmetic, English subjects, and drawing. Applications, on forms to be obtained from the Executive Officer, Education Offices, Victoria Embankment, W.C., must be returned by Aug. 31.

Acton.—Mr. J. Martin Blair, resident electrical engineer, has prepared a list of "Useful Notes on Electric Lighting," which is being distributed throughout the district. These notes include a number of estimates for lighting small residential and shop premises, and also give intelligible particulars of the facilities which the electricity department of Acton District Council offer in the way of installation work, &c. From Oct. 1 the consumer of electric current for power and heating purposes in the Acton district will have the option of either a maximum demand rate of 3d. per unit for the first two hours' consumption, and 1d. after, or a flat rate of 2d. per unit.

Aspull.—The Council have applied for an extension of time for carrying out their provisional electric lighting order, 1901.

Barrow-in Furness.—The Corporation have entered into an agreement with Messrs. Vickers, Sons & Maxim for supply of electricity to the Company's Buccleuch Dock works.

Bournemouth.—The electric tramway between Bournemouth and Parkstone, about 2 miles in length, was opened for traffic on Friday.

Brighouse.—The Council have decided to apply for Parliamentary powers to erect new electricity supply and refuse destructor works. The Council already possess a small generating station, purchased some years ago from a local company.

Burslem.—It has been decided to adopt electrically driven pumps at the sewage works.

In dry weather the estimated cost of driving one horizontal engine, operating either one 9 in. low-lift pump or two 6 in. low-lift pumps would be 1s. 5d. per hour; and the cost to drive one 25 B.H.P. electric motor, driving one 9 in. low-lift pump would be 1s. 2d. per hour. The other pumps, which are brought into action in wet weather, show a further advantage in favour of electricity, because the current used would be in direct proportion to the load, whereas in the case of steam-driven pumps a reserve of steam must always be available.

Bury (Lancs.).—The borough engineer (Mr. A. W. Bradley) is preparing plans, estimates, &c., for the extension of the Bolton-road tramway route to Bolton.

The Council have applied for sanction to a loan of £17,500 for additional plant, mains extensions, meters, &c., and the provision of a show room for the electricity department.

Colchester.—We regret to learn that the borough electrical engineer (Mr. A. R. Sillar) sustained last week somewhat severe injuries as the result of a fall from a bicycle owing to a defective brake. We are pleased to learn that Mr. Sillar's condition is not considered dangerous.

Sanction is being sought to a further loan of £11,000 for extensions of the electricity undertaking.

At the meeting of the Council last week, the chairman of the Electricity Supply committee (Mr. Barritt) submitted tables prepared by the borough electrical engineer (Mr. A. R. Sillar) showing the progress of the undertaking. From these it appeared that the capital expenditure is £67,537. 7s., or £62 per 1,000 units sold in 1906. The total gross profit was £21,638. 13s. 10d., interest came to £7,462. 15s. 11d., repayment of capital to £7,778. 9s. 3d., reduction of suspsnse account £796. 9s. 1d. and £3,343. 4s. 1d. was voted towards depreciation of site. There had been a gradual, steady and continuous rise in the amount of gross profit year by year, and the total amount which had gone to relief of rates was £2,000. The amount carried forward was £257. 15s. 6d. in 1906.

Customs Duties.—According to recent decisions the United States import duty on electric light carbons of a minimum length of 5 in. is 90c. per 100, and the duty on battery carbons not suitable for electric lighting and severally less than 5 in. inlength is 35 per cent. ad val.

Electric Lighting Notices.—The following additional notices of intention to apply for provisional electric lighting orders have been given :—

Amersham.—Empire Electric Light & Power Co.
Chorley.—A. C. Tupp and W. A. Mitchell.
Cirencester.—Cirencester Electric Supply Co.
Dunstable.—Mutual Electricity Supply Co.
Eastleigh and Bishopstoke.—Mutual Electricity Supply Co.
Leighton Buzzard.—Mutual Electricity Supply Co.
Woodhall Spa.—Foote & Milne.

Electricity in Mining.—At the recent meeting of Pease & Partners (Ltd.), Mr. A. F. Pease said that at the Loftus mines they had adopted a combined gas-producing and electrical plant, and they proposed to take a large quantity of electric current from one of the power companies for their Eldon colliery in preference to putting down a power station of their own.

Exeter.—An inquiry was opened on Tuesday into the Council's application for sanction to borrow (among other sums) £15,000 for extensions of the electric lighting mains, transformers, &c.

The town clerk (Mr. L. Parry) said that the application might be divided into three parts. They required £2,600 to meet excess expenditure on the application made in 1902, when sanction was given to borrow £68,385. The second part of the application was for £9,990 for mains, transformers, &c., which were the subject of an application in 1902. The electricity department had been steadily growing; the number of private consumers was increasing every year, and last year the number was 897. The increase was not only in private lighting, but also in the supply of power for industrial purposes. The total number of units sold to private consumers for lighting and power had increased from 295,861 in 1901 to 505,237 last year. The third part of the application was for £2,910 for laying mains, &c., in the Heavitree district. Last year there was a surplus of £934, after meeting sinking fund charges, bringing the total of the surplus interest, &c., to £1,162.

Technical evidence was given by the borough electrical engineer (Mr. H. D. Munro) and the borough engineer (Mr. D. Cameron).

The inspector (Mr. H. R. Hooper) complained that he had not received a true account of the excess expenditure. An item for boilers should have been charged to revenue.

After discussion the Town Clerk said, having in view the attitude of the Board in regard to excess expenditure, his best course would be to withdraw the application for £2,600, for reconsideration by the Council.

As to the loan for £9,990, he said approximately half of that amount had been expended within the last 12 or 18 months.

The Inspector: When did the expenditure begin?—

The Town Clerk: At the time we made our last application.

The Inspector asked for full particulars of expenditure up to March 31, 1906. Their expenditure would then be divided into two parts, money expended and money to be expended.

The Town Clerk said he prepared his particulars on the lines of the application made in 1902. He preferred to make the application on the lines suggested by the inspector.

The inquiry was adjourned sine die.

Exhibition.—The Comité Français des Expositions à l'Etranger, which promotes all French exhibitions officially recognised by the Government, last week paid a short visit to London, and confirmed the selection of the site at Shepherd's Bush for the projected Franco-British exhibition in 1908.

Godalming.—The Council have decided to give notice to the Urban Electric Supply Co. to determine the existing contract for street lighting as from 1st inst. and to enter into a fresh agreement with the company for five years for street lighting as follows:—0 arc lamps of 27,000 c.p.; 110 incandescent lamps of 70 c.p. and 130 of 25 c.p.—total 37,960 c.p. The Gas Co.'s tender was £786 per annum, and the illuminating power would be only from 20,000 c.p. to 23,000 c.p.

Great Grimsby.—The L.G. Board have again written the Corporation, adhering to their decision to exclude from loans sums paid as wages to men in the permanent employ of the Corporation.

In the opinion of the Board those wages are establishment charges and should not be paid out of borrowed moneys, and it is the Board's rule to deduct any such payments from the amount of a proposed loan. That rule (continues the letter) in no way prohibits local authorities from employing their own workmen.

After discussion, the Council unanimously resolved to make a further protest against the decision.

Greenock.—The demand for electric current for power and lighting continues to grow in a very satisfactory manner, and among recent customers are Messrs. John Hastie & Co., who have installed an additional 25 h.p. motor in the new section of their engineering works. The Glebe Sugar Refining Co. are about to experiment with electric driving, and the Corporation are installing a 20 h.p. motor in this firm's works. The Reformed Presbyterian Church in West Stewart-street is being wired.

Hanley.—The Electric Lighting committee have offered to maintain a stand-by supply of electric current for a hotel in the district for the equivalent of 552 16 c.p. lamps at £126 per annum.

The electrical engineer (Mr. C. H. Yeaman) recently reported to the committee on the best method of popularising the use of electricity for lighting and power. Mr. Yeaman is unable to recommend the provision of a show room in the centre of the town at present. As an alternative he suggests that wiring contractors engaged solely in electrical work should be supplied with current at 1d. per unit on the condition that such current be used for display purposes, and that the amount paid quarterly should not be less than the corresponding bills in the past 12 months. The recommendations have been adopted.

Islington (London).—Consideration of the recommendations of the Lighting committee as to the reorganisation of the staff, as set out in our last issue, has been adjourned until after the recess.

The Lighting committee received offers for purifying plant for treating the well water to render it suitable for feed water purposes, but the chief engineer to the National Boiler & General Insurance Co. (Mr. G. Hiller), to whom the question was submitted, advises that none of the offers be accepted.

Italy.—The British Consul-General at Naples (Mr. E. Neville Rolfe) states that important results have followed the issue of the law of July 8, 1904, under which land and motive power are granted almost free and exemption from duties and taxes allowed for 10 years to manufacturers establishing new industries or enlarging existing ones at Naples. Mr. Rolfe adds that it will take nearly three years to furnish the electric motive power promised to the new industries This, to the extent of 16,000 h.p., is to be derived from the river Volturno.

The "Bulletin" of the French Chamber of Commerce at Milan announces the establishment at Milan, with head office a Borgomanero, of a limited company with a capital of £16,000 (with power to increase to £40,000) for the generation and distribution of electric power to various places in the neighbourhood. The director of the company is Sig. Jean Ghiglione.

The "Bulletin" also states that the firm of Baron Jean La Cana has applied for a concession to construct and work an electric railway between Rome and Naples.

At Bari a new undertaking, the Società Elettrica Barese, is now furnishing electric current to private subscribers at 40c. (about 4d.) per unit, to which has to be added 6c. per unit for the Government tax. At Bari two wireless telegraph posts were recently demolished by storms, and the lighthouse tower near by has been provisionally substituted.

The wireless telegraph installation at Antivari was recently injured from the same cause, and the wireless service has, in consequence, been subject to repeated interruptions.

A company has been formed at Milan with a capital of £20,000 to construct a funicular railway at Capri and to supply electric current for lighting and power at Capri and Anacapri and other public works. The generating station will be gas-engine driven with a storage battery reserve. It is expected that the system of traction for the funicular railway will be similar to that employed at Monreale near Palermo. The length of the line is 2,170 ft., with two tunnels and and five arched viaducts. The line is to be completed by next spring. It is expected that the company will be in a position to supply current for lighting by about October.

Kingston-on-Thames.—An honorarium of £21 has been granted to the borough electrical engineer (Mr. J. E. Edgcome) and £5. 5s. to the assistant engineer (Mr. Winterhalter) for extra work in connection with the relaying of the electric light cables during the construction of the tramways.

L.C.C. Tramways.—The Catford-Victoria (via Camberwell and Vauxhall-bridge) and the Tooting-broadway and York-road, Battersea, tramway routes were inaugurated on Sunday.

Islington (London) Council last week decided to adhere to their resolution not to agree to the overhead system of traction in any part of the borough.

The contractors for the "Angel" to Highbury section of the tramways have notified the Council that they will commence to day (Friday) the work of reconstructing the permanent way of this route for the conduit system of traction.

Longton.—It has been decided to take up a loan of £3,450 for extending the electric light mains, &c.

Middleton (Lancs.).—The salary of the borough electrical engineer (Mr. S. Pauls) has been increased by £25 per annum.

Obituary.—The death is announced of Sir Sydney Hedley Waterlow, Bart., K.C.V.O., in his 84th year. Deceased was a well-known philanthropist and public man. He was Lord Mayor of London in 1872 3, and among other offices of a public character which deceased filled he was treasurer of the City and Guilds of London Institute for the Advancement of Technical Education and a member of the Royal Commission for the Exhibition of 1851.

Personal—With the issue of "The Journal of the Society of Chemical Industry" for July 31 a good portrait of Dr. Ludwig Mond, F.R.S. (of Brunner, Mond & Co., Ltd., and hon. Foreign Secretary of the Society of Chemical Industry) is issued as a supplement.

Rutherglen.—Last week the Council approved the agreement with the Clyde Valley Electrical Power Co. for the supply of electricity to the burgh.

Sheffield.—The question of tramway fares and finance occupied the attention of the Corporation for some time on Wednesday. The subject was introduced by the Lord Mayor (Col. Hughes), who submitted the report of the special committee on tramway finance.

The report stated that everything done by the Tramways committee was business-like and reasonable. It was obvious that there was no necessity to increase the fares except as regards extensions, and the special committee had come to the conclusion, without expressing an opinion whether the ½d. fares were wise, that having been started it would be unreasonable to withdraw them. The Tramways committee had dealt well with the percentage of working expenses to total revenue, but a further reduction might be looked for. Another recommendation of the special committee was that a renewals account should be instituted as a separate account, and that an annual contribution be made out of gross profits, and it was suggested that the renewals account should be raised to £75,000 by getting rid of the contingencies account, which was no longer needful, and by taking from the surplus fund the amount requisite. A penny per car-mile was roughly £26,000 or £27,000 a year, and, starting with £75,000, £20,000 a year would be sufficient. There was a limit to the amount which could be spent on renewals, but it was not clear what that amount was. Last year they spent over £12,000. It was also suggested that an insurance fund should be subsidised out of revenue—the amount to be fixed by the Tramways committee. It was considered that the surplus fund should stop at £30,000. In future, extensions would have to stand on their own basis of estimated profit likely to arise. New ground could not be broken if it was known that the money to be expended would not bring in more revenue.

Councillor Padley moved as an amendment that the net profits be not carried to general district account, but that their disposal be considered at the end of each financial year.

The Lord Mayor said the tramway profits ought to be paid to the general district rate, because the true interest of every citizen was that the rates should be kept within due limits, otherwise the educational facilities of the city would have to be curtailed.

The chairman of the Tramways committee (Ald. Clegg) rejoiced that there was little difference of opinion between members. His policy, as chairman of the committee, had been to keep a hold upon the surplus earnings of the undertaking sufficient to be safe and satisfactory. The undertaking had been put upon a firm, sound commercial basis. Some of them had never agreed that 1d. per car-mile was necessary to be set aside for the tramways. £75,000 was more than adequate for all requirements, and he did not believe it would be possible or necessary to expend £20,000 in renewals in any one year under existing conditions. He calculated that the amount would not exceed £12,000 to £15,000 per annum. The Corporation should seek powers to run motor 'buses.

South Africa.—The "British and South African Export Gazette" states that Durban and Lourenço Marques will shortly be placed in telegraphic communication by a line via Zululand.

The "African World" says that Aliwal North is the only municipality in South Africa which generates its electrical energy from water alone, although Cape Town possesses a turbine-driven station for a supplementary supply. The largest water-driven plant is at the Penhalonga Proprietary Mines, near Umtali, South Rhodesia, and comprises two Pelton water wheels, each capable of developing 450 H.P., and two 350 kw. three-phase generators.

An order for three 300 kw. motor converters, to convert three phase current (6,000 volts, 50 periods) to 550 volts d.c., has been placed with Bruce Peebles & Co. by Hubert Davies & Spain on behalf of the Natal Government railways.

The A.E.G. Electrical Co., of South Africa, have received an order for a set of transformer panels and feeders for the Village Main Reef plant.

The Brush Co. have secured the contract for a 400 kw. turbo-alternator for Port Elizabeth (S. Africa).

South Shields.—The King-street and Ocean-road section of the electric tramways was opened for traffic last week.

An inquiry was held on Wednesday into the application of the Corporation to borrow (among other sums) £4,000 for street lighting.

Spain.—The "Madrid Gazette" of June 30 contains a decree appointing a commission to submit within three months proposals for the establishment of a higher school of telegraphy, the simplification of the telegraph regulations, the development of the telephone systems, the purchase of modern material and the acceleration of delivery of telegrams, more especially those intended for the Press.

Strike.—About 120 of the Paisley District Tramways Co.'s employés ceased work on Saturday. It is stated that the men demanded 28s. per week after two years' service and a 10 hours' day within a 12 hours' limit, and declined to wait for the return of the manager, who was then absent.

The manager (Mr. Fred. Coutts) says the men's places have nearly all been filled up. A few of those who were on strike have been re-engaged, but these, it is understood, will start on the lower scale and work up again to their former positions. Practically the entire service was in operation by Tuesday.

Sunderland.—On Wednesday the Council decided to apply for sanction to a loan of £16,450 for additional machinery at the Hylton-road electricity works and at Messrs. Doxford's sub-station. It was also agreed to advertise for a successor to Mr. J. F. C. Snell as borough electrical engineer at a salary of £800, increasing to £1,000 a year. (This advertisement appears on page XIII. of this issue.)

The chairman of the Electricity and Lighting committee (Ald. Bruce), in moving the adoption of the minutes, said that Mr. Snell's appointment would terminate in June next year. Mr. Snell had decided to set up for himself as a consulting engineer. He wished to leave the employ of the Corporation six months earlier than the time mentioned in his resignation, for it was likely that he would be asked by London County Council to accept a retainer for the next Parliamentary session. He referred in eulogistic terms to Mr. Snell's services to the Corporation. On the subject of the Doxford contract, this would extend over 15 years, and the Corporation would have got a good return by the time it expired. At present Doxford's took from the Corporation 633,400 units annually, which brought a revenue of £2,892. If the Council agreed to the proposal to instal the required machinery, the yearly supply to the firm would be 9,000,000 units, which would yield a revenue of £9,375.

Other members having referred to the ability shown by Mr. Snell, the committee's recommendations were adopted.

Torquay.—On Tuesday the town clerk (Mr. F. S. Hex) reported to the Council that the total cost of the additions to and alterations of the electricity works required to give a supply of electrical energy to the local tramways was £7,958 (exclusive of engineer's fees), compared with £8,174 estimated by the consulting engineers (Messrs. Kincaid, Waller, Manville & Dawson), £7,791 estimated by the borough electrical engineer (Mr. P. Storey), and £6,750 estimated by Mr. Mitchell, engineer to the tramway company. The L. G. Board had sanctioned an expenditure of £8,099.

Tramway Parcels Service.—The number of parcels carried during the first complete year's working of the parcels department of Bradford Corporation tramways was 478,214, and the receipts were £4,035, producing a profit of £526, after allowing 10 per cent. depreciation upon capital expended (£1,710). The parcel service is, apparently, becoming increasingly popular. The parcels department has the Bradford agency for several London carriers, and undertakes the dispatch of parcels to any part of the world at a through rate.

Aberdeen Tramways committee have been authorised to make a charge of 1d. for personal luggage over 28 lb. in weight, and all packages other than personal luggage, for any distance on any one car.

Workmen's Compensation and Dangerous Trades.—The Home Secretary has appointed a Departmental Committee to inquire into and report as to what diseases and injuries by accident are due to industrial occupations, what are distinguishable as such and what can properly be added to the diseases enumerated in the third schedule of the Workmen's Compensation Bill, 1906, so as to entitle to compensation persons who may be affected thereby. The chairman of the Committee is Mr. Herbert Samuel, M.P., and the members are Prof. Clifford Allbutt, F.R.S., Mr. H. H. Cunynghame, C.B., Assistant Under-Secretary of State, Home Office, and Dr. T. M. Legge, medical inspector of factories. The secretary is Mr. F. L D. Elliott, of the Home Office.

Sports, &c—Bradford tramway employés will hold their annual sports at Saltaire Park on Wednesday next, when the new City Tramways brass band, organised and conducted by the parcel superintendent, Mr. Hobson, will give its first public performance.

Outing.—The annual outing of Messrs. A. Reyrolle & Co.'s Hebburn establishment took place on Saturday last. The morning was spent visiting the different historic spots at Alnwick. After dinner at Alnwick, the whole party drove to Alnmouth, where tea was taken. The success of the day was the sports, of which "putting the shot" and a singing competition proved the most exciting and enjoyable.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—For the year ended May 31 the total receipts of the tramways department were £70,507. 19s. 6d., compared with £69,486. 9s. 2d. in previous year.

Working expenses were £40,684. 9s. 8d., against £42,393. 6s. 10d. After paying interest (£11,061), sinking fund, &c. (£7 093. 19s. 10d.), the balance (£11,662. 10s.) has been carried to renewal account. 2,019,515 units of electrical energy were used for traction, or 1·306 units per car-mile, and 1,545,015 car-miles were run. Working expenses were 57 70 per cent. of income, the total expenses being 83·46. Capital expenditure to May 31 was £325,284. 1s. 3d.

Blackburn.—The traffic receipts of the tramways department for the year ended March 25 were £49,636. 10s. 11d., while parcels receipts were £879. 10s. 8d., and miscellaneous receipts £1,113. 7s. 3d.

Working expenses were £31,110. 17s. 1d., leaving £20,518. 11s. 9d. Interest came to £7,945. 1s. 10d., repayment of loans to £6,080, sinking fund charges to £6,600. 8s., and income tax, &c., £576. 3s. 11d., so that there was a deficit of £683. 2s. on the year's working, against £2,792 in the previous year. 9,289,035 passengers were carried and 974,031 car-miles were run.

The report of the general manager (Mr. J. H. Cowell) states that the chief item of increase in expenditure was the permanent way repairs (£1,075 more than last year) due to the adoption of the Thermit welding of joints on a portion of the Preston-road section. The reduced cost of electric current (2 70d. per car mile, against 2·77d.) is attributed to the adoption of the bonus system to drivers. The Tramways committee are experimenting with covered cars of the same type as those used in Manchester.

Burslem.—It was reported to the Council last week that the accounts of the electricity works for the past year showed a gross profit of £244; but after paying interest, &c., the deficit on the year's working was £197.

Darlington.—The revenue of the Corporation light railways for the year ended March 31 was £10,595.

Working expenses (including £2,264. 16s. for power) were £7,408. 11s. 8d., leaving £3,186. 5s. 7½d. to meet interest (£2,440. 16s. 3d.), and after providing for sinking fund there was a deficit of £867. 18s. 4½d. The percentage of working expenses to receipts was 70. The capital expended is £75,326. 11s. 6d.

Greenock.—The accounts of the electricity department for the past year show a net profit of £2,160, and the Electricity committee have decided to apply £1,500 in relief of rates and to place the balance (£660) to depreciation account.

Halifax.—The total income of the electricity department for the year ended March 31 was £36,546. 17s. 3d.

Expenses were £18,581. 11s. 7d. and gross profit £17,965. 5s. 8d. After paying interest (£8,425. 1s 7d.) and sinking fund (£5,092. 8s. 5d.), &c., the balance (£4,662. 7s. 5d.) was carried to appropriation account, out of which £3,450 was voted in aid of rates. The capital expended is £250,578. 9s. 5d., an increase of £12,517. 18s. 4d. on the year. There are 1,441 consumers (against 1,250 in 1905) and the equivalent of 121,811 8 c.p. lamps is connected. 5.043,398 units were generated and 4,371,598 units were sold (including 3,024,307 for traction and 1,268,512 for private lighting and power). The maximum supply demand was 2,823 kw.

Kingston-on-Thames.—The income of the electricity department for the past year was £11,239, against £10,432 in the previous year. The profit was £500, but the debt charge was £931 more and repairs £250 more than 1904-5. One of the most satisfactory features of the past year was that the revenue from motors increased to £463.

Kirkcaldy.—The capital expended on the electric supply undertaking at May 15 was £61,035. 10s. 7d., an increase of £3,940. 14s. 3d. on the past year.

The year's revenue was £7,681. 13s. 4d, £3,479. 16s. from traction. The total expenses were £4,054. 1s. 2d. The gross profit was £3,627. 12s. 2d., and after paying interest, sinking fund, &c., the net profit was £41. 11s. 8d., against a deficit of £423. 9s. 8d. in the previous year. 939,816 units were sold (607,384 for traction, 234,197 to private consumers and 98,235 for public lighting). Works costs were 0·76d. and the total costs 0·97d. per unit, against 0·78d. and 1·03d. in 1905. There are 265 private consumers, and the equivalent of 26,723 8 c.p. lamps connected, including 403·5 B.H.P. in motors. The load factor is 16·68 per cent., against 15·8 per cent.

The capital expenditure on the tramways is £89,403. 17s. 7d, an increase of £688. 1s. 3d. during the year. Traffic revenue, &c., was £441. 10s. The total expenses were £9,131. 2s. 6d. The gross profit was £2,455. 11s. 8d., or 2·75 per cent. on capital expended. After paying interest and sinking fund, depreciation, &c., the deficit for the year is £1,924. 12s. 9d., against £1,524. 9s. 9d. 3,626,652 passengers were carried and 419,800 car-miles run. The average fare paid per passenger was 0·737d. and the percentage of working expenses to receipts was 78.

Leyton.—The accounts of the electric light department for the year ended March 31 show the total revenue was £20,280. 6s. 2d., including £13,328. 12s. 7d. from sale of electric current for private lighting and £6,413. 16s. 3d. for public lighting.

Total expenses were £9,983. 14s. 2d., leaving £10,296. 12s. to meet interest (£4,241. 5s. 6d.) and sinking fund (£4,950. 17s. 7d.), making the net profit £1,104. 8s. 11d. 1,786,865 units were generated and 1,509,433 units were sold (648,650 units for public and 860,783 for private lighting). The total maximum supply demanded was 940 kw., and the equivalent of 62,481 8 c.p. lamps is connected to the mains. Capital expenditure is £151,838, an increase of £4,414. 11s. 3½d. on the past year.

Perth.—The accounts of the tramways department for the year ended May 15 show capital expenditure £73,994, an increase of £21,795 on the year.

The annual receipts were £6,035. 10s. 2d., an increase of £3,926, and the expenditure £4,869. 4s. 1d., leaving £1,166. 6s. 1d. After meeting interest, &c., there was a debit balance of £3,448. 6s. 2d., including £1,319. 8s. 8d. from previous year. During the year 801,577 passengers were carried. The number of car-miles run was 123,304.

Stockton-on-Tees.—The total income of the electricity department for the year ended March 31 was £7,256. 12s. 3d., including £6,438. 8s. 7d. from the sale of current and £806. 13s 4d. from public lighting.

Expenses were £3,844. 16s. 2d., leaving gross profit £3,411. 16s. 1d. After providing for interest and repayment of loans, the balance (£279. 7s. 5d.) has been transferred to depreciation. 744,224 units were generated, and 680,663 units were sold. The capital expended is £52,178. 19s. 1d., an increase of £903. 3s. 3d. during the year.

Tonbridge.—The capital expended on the electricity undertaking is £22,420. 15s. 6d., an increase of £554. 14s. 6d. during the year ended March 31.

Total receipts were £2,208. 8s. 3d., and expenses £1,516. 1s. 8½d. leaving £692. 6s. 6½d. to meet interest (£698. 8s. 1d.) and sinking fund instalment (£581. 17s. 4d.), so that the net deficit was £587. 18s. 10½d. 164,683 units were generated, 46,690 units supplied to the public lamps and 68,971 sold to private consumers. The total maximum supply demanded was 91 kw.

Wakefield.—For the year ended March 31 the income of the electricity department was £9,088. 11s. 1d., including £8,076. 19s. 8d. net from the sale of current.

Expenses were £4,239. 13s. 6d. and gross profit £4,848. 17s. 7d. After paying interest and redemption of loan charges there was a net profit of £77. 18s. 6d. 1,032,170 units were generated, 157,346 units supplied to the public lamps and 759,334 units to private consumers. The total maximum supply demanded was 786 kw. The capital expended is £70,435. 16s. 1d., an increase of £3,765. 8s. 8d. on the year.

Wallasey.—The total receipts of the Council's tramways for the year ended March 31 were £40,570. 8s. 4d., against £38,768. 3s. in 1904-5.

Working expenses were £26,220. 6s. 1d., against £24,881. 11s. 10d., leaving gross profit £14,350. 12s. 3d., compared with £13,886. 11s. 2d. After paying interest (£5,275. 10s. 5d.), sinking fund (£2,324. 19s. 2d.), &c., £2,100 has been voted to relief of rates, leaving £412. 14s. 7d. to be carried forward. The receipts per car-mile run were 11·66d. against 11·76d.; 7,528,337 passengers were carried (against 7,142,881 in 1904 5) and the total number of car-miles run was 819,216. 1,272,206 units of electrical energy were consumed. The percentage of expenses to receipts was 64·6. Working expenses (excluding cost of power) were 5·14d., and including power 7·68d. per car-mile. The capital expended is £137,585. 11s. 10d., an increase of £1,755. 17s. 1d. on the year.

West Ham.—The second annual report of the tramways manager (Mr. H. E. Blain) for the period to March 31 was recently issued and gives particulars of the various extensions of the tramways system carried out during the past year.

The revenue of the electric cars for the year was £96,538. 8s. 8d. (or 11·062d. per car-mile), with a small addition for horse-car service. Working expenses (including horse cars) were £62,069. 3s. 9d. (7·112d. per car-mile). Gross profit was £38,405. 9s. 11d., and with £2,896. 15s. 8d. received as rent the disposable balance was £41,302. 5s. 7d. Interest on capital came to £11,216. 4s. and on bank overdraft to £2,395. 6s. 11d., and after paying income tax, &c., the balance (£27,022. 14s. 8d.) was transferred to appropriation account, out of which £6,258. 4s. 9d. was applied to sinking fund, £2,083. 19s. 4d. set aside pending permanent borrowing, £2,410. 8s. 5d. appropriated to street widening, £8,270. 2s. 2d. to reserve or renewals fund and £8,000 to relief of rates. Capital expended is £438,072. 14s. 3d., an increase of £149,728. 12s. 4d. on the year. 2,094,514 car-miles were run, against 1,240,774 in 1905, and 29,364,077 passengers were carried, against 15,773,592. 2,752,432 units of electrical energy (1·31 per car-mile) were used, against 1,311,866 (1·06 per car-mile). The percentage of working expenses to receipts was 60, against 67 in 1905.

Willesden.—The capital expended on the electricity undertaking at March 31 was £164,470. 19s. 10½d. (£66,009. 14s. 6d. for generating station and equipment and £98,461. 5s. 4½d. for sub stations, mains, &c.), an increase of £9,042. 11s. 1½d. on the year.

The total revenue for the past year was £16,742. 3s., including £2,920 from public lighting and £13,180. 4s. 6d. from private consumers. £7,626. 9s. 5d. was paid for electricity in bulk, the total expenses (including £3,245. 6s. 9d. for interest and £2,146. 19s. 6d. for repayment of loan) being £17,603. 1s. 3d. The equivalent of 62,178 30-watt lamps is connected for private lighting and power, against 46,427, and there are 140 500-watt public lamps, making a total of 65,051 30-watt lamps connected, against 49,360. The maximum domand was 762·25 kw., against 622·25 kw. The price of electricity taken in bulk from the North Metropolitan Electric Power Supply Co. was 1·647d. per unit, against 1·598d., and the total costs were 2·536d., against 2·471d., and the gross profit 1·080d. per unit, against 1·178d. After paying interest and sinking fund the total costs worked out at 3·802d., against 3·593d., a deficiency of 0·186d. per unit on the third year's working, or a total of £860. 18s. 3d. The average price per unit of electricity sold to private consumers (887,598 units) was 3·43d., against 3·61d., and for public lighting (223,670 units) 3·13d., against 3·05d. The total receipts averaged 3·616d. per unit sold, against 3·649d.

Wolverhampton.—The total income of the municipal tramways for the year ended March was £41,905. 6s. 11d , and the expenditure (exclusive of renewals) was £24,277. 13s. 11d.

After contributing £5,364. 9s. 6d. to renewals fund, paying interest (£7,493. 17s. 10d.) and capital charges (£3,840. 1s. 7d.), &c., there was a net profit of £1,012. 16s. 11d. Total working costs (6·131d. per car-mile) were 0·422d. per car-mile less than in the previous year. The arrangement for through running from Bilston, Willenhall and Dudley into Wolverhampton has had a beneficial effect upon receipts. 950,338 car-miles were run and 8,847,066 passengers carried. The total traffic receipts averaged 10·445d. per car-mile. The motor 'bus account shows a loss of £179. 9s. 10d., bringing the net profit for the year down to £1,012. 16s. 11d.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

REMARKABLE TESTIMONY.

The Publisher of the Big Blue Book has received from time to time numerous testimonials regarding the general completeness and accuracy of the information and of the names and addresses which appear in that publication. One of the latest testimonials to hand is a statement by the I.T.E. Electric Co., of 20, Great Russell-street, London, W.C., to the effect that the company sent out nearly 4,000 trade circulars, addressed from the last (1906) issue of the Big Blue Book, issued at the beginning of February, and that not one of these circulars was returned through the post as undeliverable.

A few weeks back a somewhat similar testimonial was given by another firm who had selected from the list a large number of names for circularising, and only one of the circulars had been returned as "Gone away, left no address," all others having reached their intended destination.

The Publisher of the Big Blue Book claims that this is remarkable testimony to the accuracy of the Directory, which has now been in circulation for six months.

TENDERS INVITED.

Weston-super-Mare & District Electric Supply Co. (Ltd.) invite tenders for supply for the next six months of feeder and distributor cables, joint boxes, feeder pillars and other accessories. Specifications after 14th inst. from the company, Locking-road, Weston-super-Mare, where tenders must be sent by 22nd inst. See also an advertisement.

Liverpool Tramways and Electric Power and Lighting committee want tenders by first post on Oct. 1 for the exclusive right of advertising on the tramcars. Specifications from Mr. C. W. Mallins, 6, Sir Thomas-street, Liverpool.

Bootle Corporation require tenders by 10 a.m., Aug. 20, for equipment of four boilers for hand firing with bituminous slack, and for smoke preventing apparatus, pipe and boiler covering. Specifications from the borough electrical engineer.

Dudley Electricity committee invite tenders for supplying and laying feeder and distributor cables. Tenders to the Chairman by noon Aug. 13.

Stepney (London) Council want tenders by noon Sept. 27 for additions and alterations to electricity station buildings. Specifications from Borough Engineer, 15, Great Alie-street, E.

Hastings Corporation want tenders by noon Sept. 18 for Welsh smokeless coal.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of certain ports. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17–19, Bedford-street, London, W.C.

TENDERS RECEIVED AND ACCEPTED.

Leith Corporation have placed an order with the Hart Accumulator Co., Marshgate-lane, Stratford, E., for renewing the existing storage battery at the electricity works with 256 standard central station type cells.

Metropolitan Asylums Board received the following tenders for wiring, &c., Downs School:—

Dargue, Griffiths & Co. (*acc*).	£2,407
E. P. Allam & Co.	3,986
Ward, Barker & Co.	3,650
Jackson Bros.	3,523
Eastlakes Limited	3,365
Warren Smith & Co.	2,994
F. A. Glover & Co.	2,958
Buchanan & Curwen	2,950
Western Eng. Co.	2,935
Elec. Eng. & Maint. Co.	2,892
Army & Navy Aux. Co-operative Supply Co.	2,885
Frank Suter & Co.	2,791
Sweet Bros.	£2,673
L. Sunderland & Co.	2,655
Robert Cort & Son	2,651
Cowtan & Sons	2,650
John Barker & Co.	2,646
Mann, Egerton & Co.	2,643
Coleby & Co.	2,625
Tamplin & Makovski	2,555
Lund Bros. & Co.	2,550
Smeeton & Page	2,545
Bromley, Batstone & Kirk	2,499
Thos. Potter & Sons	2,493
Thos. Hiscock	2,469

The Engineer-in-chief's estimate was £2,600.

Canterbury Council have placed an order with E. J. Philpot at £40 for electrical illuminations at the Guildhall, Corn Exchange and Blaney Institute during this, the Canterbury cricket week.

Gloucester Education committee have accepted the tender of Mitchell & Co. for wiring for the electric light and bell fitting at the Derby-road schools at £303. 14s. 3d.

Important contracts for telegraph material have been placed by Cape Colony Government with the Western Electric Co., Siemens Ltd., the British General Electric Co., the Telegraph Mfg. Co. (Colonial), and Govey & Co.

Bexley Council have accepted the tender of Measures Bros. for steel work for the tramcar shed extensions at £290.

Reading Council have placed an order with Gent & Co. for an electric water-level indicator at £39.

Stockport Council have accepted the tender of T. & W. Meadows for erection of tramcar shed extensions at £1,722.

Surrey County Council have accepted the tender of H. J. Cash & Co. for wiring and fittings at the Northern Asylum at £9,740.

Chipping Norton Council have accepted the tender of H. Bunting & Son for the conversion of the public lamps from gas to electricity.

Leek Council have accepted the tender of Jas. Heath & Sons for foundations for a new engine and dynamo at £113. 12s 5d.

BUSINESS NOTICES.

The Ruberoid Co. (Ltd.), Waterloo House, 81-83, Knightrider-street, London, E.C., has been formed to take over the business of the "P. & B." and "Ruberoid" departments of Robert W. Blackwell & Co. (Ltd.), and Mr. Edgar R. James, late joint managing director of the latter company is managing director of the new company. The Ruberoid Co. will carry large stocks of "P. & B." insulating goods, and will continue to deal in the electrical insulating tapes, varnishes, and other fabrics which Messrs. R. W. Blackwell have sold so largely. The telegraphic address is "Ruberoid London."

The partnership business of Suffert, Von Laer & Co. (A. A. Suffert and F. J. Von Laer), merchants and machinery exporters, Leadenhall buildings, London, E.C., has been dissolved as from July 10.

Geo. H. Murphy and Geo. H. K. Hays, electrical engineers and contractors (trading as G. H Murphy & Co., at 94, Bermondsey-wall, London, S.E.), have dissolved partnership. Debts by Mr. Murphy, who continues under the same style.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of Wm. J. Charlesworth and Harry Jones (trading as H. Jones & Co., electrical engineers, &c.) takes place at the O.R.'s, King-street, Newcastle, Staffs., on Aug. 17, and the public examination at the Town Hall, Stoke-upon-Trent, on Aug. 28.

The trustee (Mr. J. C. Clegg) in the bankruptcy of William George Leather, electrical engineer (trading as the Windus Electric Co.), 25, Howard-street, Sheffield, has been released.

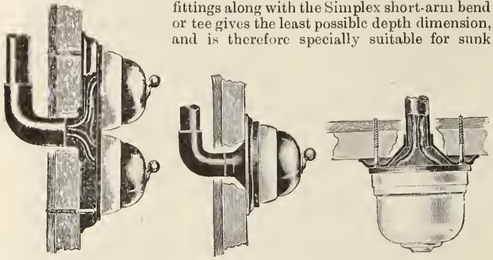
The trustee (Mr. E. L. Hough) in the bankruptcy of Henry Bock Binko, electrical engineer, 34, Leadenhall-street, London, E.C., has been released.

The Electrical Corpn. (Ltd.) is being wound up voluntarily. Mr. E. Wilding, Dashwood House, London, E.C., is liquidator.

Creditors of the Llandudno & Colwyn Bay Electric Traction Co. (Ltd.) must send particulars of their claims to Mr. John Morris, 33, Brazennose-street, Manchester, by 24th inst.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November. Some particulars are given in an advertisement and further information may be obtained from the secretary, Staple Inn-buildings, London, W.C.

Catalogues, &c.—Simplex Conduits (Ltd.) have ready a leaflet (No. 161) dealing with the new patent Simplex flush mounting boxes, a novel departure in methods of mounting switches and other forms of electric lighting fixtures. These mounting boxes are intended for concealed work, and special attention has been paid in their design to reducing the depth dimension, in this way minimising the channeling out of brickwork during erection. The use of these fittings along with the Simplex short-arm bend or tee gives the least possible depth dimension, and is therefore specially suitable for sunk work in plaster. These fittings consist of a box, in which slack wire may be coiled away, and an artistic base on which the fitting may be mounted makes a unique combination. The accompanying illustrations show a single and two-way switch of this series in position and also a ceiling rose example.



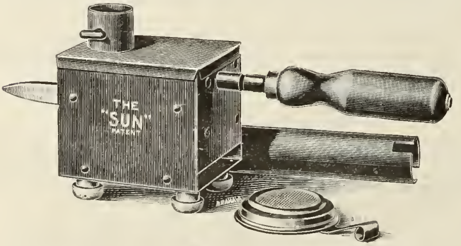
New Simplex Fittings.

The Electrical Co. are issuing an illustrated card concerning their non-magnetic meter test chronographs, which are made with a clear open dial divided in $\frac{1}{5}$th seconds, and, it is claimed, read to $\frac{1}{10}$th seconds with certainty.

A new price list of rheostats, motor starters, resistances, &c., has been issued by Ernest F. Moy, of Camden Town, London. Some good illustrations are given.

A well printed catalogue of spectroscopes and spectroscopic accessories has been forwarded by Adam Hilger (Ltd.), of 75A, Camden-road, London, N.W. The illustrations include a universal instrument covering a large range of spectrographic operations. Amongst the instruments for special purposes is a constant deviation type of spectroscope, known as the Hilger wave-length spectroscope, so devised as to admit of readings being taken in wave lengths direct. In addition to the above a number of instruments are described, and are well illustrated in this catalogue, including micrometers, polarimeters, vacuum tubes, &c.

Mr. A. H. Hunt, of 115-117, Cannon-street, London, E.C., is sole selling agent for the "Sun" portable soldering stove, of which a considerable number are in use by electrical contracting firms, &c. The accompanying illustration shows the "Sun" stove, which burns charcoal, can be used in any position, and is claimed to be the acme of simplicity in construction and use. It is entirely self-contained The work of putting the stove into operation is to fill the top with charcoal and light by means of a spirit lamp. The copper bit is never put into fire, and therefore always remains clean and bright.

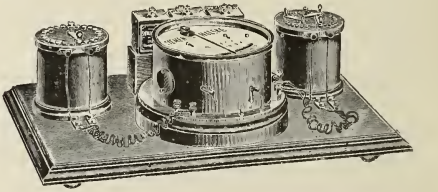


"Sun" Portable Soldering Stove.

Mavor & Coulson, 47, King-street, Mile End, Glasgow, issue each month a card giving data of their Pick-Quick electric coal cutter. The card for August is just issued, and has a special interest for colliery engineers.

Motor Speedometers.—We recently described and illustrated the "Perfect" speedometer manufactured and supplied by Messrs. S. Smith & Son, 9, Strand, London, and it is interesting to note a case where the reliability of this instrument was put to the test, and the fact that it was employed upon a car saved the driver in a charge of exceeding the speed limit. The car was a 60 H.P. Napier, and the allegation against the chauffeur was that he rode over a measured 220 yds. at a speed of 28 miles an hour. Fortunately the car was provided with two of Smith's speedometers, one of which had a tell-tale hand, and indicated the speed at 19 miles an hour. On the suggestion of the magistrate tests of the accuracy of the speedometers were made, and these being found accurate the summons was dismissed, the opinion of the magistrate being that "a mechanical instrument of this kind was more reliable than the observations of police officers."

Siemens Publications.—A number of price lists recently issued by Siemens Brothers Dynamo Works (Ltd.) have reached us, and include the following: List 2A, alternating-current generators and motors (Part I., ventilated motors); List 5A, meters and meter-testing boards (Part I., meters); sheet 15A, tantalum lamps; sheet 18, switchboard meters; sheet 19, apparatus for determining losses in core plates; and sheet 20, small pattern moving coil instruments. The first-mentioned list describes and illustrates the ventilated V type induction motors manufactured at the company's works at Stafford. The arrangement of this price list is similar to that of list 1A, dealing with continuous-current machines, recently reviewed in our columns. It will be remembered that the details of output, prices, &c., are so arranged that full particulars can be obtained of any particular machine by reading across one complete line of print. The second list deals with the principal types of Siemens-Schuckert meters, and each type is accompanied by a short specification giving all essential particulars. The third list (relating to tantalum lamps) shows that the Sun form of this lamp is now provided with a gallery, and so is suitable for connection to any lamp-holder with a shade ring. As it is not now necessary to supply a lamp holder as part of the Sun type of lamp, this means a reduction in price. Sheet 19 deals with the apparatus for determining losses in core plates, and is of considerable interest to makers of these plates, to technical colleges, &c. Three different apparatus are described and listed, including all necessary accessories. The accompanying illustration shows a magnetometer described in this list. The action of this instrument depends upon the electrodynamic effects of the lines of force on a solenoid, and the scale reading indicates the induction per square centimetre. The moving coil instruments listed in sheet 20 are new and of small pattern of the types described. The DDK combined ammeters and voltmeters in the list are made in two forms—(1) with protected terminals for motor cars, and (2) for switchboard use.



Siemens Magnetometer.

English and Spanish Dictionary of Engineering Terms.—This little work, which has been compiled by Señor Andrés J. R. V. Garcia, should prove useful to those engineers, railway contractors, &c., who have business relations with Spain. About 3,000 English and Spanish technical terms which are in general use by engineers have been collected, and the utility of the book has been increased by the addition of indexes in English and Spanish. We hope, however, that future editions will include more electrical engineering terms. The book is published at 3s. 6d. net by Hirschfeld Bros., 13, Furnival street, London, E.C.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during July, 1906:—

Electrical machinery, £56,857 (increase of £16,930); telegraph and telephone cables, £12,010; telegraph and telephone apparatus, £37,117; other electric wires and cables (rubber insulated), £2,687, (with other insulations), £606; other electrical goods and apparatus, £34,506. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £86,926 (increase, £18,804), and for the seven months ended July 31, £667,914 (increase £98,478).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Aug. 1 to 3, with the ports of destination:—

Africa—Alexandria, £52; Delagoa Bay, £361; Durban, £65; East London, £360; Port Elizabeth, £1,632. *Australasia*—Adelaide, £145; Auckland, £26; Brisbane, £440 (including £425 telegraph cable); Hobart,

£12; Lyttelton, £189; Melbourne, £96; Sydney, £34; Wellington, £140. *Belgium*—Antwerp, £65; Ostend, £59. *China*—Amoy, £11; Canton, £343; Foochow, £52; Shanghai, £1,313 (including £1,283 telegraph apparatus). *France*—Le Treport, £37. *Holland*—Amsterdam, £54 (including £29 telegraph cable). *India*—Bombay, £395 (including £37 telegraph cable; Calcutta, £381. *Japan*—Kobe, £606; Nagasaki, £567 (including £60 telegraph material); Tokyo, £1,700; Yokohama, £938. *Mauritius*, £70. *Russia*—St. Petersburg, £295. *Straits Settlements*—Penang, £25; Singapore, £80. Total £10,543 (for three days), against £11,348 for the corresponding three days last year (Aug. 2 to 4).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

June 16, 1906.

13,814 Coventry. (Border, New Zealand.) Station indicating apparatus for trains, cars, &c.*
13,818 Newbery & British Prometheus Co. Switches.
13,820 Mason & Timms. Reversible rotary turbine.
13,822 Romer. Condensers for electrical purposes.
13.836 Ocenásek. Arc Lamp.*
13,840 Martini. Automatic electron ioniser for oxidising cold crude petroleum or its distillates for explosion in internal combustion engines.
13,841 Kaisser. Electric heater for singeing threads and textile fabrics.*
13,844 B.T.-H. Co. (G.E. Co., U.S.) Induction motor control.
13,845 Newton Bros. & Newton. Magnetic separation.
13,864 Fottinger. Transmission of power. (Date applied for, 6/23/05.)*†
17,699a/05 Field & Ferranti Limited. Controllers. (Date applied for, Sept. 1, 1905.)

June, 18, 1906.

13,885 Scoccimarro. Cutout and distribution box.
13,897 Baden-Powell. Methods of generating electricity.
13,903 Stevens. Working and control for petrol electric and electric cars.*
13,912 Howard. Rotary engine and pump which can also be used as a turbine, motor or water meter.
13,928 Wetter. (May, Germany.) Electricity meters of the motor type.
13,946 Sauvé & Robbins. Induction coils.*
13,349 & 13,965 Ferranti. Electric furnaces.
13,955 Laskay. Electric self-levelling marine tables.*
13,956 Justice. (Deutsche Gasglühlicht A.-G. (Auerges), Germany). Metallic filament for glow lamps.*
13,969 Wengelin. Temporarily-acting make-and-break devices.*
13,972 Cowper-Coles. Electrodeposition of copper.
13,978 Morgan Crucible Co. & Grant. Applying pressure to commutator brushes.
13,979 Berend. (Schmitt, Germany.) Insulating materials.

June 19, 1906.

13,985 Chamberlain & Hookham & Holden. Electricity meters.
13,995 Crowley & Caunter. Electric motor.
14,006 Tucker. Switches.
14,041 Wunderlich & Hughes. Suspension of electric lamps and other articles.
14,055 Jeffreys. Electric fans and motors to render them noiseless.
14,058 Kallmann. Switching devices for electric circuits.
14,060 Muirhead. Hertzian wave telegraphy.*
14,062 Siemens & Halske A.G. Production of technically pure ductile tantalum. (Date applied for, Aug. 19, 1905.)*†
14,068 Mack. Transmission gearing.*
14,071 Goldsmith, Francombe & Scull. Automatic fire-extinguishers and alarms.*
14,073 Durkin. Controller regulators. (Date applied for, Jan. 8, 1906).*†
14,085 B.T.-H. Co. (G.E. Co., U.S.) Electric switch controlling mechanism.
14,089 Raven. Railway signalling apparatus.
14,090 Wheatley. (Lorenz, Germany.) Harmonic signalling for party lines.*

June 20, 1906.

14,163 Johnson. Electric traction systems.*
14,165 Ransford. (Cie Parisienne des Voitures Electriques, procédés Kriéger, France.) Brushes of electric motors.*
14,166 Ransford. (Cie Parisienne des Voitures Electriques, procédés Kriéger, France.) Self-propelled vehicles.*
14,175 McIntyre & Young. Combination condensers and water purifiers.*
14,187 Siemens Bros. & Co. (Siemens & Halske, A.-G., Germany.) Measuring or indicating instruments in which a rectilineally moving pointer is actuated by a rotary device.*

June 21, 1906.

14,226 Mildé. Electrically-propelled road vehicles.
14,249 B.T.-H. Co. (G.E. Co., U.S.) Shaft bearings.
14,253 Rees. Turbines.

June 22, 1906.

14,274 Wolfendale. Burglar alarm.*
14,289 Oldbury Steel Conduits & Sutton. Conduit fittings.
14,302 Clifton. Magnetic mirror.
14,304 Mugnieo. Electric organs.
14,325 Dörwald & Grant. Power transmission apparatus.
14,335 Walder. Improvements in or relating to speed recorders or indicators. (Date applied for, June 24, 1905).*†
14,336 Gadda & Conti. Improvements in reversing gear for elastic fluid turbines. (Date applied for, June 24, 1905).*†
14,342 Allan. Prepayment mechanism for electricity meters.
14,347 Mordey & Fricker. Electricity meters.
14,359 B.T.-H. Co. (G.E. Co., U.S.) Electromagnetically operating apparatus.
14,361 B.T.-H. Co. & Dawson. Electric distribution systems and apparatus therefor.
14,361 B.T.-H. Co. (G.E. Co., U.S.) Improvements in machines for making incandescent electric lamps and the like.
14,366 Roberts. (Roberts, S. Africa). Electrical switch and like gear.
14,370 Temperley & Alexander. Transporting plant.*
26,813a/05 Ashcroft. Electrolysis of metallic compounds. (Date applied for, Dec. 22, 1905.)

June 23, 1906.

14,390 Walter. Detection of electrical oscillations.
14,402 Gray. Brackets for suspending aerial cables.*
14,419 Arnall. Arrangements of wheels and axles for electric tramcars.
14,425 Sander. Manufacture of filaments for incandescent lamps.
14,426 Santo & Moulet. An improved system of automatic points for railway and tramway tracks.*
14,433 Iles & Armistead. Regulation of continuous-current motors.*

June 25, 1906.

14,458 Taylor & Cressey. Electrically-operated system of slide bars and safety bolts for railway carriage doors and other purposes.
14,487 Westinghouse Brake Co. (Westinghouse Air Brake Co.) Triple valve devices for fluid pressure brakes.
14,488 Field. Self-propelled vehicles acting as tractors.
14,501 Fynn. Dynamo-electric machines.
14,511 Schuil & Reyrolle. Controllers for electromotors.
14,517 Ravenshaw, Middleton & Townsend. Magnetic clutches.

June 26, 1906.

14,549 Jackson. Turbines (reversible).
14,553 Winans. Railway joint supporters. (Date applied for, 6/9/1905.)*†
14,577 Statter. Circuit-breakers or makers.
14,584 Warner & Sullivan. Sanding devices.
14,589 Fricker. Electric switch apparatus.
14,590 Fricker. Selecting switch mechanism for advertising, signalling, &c.
14,592 Harris. Electrical indicating apparatus.
14,608 Brockie. Arc lamps.
14,611 Burk. Electric conductor mouldings.*
14,613 Warwick Machinery Co. & Samuelson. Turbines.
14,614 Haddan. (Kutnow Bros., U.S.) Electric clocks.
14,615 Rothwell. Electric railways on surface contact system.*

June 27, 1906.

14,636 Tierney & Malone. Moving electrically the points on electric tramways and railways.
14,642 Beard. Secret keyboard for central exchange switchboard.*
14,648 Siemens Bros. & Co. (Siemens & Halske A.-G., Germany.) Electrical apparatus for calibrating measuring instruments for alternating currents.*
14,689 Brown. Control of electric signalling systems.
14,692 Ferranti. Elastic fluid motors.
14,695 B.T.-H. Co. (G.E. Co., U.S.) Power-generating systems.
14,696 Latour. Single-phase alternating-current series motor. (Date applied for, June 28, 1905.)*†
14,697 Latour. Dynamo electric machines. (Date applied for, 6/28/05.)*†
14.705 Lewis. Arc lamps.
14,712 Arnold. Continuous or alternating-current electrical machines with commutating poles. (Date applied for, Oct. 20, 1905.)*†

June 28, 1906.

14,720 Spray. Magneto-electric generators.
14,722 Campbell & Butler. Device for gauging clearance between dummy rotor and stator rings for steam turbines.
14,737 Albion Motor Car Co. & Murray. Magneto-electric generators
14,780 Lloyd. Apparatus for administering three-phase sinusoidal currents.
14,787 B.T.-H. Co. (G.E. Co., U.S.) Lightning arresters.
14,788 B.T.-H. Co. (G.E. Co., U.S.) Current collecting devices.
14,789 B.T.-H. Co. (G.E. Co., U.S.) Electric distribution systems.
14,792 Pedersen. Electromagnetic relays. (Date applied for, 7/4/05.)*†
14,803 Bradley, Powel, Donaldson & Wingfield. Electric deposition of metals or alloys.
14,804 Graham. Telephonic exchange switchboards.
14,809 Davy. Arc lamps.
14,816 and 14,901 Deutsche Gasglühlicht A.G. (Auergesellschaft). Producing metallic incandescence bodies for electric glow lamp. (Date applied for, Oct. 28, 1905.)*†

June 30, 1906.

14,828 Wilson. Control of electric motors.
14,839 Davis. Bayonet cap for electric glow lamps.
14,840 Boddam & Burt. Magnetic apparatus for the separation of ores in the wet state.
14,861 Kjobenhavns Telefon-Aktieselskab. Automatic distribution of operating service in telephone exchanges. (Date applied for, June 30, 1905.)*†

14,857 List & Bock. Turbines.
14,910 Reader. Junction-box for electric cables.*
14,911 Bould. Joint boxes for telegraphic and other cables.
14,922 Roberts. Electrolytic diaphragms.*
14,925 Wellard. Electric cells and the like.
14,935 Allgemeine Elektricitats-Ges. Dynamo electric machines. (Date applied for, June 30, 1905.)*†
14,936 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.
14,937 B.T.-H. Co. (G.E. Co., U.S.) Valve mechanism for internal combustion engines.
14,945 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke G.m.b.H., Germany.) Electric starting machines having flywheels that can be uncoupled therefrom when working with light loads.*
14,959 Heide. (Standard Screw Co., U.S.) Mechanism for transmitting movement.*

SPECIFICATIONS PUBLISHED.

1905 Specifications.

6,077 Pringle. Indicating when trolley-standards become "alive."
25,356 Trilke. Electrical winding device for clocks.
25,614 Callender's Cable & Construction Co. & Ward. Fuse and switch mechanism.
26,601 Imray. (Hoffe.) Automatic electric cutouts.
27,152 Porsche & Lohner. Dynamo-electric machines.

1906 Specifications.

772 Elektrochemische Werke Ges. Manufacture of formates. (Date applied for, April 14, 1905.)
1,935 Claremont & Stratton. Carriages for carrying cable drums.
2,194 Braunerhjelm. Wireless telegraph. (Date applied for, 3/2/1905.)
2,707 Siemens Bros. & Co. (Siemens Schuckertwerke Ges.) Introduction of electrical apparatus having magnetic cores or masses into alternating-current circuits.
2,312 Howarth. (Phönix Electrotechnishe Ges.) Regulating devices for arc lamps.
3,890 Lake. (Parker Clark Electric Co.) Incandescent lamps.
5,250 Allgemeine Elektricitäts Ges. Operating flywheel motor generators. (Date applied for, May 24, 1905.)
6,317 Foreman. Electric insulators. (Date applied for, March 16, 1905.)

COMPANIES' MEETINGS AND REPORTS.

Anglo-American Telegraph Co. (Ltd.)

The half-yearly meeting was held on Friday last under the presidency of Mr. Francis A. Bevan.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN then said: The Anglo-American Telegraph Co. has now been in existence 40 years. All sorts of predictions were made when its cables were first laid as to their duration, but I am glad to say that, on the whole, the cables have lasted for a much longer period than anyone at the time predicted. Our oldest cable in existence is that of 1873, and I am glad to say that the deep-sea part of this cable is as good—at any rate, I hope so—as on the day it was submerged. I shall refer to the shore end of this cable in my remarks later on. I wish to congratulate the shareholders in the fortieth year of the company's existence on the fact that we have had the best half-year we have ever had. The gross pool receipts amounted to £328,000. These are the receipts of ourselves, the Western Union and the Direct United States Companies. Of that amount the Anglo Co. takes £195,281. 14s. 4d., an increase on the corresponding half-year of 1905 of £17,801. 10s. Besides that, we have had increased receipts from interest, transfer fees and the charter of the s.s. "Minia." For the latter we received £8,094. 2s. 11d., or £5,494. 2s. 11d. more than in the corresponding half of last year. This makes the total increase of receipts £23,588. 1s. 1d. On the other side, working expenses have increased by £2,049. 10s. 8d., taxes in Newfoundland amount to £2,249. 3s. 10d., charter of ships for repairs of cables by £6,100, bringing the total increase of expenses to £10,481. 12s. 1d. The item of £6,100 for charter of ships for repairs to our cables is explained practically by the set off of £8,094. 2s. 11d. for the charter of our steamship "Minia." We had to make repairs to our cables on this side of the Atlantic, and it has proved to be better economy to employ other ships for these repairs than to take the "Minia" from more profitable work and to bring her from the other side of the Atlantic. We gained £1,900 by adopting this course. The ordinary expenses of the "Minia" decreased by £1,185. 12s. 7d., and we have not had to put £10,000 to renewal fund as was the case last half-year, as this fund now exceeds the £1,000,000 limit. So that there is an actual net decrease in expenses of £701. 0s. 6d., and this, with the increase in receipts, brings the total improvement on the account to £24,289. 1s. 7d., but we brought forward a smaller balance by £2,437. 5s. 11d., and therefore the net increase available for dividends is £21,941. 15s. 8d. Although the shareholders have received £3,500 more than in the corresponding half-year and we bring forward a balance of £19,694. 14s., or £18,441. 15s. 8d. more than in the corresponding half-year, the renewal fund now stands at £1,010,000, an increase on the year of £25,200, and there is an increase in the securities of £16,000, in cable stock of £15,000, and in cash of £13,000. I referred at the beginning of my speech to our 1873 cable as being in good order, which is the case with all our cables at the present time. The shore end of this 1873 cable, has, however, given us some trouble, owing, I believe, chiefly to trawlers, which it is difficult to control. They have adopted steam power and fish at greater depth than used to be done, so that within 200 fathoms depth we have had several breaks. Our 1873 shore end is rather exposed to trawlers, and we think it would be wise outlay to renew this shore end by about 80 miles of a heavier and stronger type cable. This would cost about £25,000. We propose to take this sum from the renewal fund, which stands at £10,000 over the £1,000,000, and we shall receive about £15,000 interest in the next half-year, so that if we do not have to dip into the renewal fund for other matters we shall still have an even £1,000,000. We hope this old cable will still be of some service to us. We know of no other repairs being necessary. Our deep-sea cables continue to work perfectly. As to the taxes in Newfoundland, the total for the year of this tax is £4,000, which I regard as a fine of £800 per cable on five cables. It is a question whether, even supposing the Newfoundland Government are right in their action, they can levy this fine on five cables. Five is the maximum number of cables they have selected to impose this fine upon, although they maintain we have seven cables, four on one side of the island and three on the other. On the other hand, we maintain we have only three or four cables at the outside, because we say that a cable which is landed on one side and carried across the island and goes out into the water on the other side is one and the same cable. It is quite fair we should share in the ordinary taxation of the island, but we urge that it is contrary to the terms of the charter granted to the originators of the Atlantic cable scheme, when they agreed to take the cables by way of Newfoundland and bring that distant island into communication with Europe and America, to come down upon us after all these years and impose an annual fine of £800 per cable. We shall do all we can to get rid of this fine, but we must set aside sufficient to meet it, and that is why it appears in the accounts. (Mr. Bevan then referred to the retirement of Mr. Cunard, which event was entirely due to private affairs which would prevent him attending the Board meetings. It was not intended at present to fill the vacancy). I now move the adoption of the report and accounts.

This was seconded by Sir GERALD FITZGERALD, and carried unanimously.

There being no further business, a cordial vote of thanks to the chairman, directors and staff of the Company, proposed by Sir FORTESCUE FLANNERY and seconded by Mr. CHRISTIE, was unanimously agreed to.

The proceedings then terminated.

BAKER STREET & WATERLOO RAILWAY CO.—The capital expended for the half-year ended June 30 was £328,533. During the 16 weeks (March 10 to June 30) 3,006,276 passengers were carried on the section of the line open for traffic, and the receipts from all sources amounted to £23,490. Working expenditure (so far as it is payable by the company) was £16,680. Charges for maintenance and administration are payable by the Underground Electric Railways Co. of London until the construction of the railway is completed. The balance carried to credit of net revenue is £6,809. The directors consider that the results of working during the half-year are encouraging. The Elephant and Castle station was opened on Sunday last, and the section of the line from Baker-street to Edgware-road is expected to be ready before the end of the year.

At the meeting on Wednesday Mr. T. J. Hare said the contractors (the Underground Electric Railways Co. of London) had completed the line from the Elephant & Castle to Baker-street. The whole of the rolling stock had been delivered. The extension from Baker-street towards Paddington station was being pushed on, and the directors hoped it would be opened for traffic as far as Edgware road by the end of the year. Motor 'buses were serious competitors for short distance traffic, but whether they could live at the present low fares they were charging was, he thought, doubtful. On the whole the directors considered the results of working during the 16 weeks encouraging, having regard to the fact that only a section of the line had been operated. Through bookings were in force with the City & South London Railway, and negotiations were proceeding with other companies for the issue of through tickets. The Elephant & Castle station was opened for traffic on Sunday last. That extension tapped the whole of the South London tramway systems and connected with the City & South London Railway by means of a short subway, and it was expected that a large traffic would be exchanged with that line. When towards the end of the year the further extension of the line was completed to Edgware-road, it was confidently anticipated that the receipts would show great improvement.

CHATHAM AND DISTRICT LIGHT RAILWAYS CO.—For the half-year ended June 30 the receipts were £16,757. 3s. 1d. and the expenses £10,897. 15s. 1d. Out of the balance of £5,336. 12s. 4d. preference dividend absorbs £2,637. 10s., and a dividend at the rate of 3 per cent. on the ordinary shares for the half-year £1,582. 10s., leaving £1,116 12s. 4d. to be carried forward. The extension to Rainham is nearing completion, and it is expected the line will be opened during August.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—For the year ended June 30 there was a trading profit of £24,702. 4s. 8d. After deducting debenture interest, depreciation and interim dividend on preference shares, the available balance is £13,803. 7s. 10d., to which is added £6,259. 0s. 3d. brought forward, making £20,062. 8s. 1d. The directors propose to pay the balance preference dividend and a dividend of 10 per cent. on the ordinary shares (tax free), together amounting to £5,185, to place £8,000 to reserve and to carry forward £6,877. 8s. 1d. The debenture issue of £20,000 matured for repayment on Dec. 31, 1905, and was repaid on that date. The directors refer to the sad death of their consulting manager (Mr. G. A. Grindle), in the wreck of the ss. "Hilda," while proceeding to France on the company's business. The directors have contributed to provision made for his widow and family out of the profits of the year.

CROMPTON & CO. (LTD.)—At the meeting last week the report abstracted in our last issue was adopted on the motion of the chairman (Mr. John Trotter), who congratulated the shareholders upon the improved position of the company, which was due to economy, to improvements and increased output. After referring to competition and the low prices prevailing, he said it was most encouraging that the contracts had resulted as well as they expected and that they had done distinctly better at their Chelmsford works than was anticipated. He looked forward with confidence to the immediate future. They were contemplating a still further enlargement of their works in order to cope with the constantly growing business. Mr. F. R. Reeves had retired from the general managership and he was succeeded by Mr. Stevenson, who had been chief engineer of the company for many years. Mr. Reeves remained, however, as financial adviser. Col. Crompton had also ceased to be managing director and had become consulting engineer. Mr. Hodgson had been appointed manager of the works. This year they had made a nice profit in Australia. Their order books were exceptionally full at present, and they had secured a second large contract from the Madras Electric Supply Corpn., amounting to £174,000.

DELHI ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—Col. Sir Buchanan Scott, at the statutory meeting last week, stated that on May 23 last 100,000 6 per cent. preferred and participating shares of £1 each were allotted. The contractors were proceeding with the work, and orders had been placed for the majority of the materials and plant. The directors hoped that by July 1 next the work of construction would be completed. The lighting installation, which had been gradually growing since it was erected some three years ago, might be expected to show a more rapid growth in the near future.

DIESEL ENGINE CO. (LTD.)—At the meeting on Thursday last Mr. C. C. Ellis said the orders the company were getting now were exceedingly satisfactory. They were coming from influential people in this country, as well as in foreign countries. All internal combustion engines had bad an uphill fight. They were now getting repeat orders in this country as well as in foreign countries. At present their orders on hand were for over 5,000 H.P., which was the largest they had ever had. A great deal of that was due to people having seen the engines at the Olympia and Liège exhibitions and elsewhere. The inquiries received were exceedingly numerous and required a great deal of time, ingenuity and care in replying to them and following them up.

GREAT NORTHERN & CITY RAILWAY CO.—At the meeting on Friday last the Earl of Lauderdale said the traffic on the railway had continued to increase during the past half-year, reaching 8,067,740 passengers, against 7,527,634 for the corresponding period of 1905. The gross revenue for the half-year had been £49,390, against £46,240. £100,000 had been set aside in case the opportunity presented itself of proceeding with the extension to Lothbury. The latest date for the company to take over the working of the line from the contractors under their agreement was Feb. 14, 1907 ; but it was proposed that they should do so from Jan. 1 next, the contractors holding themselves responsible to meet all liabilities up to Feb. 14. They were well equipped and able to handle a large growth of traffic without materially increasing cost. With regard to working expenses, the contractors showed these to be between 49 and 50 per cent., including rates and taxes, which had gone up 16 per cent. during last year.

LANARKSHIRE TRAMWAYS CO.—The receipts for the half-year ended June were £23,042. 4s. 1d., and the expenses £12,742. 9s. 10d., leaving £10,299. 14s. 3d. After paying interest, &c., and contributions payable to local authorities (£1,497. 8s. 2d.), and adding balance forward (£898. 8s. 7d.), £9,700. 14s. 8d. is available. A dividend at the rate of 5½ per cent. for the half-year is declared, leaving £2,981 to be carried forward. The construction of the extension to Cambuslang is expected to be ready in a few weeks.

LANCASHIRE & YORKSHIRE RAILWAY CO.—At the meeting on Wednesday Sir Geo. Armytage said the company had now coupled up their system with the Liverpool Overhead Railway and were running through to Dingle. A passenger service had also been established between Seaforth and Aintree. Two more lines were being electrified between Liverpool and Seaforth and they intended shortly also to electrify from Aintree to Sandhills, via Walton Junction, so that a complete circular service would be established from Liverpool to Aintree. Rail motors had been successful on certain lines and their number had been increased. They had decided to purchase some motor omnibuses to collect traffic from districts adjoining their line which had not at present any direct communication.

LIVERPOOL OVERHEAD RAILWAY CO.—The directors' report for the half-year ended June 30 states that gross revenue receipts were £37,642. 1s. 1d., and working expenses £30,300. 4s. 9d. The number of passengers carried was 5,445,100, against 5,617,672 and 5,558,113 in the two preceding half-years. The introduction of differential and cheaper fares has not resulted in increased traffic. The receipts per passenger have been 1·75d., against 1·82d. last year. The interchange of traffic with the L. & Y. Railway, although disappointing, shows gradual increase. The through service between Southport and Dingle, without change of carriage, was inaugurated in February and extended in June. Deducting interest, &c. (£4,329. 7s. 5d.), and adding balance brought forward (£3,784. 7s. 4d.), there is £6,796. 16s. 3d. available for dividend. After paying the preference dividend £3,796. 16s. 3d. is carried forward.

LONDON, TILBURY & SOUTHEND RAILWAY CO.—At the meeting last week Mr. A L. Stride said mileage and demurrage showed an increase of £5,389, due mainly to increased cost of working the traffic by electric traction. They had had to join up with the two underground companies if they were not to lose the money spent on the Whitechapel and Bow line, and they had been obliged to adopt the same system as the District and Metropolitan companies. When they did so they were assured that the installation would result in greater facilities and in cheaper working altogether, but to the present that had not been their experience. They were considering whether they should set up their own installation and do the work themselves entirely, rather than continue their present arrangement with the District Co.

THOMAS PARKER (LTD.)—At the meeting last week the chairman (Mr. C. T. Mander) said the company had gone through the past year with very unsatisfactory results as far as the figures were concerned. There had been no lack of energy or hard work on the part of the management and staff, but there were too many works in the country to meet the demand, and it was simply a question of the work going to the people who would quote the lowest price, and in the generality of cases during the last year or two those prices had carried practically no profit. That was a condition, however, that would no doubt adjust itself in a short time. They were in a happier condition at present than when they met last year, as their shops were now rapidly filling with orders. Improvement had been steady during the last six months and the orders booked in the present month were more than the company had had during any month for the last two and a-half years. The company had been devoting a large amount of attention to broadening the base of their operations, and they were developing certain patents which their works were admirably adapted to deal with. Those additions to their trade no doubt would help them to keep full shops when electrical work was slack.

WATERLOO & CITY RAILWAY CO.—Sir Chas. Scotter at the meeting on Thursday last week stated that within six months the company would be dead and buried. They proposed to pay a dividend of 3 per cent., which would absorb £8,100 and leave £738 to be carried forward. They could have paid 3¼ per cent., but they thought it prudent to carry the balance over and when they wound up the company any surplus revenue could be dealt with. The bill which the South Western Co. presented for acquiring (inter alia) the Waterloo & City Railway had received Royal assent, and shareholders would soon be notified the terms on which the Waterloo & City had to be transferred to the South-Western Co. The working of the line in the past half-year had been exceedingly safe and regular, in great measure attributable to the excellent manner in which their electrical engineer (Mr. Jones) had attended to his duties.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

BEAUMONT & STILL COLONIAL & FOREIGN TRAIN LIGHTING CO. (LTD.) (89,746.)—Reg. Aug. 3, capital £18,000 in £1 shares, to acquire from M. W. W. Mackie, E. J. Glyn, A. R. M. Lockwood, F. J. Beaumont and W. M. Still benefit of inventions relating to improvements in dynamos and the lighting of railway carriages and other vehicles, &c., and to carry on the business of electricians, electrical and mechanical engineers, dynamo manufacturers, suppliers of electricity, &c. First directors : E. J. Glyn, W. G. Richards, M. W. W. Mackie, F. J. Beaumont and W. M. Still. Reg. office, 24, Charles-street, Hatton-garden, London, E.C.

BRITISH TAXI-MOTOR CAB CO. (LTD.) (89,648).—Reg. July 26 capital £150,000 in £1 shares, to carry on business of motor cab proprietors, owners of electric, petrol and other vehicles, electricians, &c. Reg. office, 40, Botolph-lane, London, E.C.

COMPAGNIE INTERNATIONALE POUR LE CHAUFFAGE DES CHEMINS DE FER SYSTEME HEINTZ (LTD.) (89,693).—Reg. July 30, with a capital of £40,000 in £1 shares, to adopt an agreement with G. Westinghouse, and to carry on the business of manufacturers of and dealers in all kinds of apparatus for use in connection with heating railway carriages and other vehicles or apartments, engineers, &c. Reg. office, 82, York-road, King's Cross, N.

HAWTHORN FIRE DETECTOR CO. (LTD.) (89,697.)—Reg. July 30, capital £30,000 in £1 shares, to acquire and turn to account the inventions and patents of H. Hawthorn for improvements in electric fire alarms and thermo-indicators, and in automatic transmitters for electric fire alarms and other signals, &c. First directors, T. R. Sanders, J. W. Cleland and H. Hawthorne.

KINGSTON & CO. (LTD.) (89,727.)—Reg. Aug. 1, capital £2,000 in £1 shares, to acquire the business of electrical engineers, art metal workers, &c., carried on by Kingston & Co , at Margate, and to carry on business of electric light installers, manufacturers and repairers of all appliances connected with the installation of electric light, &c. Reg. office, Northdown-road, Margate.

NOTTINGHAM GAS & ELECTRIC FITTINGS CO. (LTD.) (89,587).—Reg. July 30, capital £1,000 in £1 shares, to acquire businesses lately carried on in Nottingham as S. Haynes & Co., the Nottingham Gas & Electrical Stores, and Watts Incandescent Depot. First directors, W. W. Favell, A. E. Favell and J. E. Watts. Reg. office, 17, Dilks-yard, Long Row West, Nottingham.

RAILWAY & TRAMWAY TRUST (LTD.) (89,684).—Reg. July 28, capital £1,000 in 10s. shares, to carry on the business of a railway, tramway and electric light and power company, &c. Reg. office, 5, Howick-place, Westminster, London.

RUSHMORE LAMPS (LTD.) (89,656).—Reg. July 26, capital £3,000 in £1 shares, to acquire the business carried on as Stewart & Tyler, and to carry on the business of manufacturers, dealers in and repairers of searchlights and lamps, electric and other illuminating apparatus, &c. First directors, G. S. S. Monck, S. F. Tyler and W. L. Stewart.

TURNERS & MANVILLE (LTD.) (89,658.)—Reg. July 26, capital £50,000 in £1 shares, to acquire business of manufacturers of and dealers in asbestos, asbestos goods, non-conducting coverings, electrical fittings, accessories and sundries, &c., carried on by the London branch of the H. W. Johns Manville Co. and by the British Johns Manville Co. in England and elsewhere. First directors, S. Turner, T. F. Manville and S. Turner, jun.

UNITED ELECTRIC TRAMWAYS CO. OF CARACAS (LTD.) (89,642).—Reg. July 25, capital £200,000 in £1 shares, to acquire from the Caracas Construction Co. (Ltd.) the benefit of an agreement between the Caracas Electric Tramway Co. (Ltd.) and the Construction Co. and all the shares in the Companhia de Tranvias Electricos de Caracas, and to carry on in the city of Caracas or elsewhere in Venezuela the business of a tramway, electricity supply, telephone and telegraph company, &c.

VERA CRUZ ELECTRIC LIGHT, POWER & TRACTION CO. (LTD.) (89,686.)—Reg. July 28, capital £300,000 in £1 shares, to carry on in Mexico or elsewhere the business of suppliers of electricity for light, power and traction, to acquire and turn to account concessions for the utilisation of water power in the generation and distribution of electricity, &c. Reg. office, 35, Great St. Helen's, London, E.C.

STATUTORY RETURNS.

BOARDMAN ELECTRICAL PATENTS CO. (LTD.)—The capital in return to Dec. 28, 1905 (filed June 6, 1906), is £2,000 in £1 shares, of which 1,000 have been taken up. £1,000 is considered as paid. Mortgages and charges, nil.

CALCUTTA TRAMWAYS CO. (LTD).—The capital in return to April 24 is £700,000 in 140,000 shares of £5 each, of which 105,000 old and 32,610 new have been taken up. £502,950 has been received and £185,100 is considered as paid. Mortgages and charges, £350,000.

On June 25 an increase of capital to £850,000 was registered.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—According to return to May 24, capital is £500,000 in 60,000 ordinary and 40,000 preference shares of £5 each, of which 35,000 ordinary and 40,000 preference have been taken up. £5 per share has been called up on 15,000 ordinary and 40,000 preference and £275,000 had been received. £100,000 is considered as paid on 20,000 ordinary. Mortgages and charges, £300,000.

CHINA & JAPAN TELEPHONE & ELECTRIC CO. (LTD.)—The capital in return to July 5 is £20,000 in £1 shares, of which 14,761 have been taken up. £14,761 is considered as paid. Mortgages and charges, £12,500.

ELECTRICAL POWER STORAGE CO. (LTD.)—In return to July 26 capital is £100,500 in 20,000 ordinary and 100 founders' shares of £5 each, of which 18,592 ordinary and 66 founders' have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary and £13,332. 5s. 1d. has been received, including £474. 5s. 1d. paid on four founders' and 405 ordinary shares forfeited. £77,300 is considered as paid on 15,460 ordinary shares. Mortgages and charges, £28,400.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)—Return to July 9 gives capital as £205,000 in 40,000 preference shares of £5 each, and 19,900 ordinary and 100 founders' shares of 5s. each, of which 34,660 preference, 19,900 ordinary and 100 founders' shares have been taken up. 5s. per share has been called up on 19,900 shares and £4,975 has been received. £173,325 is considered as paid on 34,660 preference and 100 founders'. Mortgages and charges, £205,800.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—Return to May 29 gives capital as £5,000,000 in 250,000 preference and 250,000 ordinary shares of £10 each, of which 181,127 preference and 181,127 ordinary have been taken up. £10 per share has been nominally called up on 45,009 and £433,115 has been received. £3,167,450 is considered as paid on 316,745. Mortgages and charges nil.

MUTUAL TELEPHONE CO. (LTD.)—Return to Dec. 15, 1905 (filed July 18, 1906), gives capital as £250,000 in 20,000 preference and 30,000 ordinary shares of £5 each, of which 6,283 preference and 10,348 ordinary have been taken up. 6d. per share has been called up, and £1,184. 7s. 6d. has been received, including cash paid in advance of calls. Mortgages and charges, nil.

NEW CENTURY ARC LIGHT CO. (LTD.)—Return to May 25 gives capital as £30,000 in 25,000 ordinary and 5,000 preference shares of £1 each, of which 14,306 ordinary and 5,000 preference have been taken up. £1 per share has been called up on 2,506 ordinary and £2,506 has been received. £16,800 is considered as paid on 11,800 ordinary and 5,000 preference. Mortgages and charges, £7,500.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—In return to April 11 capital is £600,000 in 30,000 ordinary and 30,000 preference shares of £10 each, of which 25,000 ordinary and 24,500 preference have been taken up. £10 per share has been called up on 17,834 ordinary and 24,500 preference, and £423,340 has been received. £66,660 is considered as paid on 6,666 ordinary shares. Mortgages and charges, £245,000.

PULFORD BROTHERS (LTD.)—In return to June 11, capital is £3,000 in £1 shares, of which 1,620 have been taken up. £1 per share has been called up on 1,170, and £1,170 has been received. £450 is considered as paid on 450 shares. Mortgages and charges, £500.

TYER & CO. (LTD.)—In return to June 12 capital is £25,000 in £1 shares, of which 22,007 have been taken up. £1 per share has been called up on 2,007, and £2,000 has been received, leaving £7 in arrears. 20,000 shares are considered as fully paid. Mortgages and charges, nil.

WEST AFRICAN TELEGRAPH CO. (LTD.)—Return to June 14 gives capital as £400,000 in 40,000 shares of £10 each, of which 23,109 have been taken up. £231,090 has been received. Mortgages and charges, nil.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—In return to May 24 capital is £200,000 in 40,000 shares of £5 each, of which 32,200 have been taken up. £5 per share has been called up on 31,950 and 5s. per share on 250 and £159,812. 10s. has been received. Mortgages and charges, £100,000.

MORTGAGES AND CHARGES.

COWPER-COLES INVENTIONS DEVELOPMENT CO. (LTD.)—Issue on July 4 of £70 6 per cent. debentures, part of series created by resolutions of June 1 and July 4, 1906, to secure £1,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

ELECTROMOBILE CO. (LTD.)—Memorandum of satisfaction for £9,000, being balance outstanding of a mortgage dated Aug. 10, 1904, stamped to cover £20,000, of which only £19,000 was advanced, has been filed. A mortgage dated July 19, 1906, to secure £9,000 and further advances, with $5\frac{1}{2}$ per cent. interest (instrument stamped to cover £20,000) has also been registered. Property charged: 10 per cent. of all moneys payable to company under contracts for sale of automobiles, for garage or supply of electricity, or for insurance or any other services in connection with automobiles or for the hire thereof. Holders, North of England Trustee, Debenture and Assets Corpn.

KEYNSHAM ELECTRIC LIGHT & POWER CO. (LTD.)—Issue on July 18 of a $5\frac{1}{2}$ per cent. debenture for £26, part of a series created Oct. 9, 1905, to secure £1,500 charged on certain land and premises at Keynsham, Somerset, and company's undertaking and property, present and future, including uncalled capital. Holder, W. J. Robinson. No trustees. Previously issued of same series, £1,104.

ORIENT ELECTRIC POWER SYND. (LTD.)—Issue on July 23 of £2,500 5 per cent. debentures, part of series created July 12, 1906, to secure £3,000 charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA (Aug. 9).—**Bank rate** $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $30\frac{3}{16}$d. per oz. Consols $88\frac{1}{4}$—$88\frac{3}{8}$ for money, $88\frac{3}{8}$—$88\frac{1}{2}$ for account; $2\frac{1}{2}$ per cent. annuities 87—$87\frac{1}{2}$. Consols Pay Day, Sept. 3; Stocks and Shares Continuation Days, Aug. 13 and 28; Ticket Days, Aug. 14 and 29; Pay Days, Aug. 15 and 30; Mining Share Carry-over Days, Aug. 10 and 27.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the five weeks ended June 29 were 687,049, compared with 550,733 units in the corresponding five weeks of the preceding year.

CHARING CROSS, EUSTON & HAMPSTEAD RAILWAY CO.—The capital expended during the past half-year was £436,402, and in the current half-year the expenditure is expected to amount to £600,000.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—After providing for interest there is an available balance for the June half-year of £875. 3s. 3d. Dividend is declared on the 5 per cent. preference shares, £100 is paid to the contractors for electrical equipment, £100 is written off working stock account, and £428 has been paid for a new electric locomotive.

GREAT WESTERN RAILWAY CO.—The report for the past half-year states that the electrification of the Hammersmith and City Railway and the works in connection therewith (including the generating station at Park Royal) are so far completed that it is hoped to bring electric working into operation in the autumn.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 10 per cent. (less tax) for the half-year ended June 30, payable Sept. 1. An interim dividend on the $4\frac{1}{2}$ per cent. preference shares will be paid on the same date.

NORTH-EASTERN RAILWAY CO.—In the report for the past half-year it is stated that the electric train working cost £15,894, against £15,824 in the corresponding period of last year. The directors recommend a dividend at the rate of $5\frac{1}{4}$ per cent.

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—At an extraordinary meeting last week it was resolved to reduce the capital from £10,000 to £6,500, cancelling paid-up capital to the extent of 14s. per share on each of the ordinary £1 shares, converting 2,100 preference shares (part of 3,849 preference shares of £1 each) unissued into 7,000 ordinary shares of 6s. each, and reducing the nominal amount of the ordinary shares to 6s. each.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The working for July resulted in 1,065,000 units being generated, yielding a gross revenue of £10,100, against 973,000 units and £8,700 for the corresponding period of last year.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.—At an extraordinary meeting at Cardiff on Tuesday, it was resolved to create and issue £500,000 prior lien debenture stock, bearing interest at 5 per cent. per annum, and redeemable at the option of the company on six months' notice after Dec. 31, 1916, at £105. The £1,000,000 of new share capital authorised to be raised by sec. 5 of the Company's Act, 1906, is to be created and issued in the form of 100,000 first preference shares of £10 each, entitled to preferential dividend of 5 per cent. per annum, ranking in priority to any dividends payable in respect to any other class of share capital of the company.

WIGAN COAL & IRON CO. (LTD.)—On Tuesday Mr. Justice Swinfen Eady authorised an alteration of the company's memorandum and articles of association, so as to include (inter alia) the generation and sale of electricity.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 1	1,519	− 60	9	13,744	− 213
Airdrie	July 27	192	+ 21	30	6,553	+ 626
Anglo-Argentine	Aug. 5	14,606	+ 1,859	31	457 215	+ 48,138
Ashton-under-Lyne Corp.	July 28	388	+ 50	18	6,360	+ 672
Ayr Corporation	Aug. 4	437	+ 23	12	4,841	− 54
Baker St. & Waterloo Ry.	,, 4	1,209	...	5	6,698	...
Barnsley	July 27	168	+ 8	30	4,806	+ 39
Barrow	,, 27	317	+ 34	30	7,305	+ 371
Bath Electric Trams, Ltd	Aug. 1	1,051	+ 268	31	24,201	+ 3,898
Birkenhead Corporation	...	...	...	...	...	...
***Birmingham Corporation**	,, 4	1,391	+ 1,050	18	14,576	+ 8,122
Birmingham & Mid.	July 27	10,169	− 335	30	304 293	+ 18,451
Blackburn Corporation	...	...	...	...	...	..
Blackpool Corporation	Aug. 2	2,152	+ 467	17	21,973	+ 1,152
Blackpool and Fleetwood	,, 2	1,418	+ 272	5	5,925	+ 570
Blackp'l, St. Anne's & Lytham	,, 2	825	+ 155	§39	12 897	+ 1,353
Bolton Corporation	,, 5	2,239	+ 228	18	39,618	+ 2,580
Bournemouth Corporation.	,, 1	1,841	+ 230	†18	29,433	+ 6,344
Bradford Corporation	,, 4	4,889	+ 210	18	84,759	+ 3,438
Brighton Corporation	,, 5	1,381	+ 36	18	18,456	− 1 006
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 3	5,506	+ 98	25	126,441	+ 3,712
Buenos Ayres & Belgrano	,, 5	3,536	− 34	31	110,130	+ 6,276
Buenos Ayres Elec. Trms.	July 7	1,163	− 11	27	37 009	+ 6,829
Burnley Corporation	Aug. 5	1 299	+ 214	18	21,180	+ 1,074
Burton Corporation	,, 6	351	...	§18	5,611	− 369
Bury Corporation	July 29	1,043	...	17	17,326	...
Calcutta Tramways Co.	Aug. 4	R42,077	− R1,798	5	R218,077	+ R8,742
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	July 28	2,287	+ 79	17	35 820	− 1,090
Cavehill	,, 27	136	+ 87	30	2,570	+ 942
Central London Railway	Aug. 4	5,194	− 373	5	28,564	− 1,045
Chatham & Dist. Lt. Rys.	,, 2	736	− 40	†31	19,780	− 470
City & South London Rly.	,, 5	2,277	+ 14	5	12,394	+ 1,075
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	,, 2	569	+ 15	31	14 626	− 379
Croydon Corporation	,, 3	1,547	+ 74	9	14,843	+ 1,011
Derby Corporation	...	...	...	...	...	...
Doncaster Corporation	...	...	...	...	...	...
Devonport & Dist. Trams	July 27	523	+ 22	30	13 330	− 386
Dover Corporation	Aug. 4	337	+ 45	18	4 333	+ 655
Dublin & Lucan Railway	,, 3	148	+ 8	§5	684	− 36
Dublin United	,, 3	5,661	+ 243	‡5	27,073	− 161
Dundee Corporation	,, 1	1,191	+ 342	§11	12,507	+ 2,655
East Ham Council	,, 4	919	+ 34	18	17,132	+ 1,573
Exeter Corporation	,, 3	327	+ 9	18	5,302	− 442
Falkirk and District	...	...	...	..	..	...
Gateshead & Dist. Trams	July 27	1,044	+ 70	30	28,692	+ 1,645
Glasgow Corporation	Aug. 4	16,465	+ 1,951	10	155,890	+ 10,550
Glossop	..	...	...	...	...	...
Gloucester Corporation	...	...	...	..	...	...
Gravesend—Northfleet	July 27	281	+ 1	30	6 957	+ 270
Gt. Northern & City Rly.	Aug. 4	1,492	+ 50	5	7,991	+ 707
Greenock & Port Glasgow	July 27	779	+ 58	30	19,537	+ 726
Halifax Corporation	..	...	...	...	...	...
Hartlepool Tramways	,, 27	380	+ 70	30	8,645	+ 938
Hastings Elec. Trams Co.	Aug. 2	1,039	...	5	4,299	...
Huddersfield	,, 4	1,589	+ 144	19	27,927	+ 2,697
Hull Corporation	,, 4	2,406	+ 150	18	40,919	+ 1,266
Ilford Dist. Coun.	...	...	...	...	...	...
Ilkeston Dist. Council	,, 1	151	+ 38	18	2,410	+ 139
Ipswich Corporation	,, 4	546	+ 20	18	8 180	− 196
Isle of Thanet Co.	,, 4	1,480	+ 16	43	19,960	− 1,294
Keighley Corporation	,, 2	193	+ 10	5	782	− 3
Kidderminster & District	July 27	146	− 4	30	3,441	− 58
Kilmarnock Corporation	Aug. 4	197	+ 4	12	2,017	− 80
Kirkcaldy Corporation	,, 1	235	+ 23	5	1 322	+ 49
Lanarkshire Trams Co.	,, 2	826	..	‡31	26,745	+ 5 682
Leamington	July 27	232	+ 1	30	5,217	+ 2,856
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	Aug. 4	2,328	− 25	31	67,863	+ 4,398
Leith Corporation	...	...	...	...	...	...
Liverpool Overhead Rly.	,, 5	1,560	− 112	5	7,833	− 408
Liverpool Corporation	July 28	11,485	+ 186	30	319 626	+ 5,726
***London County Council**	,, 28	27,057	+ 11,341	17	452,647	+ 195,661
London United	Aug. 3	7,092	+ 358	†31	188,394	+ 10,606
Lowestoft	,, 4	361	− 16	45	6,741	− 545
Maidstone Corporation	...	...	...	...	...	..
Manchester Corporation	,, 4	14,221	+ 1,352	18	247,829	+ 10,129
Mersey Railway	...	..	...	..	..	..
Merthyr	July 27	210	+ 20	30	5,767	+ 72
Metropolitan Dist. Railway	Aug. 5	7,606	+ 721	5	38,383	+ 5,258
***Metropolitan Elec. Trams.**	July 27	3,821	+ 372	30	99,459	+ 26,011
Middleton	,, 27	411	+ 14	30	10,396	+ 253
Nelson Corporation	Aug. 4	134	+ 13	19	2,743	+ 233
Newcastle-on-Tyne Corp.	,, 4	4,084	+ 141	18	79,945	+ 4,980
Newport (Mon.)	,, 4	675	+ 38	18	11,507	+ 449
Northampton Corporation.	,, 2	489	+ 19	18	8,230	+ 52
Oldham, Ashton & Hyde	July 27	603	+ 7	30	16,723	+ 488
Oldham Corporation	Aug. 5	2,026	+ 309	19	34,585	+ 2 985
Perth (N.B.) Corporation	...	...	...	..	...	...
Perth (W. A.) Elec. Trams	,, 3	1,375	+ 68	31	45,956	+ 2,726
Peterborough	July 27	158	− 6	30	3,695	− 328
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	Aug. 4	2,605	+ 35	18	38,152	− 47
Potteries	July 27	1,806	+ 79	30	52,774	+ 2,630
Preston Corporation	,, 25 Aug. 1	793 819	+ 108 + 133	5	3,988	+ 562
Reading Corporation	...	..	...	...	...	...
Rochdale Corporation	...	..	...	..	...	...
Rotherham Corporation	,, 2	523	+ 88	18	8 919	+ 816
Rothesay	July 27	700	+ 55	30	6,074	+ 1,134
Salford Corporation	...	...	...	.	...	...
Sheerness	,, 25	71	− 25	30	1,654	− 368
Sheffield Corporation	Aug. 5	5,500	+ 609	19	100,786	+ 5,558
Singapore Trams	,, 4	$7,986	...	6	$37,357	...
Southampton Corporation.	,, 1	1,140	+ 44	17	17,545	+ 63
Southend Corporation	..	.	...	...	...	...

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	July 27	406	+ 39	30	9,150	+ 150
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	...	...
Sunderland Corpn.	...	...	..	...	..	...
Sunderland & District	Aug. 1	441	...	31	11,896	...
Swansea Trams	July 27	912	+ 45	30	23,869	+ 4,124
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 27	50	− 14	30	1,315	− 121
Tynemouth and District	,, 27	140	+ 11	30	7,267	− 245
Tyneside Trams Co.	Aug. 1	498	+ 58	31	13,940	+ 913
Wallasey District Council	,, 4	953	+ 39	18	15,102	+ 417
Walsall Corporation	,, 4	555	+ 37	28	15,793	+ 887
Warrington Corporation	,, 2	368	+ 6	18	6,704	+ 575
West Ham Corporation	,, 2	2,309	+ 592	18	41,719	+ 12,832
Weston-super-Mare	July 25	351	+ 10	30	3,391	+ 135
Wolverhampton Corpn.	Aug. 1	860	...	5	4,412	...
***Worcester**	July 27	351	− 7	30	8,168	− 715
Wrexham	,, 27	116	+ 3	30	2,981	− 9
Yorkshire W.R. Trams	Aug. 5	908	+ 69	31	25,220	...
Yorkshire Woollen District	July 27	1,187	+ 325	30	26,734	+ 7,786

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Aug. 8.	
						Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	$6\frac{13}{16}$—$7\frac{1}{16}$	5 13 6	Ap, Oct	7	$6\frac{15}{16}$
5	2/9	Do. 5½% Cum. Pref.	$5\frac{3}{4}$—6	4 11 8	—	$6\frac{9}{16}$	$5\frac{13}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	133 —141	4 5 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 16 3	—	$108\frac{1}{4}$	..
5	..	Brisbane Electric Trams. Invest. Ord.	$1\frac{1}{2}$—$1\frac{3}{4}$	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	$4\frac{3}{8}$—$4\frac{5}{8}$	5 10 0	—	$4\frac{5}{8}$	$4\frac{7}{16}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	$01\frac{3}{8}$	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117 —120	5 0 0	—	1.9	$18\frac{1}{4}$
St.	5%	Do. Pref. Ord. Stk	108 —111	4 10 0	—	$109\frac{1}{2}$	[illegible]
10	5%	Do. 5% Cum. Perp. Pref. Stock.	105 —108	4 13 0	—	$106\frac{1}{8}$	106
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	$8\frac{1}{4}$—$8\frac{1}{2}$	5 0 0	—	$3\frac{3}{8}$	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	$5\frac{1}{4}$—$5\frac{3}{4}$	5 4 0	—	..	—
5	8/0	Do. "B"	$4\frac{7}{8}$—$5\frac{3}{8}$	5 9 0	—	..	—
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —100	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8 —$8\frac{1}{2}$	4 15 0	—	..	..
5	2/6	Do. Nos. 105,001 to 137,610	$7\frac{7}{8}$—$8\frac{3}{8}$	4 15 6	..	..	..
10.	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	$105\frac{3}{4}$	..
1	0/6	Cape Electric Tram Shares	$\frac{9}{16}$—$\frac{13}{16}$	6 3 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	88 —93	6 9 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	$1\frac{3}{8}$—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	$1\frac{1}{8}$—$1\frac{3}{8}$	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	4½%	†Montreal St. Ry. Sterling 4½% Debs. (1922)	100 —102	4 8 0	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	14[illegible] —14[illegible]	5 2 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	$98\frac{1}{2}$	97
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	$4\frac{3}{4}$—$5\frac{1}{4}$	5 14 6	..	$5\frac{1}{8}$	..
5	5/3	Calcutta Elec. (1-50,000)	$7\frac{1}{2}$ 8	5 0 0	..	8	$7\frac{21}{32}$
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	$2\frac{1}{2}$— 3	..	..	..	—
St.	5%	Do. 5% Debs.	85 —89	5 12 4	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	110 —113	5 6 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{25}{32}$ $\frac{23}{32}$	6 18 0	—	..	..
1	1/6	Rand Electric	$\frac{15}{16}$ — $1\frac{1}{16}$	..	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{7}{16}$ $\frac{9}{16}$	..	..	..	..
1	1/2¾	Do. 6% Non. Cum. Pref.	$\frac{7}{8}$ 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	$5\frac{1}{8}$—$5\frac{3}{8}$	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

ELECTRICITY SUPPLY.

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
10	14/0	Bournemouth & Poole Elec. Sup. Ord.	10½—11½	6 3 6	..	—	..
10	4/6	Do. 4½ per Cent. Cum. Pref	10—10½	4 5 6	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	11—12	5 0 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104—106	4 4 10	..	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛—5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101—104	4 7 6	—	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	8—9	5 11 6	—	.	..
5	3/6	Do. 7 per Cent. Pref.	7¾—8¼	4 5 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100—103	3 17 9	—	.	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4—5	5 0 0	Feb, Aug	4½	.
5	2/3	Do. 4½ per Cent. Pref.	4¼—4¾	4 11 9	Feb, Aug	4½	4⅝
St.	4%	Do. 4% Deb. Stock (red.)	99—102	3 18 3	—	101	100¼
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾—4¼	5 6 0	—	..	..
5	2/3	Do. Do. (1903)	3¾—4¼	5 6 0	—	..	..
5	3/9	Chelsea Electric Supply Ord.	5¼—5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106—108	4 3 3	Jn, Dec ..	..	.
10	5/0	City of London Electric Lighting Ord.	10—10½	5 10 6	Feb, Aug	10⅛	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½—12½	4 16 0	Jan, July	12⅛	12 1/16
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	122—125	4 0 0	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101—103	4 7 6	..	101⅞	101
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	21/32—1 1/32	3 19 10	April, Oct	.	..
5	5%	Do. Do. 5% non cum. pref.	5 3/16—5 5/16	4 5 3	April, Oct	.	..
10	6/0	County of London Elec. Supply Ord.	7¾—8¾	5 14 0	—	8 3/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Mar, Sept	12	11⅞
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	106—109	4 2 6	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101—104	4 6 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 11 9	..	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red.)	99—102	4 8 0	—	—	..
5	5/0	Hove Electric Lighting Ord.	7⅝—8⅛	5 10 0	—	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98—101	4 9 0	—	..	—
5	2/6	†Kensingtn. & Kngtsbdg. Ord	9¾—10¾	4 13 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	† Do. 4 per Cent. Deb. Stock (red.)	97—100	4 0 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101—103	3 17 6	—	..	..
3	2/4⅕	London Electric Supply Ord.	2—2½	4 0 0	—	..	..
5	3/0	Do. 6 per Cent. Pref.	5—5½	5 7 0	—	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96—99	4 0 10	Mr,Jn,S,D	97	..
5	10%	Metropolitan Electric Sup. Ord.	8—9	5 10 0	April, Oct	8⅝	8 1/32
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 9	Jan. July	5⅜	5 5/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109—113	4 1 10	Jn, Dec ..	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	94—96	3 13 0	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98—101%	4 9 1	—	..	..
10	7½%	†Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10¾—11	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103—104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝—7¾	5 1 3	Feb, Aug	..	—
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾—5⅞	4 5 1	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100—101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1 7/32—1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102—103	4 7 4	Jan, July	—	—
10	6/0	Notting Hill Electric Ord.	13½—14½	5 3 5	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97—99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6⅝—6⅞	4 17 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	97—99	4 1 0	—	..	..
5	5/0	†St. James' & Pall Mall Elec. Ord.	10¼—11¼	5 11 1	Feb, Aug	10⅝	..
5	3/6	† Do. 7 per Cent. Pref.	6¾—7¾	4 10 4	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95—97	3 12 2	—	..	.
5	4/0	Smithfield Markets Electric Sup. Ord.	2—2½	8 0 0	..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	74—78	5 2 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾—3¼	6 8 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾—⅞	..	..	.	.
1	0/8⅖	Do. 7% Cum. Pref.	1⅛—1⅜	5 2 0	..	1 1/16	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103—106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3½—4	6 10 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4¼—4¾	5 5 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	100—102	4 8 0	..	..	..
5	6/6	Westminster Elec. Sup. Ord.	9¾—10¾	6 5 0	Mar, Sept	10¼	9 13/16
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 11 0	..	..	..

ELECTRIC RAILWAYS, TRAMWAYS, &c.

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88—91	4 8 0	..	89	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16—1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16—1 1/16	4 9 0	..	—	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100—104	4 6 6	—	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98—100	4 10 0	..	..	..
10	8½%	Bristol Tramways and Carriage Ord.	15¼—15¾	5 8 0	Feb, Aug	..	—
10	4%	Do. Cum. Pref. (fully paid)	9⅞—10⅛	3 19 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101—103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	8¼—8¾	5 4 0	—	8½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	8¾—9¼	6 9 6	Feb, Aug	9 3/16	9
St.	5%	Do. 5 per Cent. Perpetual Debs	109—112	4 9 3	..	111¾	111
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	89—92	4 19 0	..	90½	..
St.	4%	Central London Ordinary Stock	85—87	4 12 0	June, Dec	86¾	..
St.	4%	Do. 4 per Cent. Pref. Stock	99—101	3 19 0	..	..	..
St.	4%	Do. Deferred Stock	73—76	5 5 0	..	76	74½
100	4%	Do. 4 per Cent. Debs.	108—110	3 12 8	..	.	—
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88—91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5—5¼	4 15 0	..	5½	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100—103	3 17 6	..	.	..
St.	2½%	City and South London Rly. Con. Ord.	45—47	4 5 1	Feb, Aug	47¼	46⅜
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	120—123	4 1 4	Feb, Aug	—	..
St.	5%	Do. (1896)	114—117	4 5 3	..	.	..
St.	5%	Do. (1901)	114—117	4 5 3	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104—107	3 14 8	May, Nov	.	..
10	6/0	†Dublin United Trams. (1896) Ltd., Ord.	14¼—15¼	3 18 6	..	.	..
10	6/0	† Do. 6 per Cent. Pref.	14—15	4 0 0	..	..	..
10	4/0	†Gt. Northern & City Rly. Prf. Ord. (4%)	3¼—3¾	10 13 4	..	3 11/32	3⅜
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100—103	4 7 6	..	.	..
10	9%	‡ Imperial Tramways Ord	15—16	5 12 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11—11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½—104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2—2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77—83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8½—8⅝	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99—102	3 19 3	Jan, July	.	..
10	5/0	London United Trams. 5% Cum. Pref.	8¼—8¾	5 14 0	—	8 21/32	8 5/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	93½—94½	4 3 0	—	95	94¼
St.	..	Mersey Con. Ord. Stock	4—6	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8—11	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—¼	..	—	⅛	..
1	0/6	Do. 5% Cum. Pref.	13/16—15/16	5 9 0	—	⅞	27/32
St.	4½%	Do. 4½% Deb. Stock	100—102	4 8 3	—	..	..
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	1—1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾—7¾	5 5 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½—8½	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100—103	4 7 3	—	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89—92	5 8 8	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90—92	5 8 8	—	..	..
St.	3½%	Waterloo and City Ord.	100—103	3 3 0	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3—3½	..	—	..	..
St.	4½%	Do. 4½% 1st Debs.	93—95	4 14 9	—	..	—

ELECTRIC MANUFACTURING, &c.

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
1	10½d.	Aron El. Met. 6% Cm. Pf.	7/16—9/16	..	—	½	..
1	2/4⅘	Babcock & Wilcox Ord	3¾—4	4 14 0	..	..	..
1	7½d.	Do. Pref	1½—1⅝	5 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6½—7	5 14 0	July, Feb	6⅞	..
5	3/0	† Do. 6 per Cent. Pref.	5½—6	5 0 0	Jan, July	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102—105	4 5 6	..	..	—
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96—98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1½—2	..	..	1 19/32	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77—83	4 16 6	..	—	..
2	1/0	Brush Electrical Engineering	⅝—⅞	..	March ..	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1¼—1¾	6 17 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97—99	4 1 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	82—84	5 7 2	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½—11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝—5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108—110	4 2 0	Nov, May	108⅝	..
1	5⅗d.	Castner-Kellner Alkali Co.	1 1/32—1 3/32	5 4 6	..	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb. (red.)	95—100	4 10 0	—	..	..
1	1/4⅘	Chadburn's (Ship) Telegraph Ord.	1 3/16—1 5/16	7 10 0	—	..	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 3 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1¾—2	3 12 0	Jan, July	.	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%—97%	5 2 0	Jan, July	97¼	96¾
5	10/0	Dick, Kerr & Co. Ord.	1 11/16—1 13/16	5 12 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	103—106	4 5 0	..	..	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	4 5 6	Feb, Aug	..	—
5	2/6	Do. (£5 paid)	2½—3	4 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85—87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90—95	5 5 0	—	..	..
5	1/6	†Edmundson's Elec. Corp. Ord.	3¼—3¾	9 12 0	H'lf-yearly	3¾	3 7/16
5	3/0	Do. 6 per Cent. Cum. Pref.	4¾—5¼	5 14 0	..	5 1/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100—103	4 7 4	—	101½	101
2	1/7½	Electric Construction Co.	⅝—⅞	11 4 0	July	..	..
2	2/9⅗	† Do. 7 per Cent. Cum. Pref	1¾—2¼	6 4 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	86—89	4 10 6	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9—9½	5 5 3	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93—97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12—13	5 15 0	Feb, Aug	12¾	—
5	2/3	Do. 4½ per Cent. Pref.	5¼—5½	4 1 6	Feb, Aug	5½	..
St.	4½%	Do. 4½ per Cent. 1st Mt. Db. St.	107—109	4 2 6	..	108½	—
St.	22/6	Do. Do. Scrip (all paid)	107—109	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wks.	17—18	2 17 2	Feb, Aug	..	..
100	..	Do. 4% Debs. Red.	100—102	3 19 6	..	101¼	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½—12	4 3 4	Mar, Sept	..	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32—31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16—1 1/16	5 15 6	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	97—100	4 10 0	..	4 9/32	..
12	12/0	Telegraph Construction & Mainten'ce.	33—35	5 14 0	Mar, July	34¼	33
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100—102	3 18 3	Jan, July	..	..
1	1/0	†Vickers, Sons & Maxim, Ltd., Ord.	2⅜—2½	6 0 0	..	2 15/32	2 13/32
1	6d.	† Do. 5% Non-Cum. Preference	1 1/16—1 3/16	4 12 0	..	..	..
St.	5%	† Do. 5% Non-Cum. Preferred	113—116	4 6 0	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103—105	3 16 0	..	104¾	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red	105—107	4 4 6	—	106	105
5	—	Willans and Robinson Ord.	¾—1¼	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	..	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77—82	4 17 6	May Nov	..	—

TELEGRAPHS.

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
10	—	Amazon Telegraph	3½—4	..	Jn, Dec ..	3 9/16	..
100	5%	Do. 5% Debs. (red.)	86—91	5 10 0	..	..	..
St.	16/0	†Anglo-American	65—67	4 17 0	F,My,Ag,N	65¼	..
St.	30/0	† Do. Preferred	111—112	5 9 0	F,My,Ag,N	112	111⅛
St.	10/0	Do. Deferred	21½—21¾	2 9 0	F,My,Ag,N	21 11/16	21¼
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½—98½	4 0 6	Jn,Ap,Jy,O	98½	98⅜
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	8 21/32	—
10	10/0	Do. Preference 10 per Cent.	17—18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾—9¼	5 8 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	3 19 0	Jan, July	..	..
20	6/6	Direct United States Cable xd & bonus	15½—16	4 18 6	Ja,Ap,Jy,O	15⅞	15⅝
100	4½%	Direct West India Cable 4½% [illegible] Db. (rd.)	99½—101½	4 8 9	Jn, Dec ..	..	..
St.	[illegible]	Eastern Ordinary xd & bonus	142—145	4 16 6	Ja,Ap,Jy,O	145	142¼
St.	17/6	Do. 3½ per Cent. Pref. Stock	90½—91½	3 16 6	Ja,Ap,Jy,O	91½	89½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107—109	3 13 4	May, Nov	108	107½
10	2/6	Eastern Extension	14—14½	4 16 6	Ja,Ap,Jy,O	14 7/16	14⅜
St.	4%	† Do. 4 per Cent. Deb. Stock	105—107	3 14 9	Feb, Aug	..	..
100	4%	†Eastern & S. African 4% Mrt. Deb, 1909	99—101	3 19 0	Feb, Aug	99	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%—102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	38—40	5 18 0	Jan, July	38¼	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99½—101½	4 8 9	June, Dec	..	..
25	32/6	Indo-European	58—60	5 8 4	May, Nov	..	..
100	4%	Mackay Companies Common	76 3/16—76 15/16	5 4 0	Jan, July	—	..
100	4%	Do. Preference	74 3/16—75 3/16	5 7 0	Ja,Ap,Jy,O	..	—
1	..	Marconi's Wireless Teleg. Co.	15/16—1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99—102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½—10	5 0 0	..	..	..
[illegible]	—	West Coast of America	¾—⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100½—103½	3 17 3	Jan, July	102	..
10	—	West India and Panama	7/16—9/16	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6½—6¾	3 18 0	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99—102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14½—14¾	4 15 0	Mr,Jn,O,D	14¾	..
100	5%	Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103—106	3 15 6	..	105⅝	104½

TELEPHONES

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
—	4%	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	94—96	4 3 4	..	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101—103	4 17 0	..	..	..
5	5/0	†Chili Telephone (fully paid)	7⅝—7⅞	4 18 0	August	..	—
1	0/4⅘	Monte Video Telephone Ord.	15/16—1 1/16	3 15 3	—	—	..
1	0/6	Do. 6% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock xd & rights	107—109	5 10 1	—	108½	107¼
St.	6%	Do. Def. Stock xd & rights	107—109	4 11 9	—	108½	107½
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	11—13	4 13 6	Feb, Aug	11 9/16	11¼
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	10—12	5 0 0	Feb, Aug	..	..
5	2/6	† Do. 5 per Cent. Non-Cum. 3rd Pref.	5¼—5¾	4 7 0	Feb, Aug	5 11/16	5 9/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97—99	3 11 8	June, Dec	98½	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102—104	3 17 0	—	103¼	102¾
1	0/2⅗	Oriental	1 1/16—1 1/16	4 3 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1 5/16	4 11 6	—	..	..
St.	4%	Do. 4% Red. Deb. Stock	97—99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101—104	4 6 6	..	..	..
5	5/0	United River Plate	7—7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109—112	4 9 3	June, Dec	..	..

FINANCIAL, INVESTMENT, &c.

Shre.	Last Dividend	Name.	Price Wed., Aug. 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 8. Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½—5	0 0 0	—	..	..
10	2/0	†Globe Telegraph and Trust	10½—11	5 0 0	Ja,Ap,Jy,O	10 13/16	10⅝
10	3/0	† Do. 6 per Cent. Pref	14½—14¾	4 1 6	Ja,Ap,Jy,O	14 11/16	14 9/16
10	6%	Submarine Cables Trust (Cert.)	129—132	4 11 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

IN his Presidential Address to the Association Française pour l'Avancement des Sciences, Prof. LIPPMANN, like Prof. RAY LANKESTER at the recent meeting of the British Association, referred to the want of appreciation of pure science on the part of the public, more particularly on the part of manufacturers. In this respect he took the view that French manufacturers are very much behind those of most other European countries, for they consider that mathematicians, physicists and chemists are expensive luxuries. Consequently, researches such as those of CARNOT have been very little utilised in comparison with their application in this country. The comparison, however, was mostly drawn between France and Germany, from which it may be inferred that, generally speaking, Prof. LIPPMANN thinks English methods are as defective as those in France.

◆

OPINIONS no doubt differ very much as to the commercial value of the pure scientist. It is, therefore, instructive to turn to the quarter from which most competition is expected, and where, presumably, things are looked at from the point of view of commercial value as much as anywhere. As instances, Prof. LIPPMANN mentions that the Zeiss works at Jena employ 14 Doctors of Science, including mathematicians as well as physicists; and at one large German analine colour works are employed 145 scientific chemists and 175 technologists. Nor are these isolated examples. The research laboratories are well equipped, and one works has a library of 14,000 books. Considering that the companies pay dividends of 20 to 30 per cent., these luxuries seem justifiable. Their neglect in France, Prof. LIPPMANN ascribes to the defective education, which he describes as Chinese in origin and in character.

◆

THE recent letters to *The Times* by Lord KELVIN and Prof. ARMSTRONG, to protest against the flights of imagination of the physicists who are investigating radium, and the subsequent correspondence taking up the other side of the question, show the want of sympathy between the chemist and the physicist. Prof. ARMSTRONG regards physicists as strangely innocent workers, guided by the all-potent influence of formulæ and fashion: he has no objection to physicists postulating the most "crack-brained of hypotheses," or dreaming the wildest of dreams, as a means of guiding inquiry; but popularity should not be courted on such a basis, for by so doing we lose all claim to guide public opinion. In a rejoinder, Sir OLIVER LODGE refers to the "characteristic comment" of Prof. ARMSTRONG, and is evidently inclined to think that the chemists will finally absorb these results, as they have others, notwithstanding the scorn that is meted out to chemical results obtained by physical means. As Sir OLIVER LODGE remarks, chemists have an instinct of their own for arriving at such doctrines as the constitution of organic compounds and other admirable discoveries; and though occasionally it may happen that their methods are odd and unconvincing to the physicist, the chemist is ready and even eager to retort that physical methods are forced and unintelligible.

◆

THE departure of the Local Government Board from its usual practice, as announced at Exeter by one of the inspectors, Mr. HOOPER, will be welcomed by those who have the misfortune to prepare schemes for approval by the Board. Hitherto it has been customary for drawings to be prepared showing full details of the proposed work, so that the inspector might be satisfied with its character, but no assurance was ever given that such details would not be considerably modified by the time the work was carried out. In many cases details of this kind are decided to greater advantage as the work proceeds. Now, however, the Board is going to follow a more enlightened course as regards loans for water or electric light mains, and will waive their demand for schedules and plans. Loans for extensions will be sanctioned for a sum not exceeding three years' average expenditure in the past, but before any further loan is granted full details will be required as to how the previous loan was expended. Moreover, an application for a loan must be made before the money is spent, instead of the expenditure preceding the application, which has been a favourite method of procedure by some local authorities. Even with the delays that seem inseparable from the Local Government Board, it should be possible to observe this stipulation without much difficulty under these more elastic conditions.

◆

AT the recent annual general meetings of railway companies it was apparent that electric traction is growing in favour. The decision of the London & North-Western Railway Co. to equip a line for electrical working from Euston to Watford is important, and a change of this kind should do much to facilitate the handling of the suburban traffic, more particularly as the new line will be independent of the existing permanent way, and thus will not interfere with present arrangements. The electric line of the North-Eastern Railway Co. at Newcastle continues to give satisfaction, the number of passengers carried during the last half-year exceeding those in the corresponding period of the previous year by 300,000. There has also been considerable development in motor-car services for outlying districts, and in the use of motor waggons, which have been appreciated by the farmers. Although the Great Northern Railway has lost a great deal of suburban traffic owing to the competition of tramways, the loss being put at 430,000 passengers for the half-year, the directors do not apparently think it worth while to trouble very much about traffic of that kind. The Chairman evidently takes the view that tramways are necessarily more convenient than railways for passengers travelling over short distances, and that consequently the situation must be accepted.

◆

SO far, the gas companies in this country have not had an opportunity of attacking the legal position of their electrical competitors, though competition on the usual lines has been keen enough. But in Melbourne it has been otherwise. The attempt on the part of the Corporation to charge low rates for power supply was met five years ago by an injunction obtained by the Gas Company to restrain the Corporation from charging preferential rates. This difficulty was met by an amending Act of Parliament which is now in force and contains the following section: "Notwithstanding anything in any other Act contained, it shall be lawful for any undertaker within the meaning of the Electric Light and Power Act, 1896, or for any gas company to charge for the supply of electricity or gas used for power or heating purposes respectively or both a lower uniform charge than that charged for the supply of electricity or gas used for lighting purposes."

AFTER this action of Parliament, peace might have been expected; but the introduction of the maximum demand system by the Corporation raised another bone of contention. The Gas Company again applied for an injunction against the Corporation to restrain them from giving preferential rates. The case was referred by the Chief Justice to the Full Court, who stated that they were bound by their previous judgment against the Corporation. Thereupon the case was taken to the Commonwealth High Court, as reported on another page, where it was decided in favour of the Corporation. Fortunately such litigation has not arisen in connection with the Electric Lighting Acts in this country; possibly the gas companies consider that their money is better spent in other ways.

◆

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Rhodes—Sitia	Aug. 10, 1906
Falmouth—Bilbao	Aug. 14, 1906

Personal.—The Emperor of Japan has appointed Mr. Geo. G. Ward, vice-president and manager of the Commercial Pacific Cable Co., a Commander of the Order of the Rising Sun. Mr. Fred. Ward, manager in England of the Commercial Company, has been appointed Commander of the Sacred Treasure, and Mr. Albert Beck, secretary of the company, Officer of the Rising Sun. These appointments have been made in connection with the extension of the Commercial Pacific Company's cable system to Japan.

Electrical Trolley Omnibuses.—Some new electrically propelled public service vehicles running on ordinary roads without rails and supplied by a double trolley line are described in *Elektrische Bahnen und Betriebe*. One of these vehicles, which was supplied by Max Schiemann & Co., of Wurzen, runs between Neuenahr and Walporzheim a route about 3½ miles in length, and the other at Charbonnières les Bains, near Lyons, on a line about 4½ miles long. The cars are each driven by two 15 H.P. motors one geared to each of the front wheels, and the steering is accomplished by swinging the whole forecarriage. Solid rubber tyres are used on the front driving wheels, but the rear wheels, which are of large diameter, have narrow iron tyres. The whole carriage weighs 3·3 tons, and can accomplish an average speed of about 8⅓ miles per hour.

Electric Signalling on the South-Eastern & Chatham Railway.—It is announced in the *Daily Mail* that experiments are being made with an electrical system of communicating signals to the drivers of trains in motion by the South-Eastern & Chatham Railway Co. A length of about 100 yds. of light contact rail is laid in the centre of the track near each signal post, and a small indicator board is placed in the cab of each locomotive. This board carries a bell and two miniature semaphore arms representing the home and distant signals and an additional arrangement of red and green lamps. Connections are also provided for a telephone set, by which the driver can communicate with the nearest signal box when the train is standing still. It is stated that the Board of Trade will shortly make an inspection of the apparatus, which is chiefly intended for use during fogs.

Overhead Wires in the City.—The recently issued report of Mr. Frank Sumner, City engineer, on the works executed by the Public Health Department of the Corporation of London, calls attention, amongst other things, to the question of overhead wires in the City. It appears that since the year 1899, when the Corporation took the matter in hand, a total of 22¼ miles of derelict wires have been removed. All owners of overhead wires are now required to identify them by having a perforated zinc label of approved pattern attached. During 1905, 69 derelict and unidentified wires of a total length of 3,490 yds. were removed. The overhead wires in the City continue to increase, and during 1905 the number of private owners of lines increased to 131, the number of companies remaining at 18. Both have considerably added to their number of spans during the last 12 months, and these now total about 699,300 spans crossing public thoroughfares, as compared with 682,000 spans last year and 260,000 spans in 1899. There has been a net increase of nearly 820 miles of National Telephone Co.'s wires.

Seeing Through the Telephone.—It is stated in *Telephony* that preliminary patents have been granted in America to Mr. J. B. Fowler, of San Diego, California, for what is described as a "seeing telephone." The apparatus, which is named by the inventor the "televue," is reported to have been tested over a line more than a mile in length, and is claimed to reproduce on a small circular disc a coloured representation of the scene at the other end of the line. The transmitting instrument has a glass disc 6 in. in diameter opposite which the person or object to be represented at the other end is placed, and the image appears on a disc $1\frac{3}{4}$ in. in diameter. No details of the apparatus are given beyond the statement that its action depends "upon the variations in the electrical resistance of a ribbon of selenium produced by variations in the intensity of a beam of light impinging upon it." It is also said that one induction coil and two batteries are provided in the instrument, in addition to the ordinary telephone equipment. We shall await, with interest, developments of the apparatus, which has boundless possibilities of utility, as we believe that the efforts of other workers in this direction have not been crowned with unqualified success.

Wireless Telegraphy.—According to the Press Association the number of Marconi wireless telegraph stations for ship and shore communication in Canada is being considerably augmented. Eight such stations have been erected at the entrance of the St. Lawrence, and there are also stations at Point Armour, Chateau Bay, Belle Isle, Battle Harbour, Venison Island, Seal Islands, Domino and Indian Harbour on the Labrador coast, St. John in New Brunswick, Cape Sable in Nova Scotia, and Cape Race in Newfoundland. New stations are to be erected at Father Point and Seven Islands in the Province of Quebec, whilst the important station at Cape Race is being extended. The Canadian Wireless Telegraph Co, which works all the Canadian Government stations, have the new stations and extensions in hand, and when they are completed there will be a complete chain of wireless telegraphic communications from Quebec to Labrador on the one side and to Cape Race on the other.

It is announced in the *Liverpool Daily Post* that wireless telegraph apparatus has been installed, on Prof. del Vecchio's system, on a number of trains in Italy, by which trains can communicate with stations and with each other.

The British Association.—The following is a list of the Papers, &c., of electrical interest which were read at the meeting of the British Association at York :—

Report of the Electrical Standards Committee : "The Positive Charge Carried by the α-Particle of Radium-C," by Prof. F. Soddy ; "Chemical and Electrical Changes Induced by Ultra-Violet Light," by Sir W. Ramsay and Dr. J. F. Spencer ; "The Electrical Discharge in Air and Its Applications," by Messrs. S. Leetham and W. Cramp ; "Recent Advances in Our Knowledge of Radiation Phenomena and their Bearing on the Optical Measurement of Temperature," by Dr. J. B. Henderson ; "A Magnetic Indicator of Temperature for Hardening Steel," by Mr. W. Taylor ; "Glow Lamps Up-to-date and the Grading of Voltages," by Sir W. H. Preece ; "The Advent of Single-phase Electric Traction on Railways," by Mr. C. F. Jenkin ; "The Removal of Dust and Smoke from Chimney Gases," by Messrs. S. H. Davies and F. G. Fryer ; "Standardisation in British Engineering Practice," by Sir John Wolfe Barry ; "Some Recent Advances of the Steam Turbine," by Mr. G. G. Stoney ; "A General Supply of Gas for Heat, Light and Power Purposes," by Mr. A. J. Martin ; "Electro-Positive Coatings for the Protection of Iron and Steel from Corrosion," by Mr. S. Cowper Coles ; "On a Glass of Low Resistivity," by Mr. C. E. S. Phillips ; Report of Falmouth Observatory Committee ; Report on Magnetic Survey in South Africa ; "Experiments Illustrating the Balancing of Engines," by Prof. W. E. Dalby ; "The Strength and Behaviour of Ductile Materials Under Combined Stress," by Mr. W. A. Scoble ; "The Deformation and Fracture of Iron and Steel," by Mr. W. Rosenhain ; "Segregation in Steel Ingots and its Effect in Modifying the Mechanical Properties of Steel," by Mr. J. E. Stead ; "Structural Changes in Nickel Wire at High Temperatures," by Mr. H. C. H. Carpenter ; "The Rate of Decay of the Phosphoresence of Balmain's Paint," by Mr. B. J. Whiteside.

Proposed New Electric Railway from Euston to Watford.—An important announcement was made by Lord Stalbridge at the half-yearly general meeting of the London & North-Western Railway on Friday last. The traffic between London and Watford and intermediate stations could not at present be coped with as fully as the directors desired without seriously interfering with the working of the long-distance traffic. They had therefore carefully considered the problem, and believed that the best solution was to build a new electric railway from Euston to Watford and the neighbourhood ; this would be partly alongside and partly under their present main line, with a loop and local station under Euston, and would serve several additional stations as well as their existing suburban stations. They would thus be able to considerably relieve the main lines and at the same time give a far better suburban service. Intercommunication could be effected with the City & South London and Charing Cross, Euston & Hampstead lines. The scheme was not in any way intended to be a competitive one, but was an attempt to meet existing difficulties and provide additional facilities on their own territory. Further details of the proposal would be brought before the shareholders at the Wharncliffe meeting in February next.

A New Harmonic Synthetiser.—A Paper by J. R. Milne in the *Proceedings* of the Royal Society of Edinburgh describes a new form of instrument for mechanically drawing curves which are the summation of a number of simple harmonic curves. The general principle of the instrument is the use of a long continuous wire attached at one point to a parallel motion carrying a pen bearing against a drum with a vertical axis, and passing alternately over small fixed and movable pullies. The moving pullies are carried eccentrically on a series of revolving wheels, each representing a constituent harmonic. Thus the resultant motion of the wire, and therefore of the pen, is a very near approximation to a summation of the various harmonic motions which are the projections of the circular motions of the moving pullies, provided that the distance apart of the fixed and moving groups of pullies is large compared with the amplitude of the displacement. An arrangement of coned pullies permits of a variation of the period of a constituent harmonic by alteration of the speed ratios of the wheels. A further device is provided for varying the amplitude of a constituent harmonic. This consists of two co-axial bevel wheels geared together after the manner of a differential gear by a third bevel wheel on a radial axis, whose angular position is capable of adjustment. These two wheels, therefore, revolve at the same speed in opposite directions, and both carry eccentric pullies round which the summation wire passes. It is thus possible, by varying the position of the connecting bevel wheel, to alter the phase relation of the two components and set them so that their maxima either coincide and assist each other or oppose and neutralise each other, or in the intermediate positions the resultant motion may possess any amplitude between these limits. A small electromotor drives the wheels by a leather belt through a worm reduction gear. The accuracy of the records is discussed mathematically in the Paper, and in the particular apparatus considered the error is shown not to exceed $\frac{1}{100}$ in.

The Faraday House Journal.—The August number of the *Faraday House Journal* contains three original articles by "Faradians." The first, by Mr. J. T. Irwin, deals with the ever-present question of London traffic, about which so much has been written but so few suggestions of any practical value have been offered. The author's solution of the problem takes the form of an electric omnibus supplied from a pair of trolley wires one above the other at the side of the road, to which contact is made by vertical bows carried on long horizontal arms supported by a tall mast on the roof of the 'bus. A small battery would also be carried to propel the vehicle at times when it is obliged to leave the side of the road, and arrangements would be made to lower the mast when passing under bridges. The author contents himself with vague generalities as to the advantages of his system, but does not condescend to details of methods of ensuring that the battery shall run under proper conditions of charge and discharge, nor does he go into particulars of its size and weight. The next article is by Mr. A. B. Clark on dry air pumps, and contains both theoretical considerations and results of tests. The third article is, perhaps, the most interesting of the three, and is a study of the magnetite arc by Mr. G. M. Dyott, of Pittsburg. The author finds that copper is the best material for the positive electrode. Regarding the negative electrode, if magnetite alone is used the arc is too rich in blue and ultra-violet rays. A brilliant fine white arc of great luminous efficiency can be obtained by the addition of titanium oxide, but the instability of such an arc is prohibitive. The addition of a small amount of chromium oxide is found to steady the arc to some extent, but lowers the luminous efficiency and imparts a greenish tinge. A further addition of some ½ per cent. of sodium fluoride has a beneficial effect. A good deal of work has apparently yet to be done before perfection is reached. The *Journal* also contains some short illustrated descriptions of recent apparatus, and some items of news relating to those connected with Faraday House.

Projected London Tramways.—The Highways committee of the London County Council has prepared a list of the tramways for which it recommends Parliamentary sanction should be sought in the session of 1907. In selecting the routes proposed, the report of the Royal Commission on London Traffic has been borne in mind, but it is quite possible that more than one line will not be proceeded with, as was the case last year, as the report mentions that certain matters have to be discussed in order to overcome objections that exist. The list, as now prepared, will, however, be submitted for the approval of the full Council after the summer recess when reports will also be submitted by the Finance and Improvements Committees. It is pointed out that as at the end of the year 1906-7 the Council will still have some 100 route miles of tramways to construct or reconstruct, which will probably extend over two years, (by which time the Greenwich generating station will be completed), only the most urgently-needed lines have been put forward this year. The total length of the proposed lines is 32½ miles, of which 26½ miles represent new tramways and 6 miles connecting lines. Of the 21 lines recommended six will be on the overhead trolley system, representing 9 miles, and the remainder on the conduit system. Five of the trolley lines will be in the south of London, and the other in the North East. The total estimated cost of the new lines is some £700,000. Among the more important may be mentioned a double line from the present terminus in Hampstead-road, across Euston-road, and along Tottenham Court-road to Francis-street, with alternative single lines thence, one along Tottenham Court-road and the other along Francis-street, Gower-street, Bedford-square, Bloomsbury-street and New Oxford-street. By this means it is hoped to overcome the objections raised in 1904 to a double line of tramways along the southern and narrower portion of Tottenham Court-road. The double line of tramways from the Marble Arch to Cricklewood, rejected this year, is revived. The route is via Edgware-road, Maida Vale and High-road, Kilburn, and the only alteration in the method now proposed of constructing the line is that provision is made for a loop line at the Marble Arch terminus round Seymour-street, Great Cumberland-place and Bryanston-street, so as to avoid a terminus at the southern end of Edgware-road. Single-line alternative routes are proposed in several instances in order to avoid the heavy expense which would be involved in street widenings were a double line to be laid in one street, and also to form alternative routes to certain existing single-line tramways.

Water Power Plant at Zogno.—An example of the numerous large water-power stations which are being established in Northern Italy is found in the plant at Zogno on the river Brembo, which is described in the *Engineer*. A dam was constructed in the river, from which a canal, about 4¾ miles in length, and partially in tunnel, takes the water to the head of a steep pipe line of four pressure pipes, 57 in. diameter and 246 ft. long, down to the power house, the total available fall being 57·74 metres (nearly 190 ft.). The power house contains four main generators each driven by a 2,000 H.P. Riva-Monneret turbine of the Francis type with horizontal shaft. The turbines are governed by the servo-motor type of governor and are coupled to the alternators by rigid instead of the more usual flexible couplings. The alternators were made by the firm of Gadda Brioschi Finzi & Co., and are of the ordinary revolving type, generating three-phase current at a pressure of 2,750 volts 42 cycles at 315 revs. per min., the rotors being specially strengthened on account of the high peripheral speed. There are also two turbo-exciter sets driven through flexible couplings, each capable of an output of 950 amperes at 110 volts and 750 revs. per min., which is sufficient to excite three of the alternators at full load. Transformers raise the voltage to 25,000. Four sets of three transformers, each of a capacity of 1,800 k.v.a., are provided. These are of the air blast type, all mounted in one line on a concrete base, but each has its own motor-driven blower. One spare blower set is also provided. The switchboard gallery commands a view of both the dynamo room and the transformers in the adjoining room, and is reached by flights of steps from both departments. The board is of the inclined bench pattern with flush type instruments sunk in the sloping top and the hand wheels controlling main switches below in front. The oil switches are separated mechanically by the hand wheels, and are contained in separate concrete cells under the gallery. The 'bus bars are carried in separate horizontal cellular concrete channels and all the instruments are, of course, worked by transformers. A new form of time switch has been installed which includes the introduction of a small fuse in parallel with the electromagnet of a relay. The relay only comes into action after this fuse has gone. The exciter board is of the ordinary vertical form at one end of the gallery. The transmission line is about 20 miles in length and is in duplicate. Lightning arresters of the Gola, Siemens and Wurtz types are provided, and each line is divided into four sections which can be isolated if required by means of switches. A pleasing feature of the station is the artistic decoration of the interior, which is carried out in true Italian spirit.

A Portable Charging Station for Electric Automobiles.—The *Electrical World* describes a portable charging station which is used by the New York Transportation Co. principally in connection with its public electric vehicle service. The equipment has been found useful on such occasions as the race meetings at Belmont Park for giving short charges to electric cabs which have come from a distance to prevent too heavy a strain on the batteries on the return journey. Under ordinary conditions an hour's connection with the portable outfit is sufficient to propel a cab 15 miles. A 60 H.P. six-cylinder petrol engine direct coupled to a four-pole compound-wound 50 kw. generator is contained in the interior of the car, the body of which consists of an old omnibus slightly altered. This set can be arranged to give 200 volts at 800 revs. per min., or 110 volts at 500 revs. per min. by a suitable field regulator. When charging batteries, the series field coils are cut out of circuit. A radiator, cooled by a fan driven by a belt from the engine, is provided on the roof of the car, where there is also a 30 gallon water tank and a 30 gallon petrol tank, which contains sufficient fuel for one day's work. The portable station is propelled by its own power, two 40 ampere 80 volt Riker motors being geared direct to the wheels. In running under its own power, the generator is operated as a compound-wound machine, the motors being connected in series. The speed of the vehicle may be varied from 2 to 15 miles per hour. In addition to speed control by throttling the engine, a controller is provided giving two forward and two reverse speeds and for cutting in an electric brake. A low speed in either direction is obtained by placing the motors in series across the generator leads with a resistance in circuit. The high speed in both directions is obtained by running the motors in series without the resistance. Twelve charging plugs are provided with flexible leads of sufficient length to accommodate as many vehicles. The plugs are connected to the switchboard, which is equipped with 12 single pole double-throw switches, one for each charging circuit. When the switch is thrown to the right the plugs are connected to the main 'bus bars; when the switches are thrown to the left the circuit is made through an ammeter shunt. The 12 charging plugs are divided into two groups by means of a double-pole double-throw switch, and the groups may be connected in series or in parallel for operation on 220 or 110 volt circuits. A double-pole double-throw switch is provided to connect the generator either to the charging 'bus bars or to the vehicle motors. Ammeters and voltmeters and a field rheostat are mounted on the switchboard, and a group of main regulating resistances is also provided. The whole vehicle and equipment is just over 7 tons in weight.

SOME NOTES ON THE MECHANICAL DESIGN OF ELECTRICAL GENERATORS.*

BY R. LIVINGSTONE.

(*Continued from page 647.*)

Bearings.—A good deal of attention has been given recently to the subject of bearing friction, and quite a mass of data has been collected on this subject.† There still, however, remains a small field for experimental work in bearings for electrical generators. In such bearings the outer housing over the bearing prevents radiation to a considerable extent, and only very low pressures can be allowed.

In general the amount of work expended in the bearing $=PV\mu$ when $P=$total pressure, $V=$surface velocity of journal, and $\mu=$coefficient of friction.

The friction in generator bearings is film friction, that is, there is a perfect film of oil between the bearing and the journal. This can be easily verified by measuring the electrical resistance between the shaft and bearing when the machine is running.

From experiments which Tower made on film friction, it is evident that for very low pressures or moderate pressures with high velocities μ varies approximately as $c/\sqrt{p}$, $p=$pressure per square inch. The amount of heat generated in the bearing then will vary as $PVc/\sqrt{p}$, or when $A=$projected area of the bearing, as

$$\frac{pAVc}{\sqrt{p}}=\sqrt{p}AVc.$$

Now the amount of heat radiated by the bearing is found to vary approximately as $c'A$; then, if the bearing is to be kept at a predetermined temperature,

$$\sqrt{p}AVc=c'A,$$

or

$$\sqrt{p}V=\frac{c'}{c}.$$

The value of the constant c'/c depends so much on the design of the bearing, kind of oil used, surface of radiation of pedestal, quantity of oil in oil chamber, &c., that it is difficult to give a value to the constant c'/c which would suit every case. Indeed, in cases where the velocity V is low, pressure P high, or arrangement of oil grooves bad, then the heat generated in the bearing might vary as $pAVc''$, and to keep the bearings at a constant temperature $pV=\frac{c'}{c''}$.

The safe method of determining the size of the bearing is to use the latter formula, giving a value to c'/c'' of 40,000. When $p=$pressure in pounds per square inch, and $V=$velocity in feet per minute. Of course, in many cases the bearings could be made much smaller than the dimensions obtained by keeping $pV=40{,}000$. Indeed, with well-designed bearings with an ample oil capacity and well ventilated the bearing might be proportioned by keeping $\sqrt{p}V=4{,}500$.

In either case the stress at the neck of the bearing must also be kept within limits, and when this stress is kept within 3,900 lb. per square inch we can immediately determine the length and diameter of a bearing to suit a given load at a given speed.

Thus for $\sqrt{p}V=4{,}500$, and $f_b=3{,}900$,

$$f_b=\frac{Wl}{2}\div\frac{\pi d^3}{32}.$$

$$\therefore\ d=\frac{\sqrt[3]{Wl}}{9\cdot15}. \qquad (6)$$

Also

$$\sqrt{\frac{W}{dl}}\times\frac{\pi dN}{12}=4{,}500.$$

$$\therefore\ l=Wd\left(\frac{N}{17{,}200}\right)^2.$$

And substituting the value of d obtained above we get

$$l=\frac{W^2}{27\cdot6}\left(\frac{N}{17{,}200}\right)^3. \qquad (7)$$

By plotting a series of curves such as are given in Fig. 5 we can at once determine the exact diameter and length of a bearing to give $\sqrt{p}V=4{,}500$, and with a stress at the neck of the journal of 3,900 lb. per square inch. In the same way we can show that to have $pV=40{,}000$ and $f=3{,}900$

$$l=\frac{WN}{152{,}000}, \qquad (8)$$

and

$$d=\frac{\sqrt[3]{Wl}}{9\cdot15}, \qquad (9)$$

when $l=$length of bearing in inches,
$W=$ total load on bearing in pounds,
$N=$revolutions per minute,
and $d=$diameter of journal in inches.

The curve giving the sizes of bearings corresponding to equations (8) and (9) is shown in Fig. 6.

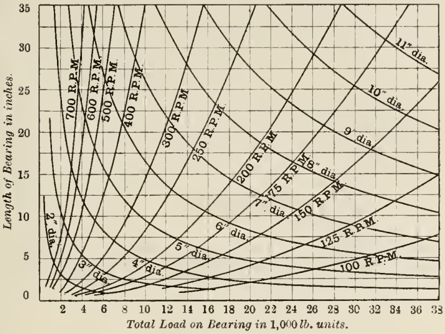

FIG. 5.

This method of obtaining the size of the bearing is, I think, original and its usefulness lies in its simplicity. The curve gives both the diameter and the length of the bearing, to suit any load at any speed, at the point where the load curve intersects the speed curve. It is certainly a great time and labour saver when determining the size of the bearings for a new machine.

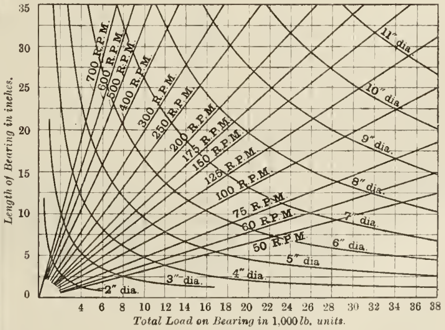

FIG. 6.

It is possible that this style of curve might be applied by electrical engineers to determine the most economical length and diameter of armature to suit a given output and speed. If at all possible it would simplify the electrical design to some extent.

When the diameter and length of bearing has been obtained in this way, the pressure per square inch should be checked to make sure that it is not sufficient to break through the oil film. The curve in Fig. 7 shows the pressure which an oil film will sustain at different velocities. It is evident that in few cases will the diameter have to be increased. An average velocity for generator bearings is 500 ft. per minute. This gives a pressure $p = 81$ for both $\sqrt{p}V = 4{,}500$ and $pV = 40{,}000$, and this pressure is well within the 168 lb. per square inch which can be sustained by the oil film with a journal velocity of 500 ft. per minute.

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* Based on a Paper read before the Dick Kerr Engineering Society.

† Tower, *Proc.* Inst. Mech. Engineers, 1883, pp. 632-665. Tower, *Proc.* Inst. Mech. Engineers, 1885, pp. 58-70. Lasche, *Journal* Inst. Elec. Eng., Vol. XXXI., pp. 43, 44.

The following experimental results will show how closely $c/\sqrt{p}$ represents the variation of μ at the lower pressures.

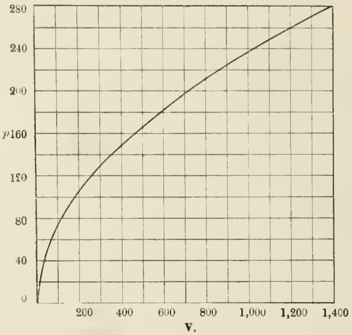


Fig. 7.

The pressures necessary to break through the oil film have been added to the original data to show where film or fluid friction changes to solid friction.

Thurston, 1873.

V = 98·5 ft. per minute; temperature 132°F.

Maximum pressure sustained by oil film.	P.	Actual μ.	μ corresponding to $c/\sqrt{p}$.
68	28·3	0·005	0·005
	56·7	0·0045	0·0036
	85	0·0042	..
V = 150 ft. per minute.			
86	50	0·013	0·013
	100	0·008	0·009
	250	0·005	0·005
	500	0·004	0·0041
	750	0·0043	..
	1,000	0·009	..

Tower, 1883.

Journal, 4 in. diameter by 6 in. long; chord of arc of contact, 2¼ in.; lubrication by pad under journal.
V = 209 ft. per minute.

Max. pressure sustained by oil film.	P lb. per sq. in.	Actual μ.	μ corresponding to $c/\sqrt{p}$.	Temp. Fahr.
108	178	0·0109	0·0109	75°
	272	0·0096	0·0088	74°
	364	0·0087	0·0076	82°
	458	0·0095	..	78°
	498	0·0091	..	77°
V = 314 ft. per minute.				
132	178	0·0133	0·0133	75°
	272	0·0105	0·0108	74°
	364	0·0078	0·0093	82°
	458	0·0084	0·0083	78°
	498	0·0103	..	77°
V = 419 ft. per minute.				
153	178	0·0154	0·0154	75°
	272	0·0125	0·0125	74°
	364	0·01	0·0108	82°
	458	0·0083	0·009	78°
	498	..	..	77°

Journal, 4 in. diameter by 6 in. long; chord of arc of contact, 3·92 in.; lubrication by oil bath, olive oil; temperature, 90°F.
V = 209 ft. per minute.

Maximum pressure sustained by oil film.	P lb. per sq. in.	Actual μ.	μ corresponding to $c/\sqrt{p}$.
108	100	0·0055	0·0055
	153	0·0035	0·00445
	205	0·0025	0·00385
	258	0·002	..
	310	0·0017	..
V = 314 ft. per minute.			
132	100	0·0069	0·0069
	153	0·0044	0·0055
	205	0·003	0·0048
	258	0·0025	..
	310	0·0021	..
V = 471 ft. per minute.			
162	100	0·0089	0·0089
	153	0·0057	0·0072
	205	0·004	0·0062
	258	0·0031	..
	310	0·0027	..

It will be observed that the method of lubrication affects the variation of the coefficient of friction considerably, and at the same time affects the amount of friction with the same loads. Goodman gives the following relative values for the friction in a journal with different methods of lubrication:—

Mode of lubrication.	Friction.
Bath	1·00
Saturated pad	1·32
Ordinary pad	2·21
Syphon	4·20

Lubrication by means of oil rings will lie between bath and ordinary pad, the exact relative value of the friction depending on the size of bearing and number of oil rings, also on the arrangement of oil grooves.

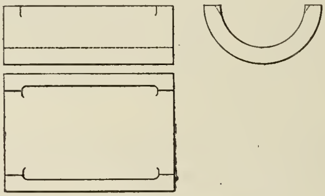


Fig. 8.

Mr. O. Lasche, of Berlin, obtained the result for high-speed bearings that $p \,.\, \mu$ is constant—that is, μ varied as c/p. This result was obtained with a surface velocity of 1,970 ft. per minute and a temperature of 122°F., the pressure being varied from 3 lb. to 44 lb. per square inch. This shows that for very high velocities the pressure, within reasonable limits, has no effect on the amount of heat generated in the bearing. The experiments made by Tower tend to show that this result might be expected, $c/\sqrt{p}$ giving lower than the actual values of μ with low velocities or poor lubrication and higher than the values at the higher velocities. Still the amount of heat carried away by the oil in ring-lubricated bearings depends to some extent on the pressure, as the amount of oil passing between the surfaces of the bearing and journal is less at high pressures than at low, so for ordinary generator bearings $\sqrt{p}$ is quite a low enough power of p to take when determining the size of the bearing. Indeed, as I have already pointed out, it is advisable to be on the safe side and use pV = a constant.

As the oil grooves and size of oil chamber have a considerable influence on the efficiency of the bearing, some attention should be paid to the arrangement of the former and the capacity of the latter. Oil should be introduced to the bearing at the point of lowest pressure—that is, on the top half of the bearing. As many oil grooves can be cut on the top half as are necessary for the efficient distribution of the oil, but no grooves need be cut in the bottom half. It is sufficient to slightly chamfer the edges as shown in Fig. 8. Indeed, it is a disadvantage to cut oil grooves in the bottom half, as they only reduce the effective bearing surface of the journal and form receptacles for the collection of dirt.

With regard to the capacity of the oil chamber, this depends to some extent on the radiating surface which can be obtained for a given volume of oil. The reservoir should be so large that it will radiate the heat conveyed by the oil from contact with the hot journal at a sufficient rate to keep the oil at a reasonably low temperature. A good empirical rule is to make the volume of the reservoir about seven-eighths of the volume of the bearing, and design the oil chamber to have the oil in contact with as much of the outer wall of the pedestal as possible.

It will be found that for average loads and speeds the dimensions of bearings obtained will be such that l/d is approximately 2·75. The volume of the reservoir in cubic inches, then, should be

$$2{\cdot}16d^3 \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

and the number of gallons required will be

$$= \frac{d^3}{128}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

The various sections of oil rings in common use are shown in Fig. 9. The diameter of the oil ring is usually made about 1¾ times the diameter of the journal. Chains have also been used for bringing up the oil, but as their use necessitates cutting away a considerable portion of the bearing at the section where they are placed their use has not become general. The section indicated by *c* (Fig. 9) has one bad feature: when used on bearings with a fairly high peripheral velocity the oil gets thrown off the sharp point instead of falling in towards the journal, and very little oil really gets to the bearing. Sections *d* and *e* are most suitable for bearings with a high peripheral velocity, but they are more expensive than any of the other sections. An oil ring should be provided for every 9 in. of bearing length—that is, up to 18 in. length two oil rings would be sufficient; but for a bearing 12 in. diameter by 36 in. long four oil rings would be necessary.

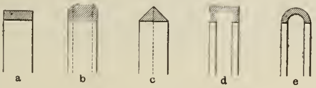


FIG. 9.

(*To be continued.*)

THE VERITY-DALZIEL TRAIN LIGHTING SYSTEM.

This system, which is in use experimentally on the Midland Railway, and is due to Mr. Dalziel, of the Railway Company, Derby, is primarily designed so that the equipment for each coach forms a complete and independent unit, although arrangements can be made so that block trains can also be worked by one or more units. The essential parts of the equipment consist of a dynamo fitted with a pole-changing switch, a regulating machine, an arrangement of automatic cut-in switches, and a battery.

The dynamo is an ordinary shunt-wound machine, but a pole-changing switch is provided, so that it can be made to work with the same polarity whatever may be its direction of rotation. The regulating machine really consists of three small machines, about the size of fan motors, with their three armatures all mounted on one shaft. These machines are the same size in every set, and if designed for the same voltage are interchangeable. There are several advantages in keeping the regulating device separate from the dynamo. The automatic cut-in switch consists of two solenoid switches which connect the dynamo first to the lamps, and then direct across the battery when certain train speeds and consequent pressures are attained, disconnecting them again when the train speed falls below that at which the dynamo is able to generate the required voltage.

One battery only is necessary, and this is used solely for supplying current when the train is standing, or when running at a speed below that at which the dynamo comes into action. Contrary to some other existing train lighting systems, the regulation is altogether independent of the battery. The battery and lights can be disconnected from the dynamo when running at any speed without affecting its voltage, and the regulation is unaffected in any way by either the demand for current or the flow of current. The means of regulation is purely electrical, and depends on voltage effects alone. The regulating machines act on the excitation of the dynamo, compensating for any speed variation and maintaining its terminal voltage at a constant value to which it may previously be adjusted by the voltage regulating switch, which latter is a small rheostat connected in the field circuit of one of the regulating machines. The machines can be designed to run at any voltage, but in the system at present in use the lamps are run at 50 volts. This is higher than the voltage generally used on British railways, but it has the advantage of reducing the size of the cables, which in large coaches, are apt to become expensive and unwieldy, and enabling cells of a size that can be conveniently handled to be employed.

The system is suitable for any class of passenger stock. The arrangement for dining cars, sleeping cars and main-line stock, in which the control of lights is placed in the hands of the passengers, is shown diagramatically in Fig. 1, and the arrangement for suburban stock, in which the lights are controlled by the guard or station staff is shown in Fig. 2. The system can also be arranged for working without any resistance in the lamp circuits, but this increases the size of the regulating machines.

The regulating machine consists of three small machines, which may be termed controller, exciter and motor, and are shown in the diagrams as C, E and M respectively. The motor, in addition to its shunt winding, has a series coil, the current through which passes to the exciter armature. All three are mounted on one shaft with two bearings only, the present sizes being 3½ in. diameter by 22 in. overall length. The outer case measures only 8½ in. × 7½ in. × 20 in., and the weight of the set is 100 lb. These sizes and weights, however, are likely to be reduced in future. The way these are connected to the circuit will be made clearer by reference to Fig. 3, in which the switches, &c., are omitted. The controller armature is permanently connected in series with the generator field coils. The motor armature, with its field coils, is connected across the mains. Current passes from the positive main through the exciter armature and field coil to the controller field coil and the motor series field coil. In a 50 volt apparatus the normal generator voltage is about 58 or 59 volts, and the exciter, which is wound for a highly-saturated field, gives about 55 to 56 volts at the low speeds. Neglecting the pressure drop in the motor series coil, it is clear that the voltage across the controller field coil will represent the difference between the voltage across the generator mains and that of the exciter. The controller armature therefore generates voltage in one direction or the other, according as the main voltage is greater or less than the standard, opposing the main voltage in the former and assisting it in the latter case. Being wound with a factor multiplying the pressure across its field coil, the effect is that a slight rise in the pressure of the generator above the standard or exciter pressure causes the strength of the field coil of the former to be greatly reduced, and, indeed, if its pressure rose to a certain value, the result would be to bring its field strength down to zero. The value of the aforementioned factor determines the amount by which the main can exceed the standard voltage. Thus, if this factor be, say, 12, and the standard pressure be 55 volts, the main pressure may approximate to, but can never reach, the value of 60 volts, because at this pressure the voltage across the dynamo field coils would be $60 - 12 \times (60 - 55) = \text{zero}$. In itself, however, this arrangement, while it definitely limits the possible variations of the dynamo pressure to a comparatively small amount does not give a constant voltage as generally understood. By means of the motor series coil, however, as the train speed and consequently the current to the exciter rises, the motor field strength is increased and the speed of the regulating machine is reduced; the standard voltage of the exciter is therefore likewise reduced, so that the controlling effect is increased. In order to keep the main voltage constant, the motor series winding must be so proportioned that an increase of voltage on the controller field coils produces an equal decrease in the exciter voltage. The effect is clearly to translate by means of this series winding the increase which otherwise would take place in the main voltage into a decrease of the standard voltage. This series coil can be arranged to give almost any desired effect—*e.g.*, a lower voltage can be obtained on the higher than on the lower speeds if required. Thus the system is regulated by voltage effects alone, and a constant pressure is maintained across the battery.

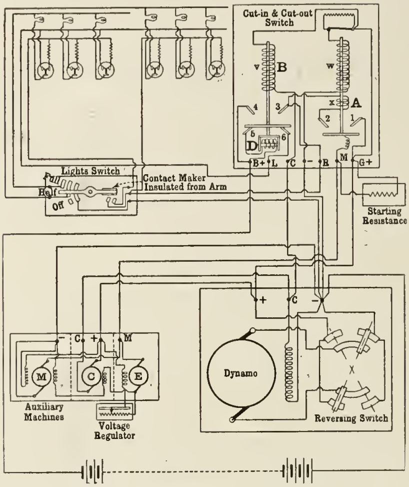


Fig. 1.—Diagram of Connections for Main Line Trains.

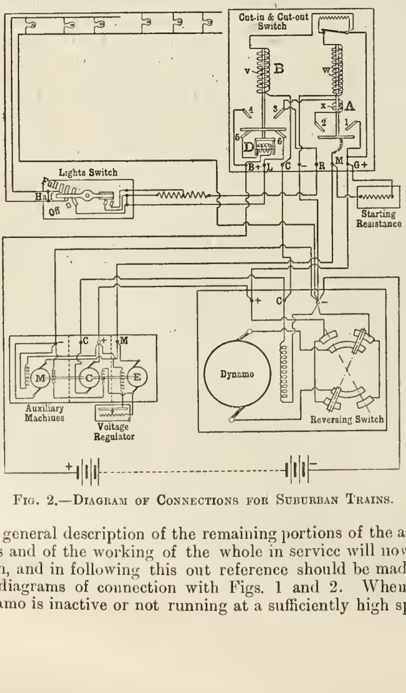


Fig. 2.—Diagram of Connections for Suburban Trains.

A general description of the remaining portions of the apparatus and of the working of the whole in service will now be given, and in following this out reference should be made to the diagrams of connection with Figs. 1 and 2. When the dynamo is inactive or not running at a sufficiently high speed to generate the necessary voltage, current is supplied to the lamps direct from the battery, the circuit being made from the battery positive to the cut-in switch through the magnet coil D; contacts 5 and 6 (which are connected by the arm of the switch B), to the lamps and through the lights-switch back to the negative.

The dynamo is a shunt-wound machine with nothing special about it in any way. It weighs from 1½ to 2 cwt., and gives its normal pressure at 400 to 450 revolutions. As explained, the controller armature of the regulating machine is connected permanently in series with its field winding. It is also fitted with the reversing switch shown in the diagram, which, when the direction of rotation is reversed, changes over the armature connections so that the polarity of the terminals remains unaltered. When the dynamo starts running it excites itself, and current is supplied to the shunt coil *w* of the cut-in switch A to the field coils and (through the starting resistance) to the armatures of the exciter and motor of the auxiliary machines, enabling them to get up speed as the generator voltage increases. The voltage rises to about 45 volts when the magnet of the coil A is sufficiently excited to pull up the switch; this short-circuits contacts 1 and 2 and also the starting resistance of the auxiliary machines. The exciter now begins to generate, and sends current through the field coils of the controller and the motorseries-coils; this makes the controller boost up the voltage on the dynamo field winding, which in turn brings up the dynamo voltage, the effect being sufficient when the switch A cuts in to raise the dynamo voltage to 55 volts.

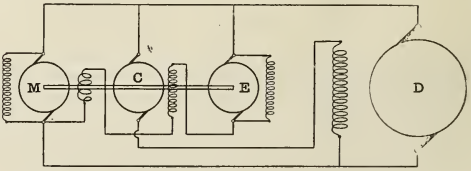


Fig. 3.—Connections of Dynamo and Auxiliary Machines.

The dynamo now begins to supply current through the coil *x* to contact 3, terminal R, and through the resistance to the lamps. As the voltage rises, more current is supplied to the lamps from the dynamo, which gradually takes over the current until the voltage gets up to 57 or 58 volts, when it supplies all the current through the resistances, which then drop about 7 volts. As the speed increases, the controller ceases to "boost up," and then reverses and "boosts down" the voltage on the generator field winding, the dynamo having attained its normal voltage, which is about 58 or 59 volts, and supplying all the current to the lights, so that no current is flowing from the battery. Reference to the diagram will show that all current passing from the battery to the lights must pass through the magnet coil D, and during the time that any current is flowing through this magnet coil D it holds down the switch B, although the magnet excited by the coil *v*, which is connected across the controller armature, is tending to pull it up. When, however, the battery ceases to supply current to the lights this holding-down effect disappears, and, the "boosting-down" voltage of the controller now being about 15 volts, the switch B goes up, disconnecting contacts 5 and 6 and connecting contacts 3 and 4. This puts the battery directly across the dynamo, the lights continuing to be fed through the resistances. The dynamo now proceeds to charge the battery, the amount of the charge depending on the state of the battery. If the E.M.F. of the battery is low it gets a heavy charging current, if high a smaller one; but, in any case, the current gradually decreases as the battery becomes fully charged, when it will be taking little or no current from the dynamo, the battery voltage approximately balancing the dynamo voltage. As the speed of the dynamo falls, the "boosting down" voltage on the controller gets less and the spring on the top of the switch B is so adjusted that the switch falls on to the lower contacts 5 and 6 as soon as this voltage falls down to about 10 volts; as the speed gets lower the battery takes over the lights as the voltage falls and when it begins to discharge current through the coil x, this neutralises the effect of the coil w and the switch A cuts out.

This method of cutting in and out ensures a minimum flicker on the lights during these operations; in fact, cutting in is nearly always imperceptible, though a slight perceptible flicker takes place sometimes in cutting out owing to the lights coming on to the freshly-charged battery. By putting the dynamo into parallel with the battery and lights with the resistance between it and then allowing it to so gradually take over (or in cutting out to relinquish) the lights that the charge is imperceptible, the very favourable conditions of cutting in and out of a double battery system are practically produced with the additional advantages of having only one battery and of this single battery having a minimum of duty put upon it. The holding down coil D also acts as a protective device to the battery, if it should get so low as to be almost "dead," owing to lights having been left on too long. In this case as soon as the switch A cuts in, current goes to the battery through the lamp resistances; the current then passing through the coil D prevents the switch B from going up until the voltage of the battery has been brought up so much that on connecting direct to the dynamo it does not take an excessive current. The same protection would be afforded should one or more of the cells become short-circuited. The times of cutting in and cutting out depend, of course, on the ratio of the dynamo and axle pulleys and the speed at which the dynamo is designed to give its voltage.

In cases where individual control of light is required, as in Fig. 1, when a lamp is switched off it is necessary to disconnect the lamp resistance (otherwise all these resistances remain in parallel and the voltage drop to the remaining lamps would be reduced). This is done by providing three point switches, as shown in the diagram, which, when a lamp is cut out, break the circuit of the corresponding resistance. In addition to these switches a master switch is provided, by means of which the whole or half the lights are switched on or off. In ordinary coaches this switch is fixed on the end of the coach and connected to a rod such as is used on gas-lighted vehicles, which can be worked from either side of the coach. It can also be arranged in block or other trains to work this switch electromagnetically from the guard's van.

Fig. 2 shows the arrangement when only the half- and full-lights switch is required. In this case there is only one resistance which carries the whole of the current; in all other respects the arrangement is the same as shown in Fig. 1.

Some of the advantages claimed for this system are briefly as follows :—

1. The conditions under which the battery has to work are much better than in constant-current systems where the battery often has to bear the brunt of the regulation, lacking current when the lights require it and having to take it perforce when they do not. In this system, on the contrary, as the battery is required only for storage, its capacity may be smaller and its first cost is reduced. In working it is relieved of duty practically immediately the first switch cuts in and goes on charge at full pressure as soon as the second goes up shortly after. If it be low, charging and recovery are rapid, even at the lowest speeds, and whether the lights are in use or not.

2. The energy consumed by this system is very low. The power lost in the lamps and the regulating apparatus is reduced to a minimum, and there is no power wasted as with slipping belts and similar devices, and the waste that goes on in some systems in forcing current through batteries already overcharged is obviated. With no lights on and the battery charged the apparatus practically runs light.

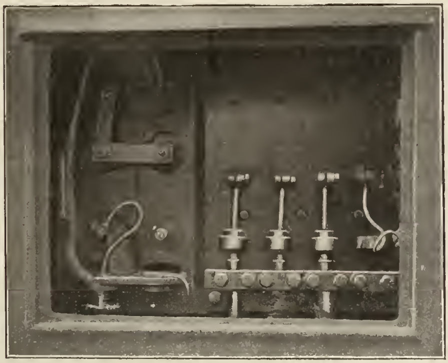
3. Constant current apparatus must be large enough to be satisfactory under the worst conditions. The apparatus must be of sufficient capacity to properly charge the battery and supply the lights at the same time, otherwise the battery may be run down. Also being of constant output design it must always work at this maximum output, and must, therefore, be of very large size and capacity. With this constant voltage system, however, the apparatus automatically adjusts its own output to the demands made upon the battery, and this output is only a maximum when and for so long as it is required. To obtain this maximum, therefore, the overload capacity possessed by all electrical machinery may be taken advantage of. The dynamo and regulating machines are both light, and, being separate, a breakdown on one does not cripple the other. Further, no adjustment to make the apparatus suit its runs is necessary. As a rule the regulation of constant-current systems is varied as between summer and winter, and as between different classes of service, so as to protect the battery, and the latter sometimes suffers for lack of this adjustment if the service of a coach is changed.

4. In this system the direct attachment of steady voltage is aimed at, instead of this being only indirectly obtained by designing for constant current. By the former method everything that can possibly affect the voltage is compensated for, not only speed variations, as in the latter case. A 40-volt apparatus can be set by the adjusting switch to run at any pressure from about 45 volts to 75 or 80, and the working is perfectly satisfactory at each pressure. Also, the regulation is as good at 90 miles per hour as at 20. In the apparatus itself there are neither mechanical governors nor complicated switch gear.

5. The lighting is not subject to anything causing flickering during running, while the pressure is constant under all conditions, and does not rise as the battery becomes charged as in constant-current systems. As it is, lights can be switched on and off without affecting the pressure in any way.

A CURIOUS SHORT-CIRCUIT.

We have received a remarkable photograph, from Mr. George Wilkinson, engineer-in-chief at Harrogate, showing the cause of a short-circuit which occurred recently on his system. The photograph, which we reproduce below, shows the back panel of a road box transformer. The high-pressure side is on the left and is divided off by a fibre partition from the low-pressure connections, the front being covered by a removable fibre door. The district supplied by this transformer was plunged into darkness one day last week, and on investigation it was found that a rat had climbed up the ironwork, seated itself upon the iron flange to which the high-pressure terminal end is fixed, and had stepped up therefrom with its front paws on the high-pressure terminal stud, the result being that it was instantly killed. An earth was consequently set up which caused the high-pressure fuse on this section to blow. The rat was very badly burnt on the chest and fore paws. Mr. Wilkinson points out that this interesting and instructive case should be an object-lesson to mains superintendents, and illustrates the wisdom of securely covering the drain pipe by means of a metal grating. In this instance the cast-iron cover had been accidentally omitted, and the rat had evidently got into the transformer from the drain.



THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.*

BY K. REINHARDT.

(Continued from page 651.)

(D) *Ignition and Starting.*—A magneto electric apparatus, driven by the engine, is generally employed for producing the electric spark to ignite the mixture at the end of the compression stroke. These have in all cases given satisfaction. This induction spark, by the aid of an accumulator, as employed by the Maschinenbau-Gesellschaft, Nürnberg, is also satisfactory. Frequently two igniters at each end of the cylinder are fitted to ensure safety and rapidity of the ignition and combustion. Even should one be out of order, the ignition plugs—which are fitted in the combustion chamber of the engine, and there carry the levers, by the separation of which the contact is broken and the spark created—were formerly cooled by a circulation of water. This has, however, been found to be unnecessary, and the plugs can now be easily removed without disturbing the water connections.

The rapid removal of plugs is important, because the presence of bad gas and the non-production of the spark are the principal causes, in modern engines, of a refusal to start. Happily, this does not often occur. If the magneto-electric apparatus is in good order it is clearly indicated that the plug is covered with moisture, and hence no spark can be originated.

Dampness can be deposited during the night when the engine is not running, also when the admission and exhaust valves are open. In starting it may be condensed and settle, from the compressed air used, if this contains moisture. In many plants the rule is to remove the plugs each time the engines are started and thoroughly heat them.

To prevent water or moist compressed air being carried over from the air-holder care must be taken to drain the latter, also to take the air from the highest point of the holder.

Should ignition fail at one end of the cylinder while the engine is working, this requires the driver's special attention. This failure may be occasioned by a leakage of the cooling water from the piston, at a pressure of three to five atmospheres, by the partial fracture of the piston, of the walls of the cylinder, or of the cover. This water, leaking out during the suction period, squirts against the plugs on the return stroke of the piston.

In such cases, when the driver is convinced that the outer ignition apparatus is in good order, the engine must be stopped and the reason of the ignition failure ascertained; also, if the load on the engine will allow of it being done, one end or one cylinder should be put out of service. If, however, they cannot be spared, at any rate the gas in the cylinder concerned must be shut off and the compression working cut out, for instance, by wedging up the exhaust valve. If it is supposed that the piston is cracked, even though the leakage be very slight, the cylinder should only be kept at work in case of great necessity, because the presence of water in the cylinder quickly causes considerable wear. If the above-mentioned precautions are taken—namely, to heat the ignition plugs before starting, and, moreover, to make sure that the gas is suitable and burning with a steady bluish flame—the starting of gas engines no longer offers the slightest difficulty. Further, since the general adoption of compressed air for starting large gas engines, the time has passed when hours, and even days, were spent in vain efforts to make the engine start.

The pressure of the air employed ranges from 6 to 25 atmospheres. In most cases the valves work in the same cycle when starting as when running. The compressed air is admitted at what would usually be the commencement of the combustion stroke, and gives the engine a start. The moment of admission of the compressed air should be determined in consideration of the fact that, in case of an ignition of the gases now drawn in, the combustion pressure attained is higher than that of the compressed air. Further, no such admission should take place before or during combustion, as it would deteriorate the mixture. In multiple cylinder engines, particularly two cycle engines, which can start with a corresponding small load, starting is often possible by admitting compressed air to one cyclinder. In such cases ignition must be allowed to take place in the second cylinder, then the compressed air must be shut off in the first cylinder, and then after a few revolutions, and after the moisture originating from the compressed air has been evapoporated by the heat developed by compression, the gas valve in the first cylinder must also be opened. In starting gas engines the ignition mechanism must be so arranged that ignition of the mixture takes place at a time which corresponds to a smaller crank angle, distant from the dead centre, than obtains at the regular speed. In the same manner the ignition must also be regulated by hand if the number of revolutions of the engine is variable, as is the case with gas blowers.

THE VARIOUS TYPES.

Double-acting Four-cycle Engine of the Maschinenbau-Gesellschaft, Nürnberg.—This firm and their licencees, Haniel & Lueg, Düsseldorf, and Friedrich-Wilhelmshütte, Mulheim-on-the-Ruhr, have, if size and horse power are taken into consideration, constructed the greatest proportion of large gas engines in Germany, including the largest units—namely, twin tandem engines, from 3,600 B.H.P. to 4,000 B.H.P. The design is very similar to that of steam engines. The frame of the engine is open at the top to render the crosshead, stuffing box, and the cylinder cover accessible; but the opening is entirely covered with a plate when the engine is running. The open frame terminates in a strong circular flange to form a concentric point with the cylinder; the flange is strengthened by tension rods extending to the part which forms the crank shaft bearing. The distance pieces, which are also strengthened by tension rods, unite the separate cylinders in a similar concentric manner. Owing to this method of construction the erection of the engine is easy and exact. The lower portion of the distance pieces form the crosshead guides for supporting the piston rods; and the upper portion is provided with an opening through which the cylinder cover and piston can be removed.

The cylinders are entirely symmetrical, with wide flanges forming large cooling spaces. A number of examination doors are provided for clearing out, when necessary, any deposit. At each cylinder end there is an inlet valve above and an exhaust valve below; and these valves are situated well outward from the cylinder walls, so that the highest temperatures occurring have to extend their influence along the axes of the valves to the outer valve boxes.

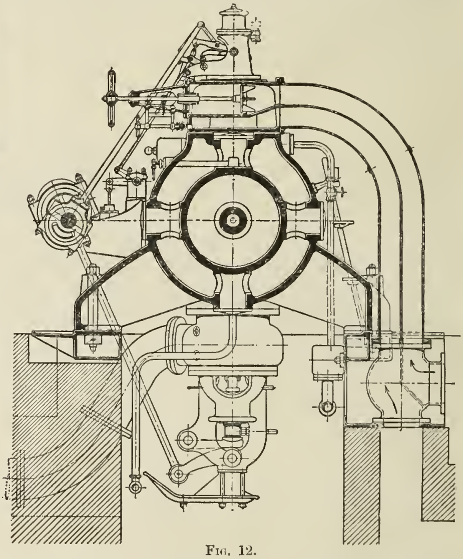


FIG. 12.

The gearing of all the valves is operated by an eccentric and roller levers (as shown in Fig. 12). The gas valves are situated in the longitudinal axis of the cylinder close to the inlet valves, and their motion is controlled by the governor.

For the method of governing and the formation of the mixture and of the exhaust valve chambers, the author would refer to what has already been mentioned in the section on valve gear.

The pistons are cast hollow but in one piece, and are pressed on to the conical part of the rod by nuts recessed into the pistons. By this means the front and back cylinder covers can be made symmetrical.

The lubrication of all the working parts is arranged in an effective manner from a central position.

With the front cover removed the front exhaust valve is accessible from the crosshead guide and under the piston rod. Attention is, however, drawn to the fact that, after having screwed off the cylinder cover and taken off the heavy cover in the manner described, this valve is accessible, although not altogether easily. Much stress should not be laid on this accessibility with cylinders of less than 500 H.P. This applies to all systems in which the exhaust valves are placed below the piston rod.

The cleaner the gas and the purer the water used for cooling the valves the less important is it that the valves should be easily accessible.

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* Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on July 24th. Slightly condensed.

The inlet valves are controlled by an eccentric on the crank shaft and a link motion with long rods, in such a manner that, with an equal power of the engine, should the air pressure become higher than usual, a smaller quantity of air is drawn in, also giving relief when starting. The pressure valve gear consists of valves preceded by slide valves, so controlled that they open much earlier than the pressure valves, but at the dead centre they close and thus give the pressure valves (which are loaded with light springs) time to close. Seeing that while the volumetric efficiency, both with isothermal and adiabatic compression, is without influence on the work to be done per unit of the quantity of air compressed, the heavy and copious lubrication required by pressure slide valves may only favour the use of valves with a long lift and with light spring pressure.

Double-acting, Four-cycle Engine of the Gasmotorenfabrik Deutz.—The Gasmotorenfabrik Deutz engines have lately been described by Prof. Meyer.* The details of the cylinder of a 250 H.P. single cylinder engine have already been described. This was the first engine of this type constructed by the Gasmotorenfabrik Deutz. Having regard to what has already been stated the peculiarities of the construction require no further explanation. It may be remarked that in these smaller engines the guides are of the circular enclosed type.

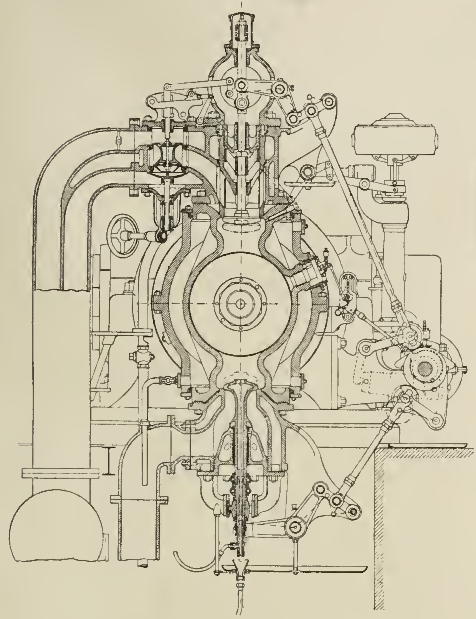

Fig. 13.

The valve gear of this engine is actuated by cams, and the quantity governing (with a constant mixture) is attained by throttling; by the governor working with a movable fulcrum on the lever of the inlet valve, by which means the lift of the inlet valve is increased or reduced. This arrangement of the valve gear is simple, as no special gas valve has to be controlled. It would not, however, be suitable for engines with two or more cylinders, say with four inlet valves, for the movable fulcrum of at least one valve lever would be fixed by the action of a strong valve spring, and thereby the governor would encounter excessive resistance. For this reason the Gasmotorenfabrik Deutz, in their latest engines, have placed, at the side of the principal valve, a special mixing valve for the admission of gas and air, so that when the governor operates, the fulcrum of the lever of the main valve is fixed while that of the mixing valve is moved (Fig. 13), thereby considerably reducing the resistance to the governor, and, moreover, the mixing valve is rendered accessible for cleaning.

Seeing that the mixing valve is controlled by the mechanism of the main valve, the gear is simple. From Fig. 13 it will be further seen that the Gasmotorenfabrik Deutz has introduced a patented arrangement of a bell-crank lever in front of the valve levers, which on the one hand replaces the action of rolling levers in lifting and closing the valves, and on the other hand prevents undesirable opening of the valves, which may occur when the engine is lightly loaded or running without load.

When the valve is closed the bell-crank lever is in its limiting position, so that the forces transmitted by the valves can cause no bending of the bell-crank lever, and therefore no motion. As shown in Fig. 13, the Gasmotorenfabrik Deutz now makes a complete separation of the inner and outer cylinder walls at the intersection with the valve chambers, whereby the stresses due to heat are reduced.

The arrangement of the governor gearing of the Deutz engine here described gives only a downward resistance for the fulcrum of the lever of the mixing valve. Should the valve spindle or the spindle guides become dirty and stick, the weight of the mixing valve and the pressure of the spring are no longer sufficient to overcome the resistance, and the action of the governor will be unreliable.

In the construction of their 2,000 H.P. tandem engine (Fig. 14) this possibility is, however, removed, because in this engine the lever of the mixing valve is made in the form of a closed link, which on both sides encloses the movable fulcrum. The movable fulcrum of the mixing valve lever is thereby the end point of a lever capable of being turned on a fixed centre by the governor, the length of which represents the radius of the curve of the link. In this case the strong spring of the inlet valve, together with the weight of the mixing valve and its light springs, aid the closing of the valve.

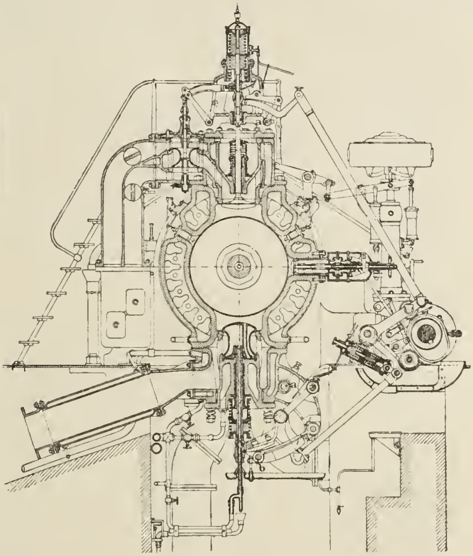

Fig. 14.

The Gasmotorenfabrik Deutz construct the frames of this type of engine open at the top. Each cylinder consists of a cast-iron liner, to which the cast-steel cylinder heads are bolted by means of flanges. The outer jacket is then completed by a circular casting in two pieces. Although this construction, in the author's opinion, is not safer than that in which the cylinder heads and the liner were cast together, it has the advantage that the simple cylinder liners can be easily made of hard cast iron.

The valve gearing is operated by round-back cams with roller levers (Fig. 14); at each cylinder end there is only one cam for the simultaneous operation of the inlet and outlet valves. The last-mentioned is double-seated in a manner similar to the valves of steam engines; but as, however, exhaust only takes place at the top seating, the deposit of dirt and cinders on the bottom seating must be considered.

The roller levers of the inlet and outlet valve gearing can be put out of gear by hanging the roller path to the levers, which can be interspersed round the eccentric pins *a*, *a* (Fig. 14). With the exhaust valve gearing the whole system of rods can be disconnected from the outlet valve spindle by removing a bolt, *b*, so that the outlet valve with its seating can be taken down.

This engine is at work at the Hoerder Verein Ironworks, and is remarkable, owing to its elegant design, strong construction, great simplicity, and faultless working.

(*To be continued.*

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* *Stahl und Eisen*, 1905, Nos. 2 and 3.

THE ADVENT OF SINGLE-PHASE ELECTRIC TRACTION.*

BY C. F. JENKIN.

The objects of this Paper are: To call attention to the rapid advent of electric traction on railways; to explain why electrification is being adopted, and the advantages which it possesses; and, finally, to describe briefly the system on which it should be carried out.

It is often claimed by railway engineers that electricity cannot haul their trains as cheaply as steam, and that therefore steam is better, and will not be replaced. Let us allow that the assumption as to cost is true for the moment—is the deduction correct? It is generally true that engineering problems reduce themselves ultimately to questions of cost, and unless a process or undertaking will pay, it is no use to advocate its introduction. But there are many ways of paying besides the direct one, and it would probably be as easy to show a record of increasing costs in the history of the world's progress as to point to the record of reduced costs. To take two instances closely connected with our subject. Is railway carriage cheaper than canal carriage, which it replaced? Or, again, is incandescent electric lighting cheaper than gas? In such cases the public is willing to pay higher for the superior service, though it may not always be easy to define in what the superiority consists. It sometimes appears to be hardly more than a matter of fashion, but there are usually subsidiary advantages which account for the change, though these may not be easy to value in money. There are other cases where more expensive accommodation is provided to meet competition, though the public will pay no more for the better service; for example, the luxurious modern railway carriages.

Fortunately, electric traction is not one of these sources of expense which the railways are driven into adopting, though they do not increase their profits, nor will its adoption depend merely on fashion. Why, then, is the new power so surely coming? Because it will increase the earning capacity of the line. This has been the experience with tramways from the beginning, and, in more recent times, with railways.

The following examples will illustrate the usual results of electrification. In 1901 the trams on the west side of London were electrified, and in three years, while the mileage was increased fourfold, the traffic increased seven and a-half-fold. The Manhattan line in New York was electrified the same year. In the first year after electrification the traffic increased 50 per cent., and the costs of working fell from 55·79 per cent. to 41·2 per cent. of the gross receipts. The Milan-Gallarate-Varese line was also electrified in 1901, and in three years the number of passengers carried increased 170 per cent. On the North-Eastern Railway at Newcastle the traffic on the electric lines has increased 25 per cent., and the receipts have gone up from £129,000 to £151,000, while the costs have only risen from £42,761 to £47,779. With these facts before us it is obvious that electricity cannot be condemned merely on the question of cost of power.

I have so far assumed that the cost of electric power is actually greater than that of steam power. This may sometimes be the case in England, where the electric power has to be generated by steam; but there are also many cases where the reverse will be true.

As an example of low costs of working, the figures published by Cserhati for the Valtellina line may be given. This line, which is 67 miles long, has been worked electrically since 1902. The costs for the first year after the line was taken over by the State were 0·0274d. per ton mile. This very low figure is accounted for by the fact that the power is generated by water, but if for the actual cost of power which is included in the above figure we substitute ½d. per unit—quite a possible figure for a large steam plant—the cost would only be 0·0336d. per ton mile. The actual cost of a similar line in the neighbourhood worked by steam was 0 067d. per ton mile, or just double the latter figure.

Numerous attempts have been made to arrive at a general comparison between the costs of electricity and steam, but these are all unsatisfactory and misleading, since the results depend almost entirely on the assumption made with regard to the nature of the service to be provided, the most economical conditions for steam being widely different from those for electricity. In almost all cases when electric working is introduced, the service is altered so that no simple basis remains for a comparison of cost. I do not therefore propose to base any part of my argument on a possible direct saving in the cost of power. What, then, are the special merits of electricity, and how does electric working increase the earning capacity of the line?

The advantages of electrification may conveniently be classified under three heads, though there is no hard and fast line between them:—

1. Improvements affecting the comfort of the passengers.
2. Improvements relating to the train service.
3. Improvements relating to the working and capacity of the line.

Under the first two headings we may consider the advantages to the passengers, and under the third the advantages to the railway company.

1. The improvements affecting their comfort which passengers obtain from electrification are: purer air, less dirt, more light and warmth, and better lighting of suburban stations. It is not necessary to enlarge on the attraction of these.

2. The improvements in the train service which the passengers obtain are: faster trains and a more frequent service, and several others depending on modified methods of working the traffic, which will be referred to later. The attraction of fast trains need not be insisted on, and the importance of the frequency of the service is quite as great. In all the cases I have quoted the conversion to electric working has been accompanied by a great increase in the frequency of the service. On the North-Eastern Railway, for instance, the number of trains was doubled; on the Milan line the car-mileage was increased 2⅓ times the first year; on a line between Hartford and New Britain the traffic trebled in four months after electrification, the number of trains having increased four times. There can be no doubt that the success of electric trams is largely due to the frequency of the service, and the more nearly that the railway service on suburban lines can approach this the more popular it will be. Thus electrification provides the public with a faster, more frequent, and a more comfortable service of trains.

3. Turning now to the railway companies' point of view, let us consider how electrification affects the working and capacity of the line.

The higher speed and more frequent service which are possible on electric lines are due to the rapid acceleration which can be attained, and the saving in shunting at the termini possible with self-propelled trains. The decrease of time lost in stopping and starting at stations enable the trains to be spaced closer together; and this, combined with the higher average speed, may increase the carrying capacity of the line between 50 and 100 per cent. That electrification is the only way in which the carrying capacity of the suburban lines can be increased is pointed out in the report of the Royal Commission on London Traffic. On the Lancashire and Yorkshire line from Liverpool to Southport the number of trains was increased from 36 to 65 per day in each direction, concerning which the chairman stated that it "would have been absolutely impossible under the old conditions." The effect of this increased carrying capacity on the earning power of the line need hardly be pointed out. As the chairman of the North-Eastern Railway said: "By running smaller trains, and more of them, they were able to serve the public better and make better profit themselves."

On main lines electrification will enable the railway companies to provide express trains running at much higher speeds than the present ones, and also to give a more frequent service, and to do more in the direction of through carriages. These advantages are due to the unlimited supply of power available at the train, and to the sub-division of the power along the train, which does away with the heavy concentrated load of the locomotive, a serious difficulty on light roads and weak bridges. The number of motors is proportional to the length of the train, and the speed is independent of the fireman's ability to keep steam and of the state of the weather.

The important trials at Zossen have shown what can be done in the direction of very high speeds. In England we are fortunate in already possessing lines sufficiently well built to enable trains of suitable design to run at much higher speeds than the present steam trains. Many of our main lines could carry trains running at an average speed of 80 miles an hour instead of something under 60 miles per hour; indeed, it is probable that higher speeds still could be used with perfect safety, and that the speeds of our express trains could be increased 50 per cent. Such speeds would, of course, fall far short of those obtained at Zossen, which reached 124 miles per hour, but they would be a very great increase on anything we have at present. Moreover, it would be easier to run a frequent service of small trains at this high speed than to run an occasional longer train; thus we should have the ideal condition from the travellers' point of view.

The advantages of the multiple-unit composition of the trains are many. In the first place, the saving of shunting at the termini is of immense importance; it affects both the size of the station and the cost and speed of working the trains. In the next place, it enables re-marshalling of trains at junctions and the handling of through carriages to be very much simplified and quickened. Finally, it enables the size of the trains to be frequently varied, so as to correspond to the requirements, thus saving empty car mileage. The working time-table of the North-Eastern Railway bears interesting testimony to the advantage which can be taken in practice of this power of altering the composition of the trains.

Subsidiary advantages of electrification depend on the supply of power all along the line. This may be usefully applied to working the signals, fog signals, switches, turn-tables, pumps, capstans, lifts, &c. Electricity is already employed in this country for working signals to a considerable extent, and its use would certainly be much extended if a supply of current were available all along the line. The electrical operation of points is also already introduced into England; it has been widely used on the Continent for many years. Messrs. Siemens Schuckert Werke have already installed complete gear for controlling over 3,000 points operated by motors. It would lead too far to go into the advantages of this system here; but there can be little doubt that it will be widely adopted wherever power is available at all the signal-boxes. With electric power available, it seems probable that improved methods of fog signalling will be devised. The usefulness of electricity for working capstans, lifts, turntables, traversers, &c., are well known, and it is also probable that a good deal of the troublesome shunting in warehouses and sheds might be done by electric locomotives where steam locomotives are inadmissible owing to the danger of fire and the nuisance of smoke

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* Paper read before Section G of the British Association, Aug. 6, 1906.

The absence of smoke will reduce costs of painting and cleaning of stations and ironwork in tunnels, &c. The troubles due to smoke in tunnels, particularly in the approaches to stations in towns, may alone be enough to make the introduction of electric working advisable; it was on this account, I believe, that electricity was first introduced into the great New York Central Station.

In addition to the advantages so far enumerated, electrification opens the way to new methods of working; and if the full benefits are to be reaped from the change of power, these new possibilities must not be neglected.

As I have already said, electrification is not simply a cheaper or more economical method of hauling trains. Electrical engineers do not say to the railway companies, "We can replace steam locomotives by electric locomotives and haul your trains at less cost." What we do say is, that if you electrify your lines they will pay better; the electrification will enable you to make your service much more popular: it will attract far more traffic, and it will enable you to carry that traffic which you could not do by the present means. The success of the tramways and the extraordinary growth of the habit of travel* in the populations where facilities of the right sort have been provided, show conclusively that there is an enormous traffic ready to be carried if it is properly catered for. Is not increase of traffic exactly what the English railway companies require at the present moment? I propose, therefore, to suggest a few of the ways in which present railway methods might be modified so as to meet the public needs. The alterations are only possible on electrified lines.

The first is a method of working the suburban traffic which has recently been successfully used in Germany. I refer to the running of the suburban railway trains over the tramways, thus bringing the trains to the public, instead of making the public go to the trains. The competition of tramways is being keenly felt by railway companies. Some are inclined to allow the local traffic to go, but this is a dangerous policy. Others, like the North-Eastern Railway in Newcastle, are meeting the competition successfully by electrifying their lines. In cases like this, the extension of the railway service into the streets would probably be most useful. It is to meet the tramway competition that this method is being proposed in America. The extension of the Liverpool to Southport line as a tram in Southport would probably attract still more traffic; the somewhat similar extension at the other terminus on to the overhead line is already accomplished. Such a spreading out of the terminal station would also do something to reduce the crowding in the station and its approaches.

Electric traction opens the way for another important improvement. Every one who lives a moderate distance outside a large town wishes the railway company to run express trains to his station which shall not stop at any of the intermediate stations. As the passengers at every station hold the same views, the solution is impossible with ordinary steam trains, but it does not appear to be impossible with electric trains. Let us imagine the 5 p.m. train starting from London with a slip carriage for each local station along the line. It runs express to the furthest, dropping a car at each station as it passes. These cars, being motor cars, are quickly run under their own power into the local siding. Instead of a separate slip carriage for every station, one for every two or three stations would be nearly as good: after being slipped at the first, it would proceed under its own power to the next station or two. The up-train at 9 a.m. next morning is not so easily arranged, but several possibilities suggest themselves. First, there does not seem to be any real danger in allowing the individual cars from each station to run after the express train and to join it while running at considerable speed, though this plan may, perhaps, appear to be somewhat visionary. A simpler method is to let each car follow the last at the shortest block interval—say, two minutes. It can easily be shown that, under ordinary conditions, all the cars would arrive before the usual stopping train, and every one would have travelled at express speed. It is worth noting that such an arrangement would require only half the car-miles of the present arrangement, and about four-fifths of the energy; for though the speed is higher, each car only starts once instead of at every station. The defect of this arrangement is that the line near the terminus is blocked for some time by the stream of cars coming in one after the other, but this can be got over by bunching the cars into short trains. This will cause a few minutes' delay to some cars, but all will travel faster than the present stopping train. Such a train is for the suburban business man, and does not provide for local traffic; but there can be no doubt that any line providing a few such express trains would at once attract a greatly increased number of residents to its districts.

My next suggestion relates to branch lines, which appear to be capable of doing far more than merely bringing a small quota of passengers to the junction to meet the main-line trains. There seems to be no reason why branch lines should not develop a considerable local traffic. On the Continent small local lines and branches are made use of economically for a great number of purposes. In Holland, for instance, a local line has a train made up of two coaches, the first carrying first-class tourists and second-class peasants, the second carrying market produce, milk, &c., and a postal compartment. This line runs through a number of villages and into Amsterdam. It is largely used by the country people, and is very handy, as it runs through the main streets of each village, and picks up on the way. Certain trains in the day run in connection with boats and circular tourist routes, and carry large numbers of tourists in cars specially built for providing a good outlook, while other trains bring the market people into town and home again. Goods trains are also run on these lines for heavier merchandise. Much has been done in Belgium and Holland to assist agriculture by means of these primitive lines. There seems to be no reason why branch lines in England should not be extended as tramways through villages, thus picking up passengers and parcels; but for success a frequent service is essential. Similarly, the electric lines abroad furnish current for lighting all the villages en route, and every little group of cottages has electric light. Power is also supplied to local hotels and workshops, so that the carpenter has his circular saw driven electrically, and so on.

These lines sometimes have primitive stations, and sometimes none; a simple platform and shelter, without ticket office or station staff, is often sufficient. Such stations, under the name of "halts," are, I am glad to see, already being introduced into England. In some cases a simple staff system of block working is used, but where the lines approach more nearly to tram lines no signalling or block working is needed.

To make this class of line pay it must be built and worked economically. Everything which is not essential must be omitted; fences, stations, station staffs, signals must be reduced to a minimum. The lines must be allowed to creep and wriggle through village streets as best they can, without rigorous restrictions as to clearances at the corners Let the cars go slow, and ring a bell, and scrape the corner house, as I saw them do in Holland. There are no restrictions on the careless farmer's cart at that corner; why should there be on the local train, which brings the careful farmer's wife and prosperity to the whole village?

It is the foolish cry for extravagant precautions which prevents the introduction into England of these methods, which have done so much for the welfare of the country districts abroad. The newspaper outcry over every death on a railway has caused the thoughtless public to demand more and more safeguards and protections to life and limb till our railways are the most expensive in the world. The result of this short-sighted cry for safety has been the checking of railway development and the high rates we have to pay for carriage. Have not the indirect effects of this policy, in depressing agriculture, in driving the country labourer into the crowded towns, and in want of work, been responsible for a thousand times the suffering? Yes; and for hundreds of times as many deaths as the railways. Mr. Charles Booth* has given weighty evidence on the great importance of facilitating railway extension for the benefit of the population. But because the one man run over is seen and forms an attractive heading to a newspaper poster, we pay more attention to him than to the thousands who suffer inconspicuously.

Electric trams are responsible for numbers of fatal accidents, but, fortunately, the Press and public have not made the same outcry about them. The result is that the working populations of large towns are now rapidly spreading out into healthier districts in the suburbs, and it is hardly too much to say that hundreds of lives are saved by the healthier conditions of life for every one that is killed by accident. Sir Clifton Robinson has stated that the population in the district served by the London United trams has increased in the five years since their introduction from 424,100 to 553,700—an increase of 109,600. It is a most fortunate fact that no Board of Trade returns are published about tram accidents. That useful department is keeping close watch over the trams; but the figures, which can be made such bad use of, are kept out of the hands of the scaremongers

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* Number of journeys per head per annum:—

Greater London.				Greater New York.			
1867	23	1890	92	1860	47	1890	283
1870	27	1900	126	1870	118	1900	320
1880	55	1901	129	1880	182		

* Vide report of the Joint Select Committee on London Underground Railways, 1901.

Turning now from the advantages of electrification in general, let us consider how it should be carried out.

Electrification will begin at many isolated centres, usually in densely populated districts or where there is a large holiday traffic; then these independent lines will extend and gradually join up. This has been the experience in America with the tram lines, which now cover hundreds of miles with continuous tracks. The Cöln–Bonn line and the Vienna–Baden line are examples of the same thing on the Continent. This being so, it is of great importance that the system adopted for the local lines should be suitable for the longer connecting lines—so as to avoid any discontinuity when the linking-up begins. In other words, preference should be given even on short lines to the system which is also suitable for the long lines.

For all lines, whether short or long, the transmission is always done, for the sake of economy, at high tension. The important question is: How shall the power be distributed to the trains?

The alternatives are: by means of a third rail on the ground or a trolley wire overhead. If the third rail on the ground is chosen, the voltage must be kept low, and the current therefore will be large. If overhead trolley wire is used the current must be small, therefore the voltage must be high.

For use with the low-tension third rail, the best motors are continuous-current motors. With the high-tension trolley wire the only motors are alternate-current motors, because it is only alternating current that can be transformed on the car to a voltage suitable for the motors. High-tension continuous-current motors can be built up to moderate pressures, but are not likely to have any wide field of usefulness.

Thus we see that the two alternatives are:—

1. The ordinary composite system of high-tension alternate-current transmission converted to low-tension continuous current distributed by means of the third rail.

2. The high-tension trolley wire and alternate current motors.

The objections to (1) for long lines are:—

(*a*) A fourth rail is necessary to bring back the large currents.

(*b*) The third and fourth rails are in the way, particularly at junctions.

(*c*) There have to be sub-stations with running machinery distributed along the line.

All these objections are got over by the second system, where the currents are so small that a fourth rail is not needed, and the third rail is out of the way overhead, and there are only a few stationary transformers along the line. The consideration, therefore, of the permanent-way equipment leads us inevitably to the conclusion that an alternating system is better than a continuous-current system.

There are two alternating-current systems possible—three phase and single-phase. The three-phase system has certain advantageous properties and has been most successfully used on some mountain lines and on the interesting Valtellina line in Italy. It has, however, one disadvantage, so serious as to outweigh all other considerations—viz., that it requires two trolley wires. There are other disadvantages connected with the motors which may be about balanced by their special advantages, but this one requirement is the determining factor.

When one considers that this requirement of two trolley wires affects the whole length of the line, with all stations, sidings, yards, &c., its importance becomes apparent. The overhead line becomes enormously more difficult to construct when there are two conductors, which have to be kept insulated, not only from the ground, but also from one another, even when the trolleys are passing the junctions.

Thus we are led almost of necessity to the single phase system, in which the overhead construction assumes the simplest form. All the wires at junctions, &c., may be connected, and the collector-bow slides from one to another without attention, and without any provision of switches and frogs or insulated sections in the wires.

Many arguments have been brought forward against single-phase traction. The motors are said to be less efficient, to be heavier, to run hotter, to spark, to have too little clearance, to be more expensive, in fact, to possess every sort of disadvantage. I do not propose to discuss all these questions to-day. I wish to rest the whole claim of the single-phase motor on the one fact which must outbalance all other considerations—the fact that it only requires a single light trolley wire to supply it with any amount of power. Of course, if the motor were so poor that it would not work satisfactorily, my argument would fall to the ground; but it has already done such excellent work that this cannot any longer be suggested.

I now proceed to describe, shortly, the general arrangement of a single-phase equipment, and then to point out some of the more interesting problems which arise in practice, and to show how they have been solved.

The equipment of the line is very similar to the well-known continuous-current tramway arrangement. A single copper trolley wire is suspended over each line of rails, and as all the wires over parallel or crossing lines of rail are at the same potential, they may be connected, the only insulation required being between wire and earth. The current is collected by means of bow collectors, which slide under the trolley wire; and as all the wires are at the same level at junctions, the bow slides freely from one to another without attention. The return current flows through the rails. Power is supplied to the trolley wire from feeders when the length of line requires them. Voltages of 3,000, 6,000, 10,000 and 15,000 for the trolley wire are already in use, and 20,000 has been successfully used experimentally in Sweden. The feeders may be at any voltage; they can be carried as bare wires on the poles. 30,000 volts is being used for the feeders at Hamburg with stationary transformers to reduce the feeder voltage to the line voltage. The power may be supplied from one or more power stations, and may be generated as single or polyphase current; but if polyphase generators are used, the phases must be kept separate and used for different sections of the line, which is usually troublesome.

The motor cars are equipped with one or more motors, each of which is fed from a transformer in the car, which reduces the trolley pressure to a moderate one—between 300 and 500 volts. The speed is controlled without loss in resistances by varying the voltage supplied by the transformer, or by a combination of this method with a variation of the excitation by means of a small auxiliary transformer.

The switching is done by means of contactors operated directly by single phase magnets, or by compressed air controlled electrically. The rest of the car equipment is similar to continuous-current plant—master controller, reverser, automatic main-switch, &c.

Braking can be done by means of the motors, with the addition of resistances; but so far no simple method has been devised by which the motors can return power to the line. The auxiliary services of lighting and heating are very easily provided for, any voltage being available. Low-voltage lamps do not flicker perceptibly with periodicities as low as 25 or even 15.

Turning now to the details. The overhead line construction has none of the difficulties connected with the third rail, the awkward gaps which occur where rails cross being no longer necessary. The common tramway trolley line hangs in curves, so that there is a more or less sharp angle at each point of support. These angles are somewhat reduced by the lift given to the trolley wire by the bow, but they cannot be made nearly straight. It is therefore obvious that the collector bow on a car can only follow these curves when moving very slowly, since the sudden change of direction of motion at the point of support will require a large force to produce it even at moderate speeds. There is always, therefore, more or less of a blow as the bow passes the supports, and the combination of the bending and the blow at the point of support results in frequent breakages. Statistics show that trolley wires break at the rate of about one per day in England, notwithstanding careful inspection and renewals. For high speeds it is therefore necessary to support the trolley wire in an approximately straight line, and only to vary its direction very gradually, and many arrangements for this purpose have been designed. Modifications of the catenary suspension have so far been the most successful, and one of the new designs is so simple that it leaves very little to be desired.

In its simplest form the trolley wire is hung at short intervals from the catenary wire by means of vertical wire droppers. The catenary wire is strained tight to prevent side swing. In this design temperature variations produce large distortions, and it is difficult to adjust the large number of droppers so that each will take its proper share of the weight of the light trolley wire.

An improvement on this is the use of two catenary wires, the trolley wire being hung between and below them. This arrangement is much steadier sideways, but is still more difficult to erect owing to the very large number of droppers.

The latest design goes back to the single catenary, but gives it a considerable sag, so that temperature distortion is reduced to a small amount. Under the catenary is hung an auxiliary wire by means of a few vertical droppers, and from this the trolley wire hangs by means of little loops, all of the same size. By this arrangement the number of droppers to adjust is reduced to one-quarter the number in the double-catenary design, and, as the weight on each is also four times as great, the adjustment is much easier. The small loops are spaced about 10 ft apart, and the trolley wire is sufficiently stiff to hang from these as a continuous girder, taking no permanent kink at the points of support. As the bow travels along it lifts a short length of the trolley wire a few inches; this is allowed for by the loops which rise off the auxiliary wire, and thus a beautifully smooth motion is obtained. A further advantage of this design is that the trolley wire is free to slip end-ways, and can be strained up without dragging the droppers out of the vertical. To prevent sideways swing the auxiliary and trolley wires are stayed to each post. On the clear line the catenary may be supported on poles with side-arm brackets, or on light beams supported on poles at each side.

In England most bridges are so low that the catenary construction cannot be carried through under them. The catenary wire may then be anchored to the bridge, and the two other wires taken through; these may be supported on short-span wires fixed against each face of the bridge, with additional span wires every 20 ft. under the arch if the bridge is long. In tunnels there is sometimes room to carry the ordinary construction through; but if not, a construction like that under bridges may be used. Rigid conductors might be used, but for high speeds the elasticity of the trolley wire is advantageous. In stations the overhead construction can often be suspended from the roof.

The trolley wire must be divided into sections to enable faults to be located and cut out without interfering with the whole system. The design of a satisfactory section insulator for high voltages is not easy, so several methods have been devised for sectioning the line without the use of a mechanical section insulator. The simplest method is to anchor the ends of adjacent sections side by side, so that they overlap a short distance, arranging the levels so that the bow slides off one and on to the other smoothly.

Return Circuit.—The rails are used as the return circuit with copper feeders if necessary. As the rails are made of magnetic material, the skin effect makes their resistance to alternating currents much higher than their resistance to continuous currents—usually three to six times as high; but the currents are so small that this disadvantage is not serious. The resistance to alternating currents is not a constant, but depends on the periodicity and current. The return circuit is far from being non-inductive; therefore the drop of volts depends not only on the resistance, but also on the self-induction of the circuit. The whole drop, due to both resistance and induction, may be kept as small as is desired by means of small sucking transformers, which suck the return current out of the rails into a return feeder. All danger from shocks from the rails may be avoided by using earth plates connected every ½ mile or so to the rails. This procedure may be safely used in long lines which run mainly through the country, but is less suitable for the parts of the line running through towns; these are, however, usually short. Electrolysis has so far given no trouble with alternating currents, and is not likely to do so except in special cases; there seems, therefore, to be no reason for keeping the drop of volts very low on long lines. The sample on the table is a piece of the earth plate from the Murnau-Oberammergau power station, which has been in use for 20 months; it is estimated that is has passed 7,500 ampere-hours. The corrosion is inappreciable.

The current flowing in the power circuit—*i.e.*, the trolley wire and the return, consisting partly of the rails and partly of the earth—will produce interferences of three kinds on neighbouring telegraph and telephone lines. To simplify the description of these let us consider a concrete case of a telegraph line on poles running the whole length of the railway. The first effect produced by the power circuit is due to the difference of volts between the earth plates at the two ends of the line, which will produce an alternating current in the telegraph line if, as is usual, it has an earth return. This can be prevented by using an insulated metallic return instead of the earth. Assuming that a wire for this purpose has been erected, the second effect will be that due to the mutual induction between the power and telegraph circuits. This effect is comparatively small, and will not be sufficient to affect the ordinary block instruments on lengths of line corresponding to ordinary block sections; it will, however, be important on longer lines. It can be approximately eliminated by twisting the telegraph circuit. Both of these effects are functions of the current in the power circuit, and are independent of the pressure.

By slightly modifying the ordinary telegraph instrument it is possible to continue to work with the earth return, and thus avoid the expense of the metallic return. Mr. Dahlander, chief engineer of the electric traction department of the Swedish State Railways, has very kindly given me permission to describe two methods which he has successfully used for this purpose. In the first the iron core of the electromagnet of the telegraph instrument is surrounded by a copper sheath, consisting of a tube and washers. This damping circuit reduces the magnetism of the iron produced by the alternating current to such a small amount that it does not interfere with the action of the instrument. In the second method the telegraph instrument is shunted by a condenser; a small liquid condenser of three cells was found to be sufficient on the circuits tested. Full particulars of these experiments will, no doubt, be given when the report of the Swedish experiments is published.

The third effect is due to static induction between the charged trolley wire and the telegraph wire. A charge will be induced in the telegraph wire which is a function of the potential of the trolley wire and is independent of the current in it. As the potential of the trolley wire is alternating the induced potential will also be alternating in sign. The potentials induced in actual cases are surprisingly large. For the Hamburg-Altona line it is calculated that the difference of potential between the telegraph wires and earth would be 1,200 volts, while on the Swedish line the difference of potential is 4,500 volts. If the wire is earthed, the alternating current which will flow in and out of it will be very small—only a few hundredths of an ampere—owing to the small capacity of the line; but this would be sufficient to give a fatal shock. The use of the metallic return for the telegraph circuit does not eliminate this charge, but roughly doubles it by doubling the capacity of the circuit. The simplest way to avoid this is to earth the circuit at one point, or on long lines to earth it through high resistance at several points. These leakage paths will not interfere appreciably with the telegraph currents.

The same three effects are produced on a telephone circuit, but they cannot be dealt with in quite the same way. The induced E.M.F. is sufficient to cause a low "hum" in the receiver, which can only be eliminated by putting the wires in a cable. The static charge can be earthed through inductances which allow the low periodicity currents to pass, but not the high periodicity talking currents. All effects are eliminated by using underground cables for both telegraph and telephone circuits.

In calculating the sizes of trolley wire and feeders, &c., the effects of the self-induction of the circuit must be allowed for. If the power factor of the load is good, the self-induction of the line will cause very little drop of voltage at the far end; but if the power factor is low, for instance, on a section of line with only one train on it at the moment when that train is starting, then the induction of the line increases the drop considerably. The drop in voltage at the far end of the line is, of course, quite a different amount from the drop in the return circuit, which may be larger.

It is advisable to adopt a high voltage for the trolley wire; the advantages are many, and the disadvantages mostly imaginary. The higher the voltage the smaller the current, and the less are the effects of induction on neighbouring circuits, and the less the drop in the rails and the better the regulation of voltage. The only undesirable effect which increases with the voltage is the static induction. By far the most satisfactory insulation for all high-tension circuits is porcelain, and with porcelain it is hardly more difficult to insulate for 20,000 volts than for 3,000. The most common objection raised to the higher voltage is the vague one of danger. The danger of falling tramway trolley wires is often spoken of, but it perhaps may not be generally known that there has never been a fatal accident in England due to a broken trolley wire. On careful examination it is difficult to see why 20,000 volts is more dangerous than 3,000; the lower voltage is quite sufficient to kill, and the higher can do no more. Whatever the voltage, it must be recognised that it is fatal to touch the trolley wire, just as it is recognised that it is fatal to stand in front of an approaching train. Nor does the higher voltage materially affect the reliability of the system. In ordinary continuous-current systems the power is all generated and distributed at high voltages, usually between 6,000 and 11,000 volts. Of course, these are reduced before reaching the motor, but so they are on the single-phase system. It will, however, be wise to proceed gradually in raising the voltage, in case any disadvantage should be found in practice which has not been foreseen. This course is being adopted on the Continent, and 20,000 volts has already been reached; this is quite a low figure compared with ordinary practice in transmission plants. Fortunately, the great flexibility of the single-phase system makes it perfectly easy to alter the voltage, and for the same rolling stock to run over lines with different voltages. By merely altering the grouping of the coils on the transformers in the carriages any trolley voltage can be used.

The Trolley.—Various forms of bow collector have been used, and for moderate speeds they are all satisfactory, but for high speeds special designs are necessary. The main object of the design must be to reduce the inertia of the moving parts, particularly of the actual contact bar. The Zossen experiments have shown how this may be accomplished by building the bow up of several parts connected by springs, thus making an extremely flexible construction, having very little inertia at the end, which is the only part which has to make very quick movements, while the lower and heavier parts follow more slowly and provide for the larger motions. The level of the trolley wire has usually to be lower when passing through bridges than in the open, and the bow must have sufficient range of motion to allow for the extreme differences of level. It is also an advantage if the design will allow the bow to reverse itself when the car is run backwards without forcing the trolley wire to rise. The bow is raised and lowered by air pressure; it is mounted on insulators on the car roof.

It would lead too far to attempt to describe the single-phase motor. It is sufficient to say that the motors which have so far been used for electric traction are mainly of two types—the compensated series motor and the compensated repulsion motor. Both have special advantages, but at present the series motor appears to be rather the better. It was at first supposed that the repulsion motor might be wound for high pressure, and thus save the transformation of the whole power in the car, only that part of the power required for excitation being transformed. It has, however, been found that the starting of the repulsion motor under these conditions is unsatisfactory, and in recent equipments main transformers have been used. These, however, do not do away with the second transformer for the magnetising current, so that two transformers are generally required with this type of motor. Both motors have series characteristics, good power factors and fairly high efficiencies. The losses in the motors are, however, higher than in continuous-current motors, and forced ventilation is generally used to carry off the heat. Some writers have assumed that the motors must be made much bigger to enable them to get rid of their heat by simple surface radiation and conduction, as is usual with continuous current motors. The simple expedient of artificial cooling is a more reasonable method of dealing with the problem.

It has been stated by several writers that the effective adhesion of the single-phase locomotive is less than of the continuous-current locomotive, because of the pulsating nature of the torque given by the single-phase motor. This, however, is not the fact.

The speed of the motors is controlled by connecting them to different numbers of turns on the secondary of the transformer, thus varying the voltage on their terminals. The compensated repulsion motor has also its magnetising current varied in the same way by connecting it to different numbers of turns on the secondary of the small transformer. No resistances are required, and there is, therefore, none of the loss which is inevitable with continuous-current motors. The speed of the motor when running can be regulated to any extent, which can only be done with continuous-current motors to a very limited extent by special devices. The actual switching is done by contactors, as in the continuous-current system. Single-phase magnets are very suitable for operating the contactors; they have the very advantageous property of taking current in proportion to the gap, so that as they close they automatically reduce their current; thus the magnets may be wound to give a large pull at a distance without overheating when kept in circuit. The troublesome vibration has been entirely got over by means of a small short-circuit ring round part of the armature. The great simplicity of the control enables the whole of the switching to be done with seven contactors, including the reversing switches. The rest of the motor car equipment is very similar to the usual continuous-current apparatus.

It is impossible to deal to-day with the generation of single-phase power. The introduction of single-phase traction is directing attention again to the subject, which has been rather neglected in recent years, owing to the greater popularity of two and three-phase. The size of single-phase generators is rather larger for the same output than that of three-phase generators. Many different methods are being tried for regulating the voltage, and it seems likely that before long a good self-regulating single-phase generator will be available, though at present the regulation leaves a good deal to be desired. This is not a very important matter so far as the traction is concerned, but it introduces difficulties if the same circuits are used for lighting. This difficulty only arises when the load is very variable, as in small installations, and disappears when the load increases and gets less peaky.

I hope I have said enough to show how varied and numerous the possibilities of electric traction are, and that while many interesting problems are arising in connection with the new system of electrification, they are being successfully solved, and that there is no serious difficulty ahead.

It is very much to be hoped that English railway engineers will not lag behind their foreign confrères in introducing electricity on their lines. It is not to our credit that there should not be a single line equipped with single phase in this country when lines are already working in Italy, Austria, Germany, France, Belgium, America and Sweden. It is not to be expected that railway companies will embark on extensive schemes at first; it is, therefore, all the more necessary that they should at once put in hand short lines, so that they may become acquained with the merits and possibilities of the single-phase system.

THE OSRAM LAMP.

Some further details of the new metallic filament lamps, which are being brought out by the German Gasglühlicht Co., in Berlin, are published in the *Elektrotechnische Zeitschrift.* The lamp, which is known as the Osram lamp, was exhibited at the congress of the Verband Deutscher Elektrotechniker, at Stuttgart and other meetings in Germany this summer, and has been manufactured for some months in sizes up to 50 c.p. for 100 to 130 volts. The efficiency claimed for the lamp is approximately 1 watt per candle-power. The average life is given, as a result of tests at the Reichsanstalt and other observations, as 1,000 hours, and it is stated that during that time there is only a very slight diminution in candle-power.

The earlier Osram lamps, like certain of their predecessors, had to be used in a vertical position to obtain the best results, but the newest type, which is illustrated in Fig. 1, can be installed in any position.

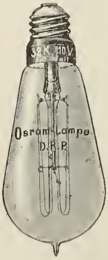

Fig. 1.–Osram Lamp.
⅓ natural size.

Experiments have shown that the average watt-consumption of the Osram lamp alters very little during the life of the lamp. The following table gives results of observations of constancy of candle-power and efficiency taken by the Reichsanstalt.

Hours of burning.	Mean voltage (volts).	Mean current (amp'r's)	Mean horizontal c.p.	Mean consumption per mean horizontal c.p. (watts)
		1.—25 *c.p. Lamps.*		
0·4	117	0·272	28·5	1·11
100	117	0·272	29·6	1·07
200	117	0·271	29·8	1·06
400	117	0·270	28·7	1·11
500	117	0·270	28·1	1·12
700	117	0·270	27·7	1·14
1,000	117	0·269	26·6	1·18
Alteration after 1,000 hrs.	—	−1·1%	−6·6%	+6·3%
Best lamp ,, ,, ,,	117	0·270	27·3	1·10
Worst ,, ,, ,, ,,	117	0·267	25·7	1·22
		2.—32 *c.p. Lamps.*		
0·4	112·75	0·314	31·9	1·10
100	112·75	0·315	33·7	1·06
200	112·75	0·316	33·9	1·04
400	112·75	0·314	33·0	1·07
500	112·75	0·314	32·7	1·08
700	112·75	0·311	31·3	1·12
1,000	112·75	0·309	30·6	1·14
Alteration after 1,000 hrs.	—	−1·5%	−4·0%	+3·6%
Best lamp ,, ,, ,,	114·0	0·310	32·0	1·10
Worst ,, ,, ,, ,,	111·5	0·304	29·0	1·17

In these tests eight samples of each size were chosen at random out of a large number, and the tests were made on the ordinary supply voltage, so that the lamps were exposed to such voltage variations as they would experience in practice. It is pointed out that shorter filament lamps, as, for example, lamps for 16 c.p. at 70 volts can be made to give even better results. Fig. 2 shows the alteration in candle-power in the form of a curve which, as will be seen, rises during the first 200 hours or so and afterwards gradually falls, passing through its initial value in from 500 to 600 hours. The corresponding efficiency curves are given in Fig. 3. It should be mentioned that all these results are expressed in the German standard (Hefner) unit.

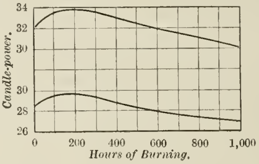

Fig. 2.

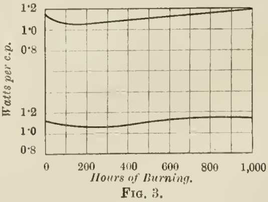

Fig. 3.

A few of the lamps burned out slightly before the 1,000 hours, but 11 out of the 16 tested were still burning at the end of that time. Tests have shown that the average life of the Osram lamp is as long on alternating as on continuous-current circuits. It is expected that arrangements will be completed to enable large quantities of these lamps to be placed on the market next month at a reduced price. It is hoped that lamps for 220 volts will shortly afterwards be produced on a large scale and also lamps of various candle-power up to 200 c.p., but at present these are only in an experimental stage.

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PAUL'S PORTABLE MICRO-AMMETER AND MILLI-VOLTMETER.

The combined portable ammeter and voltmeter made by Mr. R. W. Paul, of which we give illustrations, is suitable for reading from one millionth of an ampere and one ten-thousandth of a volt, and has some features which make it a convenient and compact form of instrument. Internal shunts and resistances are provided (as indicated in Fig. 2) so that the instrument is complete in itself for measurements up to 0·12 ampere and 2·4 volts. Owing to the special construction of the moving coil the sensibility is greater than with the usual two pivot type.

Applied as a millivoltmeter the instrument reads as low as $\frac{1}{10}$th millivolt per division, or 12 millivolts for full scale deflection. Thus the apparatus may be used in conjunction with a portable shunt of comparatively small dimensions and cost for the measurement of large currents. A suitable shunt for the measurement of currents to 120 amperes may be fitted in the lid of the box without increasing its dimensions.

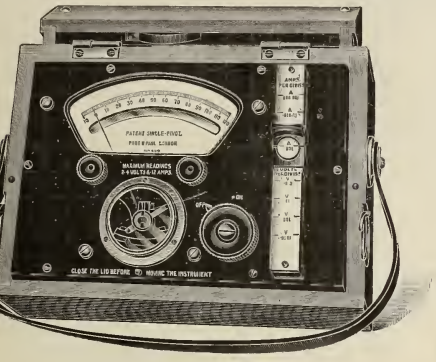

Fig. 1.

When used as a millivoltmeter, accuracy is ensured by the high internal resistance; since the resistance of the copper coil is only about 50 ohms, and the series resistance amounts to about 10,000 ohms for a scale deflection of 100 divisions with 1 volt, the temperature coefficient of the instrument is practically negligible, even when used for measuring very small pressures. An additional coil of 100,000 ohms is fitted if desired.

To avoid risk of errors in joining up, two terminals only are fitted, and connected through an "on" and "off" switch to a single slider which puts into circuit the respective shunts and series resistances, and at the same time indicates clearly by its position the value of a scale division in amperes or volts. The instrument is entirely self-contained and there are no loose parts; the act of closing the lid raises the coil from its pivot and the instrument is then secure against the effects of ordinary rough usage. The working parts are mounted on a rigid aluminium casting supported by an ebonite plate forming the front of the instrument, and they are highly insulated. The whole is enclosed in a substantial teak case with strap handle.

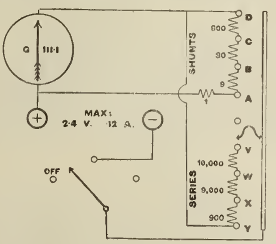

Fig. 2.—Arrangement of Resistances and Shunts.

The scale is calibrated throughout its length (4½ in.) and marked from 0—120 divisions, the divisions being practically uniform throughout and extended for a short distance to the left of zero. Each division corresponds to 1 micro-ampere when the slider is on stud A.

RECENT ADVANCES IN STEAM TURBINES, LAND AND MARINE.*

BY GERALD STONEY.

In steam turbines used for driving alternators and dynamos for electric light and power the advance during the last few years has been very rapid. It was only in 1884 that Mr. C. A. Parsons made his first turbo-dynamo of about 10 h.p., and in 1904 the size had increased to 4,000 kw., while many larger sizes, up to 6,000 kw., are now in hand under his patents. In this country the largest turbine stations are those at Neasden, Chelsea and at Carville, near Newcastle-upon-Tyne, the latter having two turbines of 2,000 kw. and two of 4,000 kw., and four more of the larger size will shortly be added, making a total installed of 28,000 kw., with an overload capacity of about 50,000 kw. for the peak load. The 4,000 kw. turbines take 15·4 lb. of steam per kilowatt-hour, with 200 lb. boiler pressure, 150°F. superheat and 28½ in. vacuum, barometer 30 in.

For the great power scheme proposed for the supply of London, turbines of 10,000 kw. have been designed with an overload capacity of 100 per cent., and it is confidently expected that with them a consumption of 13 lb. per kilowatt-hour will be reached. For continuous-current work, several turbo-dynamos of 2,000 kw. have been made, and by the use of a compensating winding and certain improvements in the commutators and brush gear the commutation troubles which were formerly experienced in large sizes have been completely overcome.

During the last three or four years a turbine blowing engine has been developed, chiefly for use in connection with blast furnaces. The air portion is built up of alternate rows of fixed and moving blades. The moving blades are set at an angle to the plane of revolution of the shaft, and each row may be compared to a multibladed propellor, the fixed or guide blades merely serving to direct the air in a longitudinal direction along the cylinder after it leaves each row of moving blades. The first machine of this type was installed at Messrs. Cookson's Lead Works on the Tyne, and was used for lead smelting. It was driven by a high-speed electric motor at about 4,000 revs. per min., and the output was 3,000 cubic ft. of free air per minute, against 1¾ lb. per square inch blast pressure. In practice it was found that the steady and continuous blast maintained by this machine greatly improved the output of lead from the furnace, as compared to that obtained with the pulsating blast from the Root's blowers previously used. A considerable number of these turbo-blowers have been built for iron smelting. As a typical case, a turbo-blowing engine at Messrs. Wilsons, Pease & Co.'s works, Middlesbrough, may be taken. This engine, when delivering 18,500 cubic ft. of free air per minute against 10 lb. blast pressure, was found to take 15,100 lb. of steam per hour. The turbine was supplied with saturated steam at a pressure of 150 lb. per square inch, and exhausted into a 27 in. vacuum (barometer 30 in.) This represents a steam consumption of only 22·5 lb. per adiabatic horse-power-hour, or an overall thermal efficiency of 37·4 per cent.

A turbo blower of a slightly different type has been constructed for dealing with large volumes at low pressures. These plants are arranged so that they can either be used for blowing or exhausting. The usual capacity is about 30,000 cubic ft. of gas per minute, and the suction or pressure about 1 lb. per square inch. In one installation in Scotland, which has been working for nearly two years, three turbo-exhausters, weighing in all 20 tons, have replaced 12 exhausters of the revolving drum type, the drums alone of which weighed together over 100 tons. In these blowers there generally are three to five cast-steel propellers with rings of spirally-shaped guide blades between them, the speed being about 7,000 to 8,000 revs. per min.

It is well known that it is almost, if not quite, impossible to utilise economically by a reciprocating engine low-pressure steam at about atmospheric pressure, and it is under these conditions that the exhaust steam turbine becomes of importance. In 1894 Mr. Parsons took out a patent for the utilisation of the exhaust from a reciprocating engine by a steam turbine, and this was first put into practice in H.M. destroyer "Velox" in 1903, which had a pair of small reciprocating engines exhausting into the main turbines at cruising speeds, they being disconnected from the main turbines when it was desired to run at high speeds. Another instance is at Messrs. John Brown & Co.'s at Sheffield, where the exhaust from a blowing engine will shortly be utilised in a steam turbine and expanded from about atmospheric pressure to a vacuum of 27 in. This will give an additional power of about 316 kw.

Since, as is well known, the steam turbine, unlike the reciprocating engine, can fully utilise the highest vacua, and can exhaust right down to the vacuum of the condenser, it is most important that this vacuum should be as high as possible. As a rule, the temperature of the inlet cooling water is fixed, and therefore it is important to keep the difference of temperature between the cooling water and that due to the vacuum in the condenser as small as possible. Great help is given by the use of what is called a "Vacuum Augmenter," which consists merely of a steam jet placed in a contracted pipe between the condenser and the air pump, which compresses the air and vapour from the condenser and delivers it to the air pump through a small auxiliary condenser. As the steam consumption in the jet of the vacuum augmenter only amounts to some 1 to 1½ per cent. of that used by the turbine, it will be seen that a gain of about ¼ in. of vacuum more than counterbalances this extra steam used.

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* Abstract of a Paper read before Section G of the British Association at York on Tuesday, August 7th.

Space forbids much being said about the greatest development of the steam turbine, that for marine propulsion. It is only 12 years since the question of building the little "Turbinia" was mooted; and yet now, out of a total number of 68 vessels on Lloyds Register of over 20 knots, no less than 10 use Parsons turbines, and the total horse-power of marine turbines completed and on order now approaches 1,000,000 H.P. On the score of economy it has been found that cross-channel boats use from 15 to 25 per cent. less coal than those with reciprocating engines, besides having a smaller engine-room staff, as well as using much less oil, waste and other stores.

In the case of tramp steamers of, say, 10 knots, a very great economy will be obtained by the use of an exhaust turbine with the reciprocating engine exhausting into it. If we examine indicator diagrams of a tramp steamer, it will be seen that the steam is usefully expanded down to about 7 lb. absolute only, and that nearly the whole of the energy, from 7 lb. to, say, 1 lb. absolute, is wasted. By the use of exhaust turbines, the greater part of this can be recovered, representing a net gain of from 15 to 25 per cent. in the power on the same coal bill. It is expected soon to put this system into actual operation.

RECENT ADVANCES IN OUR KNOWLEDGE OF RADIATION PHENOMENA, AND THEIR BEARING ON RADIATION PYROMETRY.[*]

BY PROF. J. B. HENDERSON, D.Sc.

In a previous Paper published in *The Electrician* (Vol. LI., p. 773, August 28, 1903) I drew the attention of engineers and physicists to the recent advances in the theory of radiation which have been made during the last decade, principally by the Berlin school of physicists—on the theoretical side by Boltzman, Planck and Wien, and on the experimenta side by Lummer, Pringsheim, Rubens, Paschen and Wanner.

The laws of radiation which have been developed theoretically and confirmed experimentally are four in number, and apply to the radiation from any *ideal black* body. They are

1. $\int_0^\infty E_\lambda d\lambda = \sigma T^4$ (σ being a constant)—Stefan-Boltzman law.
2. $\lambda_m T = \text{constant}$ $\Big\}$ Wien's law of displacement.
3. $E_m T^{-5} = \text{constant}$
4. $E_\lambda = \dfrac{a\lambda^{-5}}{\epsilon^{\frac{b}{\lambda T}} - 1}$, ($a$ and b being constants). Planck's law of the partition of energy in the spectrum.

λ_m is the wave-length of maximum radiant energy in the spectrum, E_m the value of the maximum radiant energy, and T the absolute temperature. The expression proposed by Wien for the partition of energy in the spectrum differs from Planck's only in omitting the figure unity in the denominator, and may be interchanged with Planck's if λT is less than 3,000.

The comparison between Wien's expression and Lummer and Pringsheim's experiments is shown in Fig. 1. It will be noticed that there is considerable deviation from the experimental results at long wave-lengths, but if Planck's expression is used these deviations disappear, except such as are within the limits of experimental error.

The above laws are developed theoretically from Maxwell's electromagnetic theory and the laws of thermodynamics, as was pointed out in the former Paper.

All accurate radiation thermometry is founded on these four laws; hence, wherever accuracy in radiation thermometry is required it is very important to remember the limitations of the laws—namely, that they apply only to the radiation from an *ideal black body*. Kirchhoff showed that the radiation inside an enclosure whose walls are at uniform temperature is the same as would be emitted by an ideal black body at the same temperature; and by using the radiation from cavities whose walls were heated electrically to uniform temperatures, the theoretical laws have been experimentally proved.

If, then, we wish to obtain accurately the temperature of any material in a furnace by means of the radiation which it emits, we must take the radiation from a cavity whose walls are at the required temperature. If the material is in liquid or pulverous form, a tube closed at one end serves the purpose if the closed end is inserted in the material and the radiation taken from the closed end. If the material is in ingot form and there is no serviceable hole in it we can use an auxiliary piece of similar material provided with a hole and placed against the ingot, so as to have practically the same temperature as the ingot. The hole or cavity may bottom against the ingot or in the auxiliary piece of material.

To use a radiation pyrometer in the tempering of armour plate on a cooling curve, it would be necessary to lay another plate with holes in it on the one to be tempered, then heat the two together in the furnace and after withdrawing them from the furnace to focus the thermometer on the bottom of one of the holes. When the required temperature is indicated the upper plate could be removed and the lower one quenched, the upper one being returned to the furnace with the next plate.

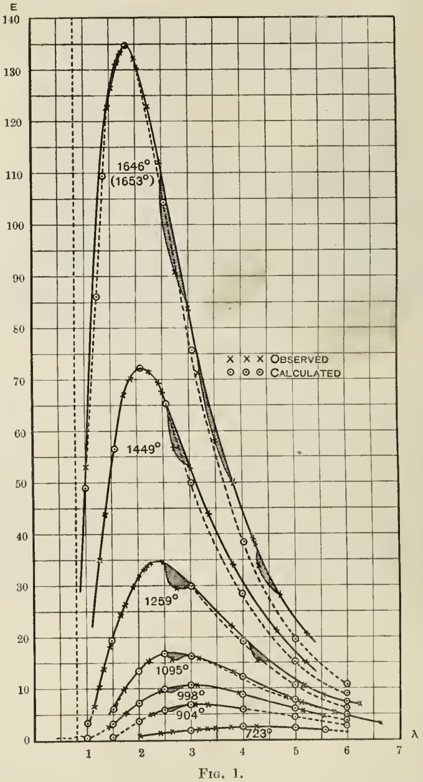

FIG. 1.

In every case where the temperature is read while in the furnace, it is necessary to shield the radiation from luminous flames after leaving the cavity. This may be done by means of tubes, and the temperature of the walls of these tubes will not affect the result, provided an image of the cavity is formed on the sensitive surface of the thermometer.

The principles on which the present radiation pyrometers are founded are the first and fourth laws. Those founded on the fourth law we may distinguish from the others by the term optical thermometers because only the luminous portion of the spectrum is used. Law II. does not lend itself well to temperature measurement, because the maximum radiation is not well marked especially at low temperatures; but it has been used in the laboratory to fix limits for the temperature of our luminants, of the sun and of some fixed stars. Law III. which measures the maximum energy in the spectrum promises better than Law II., but it has little advantage over Law I. and the instrument would be much more complicated.

Pyrometers based on Law I. have a black receiving surface for absorbing the radiation from the radiating body. This surface may be one of the junctions of a thermo couple, or the wires of a bolometer or one arm of a radiometer balance, but as we are more concerned with instruments used in the industries than with those used in the laboratory the following descriptions will be confined to the former.

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[*] Paper read before the British Association (Section A) at York, on Wednesday, August 8th.

Figs. 2 and 3 show two types of Féry pyrometers. In Fig. 2 the image of the radiant is formed on the receiving surface by means of a fluorite lens, although in some technical forms a particular kind of glass having low absorptive power in the infra red is used for the lens. The temperature of the receiving surface is measured by a thermo-couple and portable galvanometer. This pyrometer lacks sensitiveness at temperatures below 900°C., and to increase the sensitiveness Féry replaces the lens by a concave mirror, making a reflecting telescope, as shown in Fig. 3. This form can measure down to 600°C. The eye piece in both instruments is for sighting purposes, as an image of the radiant must be formed on the small receiving surface of the junction. So long as this image is larger than the receiving surface the reading of the pyrometer is independent of the distance from the radiant, because both the total radiation received by the lens or mirror and the area of the image vary inversely as the square of the distance from the radiant, hence the intensity of the image is constant.

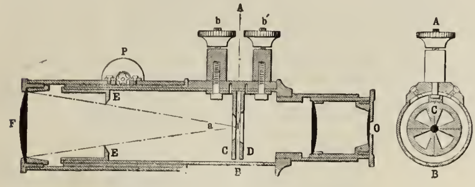

Fig. 2.—Féry's Radiation Pyrometer.

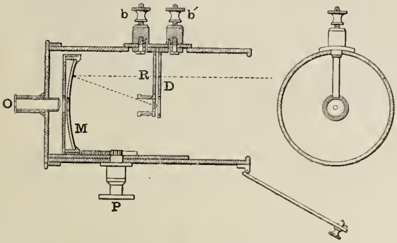

Fig. 3.—Sectional View of Féry Radiation Pyrometer.

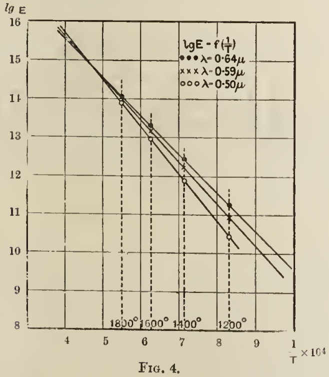

Fig. 4.

In a perfect pyrometer of this kind the receiving surface should be ideally black, and in some researches Lummer and Pringsheim have used cavities as receiving surfaces. The error introduced in a practical instrument due to this defect is, however, not of great significance. The accuracy of the Féry instrument is within 1 per cent. between 800°C. and 1,600°C. with ideal black radiation.

Law IV. gives us the equation connecting the radiant energy with temperature along an isochromatic curve. This may be written

$$\log E = c + \frac{d}{T} \text{ where } c \text{ and } d \text{ are constants.}$$

If, then, we confine our attention to one luminous wave-length, say the red line transmitted by red copper oxide glass, and plot log E as a function of 1/T, we get a straight line. Fig. 4 shows a comparison between theory and experiment for several isochromes. This is the scientific foundation of all optical pyrometers. It may be easier to calibrate them empirically, but it is possible to calibrate them by means of this equation.

Optical thermometers are simply spectro-photometers of simple form. Among the laboratory forms are le Chatelier, the Féry absorption type, the Wanner and the Lummer instruments, for a description of which the reader should consult the original memoirs or "High Temperature Measurements," by le Chatelier, Boudouard and Burgess (Wiley & Sons).

The most practical form of optical pyrometer, however, is that due to Holborn and Kurlbaum, which is shown in Fig. 5. An image of the radiant is formed in the focal plane of a telescope, and is there superposed on the filament of a small electric lamp placed in the focal plane. The current in the filament is then varied until the filament, as viewed through the eye piece of the telescope, cannot be distinguished from the image of the radiant. The current in the filament then forms a measure of the temperature. To standardise the instrument each lamp is first of all aged and then calibrated to get the connection between the current and the temperature of the filament. In measuring very high temperatures the radiation is weakened by dark glasses or by successive reflection, the glasses or reflecting surfaces being also standardised. Red glass is used in front of the eye piece.

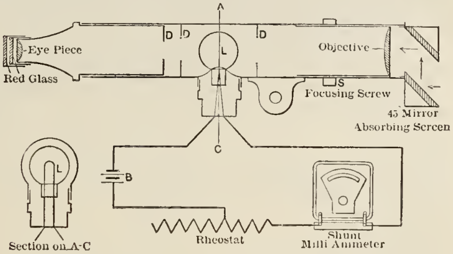

Fig. 5.—Holborn and Kurlbaum's Optical Pyrometer.

The following table given by Burgess shows the accuracy of the instrument at two points on the scale:—

Temp. from H. & K. pyrometer.	Temp. from thermo-couple.	Temp. from H. & K. pyrometer.	Temp. from thermo-couple.
1,347	1,347	632	634
1,351	1,347	634	633
1,343	1,343	633	633
1,333	1,342	633	632
1,342	1,342	..	..

The Limitation of Niagara Power.—The decisions of Mr. Taft, the American Secretary of War, regarding permissions to develop Niagara power are announced in the *Electrical World*. It will be remembered that under the law enacted at the last Congress for the preservation of the scenic beauties of Niagara Falls, the Secretary of War has the authority to grant permits to the extent of withdrawing from the river 16,500 cubic ft. per second, and it is now announced that temporary permits will be granted, as follows:—Niagara Falls Power Co., 8,600 cubic ft. per second; Niagara Power Co., 4,000 cubic ft. per second; Lockport Hydraulic Power Co., 500 cubic ft. per second from the Erie Canal and 333 cubic ft. from the lower level of the canal at Lockport. The Secretary has decided to postpone consideration of the application of the Niagara Falls Trust Co., giving as his reason that water is not being used by the company. His decision permits the Niagara, Lockport & Ontario Power Co. to import into the United States from Canada the equivalent of 25,000 H.P. from the Ontario Power Co. of Canada, and the Niagara Power Co. is also authorised to import from the Canadian Niagara Power Co not exceeding 25,000 H.P.

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In his report Prof. DICKSEE divides the plant into two parts—namely, that portion consisting of items whose life exceeds the terms of the loan relating to it, and that part whose life is less than the period during which the loan must be repaid. If there are any items whose life coincides with the time of the repayment of the loan, they may, of course, be disregarded, because when such items become worthless a fresh loan may be sanctioned by the Local Government Board for their replacement. The really important items are what may be termed the "short-lived" assets. With regard to the first portion, or the "long-lived" assets, Prof. DICKSEE finds that the proper charge against revenue to accumulate at 3 per cent. compound interest to a sum equal to the original

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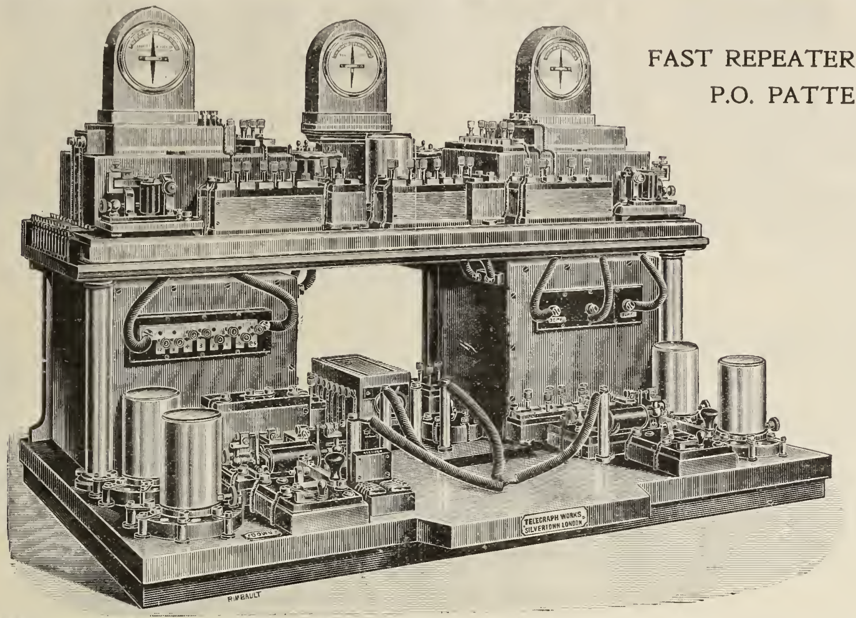

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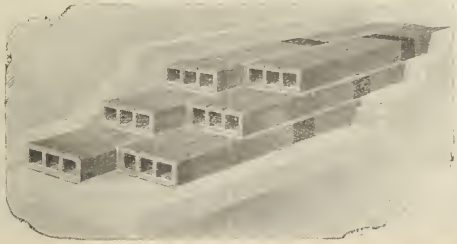

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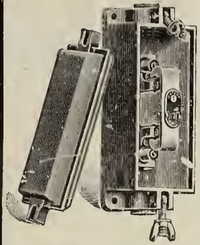

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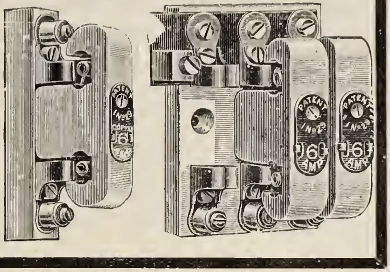

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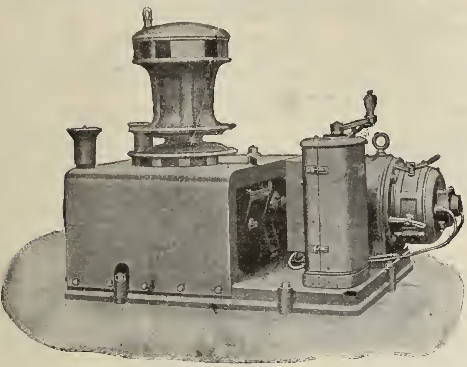

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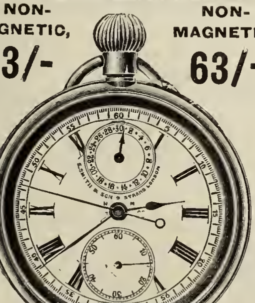
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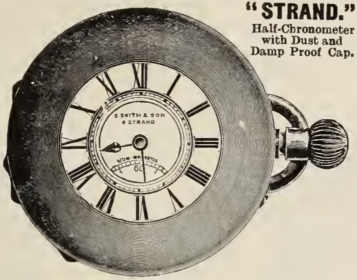

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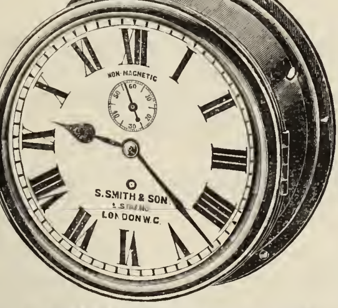

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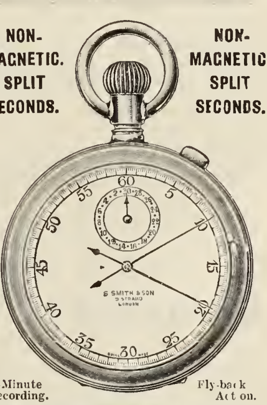

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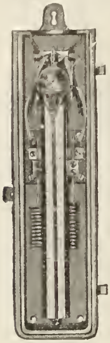

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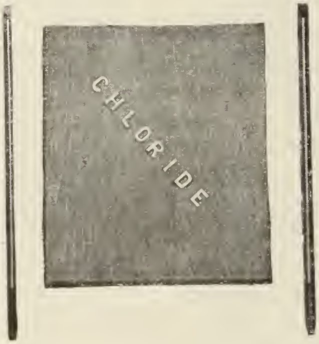

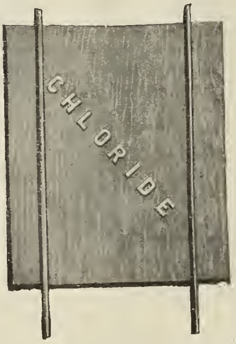

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expenditure (less the residual value) as the life of each asset expires is £5,363·66 per annum. The statutory sinking fund in respect of these items works out at £10,921·44 per annum, so that, as far as these items are concerned, the net profit, as shown by the accounts, is less than the true net profit to the extent of £5,557·78 per annum.

On the other hand, in the case of the "short-lived" assets, the proper charge against revenue to accumulate to an amount equal to the original expenditure (less the residual value) as the life of each asset expires is £4,380·85. The statutory sinking fund in respect of these items works out at £2,495·18, from which it appears that in this case there is a deficiency of £1,885·67 per annum.

Theoretically, this deficit might be set off against the surplus due to the "long-lived" assets, in order to determine the true net profit of the undertaking. Actually, however, this cannot be done, for each loan must be regarded as a whole, and renewals of any particular item must be charged against revenue until the loan relating to it has been redeemed. It follows, therefore, that the deficit of £1,885·67 must be charged against each year's revenue, in addition to the instalments of the statutory sinking fund.

To put matters on a satisfactory basis, Prof. DICKSEE suggests that the "Reserve Fund Account" and the "Depreciation and Contingency Account" should be amalgamated as a "Reserve (for Renewals) Fund," giving a sum of £16,000, which should be invested and allowed to accumulate. Further, that for the year 1905-6 a sum of £1,885·67, or preferably £2,500 (to be on the safe side), should be transferred to this fund for investment, and in future that such a charge should be calculated annually, because it bears no constant relationship to the aggregate capital expenditure. By such a course, although the loan relating to any particular asset may not have been repaid when the asset becomes of no value, such provision will have been made for repayment that the Local Government Board would not have any reasonable ground for refusing a fresh loan for renewal of the plant.

This is undoubtedly sound finance, and any local authority following such a course will find itself in a strong position, the "short-lived" assets being well provided for, and the "long-lived" assets eventually being assets of a certain value for which no sinking fund has to be provided. The amount of the reserve fund deduced depends, of course, upon the figures that are taken for the life of the different items of plant and their residual values. Such figures are to some extent a matter of opinion, and may vary from case to case. Sir WILLIAM PREECE has given figures for Bristol, but these are not necessarily applicable throughout to other towns. Such figures are of great importance, and it is a pity they have not been the subject of discussion during recent years.

There is no doubt that insufficient attention in the past has been given to the important question of "short-lived" assets, and it has been too freely assumed that the term of repayment allowed by the Local Government Board might be taken as a rough-and-ready average of the lives of the individual items of plant. It is readily seen that such an assumption is inadmissible. It might be allowable in the case of certain works frequently undertaken by local authorities, such as waterworks; but the case of an electricity works is entirely different. A waterworks grows slowly; in fact, it follows the growth of the population. An electricity works, on the other hand, grows much more rapidly; it is generally established in a populous area, and may increase to 10 times its original size in as many years. But the plant of the original station may be quite unsuitable for the larger scheme. It therefore becomes important to keep a sharp eye not only on the "short-lived" assets, but also on those which may become "short-lived" through becoming unsuitable for the needs of the station under its altered conditions; and it follows that although a "Reserve (for Renewals) Fund" is an excellent institution for placing an undertaking on a sound footing, the basis on which such a fund depends will require careful watching to ensure the fulfilment of its purpose.

BRISTOL CORPORATION ELECTRICITY SUPPLY.

The report of Mr. H. Faraday Proctor, city electrical engineer, which is issued with the statement of accounts and annual report of the Electrical Committee of the city and county of Bristol, records the completion of the second instalment of plant at the Avonbank Works and the laying of the foundations for the third instalment of the building. In addition to sundry auxiliary plant, the engine room now contains two 750 kw. Willans central valve engines coupled to Siemens alternators, three 750 kw. Parsons steam turbo-alternators, one 600 kw. Parsons Siemens turbo alternator, and two 1,000 kw. Willans-Dick, Kerr three-phase turbo-alternators. The whole of the switchboards for low-tension, high-tension and extra-high-tension working, the contract for which was placed with Messrs. Siemens, have also been completed. The three-phase plant will be taken into use this summer, the three-phase current at a pressure of 6,000 volts being delivered through three-core cables to that portion of the Temple Back works which has been equipped with motor-generators, and also to the new sub-station which has been constructed at Avon-crescent, Cumberland Basin. At these two places the three-phase current will be converted to continuous current at a pressure of 250 and 500 volts, in which form it will be delivered over low-pressure cables direct to consumers' premises. The three-phase current will also be delivered to static transformer stations, the equipment of which is somewhat similar to that of existing smaller sub-stations that have been in use by the department for the last 13 years, excepting that, to meet the desires of the Board of Trade, the sub-stations will be constructed above ground level, and, owing to the extra pressure at which the supply is given to these sub-stations, the switch appliances will have to be of a design suited to the higher pressures.

In addition to the formation of rotary converter sub-stations at Avon-crescent and at the Temple Back generating station, four ordinary static transformer sub-stations have been constructed and equipped during the year. Transformer kiosks have been used in some instances where the prospective demand would not warrant the capital outlay which would be incurred in the construction of brick sub-stations underground. These kiosks consist of cast-iron pillars containing a transformer and the necessary apparatus for connecting up and switching on the high-tension and low-tension cables. The total mileage of cables laid has been increased during the year from 246·15 to 284·35.

The increase in connections during the year under review is shown by the following table :—

Connections Reduced to Equivalent of 30 Watt Lamps.

	Mar. 25, '05.	Mar. 25, '06.
Public lamps	8,383	8,383
Motors and heating apparatus	79,896	98,770
Private lighting	185,897	195,688
Total	274,176	302,841

The total plant capacity of the Avonbank station is 6,890 kw. and of the Temple Back station 2,160 kw. The maximum load during the year was 4,840 kw. The following table gives the units sold and the various items of expenditure reduced to pence per unit sold :—

	Year ending Mar. 25, '05.	Year ending Mar. 25, '06.
Units sold for private lighting	2,620,387	2,793,993
Units sold for power	1,759,085	2,183,373
Units sold for public lamps	838,056	833,602
Total units sold	5,217,528	5,810,968

COSTS PER UNIT SOLD.	Year ending Mar. 25, '06.
GENERATING COSTS.	
Coal	0·346d.
Oil, waste, water and stores	0·040d.
Wages at generating station	0·214d.
Repairs and maintenance	0·098d.
	0·698d.
DISTRIBUTING COSTS.	
Wages, &c.	0·045d.
Repairs, maintenance, &c.	0·046d.
Sundries	0·007d.
Attention, repairs, carbons, &c., for public lamps	0·079d.
	0·177d.
TOTAL WORKS COSTS	**0·875d.**
MANAGEMENT COSTS.	
Rents, rates and taxes	0·151d.
Salaries	0·142d.
Stationery and establishment charges	0·051d.
Law, Parliamentary and insurance charges, &c.	0·025d.
Miscellaneous	0·027d.
	0·396d.
TOTAL COSTS (excluding capital charges)	**1·271d.**
Interest	0·828d.
Sinking fund, &c.	0·571d.
Reserve for renewals fund*	0 103d.
TOTAL COSTS (including capital charges)	**2·773d.**

* As recommended by Prof. Dicksee.

The working expenses, which are analysed above, amounted to £30,785, and the receipts came to £70,664. Of the balance, £39,879, thus produced, £20,015 was absorbed in interest and £13,749 in redemption and sinking fund, &c. In addition to these charges £2,500 was carried to reserve for renewals fund, being the difference between the provision for renewal of assets recommended by Prof. Dicksee and the amount of the statutory repayment of loans. Additional items of revenue, such as bank interest, &c., amounted to £1,411, and the balance from the last account was £952, so that finally there remained £5,978 to be carried forward to the next account.

The above figures are taken from the accounts, and do not show the difference between the costs of the two stations. The engineer's report, however, contains a summary of costs per unit sold, arranged slightly differently, but exhibiting the different works costs for the two stations as compared with previous years. Some of these figures are given below :—

Station.	Year endg. Mar. 25, '05.			Year endg. Mar. 25, '06.		
	Temple Back.	Avon-bank.	Com-bined system.	Temple Back.	Avon-bank.	Com-bined system.
Coal	0·527	0·391	0·442	0·372	0·329	0·346
Oil, waste, water and stores	0·052	0·043	0·047	0·036	0·043	0·040
Wages	0·255	0·233	0·290	0·216	0·212	0·259
Repairs, maintenance, &c.	0·147	0·126	0·190	0·059	0 124	0·151
Total works costs	0·981	0·793	9·969	0·683	0·708	0·796

It should be noticed that wages, repairs, maintenance, &c., include the expenses which we have allocated in our preceding table as distributing costs, and that maintenance of public lamps is not here included. The following tables contain an analysis of the capital expenditure up to March 25th, each generating station being dealt with separately :—

Temple Back.

Account.	Total, March 25, 1906.	£ per kw. for each station.
Land	£4,140	£1·9
Buildings	49,415	22·9
Machinery	88,556	41·1
Accumulators	685	0·3
Furniture and fittings	1,602	0·7
Total	£144,398	£66·9

Avonbank.

Account.	Total, March 25, 1906.	£ per kw. for each station.
Land	£16,358	£2·4
Buildings	83,092	12·1
Machinery	116,345	16·8
Accumulators	716	0 1
Total	£216,511	£31·4

The remaining items of capital expenditure are as follows :—

Account.	Total up to March 25, 1906.	£ per kw. (total).	Per cent. of total.
Generating stations as above	£360,909	£39·9	53·8
Mains	212,427	23·4	31·6
Other buildings	2,875	0·3	0·4
Machinery (sub-stations)	1,863	0·2	0·3
Transformers, &c.	18,227	2·0	2·7
Meters	17,719	2·0	2·6
Electrical instruments	732	0·1	0·1
Public lamps	13,874	1·5	2·1
Motors	3,240	0·4	0·5
Electric launch and house	311	0·0	0·0
Tools, stores and miscellaneous	39 439	4 4	5·9
Total	£671,616	£74·2	100·0

REPORT BY SIR WILLIAM PREECE ON THE PROBABLE LIFE OF PLANT AT BRISTOL.

We have received a copy of the following report, written by Sir William Preece to Mr. Faraday Proctor, city electrical engineer at Bristol, dated July 4, 1906. The figures given for the probable life of the various items of plant are those used by Prof. L. R. Dicksee in drawing up his report to the Electrical committee of the Council of Bristol, in which certain recommendations are made as to suitable provision for depreciation :—

In accordance with your request, I herewith submit my report as to the life to be allowed in respect of different sections of the electrical undertaking at Bristol.

I have also estimated what will be the residual value of each item at the end of this life.

My conclusions are as set out in the table annexed to this report, and from the figures therein given the proper provision to be made for depreciation can be worked out on an actuarial basis.

I note your remarks on the important item of the cables, and it is gratifying to learn that the cables laid in 1893 under my direction appear to be in as good a condition to-day as when first laid. This fact is of importance as demonstrating, not only that the cables were of excellent quality and carefully laid and jointed, but also that the soil beneath the streets of Bristol does not contain matter prejudicial to their life.

The samples of these cables submitted by you at my request confirm your opinion of their present condition.

It is, however, obviously impossible to make such an extensive inspection of these cables as would be necessary to justify the conclusion that no deterioration had occurred in any portions, while it is possible for a cable to deteriorate to a considerable extent without affecting the electrical properties as indicated by testing.

I have, therefore, after consideration, taken values for the probable life of the cables which are fair averages. That is to say, I expect that some short lengths of cable may have to be renewed in a few years' time, while, on the other hand, a proportion of the cable will be efficient in 50 years.

As regards residual values, as a rule, in estimating these I have given a figure for each item of plant based upon personal inspection, but in this case such minute accuracy does not seem to be necessary, and I have, therefore, estimated the value as a percentage of original cost, having regard in doing so to the fact that a large proportion of the single-phase alternating plant was purchased when prices were considerably higher than present prices.

In the case of water-tube boilers, coal bunkers and other structures, or machinery containing renewable parts subject to comparatively rapid wear, I have assumed that the required renewals will be provided for out of revenue.

In conclusion, I beg to assure you that I shall be pleased to give any further information or assistance that may be required.

—	Life in years if properly maintained.	Residual value at end of life. % of original cost.
Land	..	..
Foundations	100	nil
Buildings	80	nil
Boilers (water tube)	25	5%
Lancashire boilers	22	3%
Dynamos and alternators	30	8%
Engines and other machinery	25	6%
Cables (armoured)	35	15%
Cables (solid in wood trough)	40	12%
Buildings (sub-station)	50	nil
Sub-station equipment	25	12%
Accumulators	15	10%
Arc lamp posts	40	5%
Arc lamps	12	5%
Motors	25	9%
Office furniture	..	..
Meters	12	2%
Accessories and instruments	12	2%
Tools and sundries	10	5%
Electric launch	10	5%

In connection with the above report, the following list of the plant at Bristol, which has been kindly compiled for us by Mr. H. Faraday Proctor, city electrical engineer, will be of interest.

Temple Back Station.

Coal-handling Plant.—Motor-driven hoist.

Boilers.—Nine Lancashire, 28 ft. by 8 ft.; two Babcock & Wilcox watertube, each 2,852 sq. ft. heating surface.

Condensing Plant.—Allen surface condensers, to condense 60,000 lb. of steam per hour.

Auxiliary Steam Plant.—Two Green's economisers, each consisting of 192 pipes, with electrically-driven scrapers; two Woodeson steam-driven boiler feed pumps, each delivering 8,000 gallons of water per hour; one electric-driven Allen feed pump, delivering 4,000 gallons of water per hour; one Woodeson general service pump, delivering 10,000 gallons per hour; Doulton water softening plant.

Generating Sets.—Alternators: two Willans (three-crank)-Siemens 400 kw. disc type, single-phase 93 periods. Continuous-current sets: one 400 kw. Peebles, three 210 kw. Dick Kerr, all driven by Willans (three-crank) engines. (These are for power supply.) Two Willans (two-crank)-Siemens 165 kw. bipolar continuous-current arc lighters.

Auxiliary Sets.—Two Willans (two-crank)-Siemens 50 kw. exciters, one 5 H.P. motor-generator exciter set, two 80 kw. balancers, one 20 kw. balancer.

Switch Gear.—Siemens high-tension switch gear, with Andrews non-return and time-limit devices.

Electric Crane.—10 ton single-motor travelling crane.

Avonbank Station.

Coal-handling Plant.—Grab and motor-driven hoist, delivering to Hunt gravity railway, which in turn delivers to the Hunt conveyor.

Boilers.—Six Babcock & Wilcox land type watertube, each 4,020 sq. ft. heating surface; two Babcock & Wilcox land type watertube, each 4,780 sq. ft. heating surface; four Babcock & Wilcox land type watertube, each 5,760 sq. ft. heating surface. All the above fitted with Babcock standard superheaters and Meldrum Koker stokers.

Condensing Plant.—Surface type Allen, Mirrlees Watson, Alley & MacLellan and Parsons. Electrically-driven air and circulating pumps; independent sets for turbines; one common to Willans steam alternators, Willans-Dick Kerr, and Willans-Siemens direct-current sets; one for auxiliary plant.

Auxiliary Steam Plant.—Six Green's economisers, each consisting of about 320 pipes, motor driven; four Bumsted & Chandler induced draught fans, three coupled to Chandler's compound engines, each developing 100 I.H.P., one electric driven; two Weir steam-driven feed pumps, capacity of each 8,000 gallons per hour; two Hall feed pumps, capacity of each 8,000 gallons per hour; two Weir general service pumps, capacity of each 10,000 gallons; two Hall general service pumps, capacity of each 10,000 gallons; Doulton water-softening plant.

Generating Sets.—Two Willans (three-crank)-Siemens 750 kw. disc type; three Parsons (turbo)-Parsons 750 kw. and one Parsons (turbo)-Siemens 600 kw., single-phase, 2,000 volts, 93 periods; two Willans (turbo)-Dick Kerr 1,000 kw., three-phase, 6,000 volts, alternating, 50 periods; one Willans (three-crank)-Dick Kerr 210 kw. continuous-current; two Willans (two-crank)-Siemens 165 kw. bipolar continuous-current.

Exciters.—Two Willans (three-crank)-Westinghouse 88 kw. In addition to these the two Siemens 750 kw. sets, one Parsons 750 kw. set, and both Willans-Dick Kerr 1,000 kw. sets have direct-coupled exciters. An E.P.S. battery, 1,500 ampere-hours capacity, used for excitation.

Auxiliary Set.—Battery booster.

Switch Gear.—Extra high-tension and high-tension Siemens switch gear, with Andrews reverse-current cut-outs and Brown Boveri and Andrews maximum cut-outs. Oil-break switches. Also high-tension Ferranti hand-operated oil-break. Continuous-current switchboards, Ferranti horn-break type.

Electric Crane.—15 ton single-motor travelling crane.

Sub-stations.

Two sub-stations in which the three-phase extra high-tension alternating current is transformed to 250 and 500 volts continuous current. One is situated in what was originally a portion of the Temple Back boiler house. The plant there includes two Peebles-La Cour 500 kw. motor converters. The other sub-station is situated near the docks at Underfall Yard. The plant there installed is two 300 kw. Westinghouse rotary converters.

At the present moment there are about 80 underground sub-stations supplied from the 2,000 volt single-phase system distributing to consumers at a pressure of 105 and 210 volts three-wire system. These are equipped with static transformers. The capacity of such sub-stations varies from about 450 kw. to 25 kw.

Certain large residences in outlying districts are supplied on the house-to-house system.

Certain sub-stations, to be supplied from the extra high-tension and distributing three-phase four-wire from static transformers, are about to be constructed.

Cables.

Inter-connecting Trunk Cables.—Three 0·15 sq. in. three-core paper-insulated lead-covered cables with B.O.T. sheath beneath the lead, laid solid in wood troughing filled in with pitch, to connect the Avonbank and the Temple Back works on the extra high-pressure system.

Nine 0 3 sq. in. two-wire concentric paper-insulated lead-covered and steel-armoured cables laid direct in the ground, connecting the Avonbank and Temple Back works on the high-tension system.

Three 0·3, 0·15 and 0·3 sq. in. three-core paper-insulated lead-covered and armoured cables laid direct in the ground, connecting the two stations on the low-tension supply.

Feeders.—Of the same types as above, excepting only that some are jute-insulated instead of paper.

Distributing Cables.—The same remarks apply as to feeders.

Meters.

Westinghouse, British Thomson-Houston, Aron, Ferranti, &c.

REPORT BY PROF. L. R. DICKSEE ON DEPRECIATION AT BRISTOL.

The following is the report presented by Prof. Dicksee to the Electrical Committee of the Council of Bristol and to which reference is made in the leading article on Depreciation.

The questions in connection with the Bristol electricity accounts which you have submitted for my consideration resolve themselves into the following:—

(*a*) Can the revenue account be relieved of annual contributions to sinking fund in respect of assets displaced, provided a depreciation fund equivalent to the outstanding debt thereon has been provided out of revenue at the time of such displacement?

(*b*) Is ample provision being made for depreciation?

I have carefully considered the questions raised and conferred with your chairman, engineer, and secretary and accountant thereon, and I have also communicated with the Local Government Board with a view to ascertaining their general practice with regard to the sanctioning of loans to cover the expenditure upon renewal works. I have also perused and taken into account the report of Sir William H. Preece, K.C.B., F.R.S., as to the estimated working lives and residual values of the various assets, and now beg to report to you as follows:—

1. I understand that it is not the policy of the committee, in addition to charging revenue with the statutory provision for the repayment of loans, to also charge annually such a sum as would eventually provide for the renewal of all wasting assets as and when such renewals become necessary; but that the committee is desirous of making such charges against revenue that the balance thereof, described as "net profit," may represent the true net profit earned by the department after charging all sums that ought properly to be taken into account before arriving at that figure.

2. In order to arrive at the true annual net profit of an undertaking it is necessary that due provision should be made for the depreciation of wasting assets, and that such provision should be equitably charged against the several years during which these assets are in use. It is not necessary, however, in order to arrive at the true net profit to charge revenue with the statutory sinking fund required for the redemption of loans. If, therefore, the statutory sinking fund amounted to as much as the true depreciation charge, no further charge would be necessary in respect of depreciation, but if, on the other hand, the sinking fund instalments are insufficient for that purpose, a further provision must be made annually to cover the deficiency.

3. In cases where the term of the loan expires before the asset has been worn out the sinking fund instalment exceeds the true depreciation charge, and no further charge against revenue is necessary, inasmuch as the moneys necessary to renew such assets can then be obtained by reborrowing, as the previous loan will have been already paid off. In the case, however, of those assets whose working life is estimated to be shorter than the loan period, an additional provision is necessary, and such excess as there might be in respect of the other (long lived) assets would not be available to meet this deficiency.

4. For the purposes of my calculations I have adopted the estimated periods of life and of residual value stated in the before-mentioned report of Sir William Preece. Where these life periods coincide with the periods for which the corresponding loans were granted, the statutory sinking fund and the true depreciation charge are equal in amount, and no further adjustment would be necessary if the residual value were ignored. In most cases, however, owing to the system of sanctioning loans for equated periods, there is no such correspondence between the estimated life of the asset and the term of the loan, and these cases call for further consideration.

5. I calculate that on the capital expenditure as it stood on March 25, 1905, in respect of those assets whose estimated life exceeds their respective loan terms, the proper charge against revenue to accumulate at 3 per cent. compound interest to a sum equal to the original expenditure (less the residual value) as the life of each asset expires will be £5,363·66 per annum. The statutory sinking fund in respect of these same items works out at £10,921·44 per annum. As a consequence the accounts, as at present prepared, show a net profit less than the true net profit to the extent of this difference, which upon the basis of the present figures works out at £5,557·78 per annum—against which, however, must be set the compensating error which arises in connection with the treatment of the "short-lived" assets.

6. I calculate that on the capital expenditure, as it stood on March 25, 1905, in respect of these "short-lived" assets, the proper charge against revenue to accumulate to an amount equal to the original expenditure (less the residual value) as the life of each asset expires would be £4,380·85 per annum. On the other hand, the statutory sinking fund in respect of these same items works out at £2,495·18. There is thus a deficiency here of £1,885·67 per annum. All these calculations are based

upon the 3 per cent. tables, and assume that in each case the instalments commence with March 25th or September 29th nearest to the date of the respective sanctions, and are thus, of course, not absolutely accurate; I think, however, that they are sufficiently so for practicable purposes.

7. It is important to bear in mind that, while the deficit referred to in the preceding paragraph can be properly set against the surplus mentioned in paragraph 5 for the purpose of ascertaining the true net profit of the undertaking (thus showing that on the present system of accounting the true net profits are, upon the whole, decidedly in excess of those stated in the published accounts), no such set-off is available in practice, in that each loan must be separately regarded, and all renewals must of necessity be charged against revenue (or against a reserve for depreciation) until such time as, having redeemed the original loan out of the proceeds of which the assets were acquired, it becomes possible to again borrow for renewal purposes. It will thus be seen that, so long as the capital expenditure remains upon the scale obtaining on March 25, 1905, a sum of at least £1,885·67 must be charged against each year's revenue in addition to the statutory sinking fund instalments.

8. But even if this annual sum were to be set aside in the future, it would not suffice to compensate for the fact that, since the dates when these assets were respectively acquired, no such annual provision has, in point of fact, been systematically made. I estimate that, had such provision been systematically made from the first, it would on March 25, 1905, have accumulated to £12,629·62, which sum invested at 3 per cent. would on March 25, 1906, have amounted to £13,008 50.

9. The balances on the "reserve fund account" and the so-called "depreciation and contingency account" on March 25, 1906, amounted to £16,000. I would suggest that these two accounts be amalgamated as a "reserve (for renewals) fund," as representing the provisions set aside up to March 25, 1905 (with interest thereon to date), and I am of opinion that if so allocated they will be sufficient for that purpose; but it is imperative that the amount should be at once invested, so that for the future the fund may be systematically increased by accumulations at compound interest. It will be remembered that sec. 58 (5) of the Electric Lighting Orders Confirmation (No. 9) Act, 1883 (Bristol), provides for the investment of the reserve fund "in Government securities, or any other securities in which trustees are by law for the time being authorised to invest, or in any stock or securities of the undertakers," with a view to "accumulating the same at compound interest." The sum of £8,059. 14s. 6d. written off as depreciation prior to March 25, 1905, should be written back, credited to "reserve (for renewals) fund" and invested; and all moneys received on the sale of displaced assets since that date should henceforward be treated in the same manner.

10. I am of opinion that at the end of the year 1905-6 a further sum of £1,885·67 (or—to be on the safe side—say, £2,500) should be charged against revenue, credited to the reserve (for renewals) fund account, and also invested; but the amount of future annual instalments will, of course, necessarily be dependent on the capital expenditure from time to time, and cannot, I think, be very well estimated in advance. I would suggest that, if the matter is to be dealt with systematically, the proper charge against revenue should be carefully calculated each year upon the same basis as the above figures, for in the nature of things this charge bears no constant relationship to the aggregate capital expenditure as shown by the published accounts.

11. If the above plan be adopted, I am of opinion that the reserve (for renewals) fund will be found to serve its intended purpose of equalising the charges of revenue over a series of years, notwithstanding the fact that the exact date when it will become necessary to replace each of the various assets that wears out—or is found to be unsuitable—may be indeterminable. But this view is of necessity founded upon the assumption that upon the average these various assets will respectively last for the periods estimated by Sir William Preece, and will, when discarded, have the residual values that he has attached to them respectively. I am aware that, owing to the fire which occurred some little time since, certain assets have been discarded perhaps at a somewhat earlier date than might under normal circumstances have been expected, and for that reason I have throughout allocated a provision somewhat in excess of that which an accurate calculation of the contingencies has suggested as being absolutely necessary to meet the requirements of the case. It may be found that this margin of safety which I have provided is insufficient—or, on the other hand, it may be found that it is excessive—and for this reason I think it desirable that, at all events for the next few years, the whole subject should annually come up for reconsideration upon its merits; but at the present time I do not think it would be practicable to arrive at a fairer basis of treatment than that which I have suggested.

12. If my recommendations be adopted, all future renewals of parts will be treated under the same heading as repairs, and charged against revenue in the year then current; but all actual replacements, or renewals other than of parts, may be dealt with from time to time by (so far as may be permitted) borrowing the amount necessary to cover the cost thereof. I have been informed by the Local Government Board that "it is their general practice, when sanctioning loans for works which will be in substitution for works on which there is an outstanding debt, to exclude from the sum to be sanctioned the amount of the outstanding debt on the superseded work." I assume—and the point seems to me to be beyond reasonable doubt—that the term "outstanding debt" used in this connection does not mean debt which has not yet been redeemed by actual payment, but debt for the eventual redemption of which (when due) no provision has yet been made by way of sinking fund; and upon this assumption it seems clear that, upon an asset being superseded or replaced, it will be practicable to reborrow the whole amount in respect of which provision has already been made for repayment by way of sinking fund instalments, but not the outstanding balance unprovided for by the sinking fund.

13. The method that I recommend, therefore, is that inasmuch as the reserve (for renewals) fund which I have recommended will (if the estimated expectation of life be realised in practice) have accumulated to a sum equal to that for which *prima facie* no fresh borrowings can be obtained, the cost of renewals can be provided for as follows: Upon an asset requiring renewal, a sum equivalent to what I may call the deficiency of the statutory sinking fund to provide for the true depreciation charge to date (*i.e.*, the difference between the original cost and the amount to which the statutory sinking fund instalments have accumulated) must be transferred from "reserve (for renewals) fund" to "stock and loan redemption fund (No. 2) account," and a corresponding amount of investments transferred from "renewals investment account" to "stock investment (No. 2) account," whereupon provision will have been fully made for the eventual redemption of the whole of the original loan, and all further annual charges in respect of sinking fund instalments will be provided out of stock and loan redemption fund (No. 2) account—a state of affairs which disposes of the question (*a*) quoted above.

14. The question that next arises is one as to ways and means. Inasmuch as reborrowing can only be effected to the extent to which provision has already been made for the redemption of debt by way of sinking fund, and inasmuch as the investments accumulated on the renewals investment account to make good the deficiency have perforce been transferred to the stock and loan redemption (No. 2) account, no further moneys would be in hand available to defray the actual expenditure necessary on renewal, beyond the amount for which further borrowings would be sanctioned. But in view of the declared policy of the Local Government Board, as set out in paragraph 12 of this report, it would appear that no difficulty should be experienced in obtaining sanctions from time to time for further loans to cover the full expenditure incurred upon all necessary renewals, as by the time such applications become necessary the full amount of the previous loan will have already been provided—partly by the statutory sinking fund, and partly by transfer from the reserve (for renewals) fund—to the credit of the stock and loan redemption (No. 2) account. Thereafter no charges against revenue will be necessary to provide the sinking fund instalments on the original loan, and thus the proper charges against revenue will be found to have been equitably apportioned from year to year—a condition of affairs which disposes of the difficulties referred to in questions (*a*) and (*b*).

15. It is, perhaps, desirable that I should add that I have made no examination of the books of your department, and that the foregoing recommendations are based upon the published accounts and upon data supplied by the city electrical engineer and by your secretary and accountant—the accuracy of which, however, I have no reason to doubt.

REPORT OF THE BRITISH ASSOCIATION COMMITTEE ON PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.*

In the last report reference was made to a conference of representatives of standardising laboratories which had been invited to meet in Berlin as a preliminary to the more formal conference on electric units suggested at St. Louis.

The question of this preliminary conference was brought before the committee at a meeting on October 19, 1905, and attention was called to the importance of clause (2) of the provisional programme, viz.:—

"Shall the three units, the ohm, ampere and volt, be defined independently, or shall only two be defined, and, if so, which?"

It was agreed unanimously that two units should be defined independently, and that these two should be the unit of resistance and the unit of current. The secretary was instructed to report this to the conference at Berlin.

This conference took place in October last at the Reichsanstalt in Charlottenburg, and was attended by representatives from America, Austria, Belgium, England, France and Germany.

Agenda prepared with great care by the President of the Reichsanstalt were very carefully discussed, and, as a result, the conference expressed the wish that an international convention should be summoned in order to arrive at agreement in the electric standards which are in use in the different countries.

The following resolution was further adopted:—

"In view of the fact that the laws of the different countries in relation to electrical units are not in complete agreement, the conference holds it desirable that an official conference should be summoned in the course of a year with the object of bringing about this agreement."

The conference further expressed the opinion:—

1. That the information before it is not sufficient to enable it to propose any alteration in the formerly accepted value for the ampere.

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* This report was issued during the meeting at York. The committee consist of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Profs. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Profs. A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar and Mr. George Matthey.

2. That the information before it is not sufficient to enable it to lay down exact directions in respect to the silver voltameter and the standard cell.

3. That if a proposal for a change in the accepted value of the ampere is to be brought from any source before a formal congress to be held later, an agreement in writing on the point should be come to previously between the parties interested. If differences of opinion in the matter cannot be removed a new preliminary conference should be held.

The same procedure should be observed in regard to the specification for the silver voltameter and the standard cell, in the event of such specifications being submitted to a formal conference from any quarter.

The following formal decisions were agreed to:—

1. That only two electrical units shall be chosen as fundamental units.

2. The international ohm, defined by the resistance of a column of mercury, and the international ampere, defined by the deposition of silver, are to be taken as the fundamental electrical units.

3. The international volt is that E.M.F. which produces an electric current of 1 international ampere in a conductor whose resistance is 1 international ohm.

4. The Weston cadmium cell shall be adopted as the standard cell.

Recommendations were also made as to realising the ohm, and some particulars as to the cadmium cell were agreed upon.

These results were laid before the Board of Trade, and a Departmental committee, of which the secretary was a member, drew up a report recommending that an official conference should be invited to meet in London, and it is understood that negotiations are now on foot with view to summoning such a conference.

During the year the work in connection with the absolute ampere balance has been in progress, and is practically complete. Under the supervision of Prof. Ayrton and Mr. Mather a large number of determinations have been made, and are most satisfactory. Detailed particulars are reserved until the work is complete; but there is little doubt that the balance is a most excellent absolute instrument, and that the probable error of a determination of current by means of it is only a few parts in 100,000.

The investigation of the silver voltameter has been extended beyond the limits originally thought to be necessary. The results so far obtained are very valuable, and appear to indicate that a satisfactory form of silver voltameter is realisable. It is hoped that the publication of the results will take place at the same time as those of the ampere balance.

An appendix [not yet available] by Mr. F. E. Smith describes the methods of comparing resistances in use at the National Physical Laboratory, and discusses the sources of error and the accuracy attainable.

The grant of £25 made in 1905 has been expended in materials for the work on the ampere balance and the silver voltameter. In connection with the latter a large amount of work involving considerable expense remains to be done. For this purpose the committee ask for reappointment with a grant of £50. They recommend that Lord Rayleigh be chairman and Dr. R. T. Glazebrook secretary.

A GLASS OF LOW RESISTIVITY.*

BY CHARLES E. S. PHILLIPS.

A glass which will conduct electricity comparatively well may be obtained by fusing together sodium silicate and borax in the following proportions, viz:—

Sodium silicate	32 parts
Borax (calcined)	8 parts

If to this mixture 1·25 parts of Powell's flint glass be added greater stability results, and the surface is improved without serious loss of conductivity.

A glass suitable for the cases or windows of electrostatic instruments may thus be produced capable of being cast into plates, but on account of its low fusion point not otherwise very workable. It may, of course, be readily drawn into rods or fibres and takes a fine polish. The density of this glass is 2·490, and it is somewhat harder than the ordinary soda glass of commerce. With regard to other physical properties, it shows no fluoresence under cathode radiation, is very transparent to X rays and opaque to ultra-violet light. Its electrical conductivity is about 500 times that of the most conducting glass so far made. The resistivity of a cubic centimentre is of the order 10^9 ohms at 20°C, which, although high in itself, is exceedingly low for glass. The material when powdered and fused on to clean copper adheres well without cracking. The change of resistivity with heat (which is very marked) is being examined.

The writer's best thanks are due to Messrs. James Powell & Son, of London, for the very generous help which they have given in connection with the production of this glass and for the interest they have kindly taken in the experiments.

THEORY OF THE MAGNETIC ALLOYS OF MANGANESE.*

BY C. E. GUILLAUME.

The accidental discovery by Mr. Heusler of magnetic properties in alloys containing only manganese, aluminium and copper, aroused in 1904 a lively curiosity, notably among the German physicists and electricians. It was not that any industrial application was expected to result, immediately at least, from this interesting discovery; because, though these alloys are a little more magnetic than cast iron, in the initial period at any rate, they are much less so than soft iron. Besides, they have neither sufficient hysteresis to make good permanent magnets, nor little enough to make good transformer cores. But they form a new family of magnetic bodies, which for the moment seem destined to profoundly modify our ideas on the causes of ferromagnetism, which has hitherto only been found to a comparable degree present in the three classical magnetic metals iron, cobalt and nickel. Still, on close examination, and on considering other known facts, it becomes evident that those discovered by Mr. Heusler are not isolated; and even though we cannot pretend to formulate their complete theory, we can at all events assert that these facts do not necessitate any remodelling of existing ideas.

The discovery of Mr. Heusler was new in this sense, that he was the first to point out the existence of magnetism in a compound consisting wholly of non-magnetic substances. But the same phenomena were observed in 1892 by Mr. Hogg in an alloy where the presence of iron masked the true nature of the phenomenon. A non magnetic ferromanganese, to which aluminium was added in the liquid state, underwent strong liquation, and one of its constituents, which took up all the aluminium, became magnetic. Thus Mr. Hogg had already found one of Mr. Heusler's alloys, for in these last the copper only acts as a solvent. But it was natural to think only of a return of the magnetism of the iron, and the investigation stopped there.

Mr. Heusler's researches have clearly established the fact that, in the series of alloys studied, the magnetism is due solely to the combination MnAl, and that the copper acts only as a solvent, making the alloy malleable. The tests showed further that another combination, Mn_3Sn, is also magnetic, and furnishes, by mixing with copper, alloys analogous to the first series.

In both alloys, the susceptibility is diminished on increasing the proportion of copper. The temperature of transformation is reduced in the same sense.

Bismuth, arsenic, antimony and boron, added to manganese, also give magnetic alloys, though feebler than the last.

These are, in short, the new facts discovered by Mr. Heusler, studied by Messrs. Haupt and Stark, and of which I shall sketch out a theory. Their simple enumeration brings out one essential fact: all the magnetic alloys of the new series contain manganese. This metal, therefore, appears to play the chief part, the others being only exciters or simply solvents.

In most alloys, the melting point of the alloy is lower than that of the pure metals. This has passed as a law for some time, but there appears to be no necessity that it should be so. As a matter of fact, the alloy Al_2Au melts 17 deg. above the melting point of gold. The combination AlSb has a fusing point 400 deg. above that of the most fusible constituent. And lastly, the alloy NaSn fuses at a point 450 deg. above sodium and 344 deg. above tin.

It is significant that those alloys which have hitherto been shown to have a melting point higher than their constituents all contain either aluminium or tin—the very metals which form Heusler's two magnetic series.

Iron, on the other hand, shows a considerable change of its mechanical properties at its temperature of magnetic transformation. It contracts, and its modulus of elasticity is suddenly raised. By adding chromium, carbon, manganese or nickel in suitable quantities, its temperature of transformation may be lowered. Similarly, the alloys of nickel with copper, chromium, manganese and other metals are non-magnetic at ordinary temperatures.

The raising of the transformation point is more rare. But it has been observed in nickel iron, notably in an alloy corresponding to the combination Fe_2Ni.

Manganese and chromium complete the chemical group to which the three ferromagnetic metals belong, and Faraday had already supposed that these two metals are really magnetic, but that their transformation point is too low for observation.

Recent experiments have supported Faraday's guess. The salts of manganese and chromium are as magnetic as those of iron; and experiments made with very pure manganese have shown that it is very perceptibly magnetic.

Hence the magnetic properties of manganese might become evident if its transformation point were sufficiently raised by combination with suitable metals.

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* Paper read before the British Association (Section A) at York on Tuesday, August 7th.

* Abridged from *Bulletin de la Société Internationale des Électriciens*, June, 1906.

For the present it suffices for the explanation of magnetic alloys to remember that aluminium and tin, which make up an integral part of these alloys, are just these metals which make refractory alloys with gold, antimony and sodium. Since magnesium is closely allied to aluminium, a magnetic alloy might possibly be found in the combination MnMg. The chromium alloys should also be tested in this direction. The elevation of fusing points appears to be closely linked with the raising of transformation points.

It would then remain to explain why these metals possess this property, or at least to link it with other known properties of these metals. This will no doubt be done shortly. For the present it is enough to show that the magnetism of manganese alloys is neither mysterious nor paradoxical.

MERCUROUS SULPHATE AND STANDARD CELLS.*

BY G. A. HULETT.

The question as to the best method of preparing the mercurous sulphate and the depolariser for standard cells does not yet seem to be satisfactorily settled. Mr. E. E. Smith† proposes four methods for trial: (*a*) The electrolytic method; (*b*) by adding drop by drop mercurous nitrate to a strong sulphuric acid solution; (*c*) mercurous sulphate is dissolved in strong sulphuric acid and precipitated by diluting; (*d*) by the action of fuming sulphuric acid on mercury at ordinary temperatures. Mr. Smith invites various workers to construct cells according to his specifications and forward them to the National Physical Laboratory where they may be compared. This should give interesting information as to the reliability of the various methods.

H. v. Steinwehr‡ concludes from a few experiments that the principal if not the only cause of the variation of the E.M.F. of standard cells is traceable to a difference in the size of the particles of the mercurous sulphate used as a depolariser. It is well known that a fine-grained sample of a salt has a greater solubility, and therefore its solution will show a greater E.M.F. than the solution of a coarser-grained sample of the same salt. H. v. Steinwehr concludes from theoretical considerations that variable amounts of the hydrolysed basic salt in the depolariser could not be the cause of the variations observed in the E.M.F. of standard cells.

Last autumn a number of cells were made which gave experimental evidence on these important points. The main object of the work was to determine the effect of varying not only the strength of the sulphuric acid used in making the electrolytic mercurous sulphate, but the effect of varying the current density for a given strength acid. Samples of the sulphate were made by passing an electric current from a mercury anode into sulphuric acid. The concentrations of the acid used were 0·05 molecular, 0·5 molecular, molecular and 2·6, 3·7 and 12 times molecular, while the current densities were varied from 0·1 ampere to 5 amperes per 100 cm.^{2} mercury anode surface. The details of the method employed in making these various samples will be described below.

Some of the samples were grey and others white. With a low-current density the white product appeared, while higher-current densities gave the grey. The point at which the grey appeared depended also on the strength of the acid used. With 2·6 molecular acid the product was grey at a current density of 0·3 ampere and above, while with molecular acid the product was still white with 5 amperes per 100 cm.^{2} surface.

The grey preparation seems to give more uniform results than the white and a slightly lower value of the E.M.F. One is inclined to attribute this greyness to finely-divided mercury, probably an "anode slime," which appears only at the higher current densities, but a high-power microscope did not with certainty confirm this supposition. If the greyness is due to mercury it must be in an exceedingly fine state of division and would be an advantage, as it would tend to prevent the formation of mercuric mercury.

Previous experiences have shown me that the comparison of samples in an H cell with a common electrolyte is often misleading, therefore the various samples were actually tested in cells in which all the other materials were the same. Further, the cells were kept in a large constant temperature oil bath and compared at frequent intervals for several months. The bath contained 100 litres of kerosene oil and was electrically heated and controlled. The temperature was maintained constantly at 25°C., and has very seldom varied 0·02 deg. from that temperature. Certificated thermometers were used to determine the temperature.

The cells were placed in wooden racks, and all the anode wires were joined together while the cathode wires passed up through little glass tubes which extended 15 cm. above the racks, ending near the top of the bath, where they were very accessible. The bath now contains 120 cells, some of them over two years old. The comparisons were made by means of a Feussner potentiometer (built by Otto Wolff, Berlin) and a sensitive D'Arsonval galvanometer. The apparatus worked very satisfactorily, a difference of 0·00001 volt caused a deflection of 2 mm. on the scale. The unit chosen for this and the previous work was the international volt, which is based on the Clark cell made according to the old specifications with an assumed value of 1·434 volts at 15°C.

The cells here considered are of the usual form and were hermetically sealed. The cadmium sulphate used was carefully recrystallised and only the perfectly clear well-rinsed crystals were used. A large stock of 12·5 per cent. cadmium amalgam was made from pure materials and the mercury was distilled.* The cells were made as nearly alike as possible with the exception of the depolarisers to be tested. Precautions were taken to avoid hydrolysis in removing the acid from the various samples of mercurous sulphate, and attention was given to uniformity in making the pastes.

Table I. gives the observations made on these cells, column 1 gives the number of the cell, column 2 the date of construction, column 3 gives the strength of sulphuric acid from which the mercurous sulphate of the depolariser was made, and column 4 gives for each case the current-density employed and is expressed in amperes per 100 cm^2 mercury anode surface.

Attention is called to the last six cells (A21 to A25 inclusive). The depolarisers of these cells were made from acid of *less* than molecular concentration and the values are higher than the others and are irregular, while all the rest of the cells made from molecular sulphuric acid, or stronger than molecular, are in good agreement. There is hardly a suggestion of an effect due to different current-densities used in making the mercurous sulphate, but the strength of the acid used certainly does play a rôle as soon as it becomes less than molecular. This is also the strength acid at which the solubility curve (of mercurous sulphate in varying concentrations of sulphuric acid) shows a sharp break.† The solubility is 0·208 grammes of the sulphate in a litre of four times molecular acid, and increases to a maximum of 0·550 grammes in a litre of molecular acid. Here the curve takes a sharp turn downward, it is 0·502 grammes in 0·5 molecular and 0·455 grammes in 0·25 molecular and 0·384 grammes of mercurous sulphate in a litre of 0·05 molecular sulphuric acid, all at 25°C.

Molecular sulphuric acid then represents a point of discontinuity in the solubility curve, and also for the behaviour in cells of mercurous sulphate made from various concentrations of the acid. The principal conclusion to be drawn from the standpoint of standard cells is that, in making mercurous sulphate, one may use any strength of sulphuric acid from molecular to concentrated, and any desirable current-density. The results obtained with these cells are very favourable for the electrolytic method of preparing the sulphate, for it must be remembered that for each cell a particular sample of paste was made, requiring separate manipulations. They are, therefore, without the advantage of cells made from one uniform batch of paste.

The question of a possible effect of the size particles on the solubility of mercurous sulphate was considered when the method was devised, and it was found that there was not a measurable effect with the electrolytic preparations. Attention was called to this in the necessary precaution of stirring the system, after the current was broken, so that the very finest particles might disappear.‡

H. v. Steinwehr has lately§ called attention to this point and claims for it the principal cause of the variations observed in the E.M.F. of cells. Experimental evidence on this point is contained in Table I. The mercurous sulphate used in each cell was microscopically examined and the size of the particles measured. In the case of the first 14 cells, or all of those samples of sulphate made from molecular or stronger acid, the particles vary over a wide range from 0·002 mm. to crystals 0·070×0·130 mm. but it will be observed that these cells are all in good agreement.

The samples made from molecular acid were uniformly larger-grained than the other samples. This was to be expected, as with this strength acid the sulphate has the maximum solubility. The sample made with 0·2 amperes was particularly large-grained, and this sample was stirred with the acid and the finest particles decanted until only the very coarsest were left, and these were taken for the depolariser of cell A15. Now it will be seen that the E.M.F. of this cell is not lower but *higher* than the other cells Furthermore the cells A21 to A25 which have a high value, were constructed with mercurous sulphate made from less than molecular acids, but these samples were decidedly coarser-grained than the samples used in cells A1 to A6. Since finer samples are more soluble their solution should *increase* the E.M.F. of the cells which are made with the finer-grained depolarisers. Therefore the above results show that the effect of size of particles, in the electrolytic prepara-

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* From the *Physical Review*, XXII., p. 321, June, 1906.

† *The Electrician*, LV., p. 856, 1905.

‡ *Zeit. Instrumentk.*, XX , p. 205.

* *Physical Review*, XXI., p. 388, 1905.

† Hulett, *Zeit. Phys. Chem.*, XLIX., p. 494, 1904.

‡ Hulett, *Zeit. Phys. Chem.*, XLIX., p. 486.

§ *Ziet. Instrumentk.*, XXV., p. 205, 1905.

Table I.*

Cell.	Date.	Source of the Hg_2SO_4 Acid	D_{100}	Oct. 26.	Nov. 22.	Nov. 30.	Dec. 10.	Dec. 24.	Jan. 1.	Jan. 6.	Jan. 13.	Jan. 20	Feb. 1	Feb. 7	Feb. 20	Mar. 4	Mar. 15	Mar. 31
—	—	molar.	amp															
A1	Oct. 21	2·7	0·82	1·01905	1·01905	1·01905	1·01904	1·01905	1·01905½	1·01905	1·01905	1·01904	1·01905	1·01905	1·01905	1·01903½	1·01904	1·01905
A2	,,	2·7	0·82	04	01½	05	05	05	05	05	05	04½	05	05	05	03½	04	05
A3	,,	2·7	0·82	04	05½	05½	05	05	05	05	05	04½	05	05	05	03½	04	05
A4	,,	2·7	0·82	05	05	06½	05½	05½	05½	05	05	05	05½	05	05	04	04½	05
A5	,,	2·7	0·82	05	06	05½	05	05	05	05	05	05	05	05	05	03½	04	05
A6	,,	2·7	0·82	05	06	05½	05½	05	05	05½	06	05	05	05½	05	04	05	06
A9	Nov. 15	2·7	0·20	..	02½	02	03½	03	04	03	03	03	04	04	03½	04	03½	05
A10	,,	2·7	1·5	..	03	04	04	04	05	04½	04½	04	05	05	04½	05	05	06
A32	Dec. 15	12	0·25	..	..	..	..	04	04	03	03	04	04	02	02½	00	02	03
A33	,,	4	0·25	..	..	..	..	04	04½	04½	04	06	05	05	05	02	04	04
A12	Nov. 21	1	1·0	..	07	07	07	07	08	07½	07½	06½	07½	07½	07½	05	07	08
A13	,,	1	2·5	..	06	07	06	06	07	06	06	05	06½	06	06	04	06	07
A14	,,	1	5 0	..	04½	07	04	04½	05½	05½	05	03½	05	04½	04½	02	05	06
A15	,,	1	0·2	..	09	11	08	08½	09	08½	08½	07	08	08½	08	05	07½	08
A20	Nov 27	½	0·2	..	..	16	16	17½	15½	15	17	15	18	18	17	15	16	17
A21	,,	½	1·0	..	..	09	08½	08	07	08	10	07	08	07	07	06	07	08
A22	,,	½	4·0	..	..	14	15	15	14	18	19	14	15	14	14	13	14	15
A23	,,	$\frac{1}{20}$	0·2	..	..	25	22	20	22	21	20	18	20	18	18	17	18	19
A24	,,	$\frac{1}{20}$	0·5	..	..	30	26	25½	27	23	24	23	24	23	23	22	23	24
A25	,,	$\frac{1}{20}$	2·5	..	..	34	30	28	26	24	23	24	26	25	23	21	20	19½

* In the original Paper readings are also given for November 15th and 18th and December 17th.

Table II.†

Cell.	Date.	Mercurous sulphate.	Nov. 15	Nov. 30	Dec. 10	Dec. 17	Jan. 1	Jan. 13	Jan. 20	Feb. 7	Feb. 20	Mar. 4	Mar. 15	Mar. 31
A7	Nov. 15	Kahlbaum's mercurous sulphate	1·02235	1·01947	1·01936	1·01935	1·01935	1·01934½	1·01933½	1·01934	1·01933	1·01931	1·01932	1·01933
A11	Nov. 19	Do. rotated with mercury and 1·4 molar acid................	..	26	22	23	24	24½	20½	18½	20	18	22	24
A29	Dec. 3	Do. with mercury and 3·7 molar acid	..	..	15	15	21	19	20½	20	19	17	19	20½
A30	Dec. 15	Do. with mercury and 12·7 molar acid	..	..	..	20	20	21	19	19½	19	16	18	18
A26	Nov. 27	(Chemically) merc. nitrate—sulp. acid 90°	..	..	22	21½	21	23	29	17	20	19	20	22
A27	,,	Do. do. do. 20°	..	..	20	20½	20	20	17	15	..	..	17	18
A28	,,	Mercury sulphate reduced by mercury ..	..	..	11	10½	14	12	10	11	11	10½	12	14
A35	Dec. 21	0·1% basic mercurous sulphate added	..	..	..	..	09	11	10	09	08	06	07	08
A36	,,	0·5 do. do. do.	..	..	..	..	08	09	07	06	06	04	05	06
A37	,,	1 do. do. do.	..	..	..	..	07	07	06	05	04	03	03	04
A38	,,	5 do. do. do.	..	..	..	..	15	15	14	12	11	10	10	11
A39	,,	10 do. do. do.	..	..	..	..	21	21	19	17	16	15	15	15½
A40	,,	50 do. do. do.	..	..	..	..	46	44	41	39	35	35	33	33
A44	Jan. 5	Mercurous sulphate stirred with 8 parts of water and mercury 1 per cent. basic....	..	..	..	..	..	40	35	31	30	28	27	27
A45	,,	Mercurous sulphate stirred with 75 parts of water and mercury 3 per cent. basic .	..	..	..	..	..	27	22	20	20	17	17	17½
A46	,,	Mercurous sulphate stirred with 25 parts of water and mercury 10 per cent. basic.	..	..	..	..	..	61	56	49	46	42	41	41

† In the original Paper readings are also given for November 16th, 22nd, December 24th, January 6th and February 1st.

tions, is not measurable and that whatever deviations there are must have some other explanation.

The microscopic observations made on the samples of electrolytic mercurous sulphate indicated that the higher current densities gave finer-grained but more uniform preparations, and also that the solubility of the sulphate had an effect in the sense that the average size of the particles are smaller in the samples made from the more concentrated acids where the solubility is less. The sample made from 2·6 molecular acid with a current density of 1·5 amp. was carefully examined and found to contain for the most part particles 0·004 to 0·008 mm. with few over 0·010 mm. In all the samples of electrolytic mercurous sulphate examined, comparatively few particles that measured less than 0·002 mm. were noticed and the failure to find variations in the E.M.F., due to size of particles, with these samples agrees with the work done on the effect of size of particles on the solubility of gypsum and barium sulphate. A measurable increase in the solubility has not been obtained until these powders contained a *large number* of particles of less than 0·002 mm.[‡] Commercial mercurous sulphate is very fine grained, as has been pointed out by H. v. Steinwehr (*loc. cit.*), and it is well attention has been called to this question of a possible effect of the size of the particles.

THE QUESTION OF HYDROLYSIS.

The complete removal of the acid from the mercurous sulphate before making the paste is important, as sulphuric acid has a very marked effect on the E.M.F. of the cadmium cell, causing a low value. In removing the acid hydrolysis will take place if water or a too dilute acid is used in washing the sulphate. An acid salt is formed and goes into solution while a slightly soluble basic salt remains mixed with the washed salt.[§] The effect that this basic salt has on the E.M F. of cadmium cells was tested as follows: Some electrolytic mercurous sulphate was washed with absolute alcohol and thoroughly dried. Part of this was completely hydrolysed by treating it with successive portions of water.[‖] The hydrolysed and normal salt was then mixed in known proportions. Six samples were made containing respectively 0·1, 0·5, 1, 5 and 10 per cent. of the basic salt and these were used in cells A35 to A40 (Table II.) It was found that the effect on the E.M.F. of the cells was not constant but varied with the amount of the basic salt present in the depolariser. The variation, while not uniform, in general increases with the amount of the basic salt.

When the normal salt is shaken with water the hydrolysis goes to the equilibrium point and stops until more water is added. By using definite amounts of salt and water a known amount of the basic salt is left with the solid. Here the effect is even greater as shown by the cells (A44 to A46). In these cells the sulphate of the depolariser was formed by stirring normal mercurous sulphate with water and mercury until no further change took place and then the amount of the basic salt in the solid depended on the relative amounts of salt and water taken. In this way samples containing 1, 3, and 10 per cent. of basic salt were prepared and used in cells A44, A45, A46. Here the effect on the E.M.F. is very marked, and also variable.

It was to be expected that the presence of the basic salt on the depolariser would increase the E.M.F. of the cell since the salt has a slight solubility but it is surprising that there should be such a marked variation when the per cent. of the basic salt was varied. Any mixture of the normal and basic salts such that both are in excess after the solution is saturated should yield a definite solution that is independent of the relative amounts of the two salts. H. v. Steinwehr used this argument to prove that the basic salt could not cause variations in the E.M.F. of cells. But in view of the above facts one must rather conclude that changes are taking place in this system with the possibility of new phases being formed. Further evidence that the cathode leg of the cadmium cell is not a system in equilibrium will be given in another article.

[‡] Hulett, *Zeit. Phys. Chem.*, XXXVII., p, 385, 1901.

[§] Gouy, *Compt. Rend.*, CXXX., p. 1399, 1900; Hulett, *Zeit. Phys. Chem.*, XLIX, p. 493.

[‖] Gouy, *loc. cit.*

The similar behaviour or the samples containing the basic salt (cells A44 to A46) and those made from less than molecular acid (cells A21 to A25) suggests that hydrolysis begins as soon as the acid becomes less than molecular. One might expect a larger amount of basic salt in the sample made from the diluter acids since hydrolysis, if it occurred, would go on until a solution was formed which would prevent further change. Hydrolysis then would be the explanation of the break in the solubility curve at molecular concentration. Further evidence for this view is that an analysis of a sample of the sulphate made from one-half molecular acid indicated the presence of a basic salt.* The behaviour in cells of the samples of sulphates made from less than molecular acids makes it difficult to assume the existence of an allotropic modification as explaining the break in the solubility curve. On the other hand Cox† concludes from Gouy's results and some of his own observations, that there is only one basic mercurous sulphate and that the basic and normal salts are in equilibrium with 0·002 molecular acid. It is evident that more work needed on this question of the hydrolysis of mercurous sulphate.

The results here recorded, however, show that one cannot allow the strength of the sulphuric acid, used in making mercurous sulphate for standard cells, to become less than molecular. Until further evidence is at hand on the question just considered, it seems best to keep the mercurous sulphate, to be used in standard cells, from coming in contact with sulphuric acid of less than molecular concentration.

Samples of mercurous sulphate from other sources than electrolytic were also used, and the record of these cells will be found in Table II. Cell A7 was made from Kahlbaum's mercurous sulphate. The paste for this cell was washed with water and made according to the old specifications. It had a very high value at first and required about a month at 25 deg. to reach a fairly constant value, and then it was 0·00030 v. higher than the cells made with electrolytic sulphate. A few experiments were made to test the effect of treating commercial mercurous sulphate with sulphuric acid and mercury. Samples of Kahlbaum's preparation were stirred 12 hours with sulphuric acid and mercury, using different concentrations of acid (from 1·4 to 12 molecular). The pastes were made as described later. Cells A11, A29 and A30 are the ones here considered, and while the method of treatment yields a lower value than cell A7, it is not satisfactory. Prabably a longer stirring would give a better agreement and nearer the value given by the electrolytic.

For cell A28 the mercurous sulphate was made by reducing mercuric sulphate by stirring it with mercury and sulphuric acid. The method is simple and has the advantage of producing much finely divided mercury. This cell has given satisfactory results and one similarly made two years ago‡ behaved particularly well from the first, this cell, G3, was under observation for 18 months.

The mercurous sulphate of cells A26 and A27 was made by adding a strong solution of mercurous nitrate to sulphuric acid which was in excess and did not become less than molecular in strength. These cells are distinctly higher than the cells made with electrolytic sulphate, and higher than others I have made with "chemically" prepared sulphate, some of which were very close to the electrolytic, but never as uniform.

The evidence given by the above-described cells and also the results of the previous work indicate that the electrolytic mercurous sulphate is the most reliable preparation, and that cells made from it are reproducible to 1 or 2 parts in 100,000. It seems well therefore to give a detailed description of the method of preparation based on the results so far obtained.

THE PREPARATION OF ELECTROLYTIC MERCUROUS SULPHATE.

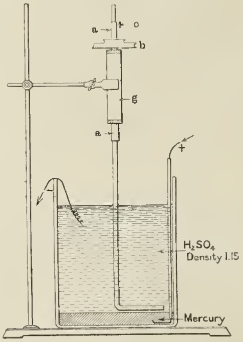
The accompanying cut represents the essential parts of the apparatus needed. A battery jar some 15 cm. in diameter and 20 cm. tall is well suited to the purpose. Mercury to the depth of 2 cm. is put into the jar and is covered with sulphuric acid to a depth of 15 cm. The strength of the acid used may vary over a considerable range as has been shown. The formation of the sulphate removes an equivalent amount of acid and for several reasons it is best to use two or three times molecular. If one volume of strong sulphuric acid (1·84 density) is poured into six times its volume of water, the strength will be about 2·6 molecular. If the acid is made by density it should be about 1·15, and with the 2 litres used in the jar one may prepare several hundred grammes without reducing the strength of the acid to 2 times molecular.

In order to insure contact with the mercury a stiff platinum wire (0·8 mm. or over) is sealed into a glass tube with the free end 4 cm. or 5 cm. long. This platinum wire is bent at right angles and extends well out into the mercury when the glass tube is clamped in position. The object of this is to insure contact with the mercury when the solid sulphate collects in the angle of the jar under the mercury. The copper wire from the positive pole of the battery is pushed down inside the glass tube, contact with the platinum wire is insured by running in a little mercury.

A platinum wire suspended in the acid serves as cathode. Here one needs a small surface and a large current-density in order that much hydrogen and relatively little mercury may be deposited. The solubility of mercurous sulphate in 2·6 molecular acid is 0·4 gramme per litre, and with the above arrangement the yield is very good, about 9 grammes per ampere hour.

A motor-driven stirrer is necessary, and it is important that the bearings work smoothly. The figure represents a very simple arrangement. A brass tube (*a*) 8 mm. in diameter is provided with a pulley wheel (*b*). This tube holds the glass stirrer, which is made fast by the set screw (*c*), the brass tube turns in the iron bearings, which are soldered into the ends of a larger 15 mm. diameter brass tube (*g*). This outer-bearing tube may be clamped in any ordinary clamp. A glass rod that fits the inner brass tube is selected and clamped in the tube. The glass rod extends about 40 cm. below the holder, and is bent at right angles. The stirrer is adjusted to the jar, so that the L part of the stirrer just escapes the mercury when rotating at a rate of about 200 revolutions per minute. Some experience is necessary to adjust the stirrer properly, if the mercury is unduly disturbed much of it will become finely divided and be troublesome.

After all is in order and the stirrer working smoothly, the current is turned on, and as soon as the acid is saturated the solid sulphate will appear on the surface of the mercury, and form a skin which does not always break up at once. This difficulty, which happens only when fresh acid and mercury are used, may be avoided by making and breaking the current several times until the solid appears throughout the acid, after which no further trouble will be experienced. A current of 2 or 3 amperes may be used, and will form some 25 grammes an hour. The rapid stirring will keep the mercury surface sufficiently free of the solid until some 50 grammes have formed; if more is needed it is best to remove the sulphate and start again, using the same acid and mercury, but not allowing the acid to get much below 1·15 in density.



When sufficient mercurous sulphate has formed, the current is broken and the motor stopped. After the solids have settled, most of the liquid is decanted (some of it in a wash bottle for assisting in the operations of transferring the solids). The solids and mercury are transferred to a large separatory funnel and the mercury removed. The sulphate finely-divided mercury and about a litre of the liquid are returned to the jar, or run into a large Erlenmeyer flask, and stirred over night. The object of this stirring is to allow the sulphate to become coarse grained, and unless most of the mercury is first removed the sulphate will often collect under it and the action is retarded. After twelve hours' stirring the sulphate settles rapidly and leaves the liquid perfectly clear. The product is still quite grey, and is to be kept under the acid from which it was made and protected from the light. It is well to take precautions to protect the sulphate from the light during all the operations.*

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* *Zeit. Anorg. Chem.*, XL., p. 178, 1904.

† *Zeit. Phys. Chem.*, XLIX., p. 496.

‡ Hulett, *Zeit. Phys. Chem.*, XLIX, p. 488.

* The effect of light is to turn the sulphate brown and then black. Just what change takes place does not seem to be known. Two years ago a cell was made up with this blackened sulphate, and had a value of 1·02038 (25 deg.) to start with, and decreased all the time it was observed (four months). At the same time some cells were made, and half of them were protected from the light, by covering with asphalt paint and shellac, but in a year's time there was no distinct difference between the cells. The brown seems to form only on the surface next to the glass and it seems probable that with ordinary usage there is no effect after the cell is made, but the mercurous sulphate should not be exposed to strong light before it is put into the cell.

Preparing the Paste.

The results here recorded show that the basic salt, formed by treating mercurous sulphate with water or too dilute acid, affects the E.M.F. of the cell when it is present in the depolariser. A higher value is obtained than when the normal salt alone is used, and the effect varies irregularly with the amount of this basic salt present in the depolariser. Until this anomaly is cleared up it seems best to avoid the basic salt altogether.

The old method of washing the salt with water gave quite uniform results when the cells were made from a particular sample of sulphate, and with a uniform preparation like the electrolytic mercurous sulphate, the old method of washing might do very well. One point is, however, to be considered: if water is passed through the sulphate in a filter the top layer only turns yellow; evidently the water becomes saturated with the soluble products of hydrolysis, and is no longer capable of effecting the lower layer.[*] This top layer has always been rejected, and thus the part taken may have contained very little basic sulphate, but the liquid which could not be entirely removed is distinctly acid.[†] Last year a cadmium cell was made in which the solution was 0·2 molecular sulphuric acid saturated with cadmium sulphate. This cell has always been low, and has now a value of 1·01845 (25 deg.). Acid seems to have more effect than other impurities and is to be avoided (Jaeger and Wachsmuth).[‡]

The problem then is to completely remove the acid and to avoid hydrolysing the salt. This may be done by washing with alcohol, and then once or twice with cadmium sulphate or zinc sulphate solution, as the case may be. For half a dozen cells, or less, one may use a Gooch crucible and Bunsen filtering flask. A little filter is cut from filter-paper with a large cork borer, and fitted to the crucible. The sulphate is brought into the crucible and the acid removed as completely as possible by suction, then some absolute alcohol is run in so as to wash the sides of the crucible and then drawn through the sulphate by suction. This is repeated five or six times, using only a few cubic centimetres of alcohol each time. The alcohol is removed by washing once or twice with a saturated solution of cadmium or zinc sulphate as the case may be.

The washing with alcohol is much more rapid and in general more effective than with the rather viscous sulphate solutions. If the sulphate is washed only with the alcohol and the paste made without completely removing the alcohol the results are good, but it is best to finally wash once with the saturated sulphate solution to be used in making the paste. In washing larger amounts one may use a small Buchener funnel and filtering flask. For thorough washing it is best not to have the sulphate over 2 cm. deep.

The washed sulphate is mixed with about one-fourth its volume of finely-powdered cadmium sulphate or zinc sulphate as the case may be, and then the saturated solution is added with stirring until a homogeneous paste is formed. The paste should be of such a consistency that it will just flow from a tube 5 mm. in diameter. The paste may be drawn up into such a tube by slight suction, and then easily and neatly introduced into the cell. The addition of mercury is not necessary with the grey electrolytic mercurous sulphate.

In the case of the cadmium cell the paste should be over 1 cm. deep in the leg of the cell. A number of cells have been made with less than 1 cm. of paste, some only a few millimetres, and they were very irregular and are now very low. The question of the changes in the cathode leg of the cadmium cell, after it is constructed, will be reported on in a succeeding article.

Dr. M. A. Hunter assisted in constructing the cells and in making the comparisons described in this article, and I take this opportunity to thank him for very valuable aid.

CORRESPONDENCE.

SOME CAUSES OF ERROR IN PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have followed with extreme interest the correspondence in your columns on the above subject. I should not now enter the arena but that I feel that I have been an even greater sinner than Mr. Wild in the way I have persistently described the inclined-screen photometer as the "Trotter" pattern, in spite of that gentleman's repeated protests.

Early bad habits are difficult to throw off, and I remember being introduced to one of these photometers, constructed by Mr. Trotter in 1894, in Col. Crompton's laboratory. It was certainly at that time, and in my opinion is still to-day, the best all-round form of photometer head obtainable. Whether the first idea was due to Conroy or to anyone else, Mr. Trotter has done an enormous amount of work in improving it, and but for him there can be little doubt that the inclined-screen photometer would not be in existence to-day as a practical instrument. That being so, I would humbly ask Mr. Trotter to allow grateful photometrists to continue to call it after him, so long, be it well understood, as they do not presume to employ an instrument "with a side shake amounting to 1 deg. and with screens on which the light is incident at an angle of 60 deg."

As regards the first point, I do not think that errors due to side shake in the photometer head need be considered, as I feel confident that in a few years' time photometers with travelling heads will be things of the past. No one who has used a fixed head will ever willingly employ a travelling one.

The question of angular errors is a much more important one, and Mr. Wild is to be congratulated on having brought the question forward, though, needless to say, it is one which has not escaped the attention of photometer manufacturers, and I cannot help agreeing with Mr. Trotter when he says that Mr. Wild "illustrates his subject by reference to ill-designed and ill-made apparatus." However, the subject has been already thoroughly thrashed out by Mr. Trotter and Mr. Lemmens, so suffice it to say that the angle of incidence in the Everett-Edgcumbe photometer (both Flicker and "Trotter"!) is 35 deg. and not 60 deg. as Mr. Wild seems to assume, so that the angle lies midway between the limits of 30 and 40 deg., which, as Mr. Trotter shows, must be observed if these errors are to be eliminated (the possible error in the extreme case of the crooked filament lamps taken by Mr. Wild would be just over 1 per cent.)

The curves given by Mr. Trotter are extremely valuable from the point of view of the Flicker photometer made by my firm, as there is always the possibility of the rotating disc being slightly bent or displaced through rough usage, so that it is gratifying to note that the angle of 35 deg. lies exactly on the flat of the curve for matt Bristol board such as we employ.—Yours, &c., Kenelm Edgcumbe.

Westminster, S.W., August 14.

An Electrical Recording Seismograph.—A seismograph, in which an electrical method is employed for recording earth tremors, and which is in use in the Meteorological Observatory of St. Ignatius College, Cleveland, is described in a recent number of the *Western Electrician.* The instrument is of the pendulum variety for recording horizontal movements in a north and south, and at the same time an east and west, direction. The pendulum itself is quite separate from the recording apparatus and is situated in a vault some distance below ground. The bob of the pendulum consists of a cylinder of cast iron weighing 115 lb. On its circumference are placed four contact pieces, 90 deg. apart, insulated by ebonite blocks. Below the suspended bob is fixed a cast steel cross bedded in cement and carrying four carbon contacts on upright pillars which can be adjusted to bear with equal pressure against the four contact pieces on the pendulum bob. These contacts form portions of four battery circuits with a common return wire. Thus, should the pendulum tend to swing to one side, due to an earth movement, the balance of pressure on the carbon contacts is upset, and, owing to an action similar to that of a microphone, the strength of current is changed in one or more of the circuits. It is thus possible, by means of a suitable recording apparatus, to obtain a record of the most minute movements by tracing the variations of current in the four circuits. In the recorder used, two pairs of iron cores are suspended from the beams of two delicate balances and each moves within a solenoid. These two pairs of solenoids carry the currents through the north and south and east and west pairs of pendulum contacts respectively so that the deflections of the two balances will correspond to the components of the movements of the pendulum along the two axes. Both scale beams actuate pens which trace their records on the same paper strip. The apparatus is not intended for the quantitative measurement of large movements, but its extreme sensitiveness should enable it to record tremors of smaller amplitude than could be easily detected by the more usual forms of seismograph.

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[*] *Zeit. Phys. Chem.*, XLIX., p. 497.

[†] *Loc. cit.*, 497.

[‡] *Wied. Ann.*, LIX., p. 586, 1896.

LEGAL INTELLIGENCE.

Mayor, &c., of Melbourne v. Attorney-General (ex rel. Metropolitan Gas Co.)

The judgment of the Full Court of Australia in this appeal was briefly reported in our issue of May 11.

Melbourne Corporation were owners of electricity supply works, and had introduced two methods of charging for electric current, one a uniform 4½d. per unit. and the other a maximum demand system (7d. for the first 45 hours' maximum demand per month and 2d. per unit after), customers having the option of selecting either method. The gas company contended that this was an infraction of sec. 39 of the Victorian Electric Light and Power Act, 1896, which provides against an undue preference in the charges made for electric current by undertakers, and the company applied for an injunction against the Corporation.

In the court of first instance Chief Justice Madden held that the section in question only meant that the same price was to be paid for the same class of supply in the same circumstances and not that a uniform charge was to be made to all consumers. He therefore entered judgment for the Corporation, with costs.

The Full Court of Victoria (Hodges and Hood, JJ.; diss. A'Beckett, J.), however, held that they were bound by a decision in an earlier action (in 1901) between the same parties, and decided that making one charge to consumers of electricity for motive power and a different charge to lighting consumers was an infringement of sec. 39 of the 1896 Act, and that it was intended that there should be only one uniform charge for all classes of consumers—small or large, day or night. The judgment of Chief Justice Madden was therefore reversed.

The Full Court of Australasia (Griffith, C.J., Barton and O'Connor, JJ.), before whom the matter was next argued, have now unanimously reversed the decision of the Victorian Court of Appeal, and have restored the judgment of Chief Justice Madden.

In delivering judgment, Chief Justice GRIFFITH referred to sec. 13a of the 1896 Act, which states the limits within which and the conditions, restrictions and liabilities under which a supply of electricity is to be compulsory or permissive. The same section also provides that the Order in Council which is to be obtained by undertakers is to prescribe the limitations and the prices to be charged in respect of the supply of electricity. Sec. 38 (1) of the Act provides that where a supply of electricity is given in any part of an area for private purposes then (except in so far as is otherwise provided by the terms of the Order) every council, company or person within that part of the area shall be entitled to a supply on the same terms on which any other council, company or person in such part of the area is entitled under similar circumstances to a corresponding supply. The Chief Justice observed that that section contemplated that terms might be fixed by the Order in Council and preferences might be allowed if the Order in Council so permitted, but it prohibited the undertakers from choosing the persons to be supplied with electricity. In England (continued the judgment) it had been decided ("Metropolitan Electric Supply Co. *v.* Ginder ") that undertakers were not prohibited from charging different rates to different persons, provided the conditions of supply were the same for all persons. So that for a supply of a large quantity or for a fixed period the terms might be quite different from those for the supply of a small quantity or for a less period. Probably the same construction should be put upon sec. 38 of the Victorian Act, if there was nothing in the context to qualify it. Sec. 39 contained three provisions. In the first place, "The undertakers shall not in making any agreements for a supply of electricity show any preference to any council, company or person." That clearly would only prohibit undertakers from charging differential prices between different persons, whom they had agreed to supply, as they were bound to do, under the previous section. The next provision was: "And the charge for such supply shall be uniform throughout such area"—that was, the whole area. Those words suggested at once that they were capable of two meanings. They might mean that the charge should be a single identical price per unit supplied. That was the opinion of the majority of the Full Court in 1901. They were also capable of meaning that the charge should be at a uniform price for the supply under the same conditions, whether of quantity or otherwise. As an illustration he instanced the discussion about the charge for telephone services. Suppose that the provision for the telephone service was that there should be a fixed minimum price of £5 per annum, and for every time the telephone was used over 800 times, a further charge of so much per occasion. In ordinary parlance, that would be called a uniform charge to all persons. Not, indeed, for every time used, but a uniform charge for the service. The following words in the 1906 Act, "So that each council, company or person shall be supplied at the same price and not less than any other council, company or person," showed that what the Legislature had in mind was a comparison as between persons, that was, a uniform charge as between persons, not as between units supplied. Then the words: "But such price shall not exceed the limits of price imposed by or in pursuance of the Order authorising them to supply electricity," followed. The only words which seemed to him to suggest serious doubt as to that being the correct interpretation, were the words "same price." If it stopped there, it would be arguable that there could not be a different price in different conditions, but the words, "not less than any other council, company or person," showed that the comparison was between persons, and not between instalments of supply. That construction gave full effect to the words of the section, whereas the other reading of the words, "the charge shall be uniform throughout the area," as equivalent to "shall be a single identical price for every unit supplied," made all the rest of the section idle. It was a well-known rule of construction that effect was to be given, if possible, to every word the Legislature had used. They were never to assume that the Legislature had used idle words, meaning nothing. That rule alone was enough to determine the meaning of the section. The only other question was whether there was anything else in the act to compel the Court to come to a different conclusion. The only section referred to as having any bearing adverse to that construction was sec. 52: "The profits which may be divided amongst the shareholders of any company being an undertaker under this act . . . shall not in any year exceed £10 per centum on so much of the paid-up capital of such company as has been appropriated for the works or expenditure of such company as an undertaker under this act." Then came the proviso: "Provided that whenever throughout any half-year any company shall charge for electricity supplied to consumers a less price than the maximum charge fixed by the Order authorising the undertaking, such company may increase such rate of dividend for such half-year by ½ per centum on the paid-up capital for each and every reduction of ¼d. per unit in the price of electricity." It was said that that assumed that the charge was to be a uniform price per unit. It assumed, certainly, that if a company—one of the three possible classes of undertakers—desired to take advantage of that provision, they must bring themselves within it, and show that they had reduced the price of electricity in accordance with that section. Beyond that it seemed to do nothing. It might be that there were two constructions open to sec. 52. One, that the question whether they had made the reduction within the meaning of that section was to be determined by the average price which they charged to all consumers, or it might mean that the maximum price to any consumer was to be the basis of calculation. Either was open, and either would give complete effect to the section. If they did not choose to take advantage of that section, or if, as was possible, the conduct of their business showed that it was not their intention to take advantage of it, there did not seem to be any reason for limiting the meaning of the word "price" in sec. 39 by its meaning in sec. 52. That reading was slightly supported by the fact that in sec. 13 the word "prices" was used, suggesting that the Order in Council was not bound to fix one uniform price per unit at which the undertakers should be at liberty to supply electricity. Also, the use of the word "limits" in sec. 39. He thought the construction was sufficiently clear that sec. 39 was addressed to preferences as between persons supplied, and did not prescribe a single identical price per unit. The Corporation offered to each consumer a choice between two scales. He, therefore, thought the opinion of Chief Justice Madden and of Mr. Justice A'Beckett was right, and that the appeal should be allowed, and the action dismissed.

Mr. Justice BARTON and Mr. Justice O'CONNOR delivered independent judgments to the same effect.

Anderson v. Halifax Corporation.

At the Sheriff's Court, Leeds, on Friday, before Mr. B. R. Stansfeld (for the Under-Sheriff of Yorkshire), with a jury, plaintiff, a life insurance agent, was awarded £700 as damages for personal injuries. Plaintiff was a passenger on one of defendants' tramcars at Halifax on Oct 23, 1905. The car ran backwards down a hill and plaintiff jumped off, sustaining serious injuries. Liability was admitted by the Corporation, and the only question was the amount of damages.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Sunderland Corporation require an electrical engineer to take complete control of the Municipal electrical undertaking. Candidates must be not more than 40 years of age, must have had a thorough training as mechanical and electrical engineers in some recognised works, also in a recognised technical college or similar institution, have had actual experience in high-tension alternating (preferably three-phase) supply, and be M.I.E.E. Preference will be given to one who has previously held with merit the position of electrical engineer of a borough or well-known supply company, and had experience in designing and controlling extensions; also to one holding the Diploma of the I.C.E. Salary £800 per annum, increasing £50 yearly to £1,000. Applications to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon, Aug. 29. Further particulars are set out in an advertisement.

An instructor in electrical engineering is wanted at the Crawford Municipal Technical Institute, Cork. Salary £200 per annum. Applications to the head master (Mr. E. A. O'Keefe, B.E., M.I.E.E.) by Aug. 31. See advertisement.

An assistant lecturer in physics is required at King's College, Strand, London, W.C. Salary £150. Applications by Sept. 1 to the Secretary.

Barrow-in-Furness Corporation invite applications for the appointment of mains superintendent at a salary of £135 per annum. Applications (addressed to Chairman of Electricity committee), to the town clerk (Mr. C. F. Preston), Town Hall, Barrow-in-Furness, Aug. 20.

Erith Urban District Council require an assistant electrical engineer, who must have had a sound mechanical training. Preference will be given to one with practical experience in the working of a three-phase system. Salary £150. Application to chief electrical engineer (Mr. Geo. E Heath), High-street, Erith, by 10 a.m. Aug 20.

Mansfield Corporation require a first assistant electrical engineer. Salary £140. Applications by 29th inst.

An assistant lecturer and demonstrator in electrical engineering is required at the University College of North Wales, Bangor. Salary £120. Applications to the Secretary and Registrar by Sept. 17.

We learn that Johannesburg Municipal Council have extended the engagement of Mr. J. F. I. Thomas as general manager of the tramways and lighting department after the period of one year's service just completed, at a salary of £1,750 per annum.

Scunthorpe Council have appointed Mr. J. Moon electrician at the waterworks at £2. 10s. per week.

Mr. W. E. French has been appointed assistant lecturer and demonstrator in electrical engineering at the University of Leeds.

Mr. T. H. Saul, of Fulham, has been appointed general clerk and commercial assistant in the electricity department of Acton District Council at a commencing salary of £100, rising by annual increments of £10 to £130 per annum.

Personal.—Mr. J. Fiddes-Brown, M.I.E.E., M.I Mech.E., has accepted the post of engineer to the Buenos Ayres & Lacroze Tramways Co., and has resigned the appointment he has held for some eight years as superintendent engineer to the Charing Cross, West End & City Electricity Supply Co. He is leaving for South America about the end of the month.

EDUCATIONAL NOTICES.

University of Manchester.—Complete theoretical and practical training is given to students preparing for the higher positions in the electrical engineering profession. This subject may be taken as part of the courses for the B.Sc. degree in both the honours schools of engineering and physics. A special course has also been arranged extending over three years and preparing for a certificate in electrical engineering. The session commences on Oct. 2. Prospectuses from the registrar.

University College, London.—The courses of instruction in mechanical, civil, electrical and municipal engineering begin on Tuesday, Oct. 2. The fee for the full three-year diploma course, including the course for graduating B.Sc. in the faculty of engineering, is 115 guineas. There are spacious electrical and mechanical engineering laboratories, workshops, drawing office, museum and lecture theatres. Particulars of courses, scholarships and of matriculation examinations in engineering may be obtained from the secretary, Mr. W. W. Seton, M.A., Gower-street, London, W.C.

King's College, London.—The 1906-7 session commences on Wednesday, Oct. 3. In addition to the ordinary day courses in engineering and applied science there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Prospectuses from the dean (Prof. D. S. Capper), or the Secretary, King's College, Strand, W.C.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Glasgow and West of Scotland Technical College.—The next session begins on Tuesday, Sept. 25, in the new buildings. The diploma of the college is granted in electrical, civil and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed University classes. There are new and well equipped laboratories in the departments of physics, electrical engineering, mechanics, technical chemistry, &c. The preliminary examination for candidates for the diploma begins on Sept. 17, and names of candidates must be lodged by Sept. 14. Prospectuses from the Secretary.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

University of Birmingham.—The 1906-7 session commences on Monday, Oct. 1. The full course in the department of engineering extends over four years. The technical engineering classes include lectures on the strength of materials, the theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing the course includes the design of tools, prime motors, dynamos and other forms of machinery. The engineering laboratory course includes determination of strength of materials, experimental study of the steam engine and boiler, frictional efficiency tests, the flow of water over weirs, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work includes the testing of continuous and alternating-current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing work. The courses also include mathematics, physics, chemistry, geology and metallurgy. Detailed syllabus can be obtained from the secretary.

University of Liverpool.—The 1906-7 session commences on Oct. 9. The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng. (or the certificate in engineering) are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are also afforded for postgraduate work and research. Prospectuses may be obtained from the Registrar.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Australasia.—The "Australian Mining Standard" says the working of the new St. Kilda-Brighton (near Melbourne) electric tramway has proved satisfactory, and the Victorian Premier (the Hon. T. Bent) has announced that the general electrification of the suburban railway sections will be proceeded with. The section between Brighton and Sandringham will be commenced immediately.

Sydney Electric Lighting committee have recommended the City Council to revoke the appointment of Mr. S. Bellamy as power-house superintendent, recently made by the Council. In making the appointment the Council disregarded six other candidates selected, at the Council's request, by the electrical engineer (Mr. T. Rooke) and the town clerk (Mr. T. H. Nesbitt).

Mr. E. Kilburn Scott and Messrs. J. M. and H. E. Coane have submitted to the Victorian Government a scheme for water-driven electricity works at Traawool, about 60 miles from Melbourne, the same distance from Bendigo, and about 100 miles from Ballarat. There is at Traawool a natural gorge, with good rock to form the bed of a weir, which would be about 1,700 ft. long and 150 ft. high. By the construction of the weir it is estimated that 75,000,000,000 cubic ft. of water may be stored, of which 60,000,000,000 cubic ft. will be above the lowest level at which it may be used for generating electricity. It is estimated that 11,000 H.P. could be distributed throughout the day and night. The scheme would involve the expenditure by the Government of about £300,000 in the purchase of land and providing for the cost of the Tallarook to Mansfield railway and a number of public roads, and it is believed that private capital to the extent of £2,000,000 could be obtained to carry out the scheme. The engineers estimate that they could supply within a radius of 100 miles (which would include Melbourne, Castlemaine, Ballarat and Bendigo) 60,000,000 units of electrical energy per annum at a cost of 1d. per unit.

Beverley.—The Town Council, who are in negotiation with Messrs. J. & J. S. Enright for a transfer of their electric lighting order (1901), are obtaining further particulars of the firm's proposals in regard to the erection of electricity supply works.

Bradford.—The Corporation have decided to grant a six days' holiday, with pay, to tramway employés of 12 months' service who are not paid at special rates for Sundays, holidays, or overtime.

Ald. Wade said that the cost of granting the holidays to the tramwaymen would be between £1,000 and £1,200 per annum.

The chairman of the Tramways committee (Ald. Priestley thought the demand of the men a legitimate one. He did not think any man ought to be paid when he did not work, but whilst they had highly-paid officials who were receiving many days' and weeks' holiday year after year, it was late in the day to object to holidays for men lower down in the departments. The tramways department was flourishing, the receipts were increasing, they were paying more wages, and he had no doubt that if the undertaking were in the hands of a syndicate it would be made to show a handsome profit.

Ultimately the motion in favour of the holiday was carried.

Canadian Telegraphs.—The Canadian Pacific Telegraph Co. propose to carry out considerable extensions of their system next year. In all 7,000 miles of new telegraph lines will be erected, of which 4,000 miles will be put up in the Western Provinces of Canada, including an additional line from Winnipeg to Vancouver.

Chingford.—The U. D. Council have decided to oppose the application of the Mutual Electricity Supply Co. for a provisional electric lighting order.

Clacton.—The Council have now completed the purchase of the electric lighting plant of Mr. Ainslie, and the Electricity committee propose to connect up Mr. Ainslie's customers to the Council's mains at the end of September.

It has also been decided to borrow a further £3,000 (at 3⅞ per cent.) for the electricity undertaking, making a total of £13,000 out of the £15,000 sanctioned.

Colchester.—We are glad to learn that Mr. A. R. Sillar, borough electrical engineer, who recently met with an accident whilst cycling, has now practically recovered and has resumed his duties. The accident, though serious, has not caused any permanent injury.

Caversham.—The Council have decided to apply for an electric lighting order, and to oppose the application by the Electricity Works Development Co. for an order.

China.—A report recently issued by the Imperial Chinese Maritime Customs gives particulars of industrial development which has taken place in Chinkiang and district, the credit of which is due to Mr. Chang Chien, of Tungchow. Electric light has been introduced into the extensive Chinese suburb between the British concession and the city, while at T'angchia-cha, a suburb of Tungchow, there are a number of cotton mills, factories, &c., which are lighted electrically. In addition, about 20 similar factories and works are in course of erection or projected.

Cottage Lighting.—The Chester Moor Collieries have had their workmen's houses at Chester Moor wired for the electric light, the workmen agreeing to each pay 6d. per fortnight for electric current.

Cuba.—The "Official Gazette" of July 31 contains a copy of a decree granting to Eduardo J. Chibás & Ricardo S. Parro a concession for an electric tramway in Santiago de Cuba. The "Gazette" may be seen at the Board of Trade Commercial Intelligence Branch, 73, Basinghall-street, London, E.C.

Customs Duties.—According to a recent decision, conduit piping imported into the colonies included in the South African Customs Union is liable, as "machinery," to a duty of 3 per cent. ad val. Goods under this clause manufactured in the United Kingdom are entitled to a rebate of 3 per cent., and are thus duty free.

Dundee.—The city electrical engineer (Mr. H. Richardson) reported to the Electricity committee on Monday that it was impossible to get delivery in less than eight months of the turbo-generator which it was proposed to put down at Dudhope Crescent-road in order to cope with next winter's demand for electrical energy.

In connection with the proposal to erect a new generating station, Mr. Richardson suggests two probable sites, one at Carolina Port and the other at King William Dock. The latter site possesses many advantages, although the initial cost would be high (£87,000). Mr. Richardson urged that at the gas works, where space was available, suction gas plant should be erected for the generation of current for traction, and the relief that would thus be given at Dudhope Crescent-road, would enable them to carry on at that station for many years to come. The committee decided to confer with the Harbour Trustees for the purpose of arranging terms as to the acquisition of a site. The Council will probably call in an expert to report upon the whole electrical problem.

Dundee.—The city electrical engineer (Mr. Harry Richardson) recommends a considerable extension of arc lighting to comprise all the principal thoroughfares in the city.

Ealing.—The Council have approved the route of the main proposed to be laid through Ealing by the Metropolitan Electric Supply Co. from Willesden generating station, for the purpose of supplying electrical energy in bulk to various authorities in Middlesex.

The Council have approved recommendations of the Electricity Supply committee increasing the salaries and wages of members of the staff and employés of the electricity department. The increases take effect as from July 1 and include the following:—

Mr. J. Douglas Knight, chief engineer, from £500 to £525; Mr. A. E. Lewis, business manager, from £275 to £300, rising by £10 annually to £350; Mr. A. E. Pullen, assistant engineer, from £250 to £260, rising annually by £10 to £280; Mr. A. Garrick, mains superintendent, from £156 to £166, rising by £10 annually to £186.

Ecuador.—In his report for the years 1899-1905 the British Consul (Mr. A. Cartwright) says an electric light company has been established in Guayaquil. Hitherto the company's operations have been mainly confined to private lighting, as no general contract for public lighting can be made on account of the existing contract with the gas company, although in the outlying districts electric lamps have been erected. The present electric light company also projected a system of electric tramways, but so far no steps have been taken to carry out the project.

By a new agreement with the Central & South American Telegraph Co, the cable has been extended to the province of Esmeraldas. In return for a concession extending their privilege to 1955 the company offered to lay a short cable to place the island of Puna (at the mouth of the Guayaquil river) in connection with the Government land line, but the offer has not been accepted, and a wireless system from Puna to Guayaquil is now proposed, to be provided free of charge by the company. They also offer to connect the land telegraph from Guayaquil to Quito by a cable from the eastern to the western bank of the river.

Projects for electric lighting plants are also being developed in Quito, Riobamba, Ambato and Latacunga, all to be worked by water power.

Electricity in Mining.—The Directors of the Cambrian Collieries have decided to work the whole of the engines above and below the ground, with the exception of the winding engines and fans, by electric power. A contract has been entered into with Messrs. Siemens Bros. & Co. for the requisite plant, and it is hoped that the electrical installation will be completed early in 1907.

Engineers' Wages.—The members of the Amalgamated Society of Engineers on the north-east coast of England have given notice to the employers for an increase of 2s. per week on time rates and 5 per cent. on piecework. The Steam Engine Makers and Machine Workers' Society has given notice for similar advances. The notices expire about end September.

"First Aid" in Electricity Works.—Councillor Peal, chairman of the Electricity Supply committee, recently presented to the ambulance detachment of Ealing electricity works the certificates of St. John's Ambulance Association, which had been gained by the whole of the 30 candidates who had been examined. The resident engineer (Mr. J. D. Knight) complimented Dr. Arthur on the success of the training the class had received and added that the St. John's Ambulance Association had been asked to form an Ealing brigade which would include the electricity department contingent and also any other eligible men in the district who were willing and able to qualify.

Franco-Swiss Commercial Convention.—The French Presidential Decree of July 30 provides that the rates of the French "minimum" tariff, as modified by the law of Dec. 21, 1905, shall continue to be applicable until the promulgation of the law ratifying the new commercial convention between France and Switzerland. H.M. Ambassador at Paris reports that no official announcement has yet been made with regard to the rates of duty established by the new Convention. It is understood, however, that the only articles of British manufacture likely to be considerably affected by the Convention are certain classes of light electrical apparatus, on which the duties have been increased.

Guatemala.—Mr. H. A. R. Hervey, Chargé d'Affaires of H.M. Legation at Guatemala, states in his report for 1905 that the total value of imports of electrical apparatus, &c., was £4,146, Germany supplying the largest share and being followed by the United States. Practically nothing was imported from the United Kingdom.

Handsworth (Staffs.)—The report of the Board of Trade inspector (Col. Yorke) in connection with the recent tramway fatality at Handsworth has been issued:—

Col. Yorke deals with the evidence given at the inquiry which he himself conducted on May 5, and states that in his opinion the child got her hand under the life-saving apparatus. An unfortunate delay of half-an-hour occurred before the body of the child could be removed, which was due to the fact that no jacks were carried. It is, however, doubtful whether lifting jacks would have had the effect of saving the child's life, as when a person got under the wheels of a tramcar there was little chance of escaping from fatal injury.

The Council decided to request the Board of Trade to insist upon jacks being carried by all tramcars, whether in connection with municipal or private enterprise.

Hereford.—The Council have decided to apply for sanction to a further loan of £6,250 for additional plant at the electricity works.

Of the proposed loan £1,178 is to be spent on a new boiler, feed pump, piping, &c.; £550 for condensing plant and feed water heater; £3,150 for a 250 kw. direct-coupled steam dynamo; £1,000 for a 60 kw. steam balancer set, cables, instruments, &c.; and £372 for contingencies.

Kearsley.—Electric lighting orders are to be applied for by Farnworth Council and the Lancashire Electric Power Co.

L. G Board Surcharges.—Hammersmith (London) district auditor of the L. G. Board (Mr. A. D. Gordon) has surcharged three members of the Hammersmith Board of Guardians in connection with the contract for the electric lighting of the workhouse.

In the accounts of the guardians for the half-year ended Lady Day, 1906, Mr. Gordon disallowed £798. 13s. 1d., entered and charged as payments to various persons under the heading of electric lighting, &c. (workhouse and infirmary account), and he surcharged Mr. Chas. Pascall, one of the guardians, with £763. 7s.; Mr. J. L. Apsey and Mr. Geo. Jarvis (both guardians) with £798. 13s. 1d., and Mr. J. Glasier, also a guardian, with £35. 6s. 1d. The reasons for the disallowance of the amounts in question were: (1) Because the guardians had to that extent over-expended in respect of electric lighting beyond the amount sanctioned by the L. G. Board; (2) because he (Mr. Gordon) was not satisfied that all the payments in question were reasonable or that all the work was properly ordered or authorised to be carried out by the guardians; (3) because proper particulars had not been produced of some part of the expenditure; and (4) because there was no authority for the said expenditure or for charging the same on the poor rate.

Leamington.—The report of the Board of Trade inspector (Col. Von Donop) on the condition of the local tramways has been issued.

The report attributes the noise made by the tramcars at certain curves to the fact that the rails at one of the curves were worn away to a dangerous extent and there were marks of frequent derailments. The company attributed the wearing away of the rails entirely to the action of a few radial axle cars, the wheels of which failed to "radiate." They had given orders for some cars of rigid wheel base, and were confident that when those were introduced the wearing away would cease. Col. Von Donop agrees with the company and thinks they cannot be pressed to take further steps at present.

Light Railways.—The Board of Trade have confirmed the Tottenham & Walthamstow and the Bath & Lansdown Light Railways Orders, 1906.

Manchester.—Owing to the rapid increase of subscribers to the telephone service in Manchester the National Telephone Co. has purchased a large site at the corner of York and George streets for a new telephone exchange, and plans are being prepared for an exchange of 10,000 lines, which will be equipped on the most up-to-date principles.

Messrs. Beyer, Peacock & Co. have found the electric current obtained from the Corporation so economical in operating their machinery that they have decided to abolish their steam plant and to take all their electric energy from the Corporation. Many other large firms are also taking current for power, and during the past year the demand for power has greatly exceeded that of any previous year.

Municipal Telephony.—Hove Corporation have agreed to accept £500 from Brighton Corporation for the telephone ducts laid by the latter in the Hove district. It will be remembered that the whole of the Brighton municipal telephone undertaking has been sold to the Postmaster-General.

The accounts of the Glasgow municipal telephone department for the year ended May 31 show revenue of £57,460. 14s. 4d., compared with £55,426. 8s. 9½d. in the preceding year. The working expenditure (including P.O. royalty of £5,727. 6s. 7d. and terminal fees £795. 9s.) was £36,768. 2s. 2d., leaving £20,692. 12s. 2d., out of which interest (£9,674. 8s. 4d.) and sinking fund (£10,970) had to be paid, leaving £48. 3s. 10d., against £1,504. 5s. 11½d. last year.

Referring to the decision to sell the undertaking to the Government for £305,000, the annual report states that the loss which it is expected the telephone department will sustain by the sale is estimated at about £15,000. This loss, however, it is pointed out, is insignificant in comparison with the benefits reaped by telephone users in Glasgow, and indirectly by the community at large from the cheaper and better service they have enjoyed as the result of the establishment of the Corporation telephone service. In an unofficial report it is stated that prior to the introduction of the Corporation system, the National Telephone Co. were charging in Glasgow rates varying from £10 to £25 according to distance, whereas the maximum now charged by the company is £10, and the average rate is not more than £5. In addition to the saving to the National Company's subscribers the Corporation had almost 13,000 telephones working, and the Corporation subscribers only paid £5. 5s. for an unlimited service.

Newport (Mon.)—The Council have decided to apply for sanction to a loan of £10,000 (repayable in 15 years) for the purchase of electrical fittings, motors, &c., to be let out on hire.

London United Tramways.—The London United Tramways (1901) recently completed the lines from New Malden through Raynes Park to North Wimbledon. Wimbledon Council refused to assent to the opening of the lines until an assurance was given by the company that the authorised lines in South Wimbledon would be immediately proceeded with. The company were not at first inclined to give this assurance, but, at the Board of Trade inspection of the lines last week, Sir Clifton Robinson satisfied the Council on the point, and the lines have been opened for traffic.

Obituary.—The death is announced of Mr. I. F. Cuttler, who was for many years manager of the St. Helens tramways. Mr. Cuttler was 68 years of age.

Paisley Tramway Strike.—This strike is now at an end as the Paisley & District Tramway Co. have filled the places of the men who went on strike and the regular service is now maintained.

Rawtenstall.—The Council have decided to take steps to acquire the local lines of the Rossendale Valley Tramways Co, and to convert them to electric traction.

The Council have asked Bacup and Haslingden Councils to send delegates to a joint conference of representatives of the three boroughs to consider the question of purchasing the local tramways and arranging for running powers for the three boroughs over the whole system.

The question of erecting joint electricity works will also be considered at the conference. Though Bacup and Rawtenstall Councils recently entered into provisional agreements for the supply of electricity in bulk from the Lancashire Electric Power Co., Rawtenstall Council have already rescinded their previous resolutions on this subject, and Bacup Council, who view the Rawtenstall suggestion favourably, will probably take the same course.

Rhyl.—There was a discussion at the meeting of the Council on Monday on the financial position of the electricity works.

It was thought by some members that there had been over capitalisation. The engineer (Mr. Wright) suggested that one of the large sets should be sold and replaced by a smaller and more modern generator, but the Electricity committee have not yet decided upon this course.

St. Anne's-on-the-Sea.—Owing to the increasing demand for electrical energy the Council have decided, on the recommendation of the Electric Light committee, to apply for sanction for a further loan of £6,000 for extensions of the distributing mains, house services, meters, &c., for the next three years.

Saffron Walden.—The Council have agreed to the revocation of the Saffron Walden electric lighting order (1904) and to the granting to Mr. Mark Parker (or to a company to be formed by him) of a new order.

Shrewsbury.—The Corporation have decided to allow (after 31st inst.) their electricity supply consumers the option of being charged at a uniform rate of 5d. per unit or on the present maximum-demand system.

Spain.—The "Madrid Gazette" for Aug. 6 announces that a concession for an electric railway between Sarria and Vallvidrera has been granted to the Cia de Ferrocarril de Sarriá á Barcelona.

The "Madrid Gazette" of Aug. 8 notifies an application by Don Emilio Montenegro for a concession for an electric tramway in Vigo. One month is allowed for the presentation of other applications.

Surbiton.—A report on the proposed extensions of the electricity works has been prepared by the consulting engineers (Messrs. Talbot & Stevenson), who advise the Council to obtain sanction to a further loan of £20,000.

The report states that the last £50,000 loan had been expended, with £1,900 in addition, and that it is necessary that a further £7,400 be expended to cope with the increasing demand for electric current. A further expenditure of £5,700 for house services, &c., to December, 1910, is also advised, and likewise a minimum of £2,500 for extensions of mains, a total of £17,500.

The Electric Light committee recommended the Council to borrow £20,000, but it was decided on Tuesday to refer the matter to the Parliamentary committee for further particulars.

Taunton.—The salary of the chief assistant engineer (Mr. Wales) has been increased from £150 to £175 per annum.

The Council have agreed to reduce the charge for electric current supplied to the Taunton Electric Traction Co. provided the company carry out an extension to Rowbarton.

Tests of Wooden Telegraph Poles.—On Wednesday, the 8th inst., a series of important tests was carried out at Messrs. R. Wade, Sons & Co.'s, Raven street Yard, Hull, in order to ascertain the breaking strain and deflection from the straight at a given load of wooden telegraph poles (both single and double) and also any permanent set after bending The arrangements were made by Mr. Christopher Wade (a director of the company), and the tests were undertaken with the approval of the Board of Trade and by the desire of several large users both of ordinary telegraph poles and of those adapted for overhead electric power lines. The tests were made under the supervision of Prof. J. Goodman, of Leeds University, and amongst others present were the electrical adviser to the Board of Trade (Mr. A. P. Trotter), Messrs. Hastings & Green (Callender's Co.), G. Morgan (Controller of the G.P.O.), Hy. Jackson (L. & Y. Railway), Ireland (G.N. Railway), Anderson and Vernier (Newcastle-on Tyne Electric Supply Co.), C. H. K. Chamen (Lancashire Electric Power Co.), and many others. The tests, which were of a valuable character, were carried out on double and single poles and in one case a single 40 ft. pole bent to the extent of 14 ft. or 15 ft. out of the straight like a huge bow before exhibiting signs of strain fracture. Complete results of the tests will be embodied in a report, copies of which will be ready shortly.

The Telephone in Afghanistan.—It is reported that the Ameer has decided to establish telephonic communication between his various chief cities, and especially on the Russian frontier.

The Allen Institute.—Mr. W. H. Allen, J.P., M.I.E.E., chairman of the well-known firm of W. H. Allen, Son & Co. (Ltd.), Queen's Engineering Works, Bedford, who has always taken a keen personal interest in the welfare and comfort of his employés, has recently given signal evidence of his generosity towards, and of his continued interest in, the company's workmen. The Allen Institute, the formal opening of which took place on the 3rd inst., has been erected and equipped by Mr. Allen for the use of the workmen and employés of the company. The Institute is well appointed and up-to-date, comprising a hall (which will be available for lectures and concerts), library and reading rooms, billiard and recreation rooms, mess room, kitchen, bed rooms, &c. The dining hall will accommodate 280 people, and the library is already supplied with about 2,000 volumes. It is abundantly clear that the most cordial relations exist between the company and their men, and the new institute will, no doubt, strengthen the existing good feeling.

Before the formal opening ceremony, which was performed by Mr. R. E. Prothero, M.V.O., Mr. Allen explained the objects he had in view in providing the institute, and said he hoped that it would advance the welfare of the company's employés. In future they would, at all events, be able to have their meals in comfort. When they wanted recreation there was a hall for concerts and lectures, and they could also indulge in social intercourse and in friendly rivalry at games. For those requiring mental recreation there were the library and reading rooms. They wanted workmen with brains, and he trusted the institute would be of assistance to them and enable them to make use of their opportunities.

Mr. Prothero, in declaring the institute formally open, delivered an interesting address, and recalled the old conditions under which the master and his men lived under one roof. Trade unionists were, he declared, too prone to insist upon their members' rights and to forget their duties. He hoped the men would make the best use of the institute and of their leisure hours. He recognised the great value of such an institute as that, but he would also ask them not to let it be a substitute for home life.

The works manager (Mr. Reid) moved a hearty vote of thanks to Mr. W. H. Allen for his splendid gift, and at the same time he presented to Mr. Allen an illuminated address from the company's employés thanking him for his generosity. He said the provision of the dining hall would add materially to the comfort of the men.

The resolution, which was seconded by the senior foreman (Mr. J. Smith), was carried with acclamation.

The building was erected to the designs of Mr. George Allen, son of the chairman.

Underground Telegraph Wires.—At Wednesday's meeting of Newcastle-on-Tyne Chamber of Commerce a communication was read from the Postmaster-General regarding underground telegraph wires.

The letter stated that the sum available in any one year for that particular purpose was limited, and he could but decide to the best of his judgment between competing claims of different parts of the country. In the present year the Post Office was engaged in extending the underground line from London westward, with a view to making a sure connection with the landing-places in Cornwall of important Atlantic and Mediterranean cables. It would be a considerable time before that work would be completed, and he was unable at present to pledge himself beyond the present programme. The telegraph communications of the north-east ports were fairly secured from breakdown by storm by reason of the number of lines of overhead telegraph which could reach them from various points on the existing underground line.

Walsall.—The Board of Trade have sanctioned the borrowing by the Council of £28,000 for the reconstruction of tramways.

Sports, &c.—The employés (with their wives) of the South Lancashire Tramways Co. and the New St. Helens & District Tramways Co. were, by permission of the Earl of Derby, entertained by the Chairman of the Lancashire United Tramways (the Hon. Arthur Stanley, M.P.) on Tuesday, at Knowsley Park. Athletic sports, open-air dancing, and performances by the Atherton Public Prize Band were amongst the amusements provided.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Barrow-in-Furness.—The accounts of the electricity department for the year to March show capital expenditure £99,541, an increase of £6,985 during the year.

The year's revenue was £11,959 (against £11,624); working expenses were £5,180 (against £4,925). Gross profit was £6,779 (£6,699), and after paying interest (£3,007) and sinking fund (£2,926) net profit was £840 (against £1,199). The maximum load was 312 kw. for traction (against 302 kw.) and 546 kw. for lighting and power (499 kw.), and the load factor was 24·30 per cent. for traction (21·67) and 12·54 for other demands (12·64). 917,925 units were sold (837,451), 501,475 to private consumers, 97,095 for public lighting and 319,355 for traction. The equivalent of 56,493 8 c.p. lamps is connected (against 50,508). The average prices obtained were 4·430d. for private lighting (4·865d.) and 2·088d. (2·032d.) for power, 2·439d. (2·956d.) for public lighting and 1·890d. (1·944d.) for traction. There are 109 motors (582 H.P.) connected, including 14 on hire against 90 (490 H.P.).

The report of the borough electrical engineer (Mr. H. R. Burnett) gives particulars of the progress made with the extensions of the works. There are 609 consumers, an increase of 63 during the year. The works costs were 1·082d. per unit (decrease 0·098d.) and the total costs 1·411d. per unit (decrease 0·057d.).

Darlington.—The accounts of the electricity department for the year ended March show capital expenditure £60,809, an increase of £5,580 for the year.

Revenue was £9,137 (compared with £8,531). Working expenses and insurance came to £3,494 (against £2,948), the gross profit being £5,643 (against £5,583). Interest required £1,630 and sinking fund £2,164. 17s. 4d., leaving £1,848 7s. 3d. Total costs were 0·894d. per unit sold (against 0·980d.). 1,030,154 units were generated, 308,638 supplied for private lighting (243,611), 115,451 for power (63,645), 79,070 to public lamps (68,354) and 434,842 for traction (345,758). The maximum supply demanded was 682·8 kw. (610 kw.) and the load factor 17·22 per cent. (13·48). There are 505 consumers (428) with the equivalent of 44,223 8 c.p. lamps connected (against 33,182).

Dundee.—The accounts of the electricity undertaking for the year to April 30 last show total capital expenditure of £177,795.

The year's revenue was £30,923 (against £28,154). Working expenses were £21,447 (against £18,441)—this figure included £6,446. 19s. 11d. for main repairs. Gross profit was £9,476 (£9,713). Interest required £5,520 (£5,482), and sinking fund £3,909 (£3,786), leaving £516 to be carried forward, compared with £469 brought from previous year. 3,963,597 units were generated, 130,888 supplied to public lamps, 1,810,115 sold by contract, and 1,498,228 to private consumers by meter. The total maximum supply demanded was 2,400 kw.

Ealing.—The income of the electricity department for the year ended March 31 was £24,969. 1s. 5d.

The expenses were £11,824. 14s. 5d. Gross profit was £13,144. 7s. After paying interest (£5,149. 14s. 9d.), sinking fund, &c., the net profit for the year was £2,318. 6s., against £1,107 in 1905. 1,378,334 units were sold, 1,042,067 for private lighting and 336,267 for public lighting. There are 2,901 consumers (including 432 consumers by prepayment meter), representing the equivalent of 99,477 8 c.p. connected. The total plant capacity is 1,770 kw. Capital expended is £181,155. 17s. 4d., an increase of £11,544. 4s. 6d. on the year.

Eastbourne.—The accounts of the electricity department for the year ended March show outstanding capital expenditure £153,543, an increase of £4,619.

Income was £20,260, working expenses were £9,166 (including £4,018 for coal), the gross profit being £11,094. After meeting capital charges (£9,791. 18s. 7d.) there is a net profit of £1,302. The total connections are equivalent to 82,476 30 watt lamps, against 73,798 last year. The plant capacity is the same as last year (1,200 kw.) and the maximum load was 900 kw. (against 875 kw.). The load factor was 12 96 per cent. (12 36), 1,280,895 units were generated (1,185,758), 166,379 supplied to public lamps (169,681), 807,702 to private consumers for lighting (753,562) and 47,758 for power (24,428). 56 motors (= 152¾ H.P.) are connected, against 40 (= 78 H.P.). Total working costs were 2·05d. (1·95d.). Net profit was 0·30d. per unit sold (0 69d.). £2,000 has been transferred to depreciation fund (which now amounts to £6,146. 10s. 10d.) out of the accumulated profits, leaving a surplus of £7,925. 15s. 9d.

Glasgow.—The gross revenue of the electricity department for the year ended May 31 was £195,841. 14s. 11d., and the expenses were £91,416. 4s. 11d., leaving £104,425. 10s.

Interest absorbed £42,486. 0s. 5d. and sinking fund £20,141. 13s. 4d., leaving £41,797. 16s. 3d., from which has to be deducted depreciation (£37,989. 10s. 6d.), leaving £3,808. 5s. 9d. This has been transferred to reserve, which now stands at £16,913. The gross revenue showed an increase of £9,470 compared with the previous year, although a reduction of charges represented about £19,000. Rates, taxes and assessments show a considerable advance on last year. The valuation of the undertaking for 1906-7 is £95,325, against £87,664 last year. Capital expenditure during the year was £161,961. 6s. 9d., making the total expenditure (less depreciation) £1,368,134. 9s. 1d. The Electricity committee recommend that, with the exception of the special rate granted during the year to large consumers of current for power, the charges for current remain as at present.

Newcastle-on-Tyne.—The receipts of the Corporation tramways for the year ended March 31 were £196,996. 8s. 9d., and the total working expenses £105,933. 4s. 8d., leaving £91,082. 14s. 1d.

After crediting bank interest, &c., the total available balance is £91,440. 15s. 11d. After providing for interest, rents, depreciation on rolling stock, &c., there remains £52,553. 12s. 4d., of which £33,209. 7s. 3d. is required for sinking fund, £18,706. 16s. 6d. has been set apart for reserve and depreciation and £640 has been applied towards cost of raising loans.

Salford.—The annual report of the tramways manager (Mr. G. W. Holford) states that the total length of tramways open is 74¾ miles, of which 36½ miles is owned by Salford, the Eccles, Swinton and Pendlebury, Prestwich and Whitefield sections being leased.

The traffic receipts for the year ended March show an increase of £13,594. 2s. 6d. (compared with the previous year), the total receipts being £223,032. 18s. 3d. The number of passengers carried was 41,807,539. The number of special cars provided during the year was 155, the receipts from same being £229. 4s. 6d. The gross profit was £79,713. 4s. 11d., to which is added £2,105. 5s. 11d. for interest on investments, making £81,818.110s. 10d., which has been dealt with as follows: Payment to local authorities for running powers, £19,557. 10s. 1d.; interest and sinking fund charges, £39,958. 19s. 3d. ; contribution in relief of rates, £13,000 ; depreciation and renewals fund, £9,302. 1s. 6d. The amount paid for electrical power was £48,574. 1s. 7d., and in wages as traffic expenses £54,640. Salaries amounted to £1,760. 10s. During the year £11,293. 11s. 8d. was expended in repairs to cars. Repairs to overhead equipment cost £2,829. 12s. There had been paid in rents for lines: To Manchester Corporation £9,012. 6s. 2d., Eccles £7,050. 3s. 8d., Prestwich £2,320. 6s. 6d., Whitefield £456, and Trafford Park Estates Co. £718. 13s. 9d. The total borrowing powers for tramways are £1,172,642. 9s. 3d., of which £659,733. 9s. 3d. has been borrowed. The gross capital expenditure to March 31 was £657,564. The tramway depot is now equipped with tools and machinery for repair work.

Whitby.—For the past year there was a gross profit of £552. 8s. 4½d. on the working of the electricity undertaking, compared with £307. 4s. 2d. in the previous year. After paying interest (£931. 1s.) and sinking fund (£1,264. 8s. 9½d.), there was a deficit of £1,643. 1s. 5d. The number of consumers and the demand for electric current are steadily increasing.

Wigan.—The accounts of the electricity department to March show capital expenditure on the Wigan undertaking of £128,408 and on the Pemberton station £47,284, total £175,692. There is a net profit on the Wigan works of £4,567 and a deficit at Pemberton of £3,837.

Capital expenditure on the tramways is £491,075. Gross profit for the past year was £17,952 (compared with £14,001 in previous year) and after meeting interest and sinking fund charges (£20,122) there is a deficiency of £2,170. 9,880,435 passengers were carried and 1,241,256 car-miles run. Revenue per car-mile 10·30d.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.

REMARKABLE TESTIMONY.

The Publisher of the Big Blue Book has received from time to time numerous testimonials regarding the general completeness and accuracy of the information and of the names and addresses which appear in that publication. One of the latest testimonials to hand is a statement by the I.T.E. Electric Co., of 20, Great Russell-street, London, W.C., to the effect that the company sent out nearly 4,000 trade circulars, addressed from the last (1906) issue of the Big Blue Book, issued at the beginning of February, and that not one of these circulars was returned through the post as undeliverable.

A few weeks back a somewhat similar testimonial was given by another firm who had selected from the list a large number of names for circularising, and only one of the circulars had been returned as "Gone away, left no address," all others having reached their intended destination.

The Publisher of the Big Blue Book claims that this is remarkable testimony to the accuracy of the Directory, which has now been in circulation for six months.

TENDERS INVITED.

St. Pancras (London) Borough Council invite tenders for supply of 2,000 kw. steam turbo-generator, switchboard, condensing plant, &c., two three-phase high-pressure 500 kw. motors coupled to direct-current low-pressure generators, switchboards, &c. Specification, &c., from the electricity department offices, 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-rd., N.W., by noon Sept. 5. See also an advertisement.

Edinburgh Corporation invite tenders for the wiring, fittings, &c., for the electricity supply installation at the police fire station, Stockbridge. Specifications (after 22nd inst.) from the city electrical engineer (Mr. Frank A. Newington), Electricity Supply Station, Dewar-place, Edinburgh. Tenders to the Town Clerk, City-chambers, Edinburgh, by Sept. 12. See also an advertisement.

Barking Town Urban District Council invite tenders for cleaning, lighting, extinguishing and renewal of lamps, lanterns, fittings, &c., of the whole of the public incandescent, Nernst and arc lamps within the district for one, two or three years. Forms of tender, &c., from the engineer (Mr. Henley Howard), and tenders (addressed to Chairman of the Electricity and Tramways committee) to the clerk of the Council (Mr. H. Hargreaves), Public Offices, Barking, by noon Sept. 12. See also an advertisement.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of certain ports. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17-19, Bedford-street, London, W.C.

Weston-super-Mare & District Electric Supply Co. (Ltd.) invite tenders for supply for the next six months of feeder and distributor cables, joint boxes, feeder pillars and other accessories. Tenders to the Company, Locking-road, Weston-super-Mare, by 22nd inst.

Bootle Corporation require tenders by 10 a.m., Aug. 20, for equipment of four boilers for hand firing with bituminous slack, and for smoke preventing apparatus, pipe and boiler covering. Specifications from the borough electrical engineer.

Newcastle-upon-Tyne Tramways committee require tenders by Sept. 11 for rails, points and crossings for renewal and extension of a double junction.

Salford Tramways committee want tenders by 3 p.m., Sept. 10, for constructional steelwork and builders' work for extensions to car depôt and workshops.

Islington (London) Guardians want tenders by noon Sept. 6 for the electrical installation, &c., in the extension of the workhouse. Specification from Mr. Wm. Smith, 65, Chancery-lane, London, W.C.

Tenders are wanted by noon of Aug. 31 for the third portion of the superstructure of Avonbank electricity works, *Bristol*. Specification from the city electrical engineer.

Handsworth (Staffs) Council want tenders by Sept. 15 for wiring the new schools in Canterbury and Westminster roads.

TENDERS RECEIVED AND ACCEPTED.

Brentford Guardians have received the following tenders for electric light wiring and fitting and for a telephone and bell installation at the new workhouse buildings at Isleworth :—

Reynolds & Co. (*accepted*)	**£730**	Smeeton & Page	£1,316
Elec. Eng. & Main. Co.	2,417	Cozens & Grose	1,310
Day & Hayes	1,600	Bromley, Batstone & Kirk	1,310
T. Potter & Sons	1,568	T. L. Hellyar & Sons	1,065
Vaughan, Brown & Cook	1,475	Western Eng. Co.	960
Nursey & Marr	1,398	Higgins & Griffiths	950
T. Hiscock	1,370	H. & C. Davis & Co.	920
Cross & Cross	1,331	Strode & Co.	849

The Australian Commonwealth Postmaster-General's Department (Sydney) have placed orders with Paton, Russell & Co. (Sydney) for 500 Ericsson bridging wall telephones, with combination backboard and battery box, at £3. 2s. 9d. per set, and 50 combination bridging Ericsson's table sets at £3. 10s. each ; and with R. B. Hungerford (Sydney) for 200 bridging wall telephones, with combination backboard and battery box at £2. 17s. 10d. each.

Greenock Corporation received nine tenders for the supply of electricity meters, and these are under consideration. The firms who tendered are: Electrical Co., Rumney & Rumney, British Thomson-Houston Co., Reason Mfg. Co., International Electric Co., Aron Electricity Meter (Ltd.), General Electric Co., Chamberlain & Hookham, and Ferranti Limited.

Greenock Corporation also received six tenders for supply of steam coal and 19 tenders for supply of oil and engine room stores. These are likewise under consideration.

Devonport Council have accepted the tender of Walter Scott (Ltd.) for tramrails at £7 per ton and fishplates and anchors at £8. 10s., and that of Hadfield's Steel Foundry Co. for tie-bars at £36. 15s., and points and crossings.

Taunton Education committee have accepted the tender of Stansell & Sons for wiring the North Town schools at £199. 13s.

Southport Council have accepted the tender of Ferranti Limited for three 30 kw. transformers at £53 each.

Ship Lighting.—Messrs. W. C. Martin & Co. have obtained the contract for the electric lighting and power installations on board the new Anchor liner "California" and two new Allan liners which are being built. The firm have also in hand contracts for the very extensive electric lighting and power installations on the new Cunarder "Mauritana," and on two new Japanese steamers, besides other ship-lighting work.

BUSINESS NOTICES.

The following are the telegraphic addresses of the Union Electric Co. (Ltd.), Park-street, Southwark, London, S.E ; Newcastle-on-Tyne and Glasgow: "Abeam London," "Abeam Newcastle," and "Kandus Glasgow." The telephone number for the company's head office in London is "2970 Hop."

Siemens Bros. Dynamo Works (Ltd.) have opened a branch office at Central House, New-street, Birmingham, which will attend to their interests in the counties of Leicestershire, Montgomeryshire, Northamptonshire, Rutlandshire, Shropshire, Staffordshire, Warwickshire and Worcestershire.

After to-morrow (Saturday) the head offices of the Yorkshire Electric Power Co. will be at Thornhill, near Dewsbury. Telegrams, "Power Mirfield" ; telephone, 155 Dewsbury.

Mr. Chas. Weiss, A.M.Inst.C.E., M.I.E.E., has left Messrs. Thos. Bolton & Sons, Oakamoor, and joined Mr. F. J. Warden-Stevens as consulting engineer at 34, Victoria-street, Westminster, S.W.

BANKRUPTCIES, LIQUIDATIONS, &c.

On Friday, at the adjourned meeting of creditors of John Fell, engineer and contractor, a scheme of arrangement was submitted.

The scheme provides for the vesting of the estate in a trustee to realise as in bankruptcy, and after allowing debtor £500 a year for maintenance, to set aside half the net earnings for three years to pay the creditors 7s. 6d. in the £. Guarantors are to be provided for not less than £1,250. Proofs were put in for £5,305, and £3,325 had been admitted. Creditors for £3,131 have voted in favour of the scheme. Mr. T. Ford was appointed trustee with a committee of inspection.

The meeting of creditors of Herr Lazarus Blumenthal, 78, Queen Victoria street, London, E.C., was held on Monday.

Debtor registered in July, 1897, the News & Entertainments Telephone Synd. (Ltd.) for acquiring a licence to use Baron Szvetic's patent for an improved telephonic system. Liabilities £2,477, assets nil. Debtor came to England in March, 1896. The nominal capital of the syndicate was £25,000, and it purchased the licence for £15,000 fully-paid shares. Debtor, who was managing director, estimated that he had lost £1,775 in connection with the syndicate.

The Scottish House-to-House Electricity Co. (Ltd.) has passed and confirmed resolutions (1) approving the agreement for the sale of the company's business to the Coatbridge & Airdric Electric Supply Co. (Ltd.), (2) to wind up the Scottish House-to-House Co. voluntarily and (3) appointing Mr. H. B. Renwick as liquidator.

A meeting will be held on Sept 19 at Mr. E. Wilding's, Dashwood House, London, E.C., to receive an account of the winding up of the General Electric Power & Traction Co. (Ltd.)

Winding-up Petition.—A petition for winding up the Empire Electric Light & Power Co. (Ltd.) has been presented by the Tudor Accumulator Co., and will be heard in the High Court, London, on Aug. 22.

Sale by Auction.—Mr. Geo. N. Dixon will sell by auction without reserve on Aug. 28 and 29, at Mears' Yard, Wyfold-road, Munster-road, Fulham, S.W., some modern tunnel boring plant used in connection with the Brompton & Piccadilly Circus Railway contract. The plant comprises electrically and steam-driven air compressors, portable air compressors, air receivers, vertical and loco type boilers, electrically-driven belt conveyors, five 3 ton steam cranes, seven hydraulic jiggers, &c. Catalogues from Messrs. Walker, Price & Reeves, 8, Sherwood-street, Piccadilly circus, London, W., or from the auctioneer, 89, Hanover-street, Liverpool (Telegrams: "Tenacity Liverpool"). Further particulars are given in an advertisement.

Sale of Electric Lighting Undertaking.—There is advertised in another column, for sale as a going concern, an electric lighting undertaking (with provisional order) for supplying two urban districts Particulars from Mr. P. Gregson, 57, Princess-street, or Messrs. Tatham, Worthington & Co., solicitors, St. James-square, Manchester.

Plant for Sale.—Mr. A. Underwood, 3, Queen-street, London, E.C., has for sale two compound Browett-Lindley engines direct-coupled to Siemens dynamos (87 amperes, 50 volts); also two Willans & Robinson compound engines coupled to Siemens dynamos (60 amperes, 500 volts).

Mr. Underwood has also for sale two Easton, two Fowler and one Prentice dynamos. See advertisement.

Mechanical Stokers.—The application of mechanical stokers in the generation of steam in South Wales coalfields has hitherto been restricted compared with their use in the English coalfields, and this is in great part due to the difficulties experienced in adapting any particular type of furnace to deal efficiently with the great variety of coals worked in this district, varying from the highly bituminous coals of the west valleys of Monmouthshire and the Forest of Dean to the dry anthracites above Swansea. Messrs. Ed. Bennis & Co., of Little Hulton, Bolton, have during the past three years been making a particular study of the coals of this field, and have adapted their patent compressed-air furnace and self cleaning machine stokers to burn coals as far apart as Llanelly and Rhymney, adjusting furnace temperatures, air pressure and the self-cleaning arrangements of the furnaces to suit individual qualities of fuel. Messrs. Bennis have successfully put to work large installations of furnaces and conveying plant at the pits of the Glamorgan Coal Co., Ocean Coal Co., Powell Duffryn Coal Co., Albion Coal Co. and Cardiff Coal Co., and we may later take the opportunity to illustrate the special features of these plants and to tabulate the results obtained in evaporative duty and economy.

Price Lists.—The Hercules Electrical Mfg. Co. have ready a new price list of ignition and storage batteries.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Aug. 4 to 14, with the ports of destination :—

Africa—Alexandria, £282; Cape Town, £1,676 (including £1,606 telegraph material); Delagoa Bay, £163; Durban, £619 (including £270 telegraph material); East London, £126; Mombasa, £35; Port Said, £30; Port Sudan, £23; Taltal, £8 (telegraph material). *Argentina*—Buenos Ayres, £4,435 (including £109 telegraph wire). *Ascension*, £73 (telegraph material. *Australasia*—Adelaide, £1,150; Auckland, £53; Brisbane, £21 (telegraph material); Fremantle, £60; Lyttelton, £8; Melbourne, £289; Otago, £1,262 (including £64 telegraph cable); Perth, £93; Port Darwin, £15 (telegraph material); Rockhampton, £56; Sydney, £1,119; Wellington, £63. *Azores*, £2,751 (including £2,731). *Azores & St. Vincent*, £395,000 (telegraph cable). *Belgium*—Antwerp, £590; Ghent, £18. *Burma*—Rangoon, £930. *Canada*—Montreal, £69. *Ceylon*—Colombo, £180. *Chili*—Valparaiso, £343; Antofagasta, £530 (including £486 telegraph material). *China*—Foochow, £680 (telegraph material). *Cyprus*, £16 (telegraph material). *Denmark*—Copenhagen, £18. *France*—Marseilles, £21. *Germany*—Cologne, £68; Hamburg, £67. *Gibraltar*, £63 (including £10 telegraph material). *Greece*—Piræus £7 (telegraph material). *Holland*—Amsterdam, £23. *Hong Kong*, £160. *India*—Bombay, £1,241 (including £27 telegraph material); Calcutta, £3,812 (including £9 telegraph material); Karachi, £12. *Italy*—Genoa, £28; Messina, £17 (telegraph material). *Japan*—Kobe, £2,539; Nagasaki, £791; Yokohama, £757. *Madeira*, £330 (telegraph paper). *Malta*, £613 (including £196 telegraph material). *Peru*—Callao, £8,010 (submarine cable); Mollendo, £24. *Portugal*—Lisbon, £48. *Russia*—Batoum, £7. *Siam*—Bangkok, £168. *Spain*—Bilbao, £202; Pasages, £5. *Straits Settlements*—Singapore, £14. *Sweden*—Gothenburg £135 (telegraph cable); Stockholm, £160 (telegraph material). *U.S.A.*—New York, £133. Total (for 11 days), £432,239, against £428,096 for the corresponding 11 days last year (Aug. 5 to 15).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Steam Turbines: with an Appendix on Gas Turbines and the Future of Heat Engines." By Dr. A. Stodola. Second revised edition of the authorised translation from the second German edition with mathematical supplement and aid, by Dr. Louis C. Loewenstein. (London: Archibald Constable & Co.) 21s.

"Some Founders of the Chemical Industry." By J. Fenwick Allen. (London: Sherratt & Hughes.) 5s.

"Books on Electricity, Annotated List of." (Brooklyn, New York: Pratt Institute.)

"Proceedings of the American Institute of Electrical Engineers." July, 1906. (New York: The Institute.) 50c.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

July 2, 1906.

14,970 GROSE. Transmitting motion or power.
14,971 DICKSON. Insulating materials.
15,007 SCHAEFER. Suspension of arc lamps. (Date applied for, 23/11/05.)*†
15,016 TIERNEY & MALONE. Point shifting arrangements for electric tramways.*
15,021 CONSORTIUM FÜR ELEKTROCHEMISCHE INDUSTRIE G.M.B.H. Incandescence bodies of tungsten for incandescent lamps. (Date applied for, July 5, 1905)*†
15,022 SCHNEIDER & WESENFELD G.M.B.H. Electrical winding apparatus for clocks. (Date applied for, March 7, 1906.)*†
15,033 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Automatically regulating the currents of circuits.*
15,034 SIEMENS BROS. DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Varying E.M.F. in finely-divided steps in three-wire installations.*
15,035 SIEMENS BROS DYNAMO WORKS. (Siemens-Schuckertwerke G.m.b.H., Germany.) Automatically regulating several parallel connected generators.*
15,052 MATHIESEN. Magnets for arc lamps.*
15,053 CHAULIN. Electrical apparatus for protection against insects. (Date applied for, July 18, 1905.)*†
15,060 SCHATTNER. Electricity meters.*

July 3, 1906.

15,099 WORTHINGTON. Electric brush for cleaning purposes.
15,100 BERRY. Automatic slipper applicable to electric tramcars.
15,104 HARDING & CLARK. Multiple control system. (Date applied for, Jan. 6, 1906.)*†

15,107 Nasmith. (Carbone, Germany.) Three-phase arc lamps.*
15,134 Moroan. Brakes of electric trams and the like.
15,135 B.T.-H. Co. (G.E. Co., U.S.) Dynamo electric machines.
15,136 B.T.-H. Co. (G.E. Co., U.S.) Signalling systems for railways and the like.
15,142 Maschinenfabrik Oerliken. Multiple stage turbines. (Date applied for, Sept. 8, 1905.)*†
15,154 Ferranti. Turbines.
15,161 Cáska. Electric relays.

July 4, 1906.

15,178 Pieper. Electrical connections of electro-mechanical motor road vehicles.*
15,195 Blake. Stands for use with telephones.
15,196 Cervenka. Electric arc lamps.
15,200 Segnitz. Cells of storage and other batteries.
15,222 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
15,223 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control.
15,230 Tournier. Electric heating devices. (Date applied for, Sept. 25/05).
15,231 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke G.m.b.H., Germany.) Driving electrically.*
15,237 Lake. (Rhode Island Electromobile Co , U.S.) Separators for secondary battery plates.*

July 5, 1906.

15,245 Robson & Clegg. Electro-thermo detector.
15,248 Filby. Mechanical propulsion for tramway cars.
15,256 & 15,259 Barr, Stroud & Jackson. Apparatus for transmitting and receiving signals.
15,281 Brookes. (Cushman Electric Co., U.S.) Controllers for variable speed motors.*
15,288 Turner. Apparatus for controlling and operating the points of electric railways and tramways.
15,289 Spencer & Spencer. Joining tubing for forming poles, masts, &c.
15,290 Philipson, Philipson & Philipson. Apparatus for preventing accidents with road vehicles.
15,310 Oliver. Arc lamps.
15,313 McCollum. Automatic electric brakes.
15,316 B.T.-H. Co. (G.E. Co., U.S.) Solenoid operated switches.
15,317 B.T.-H. Co (G.E. Co., U.S.) Internal combustion engines.
15,333 Mundigler. Turbines. (Date applied for, March 7, 1906.)*†

July 6, 1906.

14,972A/05 B.T.-H. Co. (G.E. Co., U.S.) Manufacture of incandescent electric lamp filaments from thorium and like metals. (Date applied for, July 20, 1905.)
15,354 Gratzf. Electro-galvanic appliances for rheumatism, &c.
15,358 Pogson. Globes, shades and the like for lighting purposes.
15,376 Martin. Electrically-driven grinding machines.
15,400 Lowe. Trolley pulleys of overhead-wire electric tramways.*
15,413 Reynolds. Non-slipping safety electric car brake and road-gripping block.

July 7, 1906.

15,428 Jones. Switches.
15,444 Siegwart. Manufacturing hollow masts, pipes, &c. Date applied for, July 19, 1905.)*†
15,447 Benfield. Conduit brake for tramways and railways.
15,452 Collins, Hayes & Watson. Apparatus for operating points of tramways.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

9,157 Bowley. Steam and other turbines.
11,685 Giara. Multiplex telegraph systems.
12,932A, 12,932B, 12,936A, 12,939, 12,939A, 12,939B, 12,939C Goldsborough. Turbines. (Date applied for, June 22, 1905.)
12,935 Brown. Apparatus for adjusting and equalising pressure and other brakes employed on railways and similar systems.
13,156 Birkbeck. (Phelps Co.). Incandescent lamp and periodic automatic switch for flash-light purposes.
13,158 Bastian & Calvert. Electric vapour lamps.
13,424 Fairweather. (Benjamin Electric Mfg. Co.) Incandescent lamp sockets
13,464 Artom. Wireless telegraphic apparatus.
13,563 Bastian & Calvert. Electric ignition device.
13,605 Picard. Telegraphic systems. (Date applied for, Dec. 27, 1904.)
13,696 Hamilton & Ferranti Limited. Alternating current electricity meters.
13,794 Saldaña Armature for magneto-electrical machines. (Date applied for, July 5, 1904.)
13,796 Kuttmair & Zwack. Electric signalling for railways.
13,874 Evershed & Vignoles & Evershed. Electrical transmission apparatus causing movements of any mechanism to be repeated upon distant mechanisms.
14,050 Piper. Electric quantity meters of the electrolytic type.
16,074 Gardiner. Multiple-expansion reversing steam turbine.
16,349 Dalzell. Manufacture of rails for railways and tramways.
16,656 Marconi's Wireless Telegraph Co. & Priddle. Tremblers for electric sparking apparatus.
16,724 Dawson & Horne. Electrical apparatus for controlling the working of ordnance.
17,152 Clarke. Apparatus for agitating electrolytic solutions.
17,318 D'Iszoro. Turbines.
17,402A Stern & Engisch. Switching devices for accumulators. (Date applied for, Aug. 28, 1905.)
17,835 Payne. Electrical contact-breaker for induction coils.
17,888 Holmes. Combined switches and automatic circuit-breakers.
18,312 Oppenheimer. (A.-G. Mix & Genest.) Telephone exchanges on the central battery system.
18,673A Millauro. Electric terminal. (Date applied for, Sept. 15, 1905)
18,744 Waygood & Co. & Miles. Lifts or hoists.
18,846 B.T.-H. Co. (G.E. Co., U.S.) Control of electric motors.
18,904 Smith. Switches.
19,259 Hill & Sir Hiram Maxim Electrical Co. Incandescent lamps and fittings.
20,330 B.T.-H. Co. (A.E.G.) Arc lamp electrodes.
20,501 Schütz. Telegraph and like poles.
21,239 Lino. Scoop for cleaning the rails of tramways.
21,648 W. T. Henley's Telegraph Works Co. & Nichols. Fuse boxes.
22,546 Curwen. Automatic fire alarm systems.
23,756 Hill. Junction box for cables.
24,614 Pollard Fixing or anchoring tramway rails.
24,835 Pigoott. Electric bell pushes and manufacture of same.
25,032 Hawkes. Electric stoves.
25,502 Dresdner Gasmotoren fabrik vorm. Moritz Hille. Contact breakers for internal combustion engines. (Date applied for, May 22, 1905.)
26,987 Hartung. Electric incandescent lamps of the "Nernst" type.
27,224 Sutton & Gregson. Conduits.

1906 Specifications.

953 Wilson. Wireless telegraphy.
1,695 Spencer. Automatic electric signalling for railways or the like.
1,728 Loebl. Electric alarm devices.
2,604 Lamme. Speed regulation of single-phase commutator motors. (Date applied for, Feb. 6, 1905.)
4,331 Taylor. Electric time switch.
4,808 Brooks & White. Holders for incandescent electric lamps.
4,931 Chalas, Réquillart & Contal. Electric horn. (Date applied for, March 3, 1905.)
4,951 Paulet. Electricity Meters. (Date applied for, March 1, 1905.)
4,951A Paulet. Electricity meters. (Date applied for, June 6, 1905. Originally in No. 4,951, 1906.)
5,047 Krofger. Apparatus for electro-therapeutic treatment.

COMPANIES' MEETINGS AND REPORTS.

DERBYSHIRE & NOTTINGHAMSHIRE ELECTRIC POWER CO.—For the year ended Dec. 31, 1905, the total income was £3,305. 16s. 10d., including £3,246. 7s. 8d. from sale of current under contracts. The total annual expenditure was £3,006. 8s. 11d., leaving a balance of £299. 7s. 11d. 634,923 units of electricity were generated and 560,560 sold to private consumers by meter. The total maximum supply demanded was 426 kw. Capital expended during the year was £21,037. 10s. 5d., including £12,570. 10s. 11d. on mains, making a total of £124,579. 3s. 7d.

LANARKSHIRE TRAMWAYS CO.—Mr. A. R. Monks, who presided at the meeting yesterday (Thursday) said that the directors were proceeding with the extension to Cambuslang, and had offered for subscription at par 4,300 shares of £10 each to meet the cost of construction. It was anticipated that the line would be ready in a few weeks.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday Sir W. B. Forwood said the serious competition of the new electrical service inaugurated by the L. & Y. Railway between Southport and Liverpool and of the Corporation tramways continued to affect them. In the first half of 1905 they carried 5,558,000 passengers, and in the first half of this year 5,445,000, a decrease of 113,000. The introduction of cheap 1d. fares so frequently urged upon them by shareholders had proved disappointing. Their receipts fell from 1·78d. to 1·71d. per passenger. Those long 1d. stages were withdrawn in March. They had endeavoured to limit the issue of workmen's return tickets to working men by restricting the hours of issuing those tickets, with the result that the value they received per passenger had increased to 1·83d., so that if their numbers were maintained and expenses kept down, the current half-year should show more favourable results. With the long 1d. stages the earnings per train-mile fell to 20·09d., against 22·50d. in the same half of last year. That figure compared with 33·56d. on the City & South London, 66·60d. on the Central London and 25·35d. on the Mersey Railway. The directors were forced to the conclusion that the traffic at their command is only a limited one and could not be increased by reductions in fares. They would have to look for a return of their prosperity to an increasing dock traffic and to a development of their through traffic to Formby, Southport and Aintree, which they had opened up in connection with the L. & Y. Railway and also to a lessening of expenses. Their line was only 6½ miles long, and was worked electrically and with automatic signalling. Their staff was, therefore, small, and the room for reduction in expenses was limited; they must carefully maintain the efficiency of the railway in every department. The directors had called in Mr. Jenkins, manager of the City & South London Railway, to go through all items of expenditure and to advise them if he could suggest any means by which they could effect economies in working. He recommended the closing of certain stations, and the directors had adopted an extension of the course suggested by Mr. Jenkins, and the partial closing of some stations had resulted in considerable economy in working, which for the past half-year showed a decrease of £1,348, but as they carried £500 less to renewal fund the real decrease was £848. The train-mileage run was 383,000, an increase of 18,890 miles. The total expenditure per train-mile was 16·28d., against 18·04d., or if the contingent fund were eliminated, the expenditure was only 15·66d., and although they worked and maintained more stations, that compared favourably with other electrical railway undertakings, expenditure on the City & South London being 15·08d., Central London 34·75d. and Mersey Railway 20·22d. The line and the electrical equipment had been well maintained. Their excursion traffic, quite a new feature, was growing.

LONDON ROAD CAR CO (LTD.)—At the meeting on Tuesday Mr. J. Howard Moore said the number of their motors would be very largely increased during the next few months. The item in the accounts for car and motor repairs and renewals (which included renewal of tyres) was undoubtedly a very heavy one, but their motors were in the hands of men who were, strictly speaking, drivers and not mechanics, and until the whole of the service had been substituted and all their men had had experience that item was likely to be a large one. They did not propose to publish the results of the working of the horse and motor cars separately. Since the prospectuses of the first motor company this company and the London General Omnibus Co. had disclosed their accounts four times, whilst the motor 'bus companies had not yet done so once. Out of the available balance of £17,905. 13s. 6d. it was proposed to add £3,000 to reserve for depreciation and renewal of motor chassis. An ordinary dividend of 2s. 6d. per share (at the rate of £4. 3s. 4d. per cent.) was declared.

METROPOLITAN DISTRICT RAILWAY CO.—The directors' report for the half-year ended June 30 states that the capital expenditure was £151,911. Gross receipts were £221,055 (increase £14,453) and working expenses £166,912 (increase £52,032). This large increase in working expenditure was due to more ample provision for maintenance of the railway and rolling stock and the running of a more frequent service of electric trains. The directors believe that when some economies in working (now under consideration) have been effected, and a revision of fares has been brought into operation, the net revenue will show substantial improvement. There was experienced in the early part of the half-year frequent failures and stoppages whilst the new train services and the automatic signalling system were being introduced, but the difficulties have now been practically overcome. The steam locomotives and old carriages have now been withdrawn from the working stock.

At the meeting yesterday (Thursday) Sir George Gibb said the accounts bore traces of the arduous task of the electrical equipment of the line, which had been in progress for upwards of five years and had been successfully carried out. They were practically at the end of the task and they looked forward to entering on the enjoyment of the fruits of the great efforts which had been made. The total capital expenditure in connection with the electrification amounted to £1,783,000, which included the cost of numerous improvements, such as the introduction of the automatic signalling system, with which the whole railway was equipped. During the half-year they had carried 32,759,662 passengers, an increase compared with the corresponding period of last year of 5,090,587. That was a record traffic for any half-year in the history of the undertaking, notwithstanding serious drawbacks and troubles in working which discouraged the public and prevented the full use of the railway during the early months of the year. The receipts from passenger traffic showed an increase of £16,621, but they were not a record. The net result of the six months' working was a deficiency of £49,359. In consideration of the exceptional burden the shareholders had taken upon themselves in the task of modernising that old undertaking and building up the property for the future benefit of themselves and their successors, Parliament had granted special powers to charge those deficits to capital accounts during the period of transition. The automatic signalling was working satisfactorily. At first there were a great many failures and troubles, but those had now been successfully overcome. While the new signalling would increase the working capacity of the line, it would also prove an additional factor of safety, and the cost of maintenance under ordinary conditions would not be so high as during the past half-year. They were now having little trouble with the more important parts of the rolling stock, although there still remained some work to be done on the road. The question of the revision of fares had been under careful consideration, and the board had decided that some revision was necessary. The directors did not, however, contemplate any revision which would require the authority of Parliament. Workmen's fares were wholly unremunerative. That traffic had during the past 10 years grown from 5,000,000 passengers to upwards of 16,000,000 per annum, and the rate of progress during the last two or three years had been most alarming. It was not reasonable to expect that the company should year after year continue losing large sums in the carriage of that traffic, and therefore it was proposed to make a moderate increase. What they intended to do was simply to abandon the special reductions made on the return tickets, and adopt for each passenger journey the existing single fares. The new fares would come into operation at the beginning of September.

YORKSHIRE ELECTRIC POWER CO.—The directors, in their report for the half-year ended June 30, state that, though the progress of the company has not been as rapid as anticipated, it has been steady and continuous. New consumers are being connected, and negotiations are in progress for supplying large amounts of power. At the end of June consumers were on the mains for about 1,880 H.P. of power. Further agreements now made will, when the consumers are connected, bring the total requirements to approximately 2,450 H.P. The plant installed at Thornhill station is capable, after allowing ample spare and reserve, of supplying about 10,000 H.P., so that there is still a large surplus available for future consumers. The revenue from sale of energy has, during the half-year, been sufficient to meet practically all generation costs at Thornhill, and of its distribution throughout that portion of the area in which mains are now laid; it has not yet, however, been sufficient to cover expenses incidental to developing and managing the company's business. It has been decided to remove the central offices of the company to Thornhill, where future communications should be addressed.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

I. T. E. ELECTRIC CO. (LTD.) (89,782)—Reg. Aug. 7, capital £5,000 in £1 shares, to carry on the business of electricians, mechanical engineers and manufacturers, producers and suppliers of electricity, &c. First directors, A. E. Newton, W. M. Scott and E. M. Dobelbower (all of Philadelphia) and W. E. Gibson, London. Reg. office, 20, Great Russell-street, London, W.C.

LYTHAM ELECTRIC LIGHT & POWER CO. (LTD.) (89,766)—Reg. Aug. 3, capital £20,000 in £1 shares, to carry on business of suppliers of electricity, electricians, mechanical engineers, manufacturers of and dealers in electrical apparatus, &c., and to adopt an agreement with Foote & Milne (Ltd.) for the transfer of the undertaking and powers granted by the Lytham Electric Lighting Order (1905) and the Electric Lighting Orders Confirmation (No. 6) Act, 1905. First directors, M. Robinson, A. Coulthard, H. Foote, E. J. Owen, L. Milne, K. P. J. Jolivard and E. E. Smith.

SOUTH AMERICAN DEVELOPMENT & CONSTRUCTION SYND. (LTD.) (89,791)—Reg. Aug. 7, capital £20,000 in £1 shares, to construct, work, develop and control public works, &c., to manufacture or produce electricity for light and power, to erect machinery or apparatus for applying and turning to account water or other power, &c.

STATUTORY RETURNS.

AFRICAN DIRECT TELEGRAPH CO. (LTD.)—In return to June 14 capital is given as £300,000 in 30,000 shares of £10 each, of which 23,600 have been taken up. £236,000 has been received. Mortgages and charges, £38,600.

JAMES & BROWNE (LTD.)—Return to July 13 gives capital as £30,000 in £1 shares, of which 20,000 have been taken up. £15,610 has been received and £4,390 is considered as paid. Mortgages and charges, £2,200.

MORTGAGES AND CHARGES.

FRANK SUTER & CO. (LTD.)—A memorandum of satisfaction in full of debts dated April 18, 1901, securing £5,000, has been filed. £1,000 6 per cent. second mortgage debentures, created and dated July 31, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have also been registered. No trustees. Holder, J. Singlehurst.

JAMES & BROWNE (LTD.)—Issue on July 12 of £300 and on July 26 o £800 5 per cent. debentures, part of series to secure £6,000, charged on company's undertaking and property, present and future, including uncalled capital. Trustees, J. W. Ellis and E. Hughes. Previously issued of same series, £1,900.

ST. AUSTELL & DISTRICT ELECTRIC LIGHTING & POWER CO. (LTD.)—Issue on July 26 of £150 5 per cent. debentures, part of series created June 1, 1904, to secure £2,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £650.

CITY NOTES.

MEMORANDA (Aug. 16).—**Bank rate 3½ per cent. (since June 21, 1906).** Price of silver 30⅝d. per oz. **Consols** 87⅞—88 **for money,** 88—88⅛ **for account; 2½ per cent. annuities** 86¼—86¾. **Consols Pay Day, Sept. 3; Ticket Days, Stocks and Shares Continuation Days,** Aug. 28 and Sept. 11; **Ticket Days,** Aug. 29 and Sept. 12; **Pay Days,** Aug. 30 and Sept. 13; **Mining Share Carry-over Day,** Aug. 27.

BAKER STREET AND WATERLOO RAILWAY CO.—Mr. W. E. Mandelick has been appointed secretary of this company vice Mr. E. B. Read, resigned.

DUNDEE, BROUGHTY FERRY AND DISTRICT TRAMWAYS CO. (LTD.)—The financial year will end in future on July 31, and the meetings will be held in September instead of April.

GREAT NORTHERN RAILWAY CO.—At the meeting on Friday Lord Allerton said that the Great Northern, Brompton and Piccadilly line would probably be opened at the beginning of January.

NATIONAL TELEPHONE CO. (LTD.)—A circular has been issued to the shareholders announcing the decision of the directors to increase the authorised capital by the creation of 100,000 new shares of £5 each and to offer those shares at par to the holders of the preferred and deferred stocks of the company.

NORTHERN EASTERN RAILWAY CO.—On Friday the Rt. Hon. J. L. Wharton said the success of the electric train working in the Newcastle district continued and in the past half-year they carried 300,000 more passengers than in the corresponding half of last year.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The directors recommend an interim dividend at the rate of 5 per cent.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Aug. 29 a special settling day in 20,000 £10 conversion shares (£1 paid) of the *British Aluminium Co. (Ltd.)*. The Committee have been asked to appoint special settling days in and grant quotations to provisional certificates (fully and partly paid) for 150,000 £1 6 per cent. cumulative preference shares and £150,000 4 per cent. debenture stock of the *South Metropolitan Electric Tramways & Lighting Co. (Ltd.)*

TORONTO ELECTRIC LIGHT CO.—For the half-year ended June 30 the total receipts were $439,455·56, an increase of $68,027·66 compared with the corresponding period of 1905. The net revenue was $183,462·83, an increase of $37,044·14.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 8	1,613	− 60	10	15,357	− 273
Airdrie	,, 3	211	+ 21	31	6,764	+ 647
Anglo-Argentine	,, 12	15,670	+ 2,613	32	472,885	+ 50,751
Ashton-under-Lyne Corp.	...	...	...	...	...	...
Ayr Corporation	,, 11	495	+ 3	13	5,337	− 49
Baker St. & Waterloo Ry.	,, 11	1,291	...	6	7,989	...
Barnsley	,, 3	163	+ 9	31	4,969	+ 47
Barrow	,, 3	349	+ 51	31	7,653	+ 422
Bath Electric Trams, Ltd	,, 8	1,450	+ 369	32	25,657	+ 4,268
Birkenhead Corporation	,, 12	1,210	+ 49	...	...	...
*Birmingham Corporation	,, 11	1,469	+ 1,110	19	16,045	+ 9,232
Birmingham & Mid.	,, 3	10,126	− 218	31	314 419	+ 18,233
Blackburn Corporation	,, 8	1,178	+ 154	¶19	21,010	+ 1,385
Blackpool Corporation	,, 9	3,454	+ 437	18	25,427	+ 1,804
Blackpool and Fleetwood	,, 11	2,728	+ 512	6	8,653	+ 1,127
Blackp'l,St.Anne's&Lytham	...	...	...	...	...	...
Bolton Corporation	,, 12	2 145	+ 101	19	41,762	+ 3,682
Bournemouth Corporation.	,, 8	2,743	+ 510	†19	32 176	+ 6 854
Bradford Corporation	,, 11	5,429	+ 527	19	90,188	+ 3,965
Brighton Corporation	,, 12	213	+ 22	19	20 588	− 985
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 10	6,959	+ 466	26	133,400	+ 4,178
Buenos Ayres & Belgrano	,, 12	3,859	+ 304	32	113,989	+ 6,435
Buenos Ayres Elec. Trms.	July 14	1,383	+ 310	29	38,392	+ 7,139
Burnley Corporation	Aug. 11	1 317	+ 47	19	22,497	+ 1,121
Burton Corporation	,, 12	387	− 16	§19	5 998	− 386
Bury Corporation	,, 5	1,038	...	18	18,363	...
Calcutta Tramways Co.	,, 11	R43,895	− R910	6	R261,972	+ R7,802
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 4	2,238	+ 4	18	38,059	− 1,086
Cavehill	,, 3	132	+ 88	31	2,701	+ 1,031
Central London Railway	,, 11	4,877	− 435	6	33,441	− 1,480
Chatham & Dist. Lt. Rys.	,, 9	967	− 5	†32	20,747	− 475
City & South London Rly.	,, 12	2,261	+ 87	6	14,655	+ 1,162
Colchester Corporation	,, 9	374	+ 7	...	...	...
Cork Electric Trams Co.	,, 9	614	+ 32	32	15,239	− 347
Croydon Corporation	,, 10	1,990	+ 133	10	16,832	+ 1,144
Devonport & Dist. Trams	,, 3	506	+ 11	31	13 835	− 375
Dover Corporation	,, 11	439	+ 95	19	5,273	+ 750
Dublin & Lucan Railway	,, 10	187	− 1	§6	871	− 37
Dublin United	,, 10	6,605	+ 607	16	33 677	+ 413
Dundee Corporation	,, 8	1,116	+ 259	§12	13,624	+ 2,901
East Ham Council	,, 11	1,188	+ 96	19	18,320	+ 1,669
Exeter Corporation	,, 10	438	+ 37	19	5,740	− 405
Falkirk and District	,, 8	319	...	...	...	...
Gateshead & Dist. Trams	,, 19	1,032	+ 46	31	29,724	+ 1,691
Glasgow Corporation	,, 11	17,127	+ 1,811	11	173,017	+ 12,361
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 3	279	...	31	7 236	+ 270
Gt. Northern & City Rly.	,, 11	1,414	+ 65	6	9,405	+ 772
Greenock & Port Glasgow.	,, 3	760	+ 66	31	20,297	+ 792
Halifax Corporation	,, 1	1,807	+ 113	19	32,875	+ 1,539
	,, 8	2,106	+ 235			
Hartlepool Tramways	,, 3	393	+ 91	31	9,041	+ 1,030
Hastings Elec. Trams Co.	,, 9	1 794	...	6	6,093	...
Huddersfield	,, 11	1,717	+ 176	19	29,641	+ 2,873
Hull Corporation	,, 11	2,552	− 467	19	43 472	+ 799
Ilford Dist. Coun.	,, 11	686	− 17	19	9,973	+ 70
Ilkeston Dist. Council	,, 8	197	+ 57	19	2,607	+ 196
Ipswich Corporation	,, 11	694	− 16	19	8 875	− 103
Isle of Thanet Co.	,, 11	2,211	+ 2	44	22,171	− 1,058
Keighley Corporation	,, 9	162	+ 19	6	943	+ 14
Kidderminster & District	,, 3	145	− 2	31	3,586	− 60
Kilmarnock Corporation	,, 11	152	− 2	13	2,169	− 79
Kirkcaldy Corporation	,, 8	233	+ 23	6	1 555	+ 72
Lanarkshire Trams Co.	,, 9	928	− 24	‡32	27,673	+ 5,658
Leamington	,, 3	187	− 23	31	5,404	+ 2,833
Leeds Corporation	,, 4	6,478	+ 496	19	122,074	+ 6,179
	,, 11	7,495	+ 541			
Leicester Corporation	,, 11	2,890	+ 80	32	70,753	+ 4,398
Leith Corporation	,, 4	537	+ 309	13‡	6,966	+ 2,914
	,, 11	546	+ 297			
Liverpool Overhead Rly.	,, 12	1,808	+ 6	6	9,641	− 402
Liverpool Corporation	,, 4	11,266	− 810	31	330,892	+ 5,417
*London County Council	,, 4	25,508	+ 9,952	18	478,156	+ 205,614
London United	,, 10	10,069	+ 1,216	†32	198,163	+ 11,822
Lowestoft	,, 11	509	− 22	46	7,251	− 566
Maidstone Corporation	,, 4	136	− 19	19	2,307	− 255
	,, 11	166	− 25			
Manchester Corporation	,, 11	15,713	+ 2,616	19	263 542	+ 12,741
Mersey Railway	,, 11	1,735	+ 149	6	9,876	+ 824
Merthyr	,, 3	203	+ 16	31	5,971	+ 88
Metropolitan Dist. Railway	,, 12	6,703	+ 413	6	45,086	+ 5,671
*Metropolitan Elec. Tram.	,, 3	3,718	+ 264	31	103,177	+ 26,275
Middleton	,, 3	413	+ 40	31	10,869	+ 293
Nelson Corporation	,, 11	154	+ 15	20	2,898	+ 219
Newcastle-on-Tyne Corp.	,, 11	4,137	+ 27	19	79,082	+ 5,016
Newport (Mon.)	,, 11	884	+ 69	19	12,391	+ 518
Northampton Corporation	,, 10	697	− 12	19	8,926	+ 41
Oldham, Ashton & Hyde	,, 3	622	+ 43	31	17,346	+ 531
Oldham Corporation	,, 12	1,859	+ 175	20	36,411	+ 3 160
Perth (N.B.) Corporation	,, 8	187	...	12	2 055	...
Perth (W. A.) Elec. Trams	,, 10	1,364	+ 157	32	47,320	+ 2,883
Peterborough	,, 3	162	+ 5	31	3,857	− 322
Pontypridd District Coun	...	...	...	...	...	...
Portsmouth Corporation	,, 11	3,383	− 1,595	19	41,536	− 1,612
Potteries	,, 3	1,869	+ 124	31	54,613	+ 2,754
Preston Corporation	,, 8	826	+ 155	6	4,814	+ 717
Reading Corporation	...	...	...	...	...	...
Rochdale Corporation	...	...	...	...	...	...
Rotherham Corporation	,, 9	643	+ 96	17	9 563	+ 912
Rothesay	,, 3	453	− 183	31	6,527	+ 951
Salford Corporation	,, 13	4,393	− 61	19	88,700	+ 1,078
Sheerness	,, 1	75	− 22	31	1,729	− 390
Sheffield Corporation	,, 12	5,711	+ 470	20	106,497	+ 6,028
Singapore Trams	,, 11	$8,125	...	7	$45,182	...
Southampton Corporation.	,, 8	1,328	− 20	18	18,873	+ 43

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southend Corporation	...	...	...	...	...	...
Southport Tramways	Aug. 3	412	+ 56	31	9,562	+ 206
Stalyb'dge,Hyde,&c.,Jt.Bd.	...	...	...	...	...	...
Stockport Corporation	,, 10	1,249	+ 210	19	19,449	+ 5,808
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	,, 8	657	...	32	12,573	...
Swansea Trams	,, 3	981	+ 80	31	24,853	+ 4,509
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 3	53	− 7	31	1,367	− 127
Tynemouth and District	,, 3	139	+ 39	31	7,703	− 206
Tyneside Trams Co.	,, 8	638	+ 144	32	11,578	+ 1,058
Wallasey District Council	,, 11	1,231	+ 138	19	16,333	+ 555
Walsall Corporation	,, 11	699	+ 54	29	16,492	+ 911
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 9	2,709	+ 424	19	41,429	+ 13,256
Weston-super-Mare	,, 1	325	− 13	31	3,716	+ 122
Wolverhampton Corpn.	,, 8	1,104	...	6	5,516	...
*Worcester	,, 3	339	− 8	31	8,507	− 723
Wrexham	,, 3	106	...	31	3,087	− 9
Yorkshire W.R. Trams	,, 12	1,322	+ 24	32	26,512	...
Yorkshire Woollen District	,, 3	951	+ 287	31	27,684	+ 8,073

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Aug. 15.	Rate per Cent. Yielded.	Dividend Due.	Business Week to Aug. 15.	
						Highest.	Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	$6\frac{13}{16}$—$7\frac{1}{16}$	5 13 6	Ap, Oct	7	$6\frac{13}{16}$
5	2/9	Do. 5½% Cum. Pref.	$5\frac{3}{4}$—6	4 11 8	—	$6\frac{1}{16}$	$5\frac{5}{8}$
St.	6%	Do. Permanent 6% Deb. Stock	133 —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 16 3	—	$101\frac{1}{2}$	..
5	..	Brisbane Electric Trams. Invest. Ord.	$1\frac{1}{2}$—$1\frac{3}{4}$	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	$4\frac{3}{8}$—$4\frac{5}{8}$	5 0 0	—	$4\frac{5}{8}$	$4\frac{7}{16}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117 —120	5 0 0	—	$118\frac{3}{4}$	$118\frac{1}{4}$
St.	5%	Do. Pref. Ord. Stk	108 —111	4 10 0	—	110	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	105 —108	4 13 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	$103\frac{3}{4}$	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	$3\frac{5}{8}$—4	4 7 6	—	4	$3\frac{5}{8}$
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	$5\frac{1}{2}$—$5\frac{3}{4}$	5 4 0	—	..	..
5	8/0	Do. "B"	5 —$5\frac{1}{2}$	5 0 0	—	$5\frac{3}{8}$	$5\frac{1}{8}$
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	105	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	98 —100	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8 —$8\frac{1}{2}$	4 15 0	—	$8\frac{1}{2}$	$8\frac{1}{4}$
5	2/6	Do. Nos. 105,001 to 137,610	$7\frac{7}{8}$—$8\frac{3}{8}$	4 15 6	—	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	$104\frac{1}{4}$	104
1	0/6	Cape Electric Tram Shares	$\frac{9}{16}$—$\frac{11}{16}$	6 3 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —98%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —95	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	88 —91	6 9 0	..	88	..
1	1/0	Lisbon Elec. Trams Ord.	$1\frac{3}{8}$—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	$1\frac{1}{8}$—$1\frac{3}{8}$	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	100 —102	4 8 0	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	.	$105\frac{1}{2}$	[illegible]
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	140 — 142	5 2 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	[illegible]	[illegible]
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu.Pr.	$4\frac{7}{8}$—[illegible]	5 2 0			
5	5/1	Calcutta Elec. (1-50,000)	$8\frac{3}{8}$—$8\frac{7}{8}$	[illegible] 10 0	..	$8\frac{5}{8}$	$\frac{7}{8}$
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	$2\frac{1}{2}$—3	..	..	..	—
St.	5%	Do. 5% Debs.	85 —89	5 12 4	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	110 —113	5 6 0	..	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	[illegible]	6 18 0	—	..	..
1	1/6	Rand Electric	$1\frac{1}{16}$—$1\frac{3}{16}$	..	—	..	..
1	..	River Plate Electricity Co. Ord.	$\frac{1}{2}$—$\frac{5}{8}$	..	—	..	..
1	$1/2\frac{3}{8}$	Do. 6% Non. Cum. Pref	$\frac{7}{8}$—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	$5\frac{1}{8}$—$5\frac{5}{8}$	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Aug. 15.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 15. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	14/0	†Bournemouth & Poole Elec. Sup. Ord.	10¼–11¼	6 4 0	..	–	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9¾–10¼	4 8 0	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10⅝–11⅝	5 2 0	..	–	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	6⅛–6⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	5/6	†Brompton & Kensington Elec. Sup. Ord.	7¾–8¾	5 14 0	–	..	..
5	8/6	† Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	8⅛	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	–	..	..
5	2/6	†Charing Cross (W. End & City) El. Sup. Co.	4 –5	5 0 0	Feb, Aug	4 9/16	..
5	2/8	† Do. 4½ per Cent. Pref.	4⅝–4⅞	4 12 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	99 –102	3 18 8	–	..	..
5	2/8	Do. City Undertaking 4½% Cm. Pref.	4 –4½	5 0 0	–	4⅜	4 5/16
5	2/3	Do. Do. (1903)	4 –4½	5 0 0	..	4⅛	4
5	3/9	Chelsea Electric Supply Ord.	5¼–5¾	5 6 0	March ..	5⅜	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	107½	106½
10	5/0	City of London Electric Lighting Ord.	10 –10½	5 10 6	Feb, Aug	10¼	10
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	11⅛	.
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do 4½% 2nd Deb. Stock (red.)	100 –103	4 7 6	..	.	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	31/32–1 1/32	3 19 10	April, Oct	.	..
5	5%	Do. Do. 5% non cum. pref.	5 3/16–5 5/16	4 5 3	April, Oct	..	..
10	4/0	†County of London Elec. Supply Ord.	7¾–8¾	5 14 0	–	8⅝	8⅜
10	6/0	† Do. 6 per Cent. Cum. Pref.	11 –12	5 0 0	Mar, Sept	11 9/16	11⅜
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	8/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	–	..
5	5/0	Hove Electric Lighting Ord.	7⅝–8⅛	5 10 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	†Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	97 –100	4 0 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
3	2/4½	London Electric Supply Ord.	1⅞–2⅛	4 4 0	–	2	1 15/16
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5 1/32	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	97½	..
5	4/0	†Metropolitan Electric Sup. Ord.	8 –9	5 10 0	April, Oct	8 9/16	8⅜
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 9	Jan, July	5 13/32	5 5/16
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	94 –96	3 13 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	7½%	†Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10¾–11	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 1 3	Feb, Aug	..	–
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾–5⅞	4 5 1	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	–
1	3%	Northern Counties Elec. Sup.	1 7/32–1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	–
5	4/6	Oxford Electric Ord.	6¼–6¾	4 19 0	March ..	..	–
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	10½–11½	5 11 1	Feb, Aug	..	..
5	8/6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 4	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 3 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	¾–⅞	–	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1⅛–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3½–4	6 10 0	–	3½	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	4⅝	..
St.	4½%	Do. 4½% 1st Mort. Deb.	98 –101	4 9 0	..	..	..
5	5/6	†Westminster Elec. Sup. Ord.	9½–10½	6 8 0	Mar, Sept	10¼	10⅛
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 13/32	5 5/16
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	..	89½	88½
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	–	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	–	102½	101½
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	9½%	†Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9⅞–10⅛	3 19 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	.
10	6/0	British Electric Traction Ord.	5¼–5¾	5 4 0	–	5 9/16	5⅜
10	6/0	† Do. 6 per Cent. Cum. Pref.	8¾–9¼	6 9 6	Feb, Aug	9¼	9 3/16
St.	5%	Do. 5 per Cent. Perpetual Debs	112 –115	4 7 0	..	114½	110
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	90 –93	4 16 9	..	..	..
St.	4%	†Central London Ordinary Stock	85 –87	4 12 0	June, Dec	88	81½
St.	4%	† Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	100½	..
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	76	74½
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	–	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	89 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	.	..
St.	2¼%	†City and South London Rly. Con. Ord.	44 –46	4 7 0	Feb, Aug	46⅝	43⅞
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	118 –121	4 2 9	Feb, Aug	–	..
St.	5%	† Do. (1896)	112 –115	4 7 0	..	..	..
St.	5%	† Do. (1901)	112 –115	4 7 0	–	116½	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	.
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3¼–3¾	10 13 4	..	3⅝	3½
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	..	..
10	9%	‡†Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	102½–104½	4 6 0	Jan, July	–	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	80	..
10	1½%	Liverpool Overhead Railway Ord	8⅜–8⅝	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¼–8¾	5 14 0	–	..	..
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 3	–	92½	..
St.	..	Mersey Con. Ord. Stock	4 –6	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –11	–	–	..	..
1	–	Metropolitan Elec. Trams Def.	⅛–¼	..	–	..	..
1	0/6	† Do. 5% Cum. Pref.	15/16–1 1/16	5 9 0	–	..	..
St.	4½%	Do. 4½% Deb. Stock	100 –102	4 8 3	–	..	..
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¾	5 5 0	..	..	..
10	5/0	† Do. 5 per Cent. Cum. Pref.	7¾–8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 8	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 –92	5 8 8	–	..	..
St.	3%	†Waterloo and City Ord.	101 –104	2 17 9	June, Dec	..	–
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	–	..	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 0	–	..	..

Shre.	Last Dividend	Name.	Price Wed., Aug. 15.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 15. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	–	..	..
1	2/4½	Babcock & Wilcox Ord	3⅞–4⅛	4 12 0	..	4 3/32	3 15/16
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	–
5	4/0	British Insulated & Helsby Cables Ord.	6¾–7¼	5 10 0	July, Feb	6⅞	6 13/16
5	6/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	5⅞	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1¼–1¾	..	..	–	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	78	..
2	1/0	Brush Electrical Engineering	¾–1	..	March ..	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1¾	6 17 0	Mar, Sept	1⅛	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 11 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	83¼	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	..	..
1	1⅜d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	1 1/32	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	–	..	..
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	–	..	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
8	1/6	†Crompton and Co. (Nos. 1 to 54,000)	1 11/16–1 15/16	3 13 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–98%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1 11/16–1 13/16	5 12 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	1 7/32	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1¼–1¾	4 5 6	Feb, Aug	..	–
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3¼–3¾	9 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4¾–5¼	5 14 0	..	5	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	101½	..
2	1/7½	Electric Construction Co.	¼–½	14 0 0	July	5/16	..
2	2/9⅜	Do. 7 per Cent. Cum. Pref	1¾–2¼	5 4 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	86 –89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 8	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –97	4 2 6	–	..	–
5	10/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5⅜–5⅝	4 0 0	Feb, Aug	5 17/32	5½
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	..	..
St.	22/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17¾	17½
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 4 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 13 6	..	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	97 –100	4 10 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33 –35	5 14 0	Mar, July	34¾	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	100½	–
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16–2 9/16	5 17 0	..	2½	2 7/16
1	6d.	Do. 5% Non-Cum. Preference	1 3/16–1 7/32	4 2 2	..	..	..
St.	5%	Do. 5% Non-Cum. Preferred	113 –116	4 6 0	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	103 –105	3 16 0	..	104½	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	–	106	..
5	–	Willans and Robinson Ord.	¾–1¼	..	Apr, Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2¾–3¼	..	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	–
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½–4	..	Jn, Dec	..	..
100	5%	Do. 5% Debs. (red.)	87 –92	5 8 8	..	..	..
St.	15/0	Anglo-American	66 –68	4 15 9	F, My, Ag, N	66½	..
St.	30/0	Do. Preferred	113½–114½	5 6 0	F, My, Ag, N	114½	112
St.	10/0	Do. Deferred	22⅝–22⅞	2 9 0	F, My Ag, N	22 13/16	21½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–99½	4 0 6	Jn Ap, Jy, O	98½	97½
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	–	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	9¼	–
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	6/3	Direct United States Cable	15½–16	4 18 6	Ja, Ap, Jy, O	15⅞	15 13/16
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..	..
St.	6/0	Eastern Ordinary	144 –147	4 15 0	Ja, Ap, Jy, O	145	144½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 17 9	Ja, Ap, Jy, O	91½	90½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	106½–108½	3 13 8	May, Nov	108	..
10	2/6	Eastern Extension	14¼–14¾	4 15 0	Ja, Ap, Jy, O	14⅝	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105 –107	3 14 9	Feb, Aug	106½	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	38 – 40	5 18 0	Jan, July	39¼	38⅜
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	12/6	Indo-European	58 – 60	5 8 4	May, Nov	59¾	..
100	4%	Mackay Companies Common	75 13/16–76 7/16	5 3 9	Jan, July	–	..
100	4%	Do. Preference	74 11/16–75 11/16	5 6 0	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	–
2½	–	West Coast of America	¾–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..	..
10	–	West India and Panama	⅜–½	..	May, Nov	15/32	7/16
10	4/0	Do. 6% 1st Pref.	6½–6¾	3 18 0	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14½	14⅜
100	5%	Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	.
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	105½	104½
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 8 4	..	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 –103	4 17 0	..	..	..
5	5/0	Chili Telephone (fully paid)	7⅝–7⅞	4 18 0	August	..	–
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 8	–	–	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	107½–109½	5 9 6	–	108½	107½
St.	5%	Do. Def. Stock	107 –109	4 11 9	–	108½	107½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	11 15/16	11 13/16
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97 –99	3 10 8	June, Dec	99	98¾
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 17 0	–	103½	102¾
1	0/9⅜	Oriental	1 1/16–1 3/16	4 3 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16–1 3/16	4 11 0	–	..	..
St.	4%	Do. 4% Red. Deb. Stock	97 –99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	..	..
5	5/0	United River Plate	7 –7½	5 6 8	July	7⅝	7⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	–	..	..
10	2/0	Globe Telegraph and Trust	10¾–11	5 0 0	Ja Ap, Jy O	10⅞	10⅞
10	3/0	Do. 6 per Cent. Pref	14½–14¾	4 1 6	Ja Ap, Jy, O	14⅝	14½
10	6%	Submarine Cables Trust (Cert.)	130 – 132	4 11 0	April, Oct	..	–

In calculating the yields, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE Paper by Mr. DOW, which we reproduce in this issue, will be read with interest by those engaged in the photometric comparison of sources of light differing in colour. The increasing use of lamps giving very different qualities of light makes such work of more practical importance than it used to be. Though to some people the idea of comparing a red light with a green one may seem rather absurd, it is becoming necessary to agree upon how such things shall be done if the efficiency of certain lamps, like those depending on mercury vapour, is to have any very definite meaning. The Purkinje effect, also, has hitherto been considered rather as one of those phenomena which are more curious than material; but, as pointed out by Mr. TROTTER in the discussion on Mr. DOW's paper, this phenomenon may introduce considerable error in measuring street illumination, for the illumination in such cases may be as low as some of those in which Mr. DOW found a marked effect.

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THERE is a deal of commotion in the Borough of St. Marylebone, as appears from a perusal of the *Marylebone Mercury and West London Gazette*. Our contemporary has been able to get a draft copy of the Report of the Electricity Department for the year ending with March last, from which it is apparent that the position is not very rosy. A surplus of £12,442 sounds a small return on a capital of £2,000,000, if no interest has been paid. But, as far as we are aware, interest charges have been paid out of revenue, and it must not be forgotten that the undertaking has been in a transition stage during the year in question. We prefer, however, to leave over any detailed consideration of the position until the report of the Committee, as adopted by the Council, is in our hands.

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AS remarked by Councillor JOHN LEWIS, the cost of light to the consumer in Marylebone will always be expensive, for over-capitalisation is a luxury that must be paid for, and is a burden even when the term for repayment is prolonged. It is, nevertheless, pointed out by Mr. LEWIS that, the muddle having been duly made, it is the duty of the ratepayer to make the best of it, and do so by using the light as extensively as possible. This view is sound enough in its way, but very few people support even home industries at the expense of their pocket, and still fewer are likely to support their Electricity Committees if they find it does not pay them to do so.

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THAT this is the attitude of some of the consumers is shown by letters written to the *Marylebone Mercury*. In one instance it is complained that an electric light account, which was £172. 0s. 8d. in 1905, increased by £86. 18s. for the same summer period in 1906, though the lighting was the same in both years. In another case the account was much increased, though the premises were closed earlier in the day. Results of this kind cause much dissatisfaction, and should be explained, as they probably can be simply enough, though the letters themselves do not give much of a clue. These may be cases of unremunerative customers being transferred from a flat rate to a maximum demand—a change that is likely to take place under the auspices of Mr. WRIGHT—with consequent dissatisfaction to the unremunerative consumer. In any case, the prices recently decided upon by the Council cannot be considered exorbitant. For light supplied at 240 or 480 volts the charge is 8d. per unit for an amount equivalent to 500 hours' use of the maximum demand per annum, and 1d. thereafter, the corresponding charge for power and heating being 2d. and 1d., while, for electricity supplied by separate meters to basements not used for dwelling purposes, there is a flat rate of 2d. per unit. Moreover, consumers having quarterly accounts exceeding £50 have the advantage of a discount of 25 per cent. on the excess if the accounts are settled promptly.

THE long-suffering inhabitants of London never seem to be free from the annoyance of having streets broken up for repairs or for some other purpose. Repairs are looked upon as a necessary evil which may or may not be postponed, according to circumstances, to the dog days when most people hope to be in more congenial surroundings. But in the case of mains, whether gas, water or electric, there is no reason why alterations and extensions should not be carried out to a large extent at times when the inconvenience to the public is a minimum. This view was taken by the Royal Commission on London Traffic, with the result that the Clerk to the London County Council has addressed a letter, which we give at some length on another page, to the metropolitan and borough councils asking them to assist in remedying this state of things. Apparently the idea is to promote legislation so that the breaking up of the streets may be regulated, and the public be inconvenienced less than at present. No doubt subways for pipes and cables are the ideal remedy, but it is unlikely that such a course will ever be adopted, though the cost thereof in many streets would probably not have been more than the money which has been spent in breaking up and re-making these particular streets in recent years.

Birmingham and District Electric Club.—The opening meeting of the session will be held at the Colonnade Hotel, New-street, Birmingham, on Saturday evening, September 8th, Mr. Joseph A. Jeckell (President) in the chair. No Paper is down for reading.

Technical Instruction for Works Managers.—According to *Nature*, the Physical Society of Frankfurt-on-the-Main has fitted up an electrotechnical instructional and experimental institution in which young people, after finishing their apprenticeship, may go through a further course in order to qualify themselves as works managers, &c.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906	—
Rhodes—Sitia	Aug. 10, 1906	Aug. 17, 1906
Falmouth—Bilbao	Aug. 14, 1906	—
Môle St. Nicholas—Port au Prince	Aug. 16, 1906	—

Valparaiso Earthquake.—We are glad to be able to state that, amid the devastation caused by the terrible earthquake in Chili, the staffs of the telegraph companies whose cables and lines traverse the earthquake district have escaped without accident. After only a short interruption, the services of the West Coast of America Co., of the Central & South American Co., and the land line service of the Pacific & European Co., are all in full operation. This is doubly fortunate, in that it assures the relatives and friends of those engaged in the companies' employ of their safety, and enables the companies to keep the remainder of the world in touch with the districts affected by the earthquake.

Endowments by Mr. Rockefeller.—According to *Science*, the sum of £2,000,000 given by Mr. J. D. Rockefeller to the General Education Board has been divided among the following nine institutions, on condition that the sums mentioned are augmented three times in value from other sources:—Coe College, Cedar Rapids, Ia., £10,000; Washburn College, Topeka, Kan., £5,000; Tulane University, New Orleans, £15,000; Wofford College, Spartanburg, S.C., £5,000; Furman University, Greenville, S.C., £5,000; Wake Forest College, N.C., £7,500; Howard College, Birmingham, Ala., £5,000; South-western University, Jackson, Tenn., £5,000; and Mississippi College, Clinton, Miss., £5,000.

Barron Falls Power Scheme.—A scheme is on foot for utilising the Barron River Falls, near Cairns, in Queensland. According to the *British Australasian*, the fall is 700 ft. in height, with a large volume of water. The power generated will be transmitted to Cairns and utilised as motive power in ore-treating works and for other industrial purposes. Behind Cairns, and extending inland for 150 miles, there is an immense area of mineral-bearing country, especially noted for its richness in copper, tin, wolfram, &c., most of which is roughly dealt with at the Chillagoe works, but afterwards despatched to Germany and other parts for final treatment. If electric power were available, this work would be carried out at Cairns. The same proposal was made a few years ago but defeated by Parliament.

The Decimal System.—We have received a pamphlet by Mr. Edwin Anthony dealing with the advisability of this country adopting decimal coinage, weights and measures. The question of coinage is first discussed, full particulars being given of the decimal systems used in other countries, and then the pros and cons of two or three ways of converting the British system to one depending on multiples of 10. The second chapter on weights and measures fully describes the metric system and also considers the practicability of introducing a decimal system founded on some of our present units. The difficulties attendant on any change of weights and measures are fully admitted, and it is pointed out that it is not expedient to make any change except in conjunction with our Colonies and the United States.

Personal.—It is announced that Dr. A. E. Dolbear, professor of physics at Tufts College, Mass., since 1874, has resigned.

Owing to Prof. Röntgen having declined the offer of the physics chair at the Berlin University, which has been rendered vacant by the death of Prof. Paul Drude, the direction of the Physical Institute has been temporarily placed in the hands of Prof. W. Nernst, who is director of the neighbouring Institute of Physical Chemistry. According to *Nature*, this institute, which is now known as the Physikalisch-Chemisches Institut, and was previously known as the II. Chemische Institut, has recently been extended on the electrical side by the aid of a grant of 10,000 marks. The equipment has been extended so that there is easy access to direct current at 10, 110 and 220 volts, and to low-voltage alternating current for electric furnace work.

We are pleased to learn that Mr. C. R. D. Pritchett is again at work and has resumed his position as manager of the London office of Pritchetts & Gold. Mr. Pritchett suffered a sad bereavement by the death of his wife early in June, and has since been away from business.

Electric Steel Manufacture.—A new company, called the Metallurgiska Patent Aktiebolaget, has been formed in Sweden for the purpose of developing and exploiting the Kjellin electric furnace for the manufacture of steel. According to the *Elektrotechnischer Anzeiger*, it is proposed to erect works at Gottenburg and Norrland; electrical energy will be supplied from the water-power station at the famous Trollhatten Falls, and it is anticipated that in 1908 from 10,000 H.P. to 15,000 H.P. will be required. It is estimated that the output will be at least 500,000 tons of steel and iron per annum. For Germany the Aktien Gesellschaft Friederich Krupp, of Essen, has acquired the rights and intends to develop the process in Germany, while for England the rights have been acquired by Messrs. Vickers, Sons & Maxim. It is stated that a syndicate, during the next session of Parliament, will bring in a bill for utilising water power on Loch Awe with the idea of using electric furnaces for the production of steel on a large scale. Overhead transmission is suggested for connecting the power station to the steel works at North Connel, on the western coast.

Engineering Standards Committee.—Two further reports have just been issued by the Engineering Standards Committee—viz., No. 25, Report on Errors in Workmanship based on Measurements carried out for the Committee by the National Physical Laboratory; and No. 27, Report on British Standard Systems for Limit Gauges (Running Fits). To assist them in the formulation of a system for limit gauges, the committee, in addition to collecting evidence for both manufacturers and users, carried out a comprehensive series of measurements on actual work, and a record of these measurements is contained in Report No. 25, but no system of limits is laid down therein, the recommendations being contained in Report No. 27. The first-named report is confined to measurements obtained on plain cylindrical work selected from locomotives, gun-mountings, gas engines, dynamos, high-speed engines and machine tools, and gives in great detail the results of the measurements at the National Physical Laboratory in the form of numerous folding tables, and tabulated figures giving the information collected from the various manufacturers. As stated above, the recommendations of the committee are given in Report No. 27, which are tabulated as first, second and third quality work, and extra fine quality work. The price of Report No. 25 is 10s. 6d., and of No. 27 2s. 6d.; they can be had from the offices of the Engineering Standards Committee, at 28, Victoria-street, Westminster, London.

Explosion on the Manchester Network.—On Thursday last the failure of a three-wire service joint in Victoria-street, Manchester, caused explosions in the cellar of a grocer's shop and an adjacent manhole, which did considerable damage to property. From particulars handed to our representative by Mr. Pearce, the chief engineer, we gather that the service joint was made at the time the distributors were re-laid in 1898, and is of a pattern no longer used by the department. The joint was an ordinary cable to cable one, sweated and lapped, the distributors being ¼ sq. in. vulcanised bitumen-insulated conductors, and the service leads three single 19/15 rubber insulated, the whole run in solid with bitumen in wood troughing. By the side of the distributors, of which there were five, lay a 4 in. earthenware pipe containing a small telephone cable. It is supposed that the heat set up by the bad joint, or by some other unassignable cause, caused the insulation to melt, and ultimately severe arcing gave rise to the evolution of dense volumes of smoke and gases which escaped through the ground and along the service troughing, entering the cellar in which one explosion took place. The telephone pipe also became full of gas and acted as a bye-pass to the adjacent manhole. A further explosion took place here, following the first by an interval of a minute or so. The original distributors had been laid in the pipe and were rubber covered, but they had been replaced by vulcanised bitumen cables laid solid in wood troughing. The old service cables were left in and teed on to the new distributors. All services are now laid with either armoured rubber-covered cables or paper insulated cables, laid solid. The joint in every case is a sweated and bolted one, and is enclosed in a cast-iron box surrounding the distributor and service troughing some little distance on each side of the joint. Services and joint boxes on these lines have been in use now for four years, and no instance of breakdown has yet been recorded. Some passers by suffered slight injuries in the present case, but there was no fire after the explosions, except a small flare behind the meter board, which was soon put out. The damage caused by the explosion to the stock and structure of the buildings was not of a very serious character.

Electrolytic Chlorine for the Purification of Drinking Water.—A Paper read by Dr. S. Rideal and Mr. R. Orchard before Section 3 of the Royal Sanitary Institute at Bristol, dealt with "The Prevention of the Growth of Algæ in Water Supplies," and served to indicate a new field for the application of electrolytically prepared hypochlorite solutions. The first part of the Paper dealt with the properties possessed by copper sulphate in the destruction of algæ. Electrolytic hypochlorites have been frequently used in the sterilisation of sewage and sewage effluents, so that their application to the treatment of potable water is a perfectly natural consequence of the earlier experiments. The authors carried out their experiments with a solution provided by the Digby electrolyser. The solution in question, besides having the advantage of cheapness, contains but little undecomposed sodium chloride, and consequently the final addition of chloride to the treated water is small. From a lengthy series of experiments on water drawn from the lake in St. James's Park, and on tap water infected with cultures from the lake water, the authors reach the following conclusions: that (1) green growth can be entirely prevented by the use of electrolytic chlorine; (2) the different microscopic plants require varying amounts of chlorine to inhibit their development, confervæ appearing to be most susceptible to treatment. "Available chlorine" just in excess of that immediately consumed by the water, although disappearing in a few hours, inhibited confervoid growth for some weeks. Desmids were found to be slightly more resistant and required the addition of some 0·5 part per million in excess of that immediately consumed by the water. Diatoms appeared to be still more resistant and required an excess of 1·0 part per million. (3) Animalculæ, like daphnia and cyclops, are not killed by even large doses of chlorine, and were found actively mobile after a month's treatment with 11 parts per million. (4) The addition of 1 part of copper sulphate per million was not successful with lake water, as it did not clarify, and the green growth was only slightly retarded. The effect was not equal to the use of 1·2 parts (0·2 in excess) of chlorine per million. (5) Except in the case of the desmid, *ankistrodesmus*, a distinct bleaching of the coloured algæ was noticed with upwards of 2 parts of available chlorine per million; this cannot occur without strong physiological action. (6) In the case of tap water which was treated so as to inhibit the growth of conferva, practically the only alteration in the chemical analysis is a reduction in the figure for oxygen consumed, and an increase of the chloride from 2·1 to 2·4 parts per million.

Electrical Systems of Remote Control used in the Italian Navy.—In recent years the Società Nazionale delle Officine di Savigliano has designed and carried out a considerable number of electrical power installations on battleships built in the Italian yards, including in such installations the remote control of machinery. In *l'Elettricità* are described the systems adopted for rotating the turrets and for steering. Two motors, coupled together, drive the gear for rotating the turret through a single-reduction spur gear and a worm and wheel. One of the motors is used for rapid movements and the other for aiming. The former is of 40–50 H.P., running at 800 revs. per min., corresponding to a movement of the turret of 4 deg. per second; it is compound wound, with the series winding preponderating. The other motor is of 3–5 H.P., with approximately equal series and shunt windings; with compound excitation its speed is only 100 revs. per min., and with series excitation 200 revs. per min. The aiming and quick-motion motors have been combined so that the former is always used in starting to move the turret, and is then cut out and the large motor used, the object being to work several turrets simultaneously without excessive starting currents. From the general distribution board, provided with maximum cut-outs, are led the two circuits of the two motors. That of the large motor has a starting resistance and an electrically-worked commutator. The starting resistance can be short-circuited by an electric relay connected across the motor armature. As soon as the motor reaches its normal speed and the counter E.M.F. its normal value, the relay cuts out the starting resistance. The electrically-worked commutators reverse the motor and short-circuit it, so as to give a braking effect whenever the main circuit is opened. The circuit of the small motor has a starting resistance and precisely similar commutators. The controller, fixed on the moving platform, has two press buttons for right and left aiming movements, and two levers for larger movements. The levers, moved into their middle positions, change the excitation of the small motor, and moved further, cut out the small motor and connect the large one. The small motor enables the turret to be aimed to $\frac{1}{15}$ deg. In the electrical system used for the steering gear two rheostats are connected in parallel across the mains, and two sliding contacts, one on each rheostat, are connected to a relay. The arrangement thus forms a Wheatstone bridge, in which the two rheostats form the four arms, the mains one diagonal and the relay the other. One sliding contact is connected to the steering wheel and the other to the rudder. When the steering wheel is moved the bridge is put out of balance and the relay is worked. This closes a secondary circuit, working by electromagnets a commutator and automatic starter of the rudder motor. As the rudder turns, the sliding contact connected to it gradually brings the bridge to balance, when the relay opens the motor circuit; the motor is short-circuited as soon as it is cut off the mains, so as to bring it to rest as quickly as possible. The arrangement admits of steering to within half a degree.

THE MEASUREMENT OF PHASE DIFFERENCES.

BY CHARLES V. DRYSDALE, D.Sc.

During the last few years attention has been directed to the question of phase difference measurement, and one or two papers have been devoted especially to the subject. In a paper before the Physical Society last year[*] Dr. W. E. Sumpner gave an account of a method which he had devised for the accurate determination of small differences of phase, and gave the results of some interesting tests he had made on liquid resistances and transformers. For some time before this the writer had been making tests on the small differences on phase introduced by transformers in connection with measuring instruments, and had formed the opinion that the wattmeter was the most suitable instrument for the purpose. This view has been recently endorsed by Dr. E. B. Rosa, of the National Bureau of Standards at Washington, who has made some valuable measurements on dielectric losses in condensers by wattmeter methods.[†] In neither of these papers, however, has the general question of phase measurement been dealt with, Dr. Sumpner's paper being concerned with measurements at approximately unity power factor, and Dr. Rosa's with those at very low power factors. Dr. Sumpner has also done valuable work on phase meters, but such instruments belong rather to the class of gauges or indicating devices and can hardly be used for accurate measurement, or for the determination of small phase differences.

When considering the experimental methods it is convenient to distinguish between three classes of phase measurements as follows:—

(*a*) Measurements at high power factors.
(*b*) Measurements at low power factors.
(*c*) Measurement of small differences of phase.

The determination of phase angles may be made either directly by phase meters, or by null methods with wattmeters, by measurement of the sides of a vector triangle as in the numerous voltmeter and ammeter methods, or by measuring the area and two of the sides of a vector triangle as in wattmeter deflectional methods. The last, being most simple, will be considered first.

I.—WATTMETER DEFLECTIONAL METHODS.

The commonest way of measuring power factors for ordinary commercial testing is to determine the power by a wattmeter and to divide this by the product of the effective volts and amperes. This gives us the usual relation $\cos\phi = w/\mathrm{VC}$ where ϕ is the angle of power lag, w the true power in watts, and V and C are the effective values of the P.D. and current respectively.

As a method of measuring phase angles this suffers from two defects. At high power factors we are troubled with the fact that although the inductive errors of the wattmeter are small or nil, a very small error in the reading of any of the instruments may make a very large error in the phase angle, since $d\phi = -\operatorname{cosec}\phi \,.\, d\cos\phi$. At low power factors this trouble does not exist, as here $\operatorname{cosec}\phi$ approaches unity, and the error in the angle is only equal to the error in the power factor. But at low power factors, any inductive reactions in the wattmeter have maximum effect, and this has caused a general disbelief in its applicability for such measurements.

Whenever a moderately good wattmeter free from metallic parts other than its coils is available, it forms probably by far the best method of measuring at low power factors. As the writer has shown,[‡] a wattmeter, even if very inductive, may be used with confidence for such tests. On circuits having sinusoidal wave-forms we have simply $\mathrm{P} = \mathrm{P}' - \mathrm{T}p\sqrt{1 - \mathrm{P}'^2}$ where P is the true power factor, P′ that given by dividing the wattmeter reading by the effective volts and amperes, T the time constant of the wattmeter shunt and $p = 2\pi \times$ frequency. Unless, therefore, the frequency is very high, the wave-form very irregular, or the shunt inductance abnormally large, this method gives results which are as accurate as may be required. There is no difficulty in reducing the correction to a practically negligible amount in a suitable wattmeter, and measurements of dielectric losses, &c., can be easily made.

Circuits of High Power Factor.—The wattmeter in its simple form is quite unsuitable for measurement of small phase displacements, such as are found in resistance coils and liquid loads. But with the aid of a condenser in the shunt circuit and some non-inductive load such tests are extremely easy. If this condenser shifted the phase of the wattmeter shunt current by exactly 90 deg. without altering its value, we should simply have $-\sin\phi = w/\mathrm{VC}$ instead of $\cos\phi$ as before. In practice, however, the shift of phase is less than 90 deg., owing to the resistance of the moving coil and the power absorption in the condenser. The current in the shunt circuit also depends upon the capacity of the condenser, the frequency and the wave form. On this account the simplest procedure is to connect the load, the phase displacement of which is to be determined, in series with a convenient non-inductive resistance, and to arrange the wattmeter with its main coils in series with the arrangement, and its shunt so that it can be connected to the terminals of either the non-inductive or the inductive load. The connections are shown in Fig. 1. The voltmeter should preferably be of the electrostatic type to avoid errors due to shunting, and the condenser should be connected directly in series with the moving coil without extra non-inductive resistance. If R is the normal resistance of the wattmeter shunt circuit (including the non-inductive resistance in series with it) and K is the capacity of the condenser in microfarads, the impedance of the instrument has been changed by replacing the non-inductive resistance by the condenser from R to $10^6/\mathrm{K}p$, since the resistance of the moving coil is usually negligible compared with the capacity reactance. If α is the angle by which the shunt current departs from 90 deg. lead, we shall evidently have, as the characteristic equation of the wattmeter with condenser in shunt, $\sin(\phi - \alpha) = \frac{10^6}{\mathrm{KR}p}\frac{w'}{\mathrm{VC}}$ where w' is the wattmeter reading on the scale of watts.

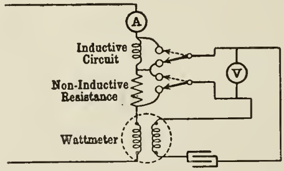

FIG. 1.

When the shunt is connected to the non-inductive resistance $\phi = 0$ and $-\sin\alpha = \frac{10^6}{\mathrm{KR}p}\frac{w_1'}{\mathrm{V_1C}}$ if w_1' is the reading, while on connecting over to the ends of the load

$$\sin(\phi - \alpha) = \frac{10^6}{\mathrm{KR}p}\,\frac{w_2'}{\mathrm{V_1C}}.$$

Since α is small, $\sin(\phi - \alpha) = \sin\phi - \alpha\cos\phi$, and

$$\sin\phi = \frac{10^6}{\mathrm{KR}p\mathrm{C}}\left(\frac{w_2'}{\mathrm{V_2}} - \frac{w_1'}{\mathrm{V_1}}\cos\phi\right);$$

or, denoting the factor $10^6/\mathrm{KR}p$ by A,

$$\sin\phi = \frac{\mathrm{A}}{\mathrm{C}}\left(\frac{w_2'}{\mathrm{V_2}} - \frac{w_1'}{\mathrm{V_1}}\cos\phi\right).$$

Since w_1' is very small we may take the approximate value for $\cos\phi = \sqrt{1 - \mathrm{A}^2\frac{w_2'^2}{\mathrm{V_2^2C^2}}}$ and

$$\sin\phi = \frac{\mathrm{A}}{\mathrm{C}}\left\{\frac{w_2'}{\mathrm{V_2}} - \frac{w_1'}{\mathrm{V_1}}\sqrt{1 - \mathrm{A}^2\frac{w_2'^2}{\mathrm{V_2^2C^2}}}\right\}.$$

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[*] "The Measurement of Small Differences of Phase," by W. E. Sumpner, D.Sc., *Phil. Mag.*, January, 1905.

[†] "Wattmeter Methods of Measuring Power Expended upon Condensers and Circuits of Low Power Factor," by E. B. Rosa, *Bulletin* No. 3, Bureau of Standards, Washington.

[‡] "The Theory and Use of the Alternate-current Wattmeter," *The Electrician*, March 15, 1901.

For circuits of high power factor $\cos\phi$ is approximately unity, and

$$\sin\phi=\phi=\frac{10^6}{\mathrm{KR}p\mathrm{C}}\left(\frac{w_2'}{V_2}-\frac{w_1'}{V_1}\right),$$

an expression which may be used in testing most ordinary loads. The more complete expression is, however, sometimes useful in short-circuit tests on transformers, &c., where the power factor lies between 0·7 and 0·9.

Owing to the great convenience of this method of testing, the writer has had an additional terminal fixed on portable wattmeters, such as the Western type, and has arranged them with a condenser, the reactance of which on a 50 ~ circuit is approximately equal to the total normal resistance of the shunt circuit. By determining once for all the angle a, which may be done by finding the reading on a non-inductive load, and connecting the current and volt leads as shown in Fig. 2, we are able to test any phase difference we please. For circuits of power factor below 0·7 the switch may be on the bottom stop, and the wattmeter used in the ordinary way, giving us $\cos\phi=w/\mathrm{VC}$, while for those of higher power factor it is switched over to the condenser and $\sin(\phi-a)=\mathrm{A}\dfrac{w'}{\mathrm{VC}}$. Much more accurate results in testing the regulation of transformers may be obtained by this device.

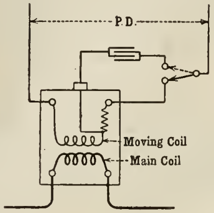

Fig. 2.

Objection may be made to this method of testing, in that the condenser introduces errors by magnifying the harmonics in the P.D. wave. To this it may be replied that tests of phase difference, unless made on circuits of sinusoidal wave form, have very little meaning. As a general rule, when only a small phase difference is produced little distortion of wave form occurs, so that if the main voltage curve is approximately sinusoidal little error will be introduced. An exception to this rule is in the case of electrolytic valves, in which the power factor is large and great distortion exists. The writer is not aware that any other method than the determining of the true and apparent power is correct in such cases, unless the wave forms are harmonically analysed and calculated out, which is obviously equally applicable to this method.

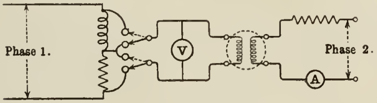

Fig. 3.

Use of Two-phase Supply.—Wherever two-phase supply is available, as from an inverted rotary converter, &c., the testing of phase differences is much simplified. Fig. 3 shows the arrangement which the writer has frequently employed, with good results, for determinations on circuits of high power factors. In this case the wattmeter is used in its ordinary state, without any modification of its connections. If the difference of phase between the circuits were exactly 90 deg. we should not require the non-inductive resistance in series with the load, and we should simply have $\sin\phi=w/\mathrm{VC}$. As this difference of phase may not be exactly 90 deg., and will be modified by the load on the first phase, it is better to take readings on both the inductive and non-inductive loads, and we then have, when the load is only slightly inductive,

$$\sin\phi=\phi=\frac{1}{\mathrm{C}}\left(\frac{w_2'}{V_2}-\frac{w_1'}{V_1}\right),$$

where w_1' and V_1 are the wattmeter, and voltmeter reads for the non-inductive resistance, and w_2' and V_2 the corresponding readings for the load under test. The method of working out for large phase differences is obvious from what has been said above.

Determination of Small Phase Differences at any Power Factor.—It is often of the greatest value to be able to determine the small phase difference introduced by, say, a transformer or shunt on a circuit at any power factor. For this purpose the best method is to employ a wattmeter, and to arrange by some means that the currents in the two coils are approximately in quadrature. One of these coils has a current of fixed value and phase in it, while the other is transferred from one of the circuits whose phase difference is to be determined, to the other. The arrangement is identical with Fig. 3, except that some means must be introduced of varying the phase of the circuit 2 to anything desired. This may, of course, be done by inductances or condensers; but the writer has found it much more convenient to employ a phase-shifting transformer for the purpose, of the form devised by him in 1901. Similar transformers are now commercially obtainable on the Continent. A two or three-phase supply is fed into a primary, like the stator of a two-pole induction motor, while the secondary consists of a rotor, wound with a single diametral winding. The polyphase supply produces a rotating field in the rotor, and the voltage of the rotor is consequently the same in all positions, but changes in phase by the same angle as the rotor is turned through. This arrangement is most convenient for testing wattmeters and supply meters, and, indeed, for a very large number of alternate-current tests.

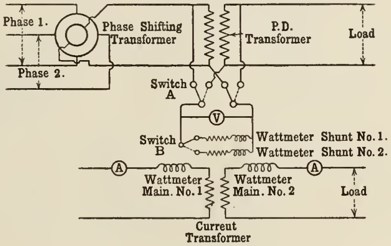

Fig. 4.

In testing small differences of phase by this method the secondary of the phase-shifting transformer is substituted for phase 2 in Fig. 3. The rotor is turned until practically no deflection is given on the wattmeter with the throw-over switch on one position. On throwing over the switch the deflection alters, if there is any difference of phase, and we have $\triangle\phi=\phi_2-\phi_1=\dfrac{1}{\mathrm{C}}\left(\dfrac{w_2'}{V_2}-\dfrac{w_1'}{V_1}\right)$ as before.

This arrangement serves for all measurements of differences of phases of voltages, and also of currents, if it is permissible to introduce non-inductive resistances in series with the circuits over which the drop can be taken. In some cases, however, such resistances cannot be used, notably when current transformers are used with instruments. One cannot change the main coil of the wattmeter over from one circuit to another, but this difficulty is overcome by the use of a double wattmeter. The writer has had several of these instruments constructed for polyphase power measurement, and care has, of course, been taken to get absolute identity of sensitiveness in the two systems and non-interference with one another. Fig. 4 shows the arrangement which has been adopted for measuring the phase differences introduced in both the P.D. and the current by instrument transformers. By changing over the switch A the shunt of the wattmeter is transferred from the primary to the secondary terminals of the voltage transformer, while the changing over of switch B completes the shunt circuit of one or other system, and gives the difference of phase between the primary and secondary currents of the current transformer. The phase-shifting transformer enables the P.D. and currents to be set to approximate quadrature whatever the nature of load. The procedure and simple calculations required are obvious. Where the ratio of transformation is at all high it is advisable to use a pair of step-up and step-down transformers instead of single transformers.

(*To be concluded.*)

GLASGOW CORPORATION ELECTRICITY SUPPLY.

The annual report of the Electricity committee of the Corporation of Glasgow records a considerable increase of activity in all directions during the past year. This is well shown by the fact that the maximum load on the generating stations shows an increase of 21·3 per cent. over that of the previous year. The total number of consumers has increased by 17·7 per cent. and the total horse-power of motors connected to the mains has increased by over 27 per cent. The financial results are generally satisfactory. Notwithstanding the reduction in the charges for current, which came into force during the year, the committee have been enabled to meet working expenditure, interest on loans, the increased contribution to the sinking fund and to provide for depreciation on the same scale as last year. The following extensions of plant have been made during the year under review.

Port Dundas Station.—This generating station has now had installed the two 4,500 H.P. turbo-generators referred to in last year's report, with the necessary switch gear and connections. These turbines were running during the past winter, and were a great help to the department in meeting the increased demand. Four additional boilers have been contracted for with the Stirling Boiler Co., are in course of erection and are expected to be in operation during the coming winter. These boilers will be required in connection with the additional 4,500 H.P. turbo-generator, which has also been contracted for, and is in course of erection. High-tension switch gear in connection with this alternator and with feeders to Springburn has also been placed. Coal and ash-handling plant has been erected, and has not only increased the working facilities, but has decreased the working costs.

Pollokshaws-road Station.—At this generating station six additional Babcock & Wilcox boilers along with economisers are in course of erection. Induced-draught fans to increase the output of the boilers, and so help to meet sudden demands in foggy weather, have also been installed. Two 4,500 H.P. turbo-generators are to be placed in this station, and this has rendered necessary the addition of blowing fans to the cooling towers in order that their capacity may be increased.

Waterloo-street Sub station.—The extension of this sub-station and offices is not yet completed, but so soon as the sub-station is ready, which is expected to be in the course of a month, three 1,000 kw. motor-generators, with the necessary switch gear for alternating and direct current, which have already been contracted for, will be installed.

Dalmarnock Sub-station.—To meet the growing demand for current in the Bridgeton district, this sub-station will shortly have added to it one 1,000 kw. motor-generator set with the necessary switch gear. This sub-station is at present supplied by the tramways department through their Whitevale sub-station, but a high-tension supply will be available from the Pollokshaws-road works when the turbo-alternators are in operation.

Cathedral-street Sub-station.—Two additional 1,000 kw. motor-generator sets, with the necessary switch gear, will be added.

Springburn Sub-station.—In addition to the above sub-stations it has been found that, owing to the large demand for current in the Springburn district, principally by large industrial works, it has been necessary to erect a sub-station in this district. Ground has accordingly been acquired at the corner of Flemington and Ringford Streets, and the sub-station thereon is rapidly approaching completion. Three 1,000 kw. and two 500 kw. motor-generator sets, with the necessary switch gear, have been contracted for and will be erected as soon as the station is ready. This station will be in operation during the coming winter. Eleven miles of feeder have been laid during the year on the north side of the river, and about 2 miles on the south side of the river, while about 11 miles of distributing main have been laid on the north side of the river and 7 miles on the south side, exclusive of 466 yds. of distributing main laid in Kinning Park.

The table below gives an analysis of the costs reduced to pence per unit sold:—

	Year ending May 31, 1905.	Year ending May 31, 1906.
Units sold for private lighting	11,936,224	13,345,666
Units sold for power purposes	4,706,029	6,575,496
Units sold for public lamps	1,525,505	1,525,505
Units sold by contract	80,710	89,758
Total units sold	**18,248,468**	**21,536,425**
COSTS PER UNIT SOLD.		
GENERATING COSTS.		
Coal	0·215d.	0·223d.
Oil, waste, water and stores	0·034d.	0·032d.
Wages and salaries	0·092d.	0·103d.
Repairs and maintenance	0·055d.	0·079d.
Sundries (including purchase of a small proportion of units from the tramway dept.)	0·101d.	0·071d.
	0·497d.	0·508d.
DISTRIBUTING COSTS.		
Wages and salaries	0·027d.	0·025d.
Repairs, stores, &c.	0·097d.	0·108d.
Maintenance, &c., of public lamps	0·045d.	0·039d.
	0·169d.	0·172d.
TOTAL WORKS COSTS	**0·666d.**	**0·680d.**
MANAGEMENT CHARGES.		
Rents, rates and taxes	0·182d.	0·237d.
Salaries, stationery and establishment charges	0·094d.	0·102d.
Special charges incidental to change of voltage	0·038d.	—
	0·314d.	0·339d.
TOTAL COSTS (excluding capital charges)	**0·980d.**	**1·019d.**
Interest	0·502d.	0·474d.
Sinking fund	0·204d.	0·224d.
Depreciation	0·550d.	0·424d.
	1·256d.	1·122d.
TOTAL COSTS (including capital charges)	**2·236d.**	**2·141d.**

It will be noticed that we have given these figures in a slightly different form from our analysis of last year (*The Electrician*, Vol. LV., p. 663) in order to make the table more complete. The total working expenses as analysed above came to £91,416 and the receipts amounted to £195,842, giving a balance of £104,426. Of this, £37,990 was charged to depreciation, £42,486 was absorbed in interest and £20,142 was carried to Sinking Fund, leaving finally a profit of £3,808, which was carried to Reserve. It is interesting to observe that although the working expenses per unit sold have slightly increased since last year, the capital charges, in view of the much greater number of units sold, appear less; so that the total cost per unit sold comes out slightly less. As, however, the price charged to consumers has been considerably reduced, the receipts per unit sold have fallen from 2·45d. to 2·19d. with the result that the final profit is only £3,808 instead of £69,934, which was the figure for the previous year.

The total units generated during the year (including the 1,406,243 units purchased from the tramways department) amounted to 25,758,521. Of this, 1,529,148 units were used on the works and 2,692,948 lost in distribution or otherwise unaccounted for. The total maximum supply demanded was 16,304 kw. and the total plant capacity of the three stations is 20,335 kw. The quantity sold for heating purposes was 48,607 units. The power factor works out at 15·0 per cent.

The following table gives an analysis of the capital expenditure up to May 31, 1906 :—

Account.	Total May 31, 1906.	£ per kw.	Per cent. of total.
Land and buildings	£211,172	10·30	15·4
Machinery	324,821	15·86	23·7
Accumulators	11,087	0·54	0·8
Mains	768,447	37·47	56·2
Meters	47,207	2·30	3·5
Electrical instruments	1,417	0·07	0·1
Stores	1,832	0·09	0·1
Furniture	2,151	0·10	0·2
Total	£1,368,134	£66·73	100·0

THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.*

BY K. REINHARDT.

(*Continued from page 693.*)

Double-acting Four-cycle Engine by Ehrhardt & Sehmer, Schleifmühle.—Ehrhardt & Sehmer are licencees of the Gasmotorenfabrik Deutz. Their gas engines are constructed, as those of the latter, with quantity governing, but in other respects they have not retained the outer arrangement of the Deutz engine, for instance, with respect to the operation of the mixing valve. The inlet valves and mixing valves are in a similar erection in the longitudinal axis of the cylinder, as is the case with the Nürnberg engine, with this exception, that in the Ehrhardt & Sehmer engine each valve, including the mixing valves, is operated by a round-back cam.

The mixing valves are, according to information received from the firm, arranged in such a manner that, for working with various gases, the area of the valve passage can be varied.

The cylinders have large water-cooling spaces. They and the water-jacket are cast in one piece, and are, as in the case of the Nürnberg engine, supported by the frames, by the distance piece between the cylinders and by the back guide. The outlet valves can be removed, with their casings, without disconnecting the piping, the space under the cylinders being entirely free. It will be seen from the figures that all the details of this engine are well made and of strong proportions.

Double-acting Four-cycle Engine by the Märkische Maschinenbau-Anstalt, Wetter-Ruhr.—The Märkische Maschinenbau-Anstalt is the licencee of the Belgian firm, Cockerill, and adheres to their design.

The massive frame supports the guides between two high cheeks, which in tandem engines are continued to the back cylinder, and the stresses are thus transferred to the crank-shaft bearing. Less objection can be made to this manner of construction than to the retention of the class of cylinder heads that are so liable to fracture—even though they are closed with a cylinder cover—and to the construction of such cylinder heads, each cast in one piece, with one of the cheeks of the frame. Cockerill themselves discarded this construction in the engines they exhibited at the International Exhibition of Liège, whilst they no longer construct the cylinder heads, nor cast the cylinder together with the side cheeks of the frame.

The outer casing is divided in the middle and closed by a ring which is slipped over and made tight by short stuffing boxes. The valves are operated by cams and roller levers.

Up to the present time the Märkische Maschinenbau-Anstalt have built their engines with quality governing; they propose in the future to employ the quantity method of governing.

The arrangement for admitting the water for cooling the pistons is very carefully designed. Water is admitted by means of a combination of a turned tube with a telescope sliding-pipe. The water is conducted away from the piston rod by a pipe, screwed into the piston rod, which travels backwards and forwards in a slot in the cover of a trough. To remove the exhaust valve the whole valve casing must be disconnected from the pipe.

Double-acting Four-cycle Engine by the Elsässische Maschinenbau-Gesellschaft Mülhausen.—This firm originally, as the licencees of the company, also constructed engines of the Cockerill type ; latterly, however, they have entirely modified their designs.

Two such engines, each of 1,500 H.P., have been working for a considerable time at the Differdingen Ironworks, and are remarkable for their steady running. The frames consist of two girders, symmetrical with the longitudinal axis of the engines, joined together by cross pieces, which join the massive flanged ends of the frames to the crank-shaft bearings, whereby the stresses caused by explosion are transmitted to the crank-shaft bearing, without any bending moment, in the vertical plane symmetrical to the side girders. Between these two girders the water-cooled guides are situated.

Both the gas cylinders and the blowing cylinder are joined together by concentric distance pieces, open at the top and strengthened with tie-rods ; and foundation support is given only at the distance pieces and the blowing cylinder.

The gas cylinders resemble those of the Gasmotorenfabrik Deutz in the manner in which they are cast. The liner and the jacket are cast together ; the latter is open in the middle for about one-third of its length, and closed by a ring cast in two parts. The pistons of the gas engines are of cast iron, in one piece, and fixed to the rods by means of nuts. The circulation of the cooling water takes place from a telescope pipe, with inlet in the front piston rod and outlet over a trough in the back distance piece.

In this manner the pistons are water-cooled in a very effective manner, but a higher pressure is necessary than when each piston is cooled separately.

The gas pistons can be very easily removed by detaching the crosshead, the couplings and the cover, whilst the front piston can be taken out at the front, and the back piston at the rear in the distance piece between the gas and blowing cylinder ; the piston rod of the back gas cylinder is pushed into the hollow piston rod of the blowing cylinder.

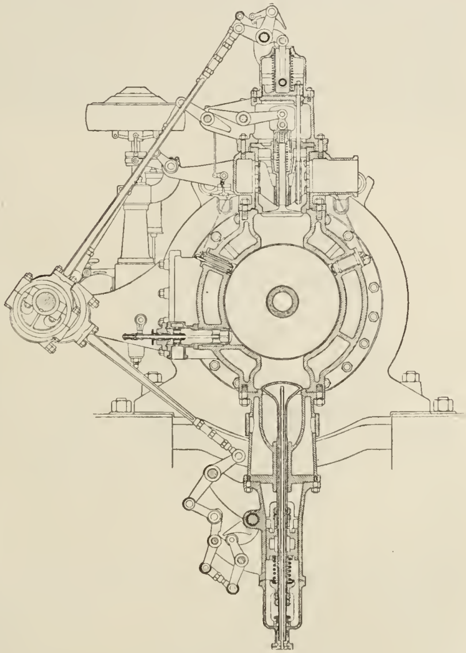

FIG. 15.

The governor regulates quantity governing in such a manner that it causes a mixing slide, opening with the inlet valve, to suddenly close sooner or later (Fig. 15). Around the slide is a circular chamber, divided by a partition into two halves, one of these being in communication with the air and the other with the gas. So long as the mixing slide remains open it allows the inlet of air by one half of the chamber and gas by the other half. The mixture is formed by the motion of the air and gas together when passing the inlet valve, and is quite effective.

The gearing of the inlet and outlet valves is controlled by an eccentric and roller levers, and the outlet valve is opened and closed with a restricted motion, and after closing it is kept closed by the action of only a short strong spring (Fig. 15).

The blowing cylinder is water-cooled, and provided with suction and pressure valves on the Hörbiger & Rogler system, and the piston is rendered tight by two piston rings, made in halves and lined with white metal, and pressed against the walls of the cylinder by springs. To render an increase of the air pressure possible (in this case from 0·5 to 1 atmosphere) the covers of the blowing cylinders are provided with chambers, which can be put into communication with the cylinder by means of valves operated by hand. Thereby the clearance spaces are increased, and, for an equal load of the gas engine, a corresponding higher pressure with a smaller quantity of air per revolution is attained.

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* Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on July 24th. Slightly condensed.

For this increase of air pressure three steps from 0·5 to 1 atmosphere are provided for by three chambers in the covers. A fourth chamber is arranged with a special valve as a circulating space for starting the engine with a relieved load.

Double-acting Four-cycle Engine by Fried. Krupp Aktien Gesellschaft, Essen-Ruhr.—This motor, which this firm has several times constructed for their own use, is worthy of notice, owing to the arrangement of the valves and the construction of the cylinder.

Both the inlet and the outlet valves are situated above the cylinder, in its longitudinal axis, together in the same cast-steel valve chamber (Fig. 16). As compared with the outlet valve situated under the cylinder, the advantage of the easy accessibility by direct lifting by a crane or traveller, of the possibility of easily examining the whole of the valve motion, as well as of the unbroken foundation bedplate, is very obvious.

The cylinder liner is provided with short shoulders to receive the valve chambers, inserted into the jacket, which is open at the top, and at the front end is bolted to the same; while at the other end the liner and the jacket are made tight by a short stuffing box, in such a manner that the liner is free to expand independently.

In this construction of cylinder the stresses caused by heat, that usually occur when the liner and the jacket are cast together, are avoided. The cylinder is fixed to the frame by means of massive attachments cast on to the jacket. The quantity method of governing is adopted.

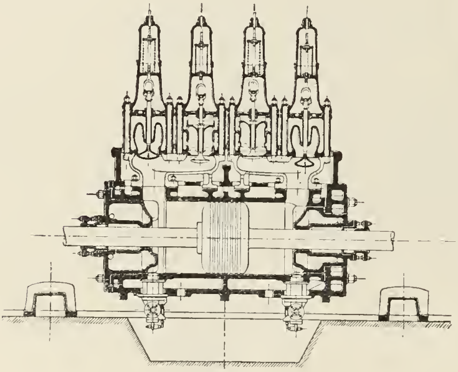

Fig. 16.

Double-acting Four-cycle Engine by the Gutehoffnungshütte, Oberhausen.—The Gutehoffnungshütte, in addition to two-cycle engines on the Körting system, also builds four-cycle engines.

Their type of engine is represented in Fig. 17.

The arrangement of the frame of the cylinder, cover and distance pieces has already in several instances been described.

One of the inlet valves above the cylinder and one of the outlet valves situated under the cylinder are operated by the same cam with roller levers.

The outlet valve can be removed without disconnecting the piping. The mixing valve for quantity governing (Fig. 17) is situated at the side of the inlet valve, and is brought into action by a release mechanism actuated by the governor. For the admission of air and gas there are two circular slides on the same axis, so arranged that their openings can be separately regulated to obtain the best mixing during the working of the engine.

Double-acting Four-cycle Engine by Schüchtermann & Kremer, Dortmund.—The Schüchtermann & Kremer engines, in the construction of which the author has participated, differ from other types, principally by the outlet valve being placed at the side of the cylinder in order to be more accessible, and by the above-described system of governing for producing a constant quantity of mixture and constant compression (Fig. 8). Both arrangements have given good results.

Double-acting Four-cycle Engine by the Maschinenbau-Aktiengesellschaft Union, Essen-Ruhr.—The construction of this engine is characterised by the above-described Reichenbach valve gear, and also by the manner in which the cylinder is constructed. The outer jacket is partly open in the middle in a manner similar to that of the Gasmotorenfabrik Deutz engine, and covered by a plate cylinder; further, the jacket near the two end flanges is split after casting, and rendered tight by joints of rubber cords and wire. Thereby conflicting stresses of the inner liner and of the outer jacket, caused by their different temperatures, at least in a longitudinal direction, are avoided, and also of the flanges. These flanges transfer the stress due to explosive action, by massive points, to the liner only. One inlet valve and the corresponding outlet valve are operated by an eccentric with roller levers. The inlet valve is, indeed, unnecessarily cooled. It is stated by the makers that the hollow disc of the outlet valve can be withdrawn through the cylinder by removing a screw. In large gas engines the mixing valve should not be automatic, but moved by the valve-gear shaft, and placed nearer to the inlet valve in order to avoid a large reserve of mixture.

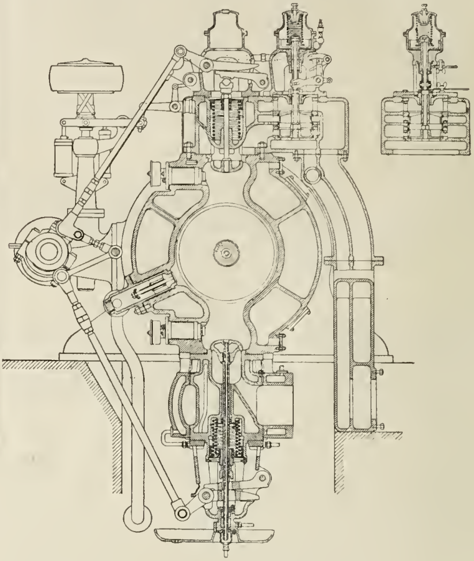

Fig. 17.

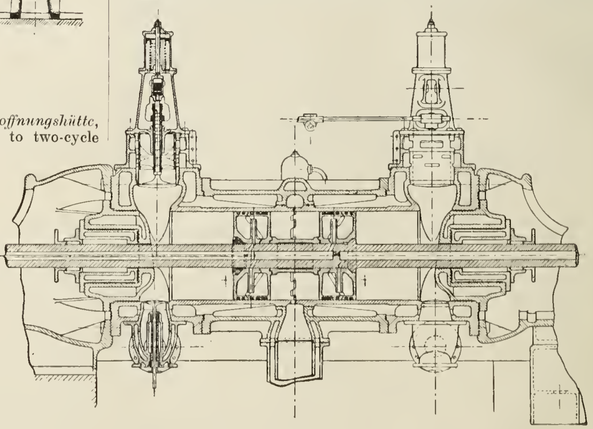

Fig. 18.

Double-acting Four-cycle Engine by the Duisburger Maschinenbau-Aktiengesellschaft, formerly Bechem & Keetman, Duisburg.— This engine is noteworthy in many ways. It has at the top of each end of the cylinder an inlet valve, and vertically under the same an outlet valve, arranged in such a manner that the common axis of the valves is far enough to the side of the piston rod to allow the outlet valve, with its spindle, to be lifted up without hindrance when the inlet valve and its seating has been removed.

Further, a closed link motion, automatic in action, with the working piston as used in two-cycle engines, is employed, as well as an outlet valve for the exhaust of the burnt gases (Fig. 18), so that, at the end of each explosion stroke, the special piston, composed of three parts, first opens short slots, thereby the pressure of the gases is equalised to that of the atmosphere, and only afterwards is the outlet valve allowed to open. It is clear, without further comment, that by this means the outlet valve is released before lifting, and that the exhaust valve chamber and the piping connected therewith are no longer exposed to such high temperatures.

It appears to me to be doubtful, however, whether, in the first place, the outlet valve can really be made much smaller, in the manner claimed by the builders, without causing a too high back pressure during the whole length of the exhaust stroke; and whether, secondly, it is not necessary, also, to cool the outlet valves in larger engines; because, if the gases passing through the outlet valve are no longer so hot as with other four-cycle engines, yet this valve is situated in the explosion chamber, without, as is the case with the inlet valve, being cooled by the fresh entering mixture

The distance between the outer piston ends must be equal to the stroke of the engine, and for this reason the engine must be considerably longer than the first described four-cycle engines.

The idea of exhaust slots or ports controlled by the piston in four-cycle engines is not new, since it has been taken into consideration by most builders of the newer types.

The valves are operated by cams with the aid of roller levers, and the method of governing is by quality. The quantity method could not be employed, because with a light load, combined with a corresponding back pressure in the cylinder towards the end of the suction stroke, it would cause too large a return flow from the exhaust pipe through the slots.

According to the builders, the combustion, in spite of the quality governing, is complete at all loads. They attribute this to the peculiar form of the combustion chamber, which should bring it about, that after ignition the portions of the charge that are not yet burning are put into motion and are directed into paths which lead to the portions which are already burning.

As may be seen from Fig. 18, the cylinder consists of three principal parts, an outer jacket strongly held in the middle, in which from both sides a liner, cast in one piece with the valve chamber facings and a strong flange for bolting to the jacket, is inserted, so that the two cylinder liners meet with a small clearance in the exhaust slots. In the longitudinal axis of the jacket, for this reason, no tensile or compressive stresses can appear.

(*To be continued.*)

STANDARDISATION IN BRITISH ENGINEERING PRACTICE.*

BY SIR JOHN WOLFE BARRY, K.C.B., F.R.S.

In treating the subject of standardisation in engineering practice a place of honour must be accorded to Sir Joseph Whitworth, who was mainly instrumental in bringing home to the engineering world the advantages to be gained by standardisation. Sir Joseph Whitworth's favourite illustration when urging the necessity for standardisation was that of candles and candlesticks, which came home in the early eighties to every user in a way which it may not do in the present day, when so many of us are accustomed to light our rooms by merely turning on a tap or a switch. Sir Joseph Whitworth said: "Candles and candlesticks are in use in almost every house, and nothing could be more convenient than for the candles to fit accurately into the sockets of the candlesticks, which at present they seldom or never do." The lesson taught by his illustration lies at the root of standardisation, and necessarily carries with it the restriction of the few to the advantage of the many. Broadly speaking, there is no reason why the candle maker should not make the ends of his candles to any design and shape which may be most convenient to himself, and the candlestick maker might adopt any form of socket in his candlestick which he may desire. Obviously the multiplication of sizes and shapes of candles and sockets is not to the advantage of the general user, while a restriction to a sufficiently wide range of sizes to suit all practical purposes is to the advantage of the user, and consequently must result ultimately to the advantage of the manufacturer. The principle underlying the above homely illustration is applicable to all engineering practice, and lies at the root of the work which the Engineering Standards Committee has been formed to carry out.

The opposition he met with in many quarters from those who thought that the maintenance of some particular form of screw-thread would ensure customers returning to them for repairs, &c., is well known, and it was some years before the series of threads introduced by Whitworth could in any sense be said to have been universally adopted as standards.

The department in which Sir Joseph Whitworth's work took practical shape was in connection with the series of screw-threads introduced by him, which have now come to be regarded as the standard threads almost universally. So advantageous is the existence of standard sizes that the Whitworth series, though based on the inch, are largely used even in countries where the metric system is in vogue.

FORMATION OF THE ENGINEERING STANDARDS COMMITTEE.

It had long been felt that a great waste of time and money was occurring in the rolling mills throughout the country by the use of an unnecessary number of varying sizes and shapes of angles, channels, tees, bars, rails, &c. The want of some recognised and important body to lay down authoritative standards was emphasised on my mind by some remarks by Lord Salisbury in his reply to the deputation, of which I formed one, who waited upon him at the Foreign Office in February, 1897, to urge the establishment of the National Physical Laboratory.

Enquiries among engineers and manufacturers of steel convinced me that though there was not complete unanimity, there was a great preponderance of opinion that it was high time that in the interests of the nation, as also of the manufacturers, an effort should be made to simplify and economise the cost of production. The need of some action to lay down authoritative standards, at least in manufactured steel, was, amongst other similar communications, forcibly expressed in a letter received by me from Mr. John Strain, the chairman of the Lanarkshire Steel Works, in 1900, and I was gradually led, both on general lines, as well as by particular instances, to suggest, in January, 1901, to the Council of the Institution of Civil Engineers that a committee be appointed to consider forthwith the advisability of standardising, in the first instance, various kinds of iron and steel sections. My motion was carried, and the original committee consisted of seven members—viz., Sir Benjamin Baker, Sir Frederick Bramwell, Sir Douglas Fox, Mr. J. A. McDonald, Mr. James Mansergh, Prof. Unwin, and myself, all of whom were members of Council of the Institution of Civil Engineers. At their first meeting in February, 1901, the late Mr. James Mansergh, who was then president of the Institution of Civil Engineers, was appointed chairman, which post he occupied till his lamented death in 1905, and Dr. Tudsbery, secretary of the Institution, was nominated as hon. secretary.

It was decided at this meeting to recommend that the Council of the Institution of Civil Engineers alone should not attempt to deal with so far-reaching a matter, but that the Institution should approach the Councils of the Institution of Mechanical Engineers, the Institution of Naval Architects and the Iron and Steel Institute, inviting them to nominate members on the committee. This invitation was accepted, and the Committee thus constituted met for the first time in April, 1901. Mr. Leslie Robertson was appointed as secretary, and to his indefatigable exertions the movement is very greatly indebted.

At a later date it was decided to enlarge the reference to the Committee, and the Institution of Electrical Engineers was approached and invited to co-operate with the other four institutions, which invitation they accepted. Thus constituted, and supported by the five leading technical institutions, the Engineering Standards Committee has gradually grown from one committee with seven original members till at present it numbers 36 committees with about 260 members, and the number of subjects dealt with has increased from the original matter of the standardisation of iron and steel sections to no less than 30 different subjects, entailing the preparation of about 75 different specifications and reports.

The whole work is controlled by what is known as the Main Committee, which is composed of the representatives of the five institutions referred to above, and to this Committee falls the entire organisation of the work, the raising of the necessary funds, the controlling of the expenditure, the arranging of the subjects to be dealt with by the various sectional and sub-committees, and the passing of all reports prior to publication.

Under the Main Committee there are 12 sectional committees appointed by the Main Committee, and 24 sub committees appointed by the Sectional committees.

In the initial stages the funds necessary for carrying on the work were supplied entirely by the supporting institutions; but it was recognised at an early date that the support and countenance of His Majesty's Government would be invaluable to the movement, and also that the various Government departments, who were large users of the materials for which standards were being drawn up, should be asked to support the committee by nominating representatives to assist in their deliberations and by the adoption of the Committee's standards when issued. With this object the Committee approached His Majesty's Government, and at the instance of Mr. Arnold Forster (who was then Parliamentary Secretary to the Admiralty) an interview was held with Mr. Balfour, who accorded them a most favourable reception, and stated that he was convinced that the public advantages of standardisation were so great that no one could have any doubt of the importance and magnitude of the subject. He intimated that the financial support sought by the Committee would be forthcoming, and, further, that the findings of the Committee would, as far as possible, be adopted for use in the Government departments, and that they should be further supported by the appointment on the various committees of engineer officers representing different Government departments.

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* Paper read before the British Association (Section G), at York, on Friday, August 3rd.

Subsequently, a deputation was requested to wait upon the President of the Board of Trade in regard to the definite financial support of His Majesty's Government, and as a result of this interview the Treasury included a sum of £3,000 in the estimates for 1903-4 as a contribution to the funds of the Committee for that year. At a later date they agreed to extend their financial support over the two following years by giving the committee a grant in aid equal to the amount contributed by the supporting institutions, manufacturers and others. They have further agreed to continue the grant on a reduced scale to the end of the financial year 1908-9. The view of the Government was that though standardisation deserved their support as large consumers, and from the point of view of its being a national matter in the competition of this country with foreign nations, it was also very distinctly to the private advantage of individual manufacturers, and they rightly made it a condition and measure of their support that manufacturers and private companies who were large consumers should also provide financial assistance.

The leading manufacturers, railway and other companies, who it was felt would be materially benefited by the work of the committee, were accordingly asked to assist the Committee not only in the nomination of gentlemen to serve on the various committees, but also to contribute towards the finances required to carry on the work, and to this appeal a liberal response has been received.

The Indian Government has also made a grant of £1,000 towards the general expenses of the Committee in recognition of work done in the interests of that country, and especially in regard to the report on the Standardisation of Indian Locomotives which received the approval of the Secretary of State for India.

The Secretary of State for India in Council has since asked that the Locomotive committee may be made a permanent body, for the purpose of considering questions remitted to them from time to time by the railway board in India, which request the main committee has acceded to, and the Indian Government has undertaken to defray the expenses incurred by the committee in the preparation of reports on any subjects affecting India remitted to them.

Though in this country we are not so liberal in the support accorded to scientific investigations as some foreign governments are, yet the financial support accorded to the committee, as also the recent extension of their grant to the National Physical Laboratory form a worthy illustration of how the financial support of an enlightened Government can be used to foster movements which redound to the good of the community at large.

Constitution and Method of Procedure.

As far as possible the committees have been so constituted as to embrace among their number representatives of all interests involved—the Government departments, the specifying or consulting engineers, manufacturers, users, contractors and purchasers; and where any industries are controlled by trade associations, these associations have usually been requested to nominate official delegates on the committee. It has thus been practically ensured that those serving upon the committee can speak with full knowledge and authority on the subjects dealt with.

In order to obtain the necessary information upon which to base their decisions, and to have access to a wider source of information than would be available were it restricted to members serving on the committees, carefully prepared lists of questions for circulation to users and manufacturers throughout the country have been issued, and the replies to these questions have been collated, and on the results of these inquiries the Committee's decisions are largely based.

In a number of instances the Committee have not been content with written replies, but have summoned before them representatives of the trades involved, in order that evidence may be laid before them in greater detail; and in some instances meetings of a more public nature have been convened by the Sectional committees in order that a more widely-expressed opinion may be obtained on different points under discussion.

The specifications are usually, in the first instance, drafted by a sub-committee appointed by each Sectional committee, and when completed are sent up to the Sectional committee for their careful consideration. All specifications, after passing the Sectional committees, have further to go before the Main Committee prior to their publication. By this means the labours of the various committees are correlated, and any hasty legislation is avoided, and as far as possible the best interests of user and producer are safeguarded.

It was felt from the first that a most important point in any proper scheme of standardisation was to avoid the danger either of crippling invention or perpetuating forms or processes which in course of time might become obsolete. Accordingly it was recognised in the first motion made at the Institution of Civil Engineers that there must be provision for a continuance of the existence of the body which might be formed to take the matter in hand. It was not enough to standardise the most approved forms and processes of manufacture, but it was urgently necessary to provide for future improvements.

To carry out this view the Main and Sectional committees continue in existence after their reports have been made, and an opportunity is afforded once a year to the Sectional committees of revising the specifications issued by them, so as to ensure that the standard specifications are kept thoroughly apace with the progress made from time to time in engineering science, so that there should be no stereotyping of design or practice.

Standardisation of Shape and Form.

Standardisation may roughly be divided into two classes: that dealing with shape and form and that dealing with material. In regard to shape and form, the guiding principle of the Committee has been to place at the disposal of the engineer such shapes and sizes as may reasonably be needed by him to meet the general requirements of every-day work, and they have carefully avoided indicating to the engineer how and when these shapes should be used, or what particular strains should be allowed in the material composing them. The Committee have felt that this is a question entirely for the engineer, and that he alone must decide what stresses may be allowed in the structures which he is engaged in designing.

In one instance only have they departed from this principle, and that at the special request of the Secretary of State for India, who desired them to lay down certain specific types of locomotives for use on Indian railways, which it will be remembered, unlike the railways in this country, are under direct Government control.

As illustrating the graduation in the standardisation of shapes and forms, it may be mentioned that the committee have laid down 16 sizes of equal angles, 30 of unequal angles, 20 of bulb angles, 6 of bulb tees, 7 of bulb plates, 8 of Z bars, 27 of channels, 30 of beams and 20 of tees. Besides the above there are, advancing by 5 lb. at a time, 9 sizes of bull-headed rails from 60 lb. to 100 lb. per yard, 17 sizes of flat bottomed rails from 20 lb. to 100 lb. per yard, and 5 sizes of tramway rails from 90 lb. to 110 lb. per yard, with their corresponding sections having a wider groove for use on curves.

Standardisation of Material.

When the Committee commenced their labours it was not their intention to deal with the standardisation of material, but it soon became evident that assistance of a very real character could be rendered to the manufacturers of this country if high-class standard specifications were issued, covering the materials more generally used in engineering.

The multiplication of various specifications differing from one another often in unimportant details, but yet sufficiently divergent to preclude the unification of the process of manufacture, was a widely experienced difficulty, and one which the committee sought, by the issue of standard specifications, to remove. It was felt that if a high-class standard specification were generally acknowledged, it would inevitably have the tendency of improving manufacture and assisting British contractors to meet competition.

Advantages of Standardisation.

The advantages accruing from the work accomplished are now so familiar that we hardly realise their extent, and may be tempted to minimise their value.

It must, of course, be borne in mind that every advantage is accompanied in a lesser or greater degree by some disadvantage. For instance, should standardisation be pushed too far, it might in some instances stultify design or retard progress of invention; but provided that it is clearly understood that special circumstances must exist which warrant special designs, and as long as standardisation is confined to broad principles, and the standards laid down are sufficiently numerous, the advantages must immeasurably outweigh the disadvantages. Exceptional cases may no doubt exist where the use of some particular form of angle or channel is justified, and where the expense entailed in cutting special rolls, and delay in manufacture by the consequent changing of rolls, is warranted; but in the vast majority of cases an engineer can equally well use standard sizes without in any way cramping or impairing his design. In the case of steel, standard sizes are also very valuable to trade, as, since they avoid the necessity of cutting new rolls, they can be rolled to stock, thus obviating any interruption in process of manufacture or delay in delivery.

As a practical illustration the testimony of a large steelmaker in Scotland may be cited, who admits that since the introduction of standard sizes his firm has been able to break up some hundreds of tons of rolls, and by no means the least advantage gained is that in his works the process of manufacture is now no longer so constantly interrupted as it used to be, due to the frequent changing of the rolls to produce in smaller quantities the many special sizes asked for, without any corresponding advantage to the consumer.

A further striking illustration of the advantages of standardisation occurred in connection with the construction of the tramways of a large Midland city. An order for the rails (to be made in conformity with the British standard specification) was, in the first instance, placed with a Continental firm. From want of expedition and punctuality in making deliveries, and from failure to comply with the stipulated tests, &c., the Corporation and their contractors were placed in a position of considerable difficulty by the constructional work being brought to a standstill. This caused them to approach a British firm, who, having the "standard" rolls already cut, undertook to make a delivery within a few days, with the result that the Continental order was cancelled and transferred to the British firm.

Altogether orders have already been received for nearly 100,000 tons of these standard rails, probably representing a value of over half a million of money. Practically all the British firms of tramway-rail makers are now equipped with sets of rolls for the standard sections, and they are thus enabled to deliver such rails at very short notice, instead of, as was often necessary, having to spend several weeks in the preparation of new rolls. This is not only a great advantage to the purchaser, but also a considerable saving in expenditure to the maker, as the cutting of a set of rolls usually costs about £200.

The best interests of the community at large must certainly be served when articles of acknowledged and universally-used sizes can be produced with the minimum amount of expenditure and with the least possible delay in delivery.

Apart from its general influence on the expansion of trade, it is estimated that there will be a saving of some millions sterling to British manufacturers in reduction of cost of production by the standardisation of iron and steel sections alone.

Mention may be made of the work accomplished by the Sectional committee on screw-threads and limit-gauges, who, following in the train of Sir Joseph Whitworth, have standardised the shape and form of threads originally devised by him, and have added to his series of somewhat coarse pitches a finer series of pitches suitable for parts of machinery subject to vibration, &c., and more suited to meet the recent advances in engineering practice. They have further embodied in their findings the series of fine threads decided upon by the committee appointed by this Association.

Numerous instances might be cited of a similar nature, but these will suffice to indicate the general advantages accruing from the introduction of suitably chosen standards in this country.

With a view of introducing standardisation in its most efficient and stable form the Committee have decided to establish at the National Physical Laboratory at Bushy a series of gauges and templates to which all the templates throughout the country can be referred, and from time to time checked. Thus they have already established a standard series of templates for bull-headed and flat-bottomed railway rails, tramway rails and pipe flanges, and are hoping to add, at no very distant date, standard gauges for screws, both with the ordinary Whitworth pitch and the finer pitch referred to above. All these standards are made with the greatest possible accuracy, and are most carefully verified by measuring instruments at the Laboratory before acceptance. It is confidently hoped that by establishing a mechanical high court of appeal, unification and accuracy may be promoted throughout the country.

Mention might also be made of the research work which the National Physical Laboratory have accomplished at the request of the Sectional committee on electrical plant, with regard to insulating materials generally, the temperature rise in the field coils of electrical machinery, &c.

Owing to continuity of existence, we have now in the British Standards Committee a body to whom engineers and manufacturers can refer when they desire that subjects for standardisation should receive consideration, and, further, that this body is distinctly representative, drawing its members from all parts of the kingdom, and from every section of those affected, we can ensure continuity of policy and adhesion to the standards laid down from time to time by Government departments and public companies, which have never previously been obtained.

Though less apparent at first sight, perhaps one of the main advantages of the appointment of the Standards Committee has been the fact that it has provided an impartial tribunal of a very high technical order, where conflicting interests, often of large importance, and involving considerable financial considerations, can be thoroughly and impartially thrashed out. The accredited representatives of the various industries are certain of obtaining a patient hearing, and where divergent interests have to be reconciled, of arriving at a compromise best suited to meet the needs of both parties concerned.

A fact which I should like to touch upon before closing is the willing and gratuitous services rendered by the gentlemen, of the highest position in their various professions and trades, who serve with the greatest zeal and self-devotion on the various sectional committees and sub-committees. To attend the meetings of the committees they frequently have to travel long distances and devote very much time entirely at their own charges. I desire to bear testimony here to the invaluable services so ungrudgingly rendered by those serving on the various committees in the interest of standardisation.

It is impossible within the limits of this short Paper to cover the whole ground of the Committee's operations, but sufficient has, I think, been said to justify the existence of the Committee and the growth it has experienced, by showing the advantage which it has been able to confer upon those for whom its findings have been drafted.

Considering the short time which has elapsed since the issue of the first standard sections and specification, the success of the movement has been most marked and beneficial. It may be confidently predicted that the future effect of the movement will be greatly to the benefit of the nation.

WATER-POWER STATION AT LAUNCESTON, TASMANIA.

BY A. MARTINEK AND A. LAURI.*

Launceston has had a water-power station since 1896, but after six years' working, this proved to be of insufficient size and unsuited to the needs of the town. The water power was derived from the South Esk River, and the station contained five vortex turbines of 160 H.P. each, coupled to single-phase alternators, giving 2,000 volts at 92 periods. There were also five smaller turbine-alternator sets, each of 21 H.P., which were used for the arc lighting of the town, including in all 140 lamps, divided into four groups. In 1902 Mr. W. Corin, the borough electrical engineer, proposed to utilise to a fuller extent the power furnished by the Esk River, and a new scheme was decided upon. This consisted in replacing the old machines by others, of similar number, each to be of 500 H.P., and to deliver polyphase current at 5,200 volts. The change in voltage was considered necessary, seeing that the power station is at a distance of 3 miles from the centre of the town. The fall to be utilised was 34·5 metres. The water was brought through a tunnel, blasted out of the rock, 840 metres long, into two riveted steel pipes, each 62 metres long, which run in parallel to the power house. These pipes are 1·5 metres in diameter in their upper portion and 1·2 metres in the lower; they discharge into a common pipe at the power house, which is 1·85 metres in diameter. The turbines are of the horizontal type, working at 500 revs. per min. They are intended to take 1,400 litres of water per second and, assuming an efficiency of 80 per cent., they would then give 514 H.P. Their speed can be controlled from the switchboard by means of a motor. This method of regulation (see Austrian Patent No. 12,145) can only be carried out by the co-operation of both the switchboard and turbine attendants. There are also four smaller turbines for the exciters, each of which is sufficient for two of the alternators.

The three-phase machines have a normal output of 400 kw. at 5,200 volts. The rotating magnets have 12 poles; hence, at 500 revs. per min., the frequency is 50. They are wound with copper strip, standing on edge, the magnets themselves being of cast steel, with poles of circular section. The principal data of the machines are as follows: Diameter of rotor, 1,335 mm.; diameter of stator, 1,360 mm.; the stator winding consists of 36 coils, each containing 24 turns of wire of 4·8 mm. diameter; the insulation of the slots is composed of micanite tubes of 3 mm. thickness in the walls; and the velocity of the circumference of the rotor is 35 metres per second. The losses at full load with $\cos \phi = 1$ are as follows: In friction, 7 kw.; iron losses, 10 kw.; loss due to ohmic resistance of armature, 2·9 kw.; loss due to ohmic resistance of exciting coils on the magnets, 2·5 kw., making in all 22·4 kw. Assuming $\cos \phi = 1$, the efficiency at full load is 94·3 per cent., at three-quarter load 93 per cent., and at half load 90·4 per cent.; with $\cos \phi = 0{\cdot}8$, these figures respectively become 92·3, 90·8 and 88 per cent. The exciter dynamos have each an output of 14 kw., or of 255 amperes at 55 volts.

The main switchboard is placed along one of the walls of the building, having, however, a projecting space behind; consequently there is ample room behind the board for all high and low-tension apparatus used in connection with the main machinery, and also for switches and safety devices for the feeders. The alternators run in parallel on the high-tension 'bus bars, and they are switched on in the usual way by means of phase lamps. The paralleling of the machine is simplified by the device, already noticed, by which the switchboard attendant has control over the turbine regulators. On the panel controlling each machine is a three-pole high-tension switch, a three-pole high-tension safety device, which is of the horn type, a voltmeter, three ammeters, a wattmeter and a power-factor indicator. In the exciter circuits, both shunt and series resistances are provided. The distribution is effected by means of high-tension wires, arranged on insulators, which are supported on iron poles at the corners of an equilateral triangle. The distance from the power station to the main sub-station is 3 miles. The river, which is 80 yds. broad, has to be crossed in the immediate neighbourhood of the turbine station, and the cables have to be carried in one span across this distance. For this purpose silicon-bronze wires are used, which have a breaking strength of 61·11 kg. per square millimetre. The cables are led to a main transformer station in Launceston, whence current at low tension is distributed by means of three-core armoured cables. A pressure of 190 volts has been chosen as suitable for power purposes and of 110 volts for lighting. The immediate neighbourhood of this transformer station is lighted by means of a special transformer, the pressure of which is capable of a fine adjustment. Its capacity is 360 kw., and the pressure of its output can be varied by 10 per cent. It is arranged that the primary can receive current at pressures between 5,000 and 5,500 volts, and the secondary can give its output at pressures between 200 and 220 volts. The windings on the primary and secondary are arranged so that either can be shortened, as desired, by means of taps, which are brought out from points near the ends of the respective coils and led to a regulating board, which is arranged on the cellular system. The diagram shows the design of this regulator. The high-tension side can be controlled in 20 stages, while on the low-tension portion there are 10 steps. The transformer house is built on two floors; on the lower, the transformers are arranged, and on the upper the switchboards used in connection with the work of distribution are placed. The cables already existing have been utilised in connection with the extended system; naturally enough, they have had to be somewhat rearranged. Additions have also been made, particularly for motor purposes. At the present moment 121 motors are connected to the network, taking in all about 500 H.P. The street lighting is carried out entirely by means of alternating-current arc lamps, which are switched on and off from the main sub-station.

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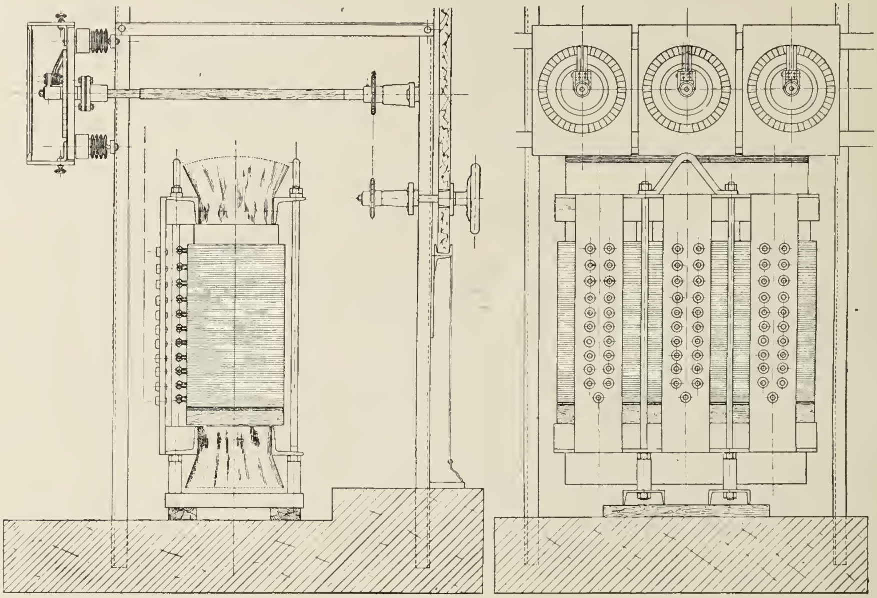
* Abstracted from the *Elektrotechnische Zeitschrift*.


Section. Elevation.

Regulator for Transformer.

The work of installing the machinery in the power station was one of some difficulty. The site was in a gorge through which the river ran. There was no means of access by road, but a telpher line was constructed, over which the various parts of the turbines and alternators were carried. A small suspension bridge has also been constructed for the use of the staff. The station has been working since January, 1905, the machinery being taken over after an exhaustive series of tests. The turbines were found to have an efficiency of 80 per cent. at full load, and of 81 per cent. at three-quarter load; the alternators at full load had an efficiency of 94 per cent., making an overall efficiency of 75·2 per cent., as compared with the guarantee of 73·8. With regard to the regulation, it was found on switching off, when the machines had half of their full load, that the speed altered by 2 per cent , a momentary variation of between 5 and 6 per cent. being observed at the instant when the load was thrown off. At full load under similar conditions the speed altered by 4 per cent., with a momentary variation of 12 per cent. The specification stated that the machinery was to be capable of standing an overload of 20 per cent., and that the maximum temperature rise after six hours' run at full load was not to exceed 72°F. As a matter of fact, it has proved to be capable of standing an overload of 30 per cent., and even at this output the temperature rise was only 36°F. Consequently the four machines already installed are capable of utilising the whole of the water which is at present delivered to the power station.

The whole of the work has been carried out under the supervision of Mr. W. Corin, who is the borough electrical engineer in Launceston, the contractors being Messrs. Kolben & Co., of Prague.

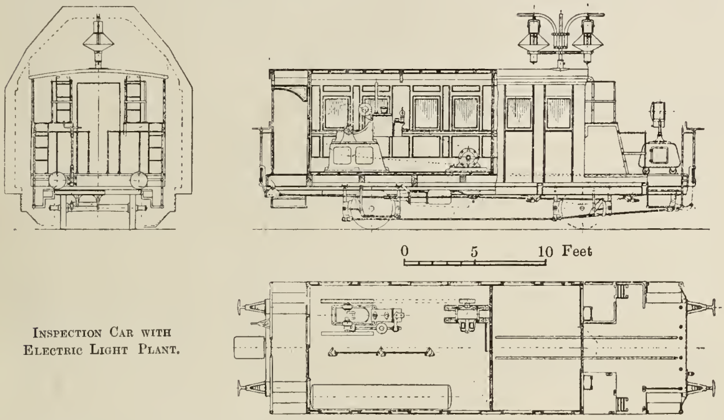
A TUNNEL INSPECTION CAR USED IN THE SIMPLON TUNNEL.

An inspection car fitted with a complete electric light installation which has been designed for the examination of the interior of the Simplon Tunnel and the periodical inspection of the overhead electrical equipment is described by S. Herzog in a recent issue of the *Schweizerische Elektrotechnische Zeitshrift.* The whole lighting plant carried on the car is entirely self-contained, as, in order to be of use in case of breakdowns to the traction supply, it was desirable to arrange its working to be quite independent of external sources of current.

The general arrangement of the car is shown in the accompanying figure. It is mounted on a two-axle truck and is fitted with Westinghouse brake as well as two independent hand brakes. All fittings are arranged so that it can be coupled on to any ordinary train.

The interior of the car contains the generating set, which is driven by a single-cylinder 6 B.H.P. slow-speed petrol engine running at 300 revs. per min. Two independent petrol tanks are provided, each of which contains sufficient fuel for a run of 10 hours. The carburetter of the engine is so arranged that, if necessary, either alcohol or paraffin can be used as fuel. In order that the air of the tunnel shall not be vitiated by the exhaust of the engine a special condensing arrangement is adopted. The tank for the cooling water has a capacity of about 700 litres (154 gallons) and a pump is used for circulating the water through the cylinder jacket. The engine drives a shunt-wound dynamo through a belt. The normal output is 50 amperes at 65 volts at a speed of 350 revs. per min. All the necessary switches, fuses and instruments are mounted on a small panel near the dynamo, and a shunt-regulating switch and resistance is also provided. Five circuits are taken from the switchboard, one for the searchlight projector, five for other arc lamps and the remaining circuit for the interior lighting of the car.

Although primarily intended for tunnel lighting, the equipment is also arranged so as to be of use for purposes of temporary lighting on the open air portions of the railway. For this latter purpose, five arc-lamp poles can be carried on the roof of the car. These are 7 metres high, and are intended to be stuck into the ground wherever lighting is temporarily required. A complete equipment of anchoring ropes, &c., for these masts is carried on the car, and each pole is provided with a hoisting arrangement for the arc lamps. The lamps themselves are of the differential type for 10 amperes, and burn for 16 hours. Double-cored rubber insulated cables are used for the leads from the car to the lamps. Five cables, 40, 90, 140, 190 and 240 metres in length, are carried on the car coiled on separate drums, so that a length of 250 metres (about 275 yds.) of line can be efficiently illuminated.



Inspection Car with Electric Light Plant.

When the car is being used for examination of the tunnel two of the arc lamps are hung on the brackets shown in the figure, and white enamelled reflectors are mounted under them, so that the roof of the tunnel is illuminated with a well-diffused light without strong shadows. The illumination of the walls of the tunnel and of the track is effected by the projector mounted on the platform at the front of the car. This is fitted with a 20-ampere lamp, and is provided with an obscured as well as a clear-glass front. The projector is mounted on a carriage which runs on rails, so that it can be withdrawn into the inner part of the car.

ADMISSIBLE LIMITS OF PRESSURE FOR THE USE OF UNDERGROUND ARMOURED CABLES.

A long Paper by M. de Marchena, published in the *Bulletin de la Société Internationale des Electriciens*, describes some early and recent experiences in the use of underground cables for extra high-pressure transmissions, and discusses the possible limitations in pressure for which underground armoured cables can be satisfactorily manufactured. The author, in his capacity of engineer to the French Thomson-Houston Co., superintended the laying at Nice of an 11,000 volt three-core cable some 8½ miles in length as early as 1901, at a time when the use of underground cables for pressures higher than 5,000 or 6,000 volts was almost unheard of. This cable had three conductors, each 75 sq. mm. in section, each of which was covered with impregnated paper to a thickness of nowhere less than 5 mm., and the three together were again covered with a layer of the same material 4 mm thick, so that 9 mm. of insulation intervened between either conductor and the lead and 10 mm. between any two conductors. The cable was put in service early in 1902, and a certain amount of trouble was experienced at first, but was finally got over after the relaying of a certain section. Considerable extensions to the system have since been successfully put into operation, the whole 11,000 volt network now extending over about 28 miles. Since the laying of the original Nice cable the use of 11,000 volt transmissions has, of course, become camparatively common. Examples are to be found in London, Paris, Berlin and New York, and it is worthy of note that the dimensions of the insulation used do not greatly differ from those given above.*

Experiences are then described with three experimental underground cables for 28,000 volts which were laid in the neighbourhood of Toulon in 1904. Previous to this, the highest pressure used on an underground cable had been 22,000 volts, which pressure was used on a pair of cables about 3 miles long at St. Paul in the United States. One of these cables was rubber-insulated with 5·5 mm. round each conductor and 4 mm. over the three, and the other had 6·5 mm. of paper over each conductor and an external covering of 3 mm. in depth.

The Toulon line was about 2¼ miles in length, and three independent cables were laid, one by one manufacturer, and the remaining two by another. Each cable had three cores of 25 sq. mm. section, but the insulation was different in the three cases. In the first cable, type A, each conductor was composed of 19 strands, of which the 12 external ones were separately covered with about ¼ mm. of paper. Each complete conductor was insulated with impregnated paper to a thickness of 7 mm., and the three cores thus insulated were then laid together with three hemp cords to make the periphery approximately circular and twisted together with a pitch of about 1 metre. A further covering of 7 mm. of paper was then applied, followed by a thin layer of cloth, over which came the lead covering and armouring, giving an external diameter of 85 mm.

The second maker supplied two types, B and C, both somewhat different to type A. In type B the three conductors were each made up of 19 wires without any individual insulation and covered with 7 mm. of impregnated paper. The external diameter of this cable was about 65 mm. Cable C was generally similar, but the dimensions of the insulation were cut much finer, being in fact very little greater than those in use at the time for 11,000 volts. All these cables were tested with 60,000 volts for one hour and 80,000 volts for one minute between conductors, and 36,000 volts for one hour and 50,000 volts for one minute between conductors and lead. The cables were protected from abnormal rises of voltage by a system of spark-gaps and were in constant use for about six months, during which time only one short circuit occurred, and that, which was on cable A, was partly attributable to mechanical causes

The author considers that these results are very encouraging as regards the use of high pressures on underground cables. He is not prepared to state that his experiments are absolutely conclusive as regards 30,000 volts, as only short lengths of cable were used, but he is of opinion that cables similar to type B could be used with the utmost confidence for service with 20,000 to 22,000 volts. Regarding the ultimate limit of high voltage working which may be reached on cables, it is difficult to speak with certainty, but the following considerations are of interest as bearing on the subject.

The material employed for the insulation of paper cables is always composed of some mixture of oily and resinous components, of various natures and in varying proportions, and there does not seem at present to be much hope of increasing the resistance to breakdown much beyond 12,000 to 15,000 volts per millimetre thickness of the impregnated paper; and, indeed, with the substances now in use it is rarely possible to attain these figures.

On the other hand, it is not practicable to increase the thickness of the insulating layer without limit on account partly of the difficulty of assuring satisfactorily impregnation of a paper covering of great thickness and partly of considerations of flexibility in handling and laying. M. Marchena puts the limit of outside diameter at 80 to 85 mm. and recommends that, if possible, 70 mm. should not be exceeded.

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* See *The Electrician*, Vol. LVI., p. 27.

Theoretical considerations also indicate that after a certain point an increase in the thickness of the insulating material only produces a very small effect from the point of view of diminishing the fatigue of the insulation. Considering the case of a cable with a single cylindrical conductor with the potential gradient uniformly distributed round it, the potential at any point in the dielectric distant x from the centre does not follow a simple linear function, but can be represented by the formula

$$v = \frac{V[A - \log(r+x)]}{B},$$

where V is the difference of potential between the conductor and the lead sheath, and r is the radius of the conductor.

Therefore, if e is the thickness of the insulating layer, the maximum difference per unit thickness is given by

$$\left(\frac{dv}{dx}\right)_{\max} = \frac{V}{r \log \frac{r+e}{r}}.$$

This clearly shows that above a certain point, the value of the maximum potential gradient is but little influenced by an increase in the thickness e. In practice it is not advisable to allow e to exceed the diameter of the conductor which it is desired to insulate.

Suggestions have been made from time to time to make up the insulation of successive layers of different materials of graduated dielectric strengths, but in the opinion of the author there are some practical difficulties in the way of satisfactorily putting this method into practice.

In connection with M. Marchena's paper, it is interesting to note that a three-core cable, which will work at 20,000 volts, is now being laid by the British Insulated and Helsby Cables (Ltd.) for the County of Durham Power Company, which has complied with the following tests: 80,000 volts after bending round barrel 12 times diameter of cable, 50,000 volts for three hours, 30,000 volts for five hours at a temperature of 156°F., and 90,000 volts for two minutes at a temperature of 156°F. The overall diameter of this cable, which is lead covered, but not armoured, is about 62·5 mm., and the minimum thickness of insulation from core to core is about 13 mm.

An example of a cable with graded insulation is to be found in the single-core 100,000 volt cable exhibited by Messrs. Pirelli at the Milan exhibition, in which three layers of different qualities of rubber are used, over which is a layer of impregnated paper. The overall diameter of this cable is about 59 mm., and the thickness of insulation 14·5 mm. It is said that this cable has already been tested up to 150,000 volts, and will shortly be tested up to 300,000 volts, but it has not as yet been put to practical use.

A 100,000 VOLT EXPERIMENTAL TRANSMISSION LINE.*

BY K. WERNICKE

In testing high-tension insulators for transmission lines, storm conditions such as rain, fog, snow, &c., are taken into account by pouring water over the insulator and determining the voltage, at which the brush discharges, around the insulator to the pin, occur. It would be far better and more in accordance with present-day practice to test insulators under actual operating conditions; that is, by mounting them on a pole in the open air and determining the voltage at which brush discharge occurs under various conditions of weather. Artificially produced rain can be taken as a substitute for rain which falls nearly vertically. However, as a matter of fact, rain is often accompanied by high wind and in many cases is driven horizontally against the insulators; in these cases artificial rain would be of little use in determining the behaviour of the insulator under storm conditions.

Mr. Robert M. Frieze explains the cause of brush discharge over wet insulators, thus: The upper surface of the top petticoat of the insulator is rendered conducting by the film of rain water, and the little streams of water which fall from the edge of the top petticoat have the same potential as the line; therefore these streams do not follow the laws of gravitation, but are attracted toward the pin, which is of opposite potential; thus it is that the water forms a conducting path between the line conductor and the pin. A wind which drives the rain in a nearly horizontal direction will naturally assist the action described by Mr. Frieze, and thus lower the potential at which the discharge occurs to a value which truly corresponds to actual practice. Having once determined correct values for the potential of discharge it is possible to decide on a safe working voltage for the insulator.

Of course, it is not necessary, and in manufacturing on a large scale it is utterly impossible, to test all insulators in this manner, since an incalculable amount of time would be lost in waiting for the desired weather conditions. A few samples of each type should be chosen and thoroughly studied and tested so as to make it possible to judge the quality of other insulators of the same type. Every insulator which leaves the factory should be subjected to the puncture test so as to detect faults in the material.

In order to test high-tension insulators under actual working conditions, the Insulatorwerke A.G. in Pankow, near Berlin, erected an experimental line equipped with insulators made by the Ambroin Werke (Kleinsteuber patent). It is thought that a description of this line should be of interest, since a pressure of 100,000 volts is used, and furthermore, in addition to the transmission line in the open, a part of the line is carried indoors and under conditions which can scarcely be called favourable. At two points in particular special care was required—namely, where the conductors passed through a masonry wall and a doorway respectively.

The line commences in the transformer room. In this room is placed a 20 kw. transformer, having a transformation ratio of 2 : 1,000. The switchboard for the transformer is equipped with a two-pole switch, an overload circuit-breaker, a hot-wire voltmeter and a hot wire ammeter, all in the primary circuit. Although the voltmeter is connected in the primary circuit, the scale is calculated from the ratio of transformation to read the secondary voltage. The ammeter is fastened at the side of the switchboard. The primary current amounted to 18 amperes with the secondary on open circuit at 100,000 volts.

In front of the switchboard is the regulator, which is similar in construction to a railway motor controller, and permits the variation of the pressure in steps of 10,000 volts. The sudden jumps from one voltage to the next higher, which were necessary evils with this style of regulator, often caused surges which would operate the breaker in the primary circuit. On account of these annoyances the above type of regulator was replaced by an induction regulator which permits a gradual change from the lowest to the highest voltage.

The line conductors, which consist of bare zinc-plated copper wire 1·5 mm. in diameter, are carried through the wall above and at the left of the transformer. The entry consists of an Ambroin plate 1,000 × 1,000 × 25 mm., through which are passed two Ambroin tubes, 60 mm. outside diameter, 26 mm. inside diameter, 600 mm. long and 500 mm. between centres. Round metal rods are fastened in these tubes by means of Ambroin sleeves, the ends of the rods being provided with clamps for connection to the line conductors. A hemp-string net is strung underneath the line throughout its length in order to catch broken conductors and prevent them from reaching the ground. (The net was purposely made of non-metallic material to prevent condenser effect.)

The conductors next pass through a narrow floor, and in order to do this they make a right angular turn. The wires are here carried upon Ambroin insulators supported upon wall brackets. Passing through the entry in the door the line reaches the open air. This entry is constructed in exactly the same manner as the one in the transformer room, except that the conductors are placed side by side instead of one above the other. The last stretch of the line passes over the factory court yard and ends on a wooden pole 5 metres high, upon which are mounted the insulators to be tested. There is also an arrangement whereby a considerable number of insulators can be set upon level ground and tested. For this purpose wires are led from the main line to the various points in the factory court yard where insulators are mounted to be tested under all sorts of weather conditions.

The first tests were limited to simple trials made to determine the safety and reliability of the installation. These consisted of impressing full voltage (100,000 volts) upon the line for one hour each day for three successive days. On the first day there was a heavy rain, and on the two following days there were big snowstorms; nevertheless there were no noticeable disturbances, not even at the entries, which are the weakest points in the installation.

The only trouble experienced was caused by the opening of the circuit breaker, when the voltage was raised too rapidly. Since, as was mentioned above, the voltage was varied in steps of 10,000 volts, an extra rise in current accompanied each advance of the voltage. Now when the operator did not pause about 15 seconds on each step the surges were so great as to cause the circuit breaker in the primary circuit to operate. When care was taken to pause at each step the disturbances were greatly reduced, but since the installation of the induction regulator there has been absolutely no sign of trouble from this source. The extra rise in potential could be detected along the line of a sharp clicking sound, so that the observer stationed in the factory court yard could follow the adjustment of the regulator from step to step without being in communication with the attendant in the transformer room. At 40,000 volts there is a perceptible corona about the wires and a humming sound which denotes the passage of electricity into the atmosphere. At 100,000 volts there is a corona at the points where the conductors pass through tubes in the entry plates; the transformer terminals and, in fact, everything connected to the line is surrounded by a glow of light. After the reliability of the installation had been proven, by the preliminary tests, the actual tests upon insulators were begun. The testing plant has now been in almost daily use for six months and works as well now as the first day it was put in service. The successful operation of this testing plant has proved that an installation operating at 100,000 volts, when properly insulated, is perfectly feasible even for conductors carried indoors.

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* Abstracted from the *Electrical World*.

THE KJELLIN ELECTRIC STEEL FURNACE.[*]

BY E. C. IBBOTSON.

This process was reported upon by the Canadian Commission in 1904, and much detailed information was also given in a Paper by Chief Engineer V. Engelhardt, published in *Stahl und Eisen.*[†] Believing that some of the latest particulars of the process will be of interest, the author submits the following data :—

At Gysinge, in Sweden, during the year ending May 31, 1906, from a fixed furnace giving 1 ton (2,240 lb.) of steel per tap, there were produced 950 tons of tool steel and special steel ingots.

In carbon and iron tool steels all the usual tempers were made. The bulk of this steel was made from charges composed of about 80 per cent. of Swedish white pig iron and 20 per cent. of steel scrap. The percentage of carbon was regulated by the addition of briquettes. Other charges were made from Swedish white iron and steel scrap.

The average time taken per charge, for the year, when adding briquettes, was 7¼ hours, and the electric energy consumed was 1,128 units (kilowatt-hours) per ton. The average time per charge for white iron and scrap charges was 5½ hours, and the electric energy consumed was 886 units per ton. These consumptions include all time and energy lost from various causes, such as bad water supply, ice, &c.

It is quite ordinary practice to complete the charges with briquettes in 6½ hours, and without briquettes in 5 hours, as shown by the following typical charges :—

White pig iron, 1,457 lb. ; steel scrap, 439 lb. ; briquettes, 220 lb. ; ferro-silicon (50 per cent. of silicon), 17 lb. ; ferro-manganese (80 per cent. of manganese), 15 lb. ; aluminium, 1 oz.

The times, strength of current and units consumed for this charge were as follows :—

Time.	Current.		——
	Kw.	Units.	
5:30	125	..	Charging two-thirds of the pig iron.
6:00	145	67·50	....
6:30	160	76·25	....
7:00	170	82·50	Charging the remaining one-third of the pig and the scrap.
7:30	170	85·00	....
8:00	165	83·75	Clear melted.
8:30	165	82·50	Briquettes added.
9:00	165	82·50	....
9:30	165	82·50	Briquettes added.
10:00	165	82·50	....
10:30	165	82·50	Briquettes added.
11:00	165	82·50	....
11:30	165	82·50	....
12:00	130	73 75	Ferro-silicon and ferro-manganese added. Tapped.
6½ hours	..	1,046·25	

A second charge was made as follows :—

Steel scrap, 1,372 lb. ; white iron, 914 lb. ; ferro-silicon, 4·5 lb. ; ferro-manganese, 6·5 lb. ; aluminium 1 oz.

The time was reduced, no briquettes being added. The results were as follows :—

Time.	Current.		——
	Kw.	Units.	
7:00	125	..	Charging all pig and one-half scrap.
7:30	145	67·50	....
8:00	155	75·00	....
8:30	160	78·75	Charging scrap.
9:00	165	81·25	....
9:30	170	83·75	....
10:00	165	83·75	Clear melted.
10:30	165	82 50	....
11:00	165	82·50	....
11:30	165	82·50	....
12:00	135	75·50	Ferro-silicon and ferro manganese added. Tapped.
5 hours	..	793·00	

The chemical composition of the materials charged and of the resulting steel were as follows :—

White Iron (Herräng).

	Per cent.		Per cent.
Total carbon	4·00	Sulphur	0·010
Silicon	0·15	Phosphorus	0·012
Manganese	0·18		

Briquettes.

Iron	59·0	Silica	11 00
Sulphur	0·010	Lime (CaO)	2·50
Phosphorus	0·006	Alumina	0·50

Steel Ingots.

	Per cent.		Per cent.
Carbon	0·40 to 2·00	Sulphur	0·012
Silicon	0·12	Phosphorus	0·014
Manganese	0 34		

The lining of this furnace during the year was magnesite. When using briquettes the lining lasts, on an average, five weeks, and when charges are worked without briquettes the average life of the lining is seven weeks.

Various tests have been made of the steels produced in this furnace, and many have been given in previous reports. During the year satisfactory results obtained in works practice have been reported, particularly in connection with the following steels: stamping dies, punches, cold chisels, screwing dies and taps, cutlery, drills and turning tools. The following special steels have also been produced: Tungsten steel (including permanent magnet steel), chromium steel, nickel steel, nickel-chromium steel, self-hardening steel, and high-speed tool steel. High-speed tool steel, tested to one of the latest Government specifications, gave satisfactory results, while 25 per cent. unannealed 2 in. nickel steel bar, ½ in. in diameter, gave a yield point of 30·68 tons per square inch, a maximum stress of 50·44 tons per square inch, an elongation of 44 per cent., and a reduction of area of 60 per cent.

Electrical tests carried out have shown that No. 6 gauge rods had a specific resistance of 36 microhms per cubic inch ; No. 16 gauge wire a specific resistance of 33·5 microhms per cubic inch.

The form of filling furnace[*] adopted and recently erected has the advantages that it can be tipped over the lip, or from the taphole, and can easily be repaired and re-lined when necessary.

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[*] Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers in July. Slightly abbreviated.

[†] Vol. XXV., 1905, Nos. 3, 4 and 5.

[*] [A drawing of this furnace is given in the Paper. It is practically the same as that shown in *The Electrician* for March 17, 1905, p. 877].

COMPARISON OF THURY AND THREE-PHASE SYSTEMS.

At a time when the direct-current transmission system of M. Thury is being widely considered in connection with long-distance power transmission, and especially in the case of the 700-mile transmission from the Zambesi Falls of South Africa, it is interesting to note the results arrived at under certain conditions by Signor Motta, of the Milan University, who, acting on behalf of the City Council, undertook a lengthy series of calculations and tests, and has finally decided in favour of the three-phase system and against the direct-current system.

The city of Milan has its public lighting provided by its own steam plant, and the private lighting and power for traction is supplied by the Milan Edison Company, which is one of the oldest electric power companies of the world. The tramway system, however, is the property of the municipality, and of late strong agitation has arisen in favour of making the tramway system entirely municipal. The general conditions are as follows:—

Water rights have been acquired at Grosoto on the Upper Adda River, in Valtellina, where the supply will be sufficient to provide 38,200 B.H.P. at the turbines, or, approximately, 28,000 kw. at Milan at the secondaries of the transformers. The transmission line is to be 150 km. long and will pass over the Orobie Mountains, a part of the Pre-Alpine range, the highest point being 3,500 ft. above sea level.

The comparison above referred to was made on the basis of 150,000 volts continuous current and 60,000 alternating three-phase current, these values being settled by consideration of the most economical voltage of each system.

The Thury system was to consist of 10 groups, each group to have four generators, driven by one water turbine, the voltage limit per group being 15,000 volts. The preliminary system provided for a continuous-current transmission line, having both positive and negative conductors, the earth return not being employed and no permanent earth to be made at all on the system.

The 60,000 volt, three-phase scheme is to consist of a number of units operating in multiple in the usual way with no novel features, the exact frequency to be determined later, but probably it will be 42 cycles.

The summary may be divided into two comparisons, as follows :—

EFFICIENCY COMPARISON.

Continuous current System.—The overall efficiency of the two systems shows 3 per cent. in favour of the three-phase plan, the values given below being based on the full load of 28.000 kw. The detailed efficiencies are as follows :—

Water pipe efficiency	96·5	per cent.
Turbine efficiency	75·0	,,
Generators	92·0	,,
Line	95·3	,,
Motors	92·0	,,
Alternators for secondary distribution	93·0	,,
Giving a total overall efficiency	54·2	,,

Three-phase System.—The efficiency of the water pipes and turbines remain the same; that of the line, however, drops to 91 per cent., and the total overall efficiency is 55·8 per cent.

Cost Comparison.

The costs of the two schemes as calculated show in favour of the continuous-current system by 1·6 per cent., the figures being approximately 10,000,000fr. for the continuous-current transmission and 10,160,000fr. for the three-phase system. These costs are based on machinery, switchboards, line, insulators, poles, transformers for the alternating system and motor-generator transformers for the receiving end of the Thury system.

The following subdivided costs are of interest as showing a remarkable feature of the continuous-current Thury system—viz., the extreme cheapness of the transmission line and the high cost of the motor-generator transformers at the receiving end.

Continuous-current System.—(1) Machinery, including transformers, switchboards, &c., 7,000,000fr.; (2) line, including insulators, poles, lightning arresters, &c., 3,000,000fr.

Alternating-current Three-phase System.—(1) Machinery, including transformers, switchboards, &c., 3,750,000fr.; (2) line, including insulators, poles, lightning arresters, &c., 6,410,000fr.

The actual calculated cost of the machinery for the Milan substation on the Thury system was 3,600,000fr., whereas the cost of the transformers for the three-phase system did not exceed 790,000fr.

The costs include the interest on capital during construction. The period of construction may be assumed the same in each case. The cost per kilowatt per year, including all items, gives a calculated value of 160fr. for the three-phase system, this being based on the assumption that 8,760 hours per annum will be demanded—that is, full load the whole year, which, under the peculiar conditions of power demand in the city of Milan, is not an unreasonable assumption.

An additional steam station for peak loads with a maximum output of 9,000 kw. and an average of 4,500 kw. for the whole year, and provided with accumulators, will also be provided, but no estimates of cost have as yet been prepared for this scheme.

The demand for power in the city of Milan during the last few months has increased so rapidly that it is doubtful if this scheme will be sufficient, and power is being eagerly sought for from other sources. The traction system in Milan may be said to operate for 17 hours in every 24, and during the remaining seven hours some of the factories will be offered exceptionally cheap rates to encourage their operation at this time; for this class of customers at present 3,000 kw. are supplied every night.

Other details of the comparison of interest are as follows:—

The three-phase line to consist of three wires, each of 240 sq. mm. section, and the continuous-current line to consist of four wires, two for each side and each of 140 sq. mm. section. One feature which was a strong consideration in the decision to adopt the three-phase system instead of the continuous-current system was the proposal of M. Thury to have 104 commutators in series throughout the whole system.

THE ELECTRICAL PLANT OF THE CANADIAN NIAGARA POWER CO.*

The plant of the Canadian Niagara Power Co. was the first of the power houses on the Canadian side of the falls to be designed and to have construction work begun upon it. As soon as the decision was made to go ahead with this development the question was raised as to whether the plan should be indentical with those of its allied company, the Niagara Falls Power Co., on the American side, or whether engineering advances had taken place since their completion sufficient to justify changes and improvements. In general it was decided to adopt the same system of development, but certain essential changes were introduced, among which were the following:—

(1) Generating units of 10,000 H.P., instead of 5,000 H.P., were adopted; (2) generated voltage was raised to 12,000 volts: (3) generators were wound for three-phase instead of two phase.

It was decided to change from 5,000 H.P. to 10,000 H.P. for the generating units for the following reasons:—(1) To reduce the length of the wheel pit, power house, forebay, &c., and consequently to reduce their cost of construction; (2) to reduce the cost per horse-power of the generators, water wheels, &c.; (3) the load of the Niagara Falls Power Co. and its ally, the Canadian Niagara Power Co., had become so large that a unit of 10,000 H.P. could be installed without having such unit represent too large a proportion of the total load, from the standpoint of convenience and flexibility of operation.

The decision to have the generators wound for 12,000 volts was made to effect economies in station wiring and in the system of underground distribution necessary to transmit the power from the power house outside the limits of the Victoria Park. The particular voltage of 12,000 was selected as being the highest which at that time was considered reasonably safe for underground service, and also because the Niagara Falls Power Co. has already adopted this as a transformed voltage for the transmission of power to some of its local customers. Three-phase was taken instead of the two-phase winding of the American machines on account of the simplification of switches, wiring, &c., and also to effect the saving of 25 per cent. in transmission copper.

The general hydraulic construction of this plant is very similar to that of the American plant, which is too well known to engineers to require detailed description.

The turbines were all designed by Escher, Wyss & Cie., and are of the Francis type—inward discharge, with draft tubes led to the bottom of the wheel pit. A regulating gate is installed at the end of the wheel pit to maintain the level of the tail water at a sufficient height at all loads to cover the mouths of the draft tubes. This regulating gate is operated by an 85 H.P. continuous-current motor, hand-controlled. The weight of the rotating machinery is carried by an oil-thrust bearing under the dynamos, and also by an hydraulic piston at the bottom of the turbine. The turbines give an output of about 12,000 H.P. at full-gate opening at a head of approximately 135 ft.

The generators are of the internal revolving field type, with 12 poles giving 25 cycles at 250 revs. per min., and were built by the General Electric Co. The efficiency at full load is about 98 per cent., and the regulation on full non-inductive load about 8 per cent. The armatures are star-connected, and the neutral is brought out so that it can be earthed if desired.

From the generators the current is led through varnished cambric insulated cables to double-throw selector oil switches, and thence to the 'bus bars, of which there are four sets. The oil switches are electrically operated by relay switches placed on the main switchboard panels. This operating board consists of 5 generator panels, 20 feeder panels, 10 recording wattmeter panels, and 3 'bus-bar interconnecting panels. Each panel is distinct, and contains no instruments or switches except those belonging to the particular feeder or generator in question. In this regard it is different from most of the switchboard arrangements adopted in modern plants. The so-called "bench-board" system of operation usually installed economises space, but it has certain disadvantages. The concentration of instruments and relays necessitated in this construction may cause considerable confusion at times of emergency. With the panel construction adopted in this plant, possibly more space is occupied by the board itself, but operating simplicity and directness results. The separate panel construction also permits the separation of control wires, which become so congested in the bench-board arrangement.

The present equipment of the power house comprises five machines, and this group and its switchboard is considered as a complete plant. When the power house structure is extended to its full length six more 10,000 H.P. units will be installed, having an entirely separte switchboard, separate exciter plant, &c. This separation is made for the reason that 50,000 H.P. is believed to be as large an amount of power as should be under the control of a single switchboard and its attendant.

The exciter plant is located in a compartment near the bottom of the wheel pit at the turbine deck level. There are three 200 kw. 125 volt continuous-current generators, each connected to an independent turbine. Any two of these units will carry the entire continuous-current load of the power house. There are two sets of exciter 'bus bars, one of which supplies the generator fields, and the other the continuous-current power system, including motors and arc lights. The current is carried up the pit to the main floor of the power house through a system of vertical copper bars supported every 10 ft.

All the power from the power house is transmitted underground by means of 000 B. & S. paper-insulated triplex lead-covered cables. The feeders are divided into two groups. One set leads from the north end of the power house through Victoria Park and across the arch bridge to the plants of the Niagara Falls Power Co., with which they are interconnected. The other group runs south up the high bank above the power house to the transformer house there located.

The conduits are constructed in four groups of eight ducts each. The groups are segregated in order to separate the cables in the manholes, and consequently to reduce to a minimum the risk of damage from short-circuit and also to prevent overheating of the cables in the ducts, the separation of the groups facilitating the conduction of heat in the ground. In no case is the group wider than two ducts, so that every duct has the ground in contact at least on one face. The cables are rated at a maximum of 4,000 H.P. each at 12,000 volts. This rating corresponds to about a 40°C. rise in copper temperature when all the cables in the group are in service at full load. The manholes are all made double with a concrete fire wall between the two halves, so that in case of a destructive manhole short-circuit, not more than one-half the feeders could be involved. The interconnection of the 12,000 volt Canadian system with the 2,400 volt two-phase system of the Niagara Falls Power Co. is effected through Scott-connected transformers. These transformers keep the two systems constantly in parallel and no trouble is experienced regarding the distribution of the load. The equipment of the main transformer house comprises 12 1,250 kw. transformers, each bank, therefore, requiring one-half the output of a generator at the power house. Transformers of comparatively small size were installed for reasons of flexibility of operation. The very large transformer units now being used in some plants cost considerably less per kilowatt, but the large size of units makes it difficult to isolate circuits and 'bus-bar sections so necessary at times in the operation of a plant. The building is divided into three sections. The east bay contains all the 12,000 switches and 'bus bars, the central bay contains only the step-up transformers and the west bay the 60,000 volt switching apparatus. The transformers are of the oil type, water cooled. The water supply is insured by a storage standpipe adjacent to the transformer house, which has sufficient capacity to operate the transformers for 48 hours in case of a waterworks shutdown.

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* Abstract of a Paper recently read before the Canadian Electrical Association at Ontario by H. W. Buck, and reperted in the *Electrical Review* (of New York)

The arrangement of windings on the 1,250 kw. transformers is somewhat unusual. The transformers are constructed with five similar coils, two of which constitute one winding and three the other winding, either of which set can be used interchangeably as primary or secondary. By the various combinations of coils, as idicated below, any of the following voltage ratios can be obtained with the full copper efficiency of each coil:—

12,000 volts Δ to 24,000 volts Δ,
12,000 volts Δ to 36,000 volts Δ,
12,000 volts Δ to 41,500 volts Y,
12,000 volts Δ to 62,500 volts Y.

The west bay of the building also contains 3,000 H.P. in air-blast transformers, which lower the generated voltage from 12,000 to 2,400 for distribution of power to several small consumers in the city of Niagara Falls, Ontario, to whom it would be unsuitable to deliver power at as high a voltage as 12,000 volts. This distribution at 2,400 volts is by an overhead line.

All the high-tension wiring in the transformer house is insulated for the highest voltage, 62,500 volts, and the conductors are of sufficient current-carrying capacity for operation at full output at the lowest transformer voltage—viz., 24,000 volts.

The output from this transformer house will be used partially for transmission at 24,000 volts to Fort Erie, and thence across the Niagara River to Buffalo, the distance being about 15 miles. There are some engineering features connected with this work which may be of interest.

The transmission line is built on a private right-of-way, 30 ft. wide, extending from the transformer house to the river front at Fort Erie. There will be two pole lines on this right-of-way, each carrying two circuits. The circuits have a nominal rating of 12,500 H.P. each at 24,000 volts, making 50,000 H.P. total for the transmission. The poles consist of two 4 in. wrought-iron pipes jointed together at the centre by a malleable casting which has four struts projecting radially at 90 deg. angles. Truss rods secured at the top and bottom of the poles pass over the ends of these struts, which, when tightened up, stiffen the jointed pipe. The function of this central tubular member is to resist downward compression only. The horizontal stresses on the pole are resisted by four guy rods anchored in the ground with concrete guy stubs. There is one of these guys in each quadrant around the pole. The poles are 40 ft. in height, and are placed apart at distances ranging from 250 ft. to 300 ft.

The insulators are made of a compound known as "electrose." This material is a very good insulator, is very strong mechanically and is entirely free from cracks and other defects which are common in glass and porcelain. Similar insulators have been used on the Buffalo transmission lines of the Niagara Falls Power Co. for the past three years, and they are the only insulators on those lines which have caused no trouble. It is impossible to shatter electrose insulators by stone throwing, and they will frequently turn a rifle bullet without being damaged seriously. The conductor used on this line is of aluminium of 500,000 circular mils in section and having 37 strands.

At Fort Erie the line is tapped by a connection to a local substation for the supply of power to that municipality. The line then rises from the standard 40 ft. elevation to a tower 80 ft. high, erected about 4,200 ft. from the Canadian shore line of the Niagara river. Thence the line rises again by a single span of 1,200 ft. to a tower on the river bank 210 ft. in height. Thence by another single span of 2,300 ft. the line passes to the Buffalo side of the river to another 210 ft. tower. From there it drops down to a new 50,000 H.P. terminal house constructed for the distribution of this power in Buffalo.

For this long-span crossing, 500,000 circular mils 61-strand aluminium cable is used. Each wire is secured to the top of one pole to an insulated support. At the towers the lines are attached through strain insulators to steel cables, which pass sheaves about 24 in. in diameter, and thence to weights which are equal to the tension on the wire in pounds. This amounts to 4,500 lb. on each line. The live portion of the line passes down the tower from the outside of the strain insulator to the terminal house on the Buffalo side and to the main transmission line on the Canadian side.

The power house has been in successful operation for about a year, and five generators are now in service. The transmission lines to Fort Erie and Buffalo are now in process of construction, and are expected to be put in service about November 1st.

A MAGNETIC INDICATOR OF TEMPERATURE FOR HARDENING STEEL.*

BY WILLIAM TAYLOR.

The well-known troubles of warping and change of size when hardening tool steel, experienced in the case of some specially exacting work, led me to seek some more reliable and convenient indicator of hardening temperature than those in common use. Dissatisfied with the results obtained by the use in an ordinary workshop of an electrical pyrometer employing a thermojunction, with the inconvenience of having to obtain a cooling curve with each sample of steel, and the uncertainty arising from the need of heating the object above the critical point so obtained to meet the fact that the critical point for heating is higher than that for cooling, I sought to make use of the known fact that at this critical point the magnetic permeability of the steel is changed. With the co-operation of Mr. F. J. Mudford I experimented with a magnetic induction balance consisting of three similar flat coils of wire placed parallel on a common axis and equally spaced, the inner coil in circuit with a telephone receiver, and the outer coil supplied in series with an alternating current, and so connected that at ordinary times no sound was produced in the telephone. When, however, steel was placed between the centre coil and either of the outer ones, the magnetic balance was disturbed and a sound produced in the telephone. The steel was then heated, and when it reached the critical temperature and became non-magnetic, the sound in the telephone abruptly ceased, whereupon the steel was quenched and hardened. Steels with carbon contents ranging from 0·7 to 1·35 per cent. were hardened in this way at temperatures which, judged by the eye alone, no skilled mechanic would feel safe in using; while the fine grain shown on fracture, together with the invariable hardness, showed how closely the critical temperature had been obtained. In each case, on letting the steel cool so that sound was resumed in the telephone, the steel failed to harden, although the fall of temperature was imperceptible to the eye. Following this experiment, a magnetic indicator attached to a small muffle furnace was constructed, and has been in daily use in a tool room for several months, where it has served to indicate temperatures for hardening press tools, milling cutters, taps, reamers, &c., and has established a record during that time in that not a single piece has been lost through warping or cracking in hardening, while the quality of the hardening has been excellent.

The attachment consists of a hardened steel permanent magnet, extended by soft iron pole pieces into the general form of a horseshoe magnet, the gap of which is in the muffle of the furnace, and is so adjustable that the piece of steel to be hardened may be arranged to fill the magnetic gap. The pole-piece at one side of the furnace is hinged, by rocking on the magnet, and is prolonged in such a way as to form a second, and alternative, magnetic circuit, tending to displace the rocking pole-piece and withdraw it from the object being heated. This, however, so long as the object is magnetic, is prevented; but when its temperature rises to the critical point and the steel object, becoming non-magnetic, releases the pole-piece, the latter rocks, and in so doing establishes an electrical circuit by which a bell is rung, giving audible warning to the attendant. This device has proved of great practical service by making the work of miscellaneous hardening safe and certain in its results It is noticeable in every case that the temperature at which hardening is thus safely accomplished is visibly lower than that at which a skilled workman would ordinarily harden steel when endeavouring, on the one hand, to avoid over-heating, with its resulting brittleness, cracking and warping, and, on the other hand, the failure to harden and the certainty that in re-hardening these risks of cracking and warping would be multiplied.

Telephone Cable on Pupin's System.—A telephone cable has been laid in Lake Constance between Friedrichshafen and Romanshorn. According to the *Cologne Gazette*, it is 8¼ miles in length, and is on the Pupin system, by which the transmission has been much improved.

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* Paper read before the British Association at York on August 3rd.

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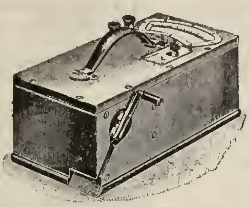

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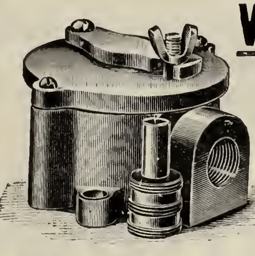

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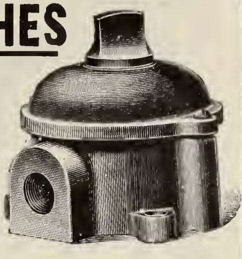

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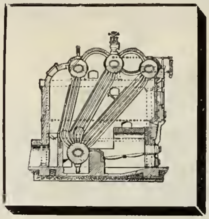

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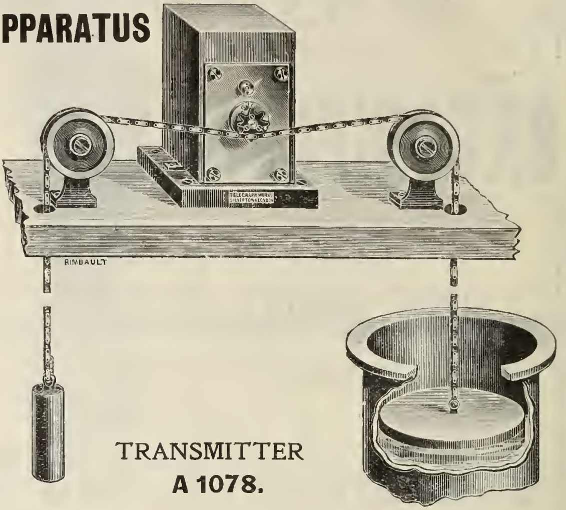

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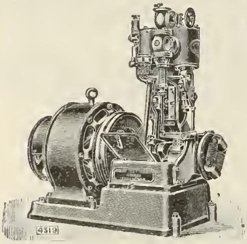

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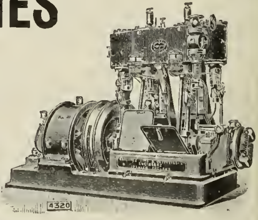

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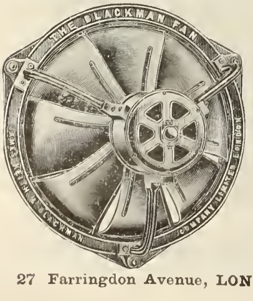

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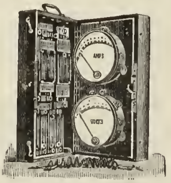

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case of electric lighting stations, because a remunerative price is obtainable with a comparatively small load. Moreover, the advantages of electric light are so well recognised that a competitive price is not so essential. But in the case of a Power Company it is a question of keen competition with other sources of power from the beginning, so that a policy of starting with somewhat high prices, which are lowered as the business expands, is not so admissible.

There is, however, the difficulty of running large units during the first years of the undertaking on a comparatively low load, with consequently unsatisfactory results and probably no return on the capital invested. The only satisfactory solution of this difficulty seems to be by co-operation, as suggested by the present crisis of the South Wales Company. The collieries and factories in the area of supply should bear in mind that it is to their advantage to have cheap power quite as much as it is advantageous to the power company to pay satisfactory dividends. It is not, therefore, to their advantage to let the power company fight its way to success as best it may, and to finally take advantage of the power supply when forced by competition to do so, or when other people have proved the success of the experiment. There should be co-operation from the beginning, so that the power company may start with definite contracts, and with the knowledge that the business is of sufficient magnitude to warrant the installation of large units at a low capital cost per horse-power.

It is, however, equally essential that a satisfactory scale of prices for electric energy should be drawn up from the very beginning of the power company's undertaking. In the case of the South Wales Company this does not seem to have been done. A flat rate appears to have been charged, with the result that the colliery managers, having a better appreciation of such a matter than the Power Company, utilised the electric energy for haulage purposes and such intermittent work as was expensive to themselves, but continued to work by steam such pumps and fans as were required to run day and night. The final result, therefore, was only a partial success for the collieries and unremunerative business for the Power Company. In the words of Mr. MERZ, the terms should be such that the collieries can afford to use electric energy for *all* purposes. Probably no better tariff could be adopted than a fixed charge, such as £1 as suggested, per quarter per horse-power of maximum demand, and a low rate per unit in addition.

As this principle of co-operation has been definitely adopted by a number of its important consumers, we hope the South Wales Power Company will now find its difficulties practically at an end, and will enter into a period of prosperity.

OBITUARY.

JAMES DREDGE.

We regret to have to record the sudden death on Wednesday, the 15th inst., of Mr. James Dredge, who has been, for nearly 40 years, associated with the editorial management of *Engineering*.

Mr. Dredge was the son of Mr. James Dredge, of Bath, where he was born on July 29, 1840, so that he was in his 67th year. He commenced his professional training at an early age under his elder brother, the late Mr. William Dredge, who was established in London as a civil engineer. From 1858 to 1861 Mr. Dredge was, with the late Mr. D. K. Clark, the author of several classic works on railway machinery. In 1862 he entered the office of Mr. (afterwards Sir) John Fowler, remaining there until the end of 1865.

His first connection with *Engineering* was contemporaneous with the founding of the paper. Mr. Zerah Colburn, who had been editor of the *Engineer*, commenced *Engineering* in 1866, having previously arranged with Mr. W. H. Maw, with whom he had been brought into contact in connection with locomotive work, to join him as sub-editor of the new paper, while the late Mr. Dredge, who had become acquainted with Mr. Colburn when the latter was collaborating with Mr. Clark in his well-known work, "Recent Practice in Locomotive Engineering," was given charge of matters connected with the illustrations. Upon the death of Mr. Zerah Colburn in 1870, Mr. Dredge joined Mr. Maw as co-editor.

Contemporaneously with his editorial work Mr. Dredge devoted considerable time and influence to the advancement of British engineering and commerce through the medium of various international exhibitions. He took a deep interest in the Vienna Exhibition of 1873, the Centennial Exhibition at Philadelphia of 1876, and the Paris Exhibitions of 1878 and 1889. He was a member of the Royal British Commission for the Chicago Exhibition of 1893, was Commissioner-General for Great Britain for the Brussels Exhibition of 1897, and a Vice-President of the British Commission for the Milan Exhibition of the present year. For his work at Paris in 1889 he was appointed an Officer of the Legion of Honour, and for his services at Brussels he was made a Companion of the Order of St. Michael and St. George. Mr. Dredge paid frequent visits to America, and was well known there, as well as in France and other Continental countries.

He was the author of various books, including one on "Electric Illumination." He was a member of the Institution of Mechanical Engineers and of the Institution of Civil Engineers, an honorary member of the American Society of Mechanical Engineers, and for some time he served on the Council of the Society of Arts.

About three years ago he was striken with paralysis, and although he never recovered his bodily strength his intellect remained active, and he still devoted considerable time to the editing of *Traction and Transmission*, a publication of which he was the originator, and in which he took the keenest interest, until its discontinuance in 1904. Recently, however, he wintered at his house in San Remo, and spent the summer at his home at Titchfield in Hampshire. A few weeks ago he returned to this country, and had taken a charming cottage at Pinner, where he had a further seizure, and expired instantaneously, on the 15th inst, to the regret of a very wide circle of friends.

THE ELECTROLYTIC DEPOSITION OF GOLD FROM CYANIDE SOLUTIONS.

Commercially, as is well known, large quantities of gold are recovered from cyanide solutions by means of the electric current. The electrolyte is caused to flow through a number of troughs in which are hung thin lead sheets to act as kathodes which are connected up in parallel and are opposed to iron anodes, the troughs being connected together in series. The E.M.F. to each bath is between 2 and 3 volts, and a current of about 0·5 ampere per square metre is employed. The gold gradually deposits upon the lead kathode, and in course of time Prussian blue and ferric oxide are formed on the iron anodes.

Although, as already remarked, a large amount of gold is recovered in this manner, the evidence as to the current efficiency is extremely vague and contradictory, and very little actual work appears to have been undertaken—even considering the high value of gold—to ascertain this important factor. In the *Zeitschrift für Elektrochemie* for August 10th an interesting and suggestive Paper is published by Prof. Bernh. Neumann. The object of the work was to ascertain, in the first place, what was the current efficiency from solutions of different concentration; secondly, whether a high or low current was the more economical; and thirdly, whether other electrodes than lead and iron could be used.

The apparatus employed consisted of a trough containing about 7 litres of solution; the kathodes were thin sheets of lead and the anodes thin iron plates. Prof. Neumann found that with a gold solution containing 10 grammes of gold per cubic metre of solution with 0·05 per cent. of potassium cyanide, and employing a current of 0·5 ampere per square metre that the highest efficiency was about 3·8 per cent. The efficiency in the first hour was below 1 per cent., but reached a maximum at the fifth hour when it gradually fell off again. He considers the low efficiency at the commencement to be due to an oxide film upon the surface of the lead kathode, and thinks that the greatest rate of deposit is only obtained when the surface of the lead has become quite clean from the reducing action of the hydrogen. With a concentration representing 3 grammes of gold per cubic metre the current yield was 1·33 per cent. after the eighth hour.

On decreasing the current density to 0·25 ampere per square metre the current efficiency went up to nearly 8 per cent. when the concentration of the gold was 10 grammes per cubic metre, whereas with a concentration of 3 grammes per cubic metre it was about 3·2 per cent. The higher the current density the lower the current yield, as shown by the following table, the strength of the solution being 10 grammes per cubic metre :—

Amperes per square metre.	Current yield.
0·25	7·56 per cent.
0·50	3·81 ,, ,,
2·40	0·41 ,, ,,
4·00	0·24 ,, ,,
9·00	0·16 ,, ,,

In one case, where with a current of 2·5 amperes the experiment was carried on for 1½ months, the current yield was only 0·12 per cent. Neumann considers that on a commercial scale the actual efficiency must be well below 1 per cent. Owing to the formation of Prussian blue and iron oxide at the anodes, Andreoli has suggested the use of lead peroxide anodes. Neumann finds, however, that it is not possible so to peroxidise lead that it is unacted upon when made the anode in a solution of potassium cyanide. As the electrolysis proceeds, white spots of lead cyanide begin to form on the electrode and after a time the lead cyanide falls off as a powder and shortly contaminates the whole bath.

Many observers state that carbon anodes are unsatisfactory, but it probably depends upon what form of carbon is employed. Neumann finds that anodes of Acheson graphite are apparently unacted upon when used in a cyanide solution. We are not surprised at this, as we have ourselves found that in alkaline and cyanide solutions Acheson graphite anodes are exceedingly resistant, and even after continued use are very little acted upon. When lead kathodes are employed the gold can only be obtained from the lead by ordinary metallurgical processes and it is even then not easy to obtain the gold in a state of absolute purity, it being usually between 800 to 900/1,000 fine. This is due to the fact that, at the potential employed, other metals, such as silver and copper, are deposited along with the gold upon the lead kathodes. Mercury kathodes are not satisfactory owing to the immense quantity of this expensive metal which it is necessary to employ when working on a large scale and to losses in working. But the gold can very satisfactorily be deposited upon graphite kathodes. Furthermore, the carbon kathodes may afterwards be employed as anodes, and by working in acid solutions with a low E.M.F. the gold may be re-deposited in a state of almost absolute purity. Attempts were at first made to re-deposit from an electrolyte of potassium cyanide, but the current efficiency was less than 0·5 per cent. with low currents, and with high currents absolutely no deposit was obtained. The solution of the gold at the anode was exceedingly rapid, but the amount deposited at the kathode was most unsatisfactory, even when the cyanide solution contained gold before the anodes were placed in it.

When the gold-coated anodes were placed in a dilute solution of hydrochloric acid containing sodium chloride—3 per cent. hydrochloric acid and 20 per cent. sodium chloride—deposits up to 150 per cent. were obtained. The current yield is calculated supposing gold to be trivalent. Wohlwill has found that in a gold coulombmeter there is always more gold deposited than agrees with Au^{III}. The explanation of this apparent anomaly is that a portion of the gold is present in the monovalent condition; this, then, at the electrode becomes again trivalent, thus :—

$$3AuCl = AuCl_3 + 2Au,$$

in an exactly similar manner to the conversion of cuprous sulphate into cupric sulphate—

$$Cu_2SO_4 = CuSO_4 + Cu.$$

The amount of gold at the anode which passes into the monovalent condition is dependent upon the current density. With high current densities there is very little formation of monovalent ions, but with low current densities the formation of monovalent ions is considerable. Hence, with low current densities, the current efficiency is much over 100 per cent., whereas with high currents, the gold being almost entirely in the trivalent state, the amount deposited does not exceed the theoretical quantity.

Whether it will be found advantageous to use graphite anodes and kathodes on a commercial scale is, of course, a matter of experiment and, naturally, of expense. Certainly graphite anodes *per se* cannot compete with iron anodes on score of price; but if they last longer and contaminate the electrolyte less, then possibly they might be found better in the long run. The question of carbon kathodes also resolves itself into one of cost; the greatest advantage here is the doing away of the metallurgical process for recovering the gold and the obtaining of such pure gold by electrolysis.

THE EFFECT OF ELECTRICAL OSCILLATIONS ON IRON IN A MAGNETIC FIELD.[*]

BY W. H. ECCLES, D.SC.

The following investigation of the action of high-frequency oscillations upon iron held magnetised in a magnetic field was carried through in July and August of last year, and was undertaken to supplement in a quantitative manner the rather vague information available. Since Marconi[†] announced in 1902 that feeble electrical oscillations were capable of altering the flux of induction in a piece of magnetised soft iron, a great deal of work has been done in the endeavour to determine what it is that really happens in this process, but there is still a lack of precise data. This is due no doubt to experimental difficulties, such as the shielding of the iron by the eddy currents produced by the oscillations, and the difficulty of producing definite oscillations. Experiments have been carried out by Russell,[‡] Piola,[§] and others. In the present experiments, oscillations were used whose magnetic field was along the direction of the principal magnetic field, and any difficulty due to skin effect was avoided by having the oscillations so feeble that only the outermost layers of the iron wire were employed.

In these experiments fairly soft Swedish charcoal iron, aged, and not freshly annealed, was taken a large number of times round a definite magnet cycle (as in ordinary magnetic testing) till what may be called a cyclic state was attained. The field was then given any desired value, and the iron submitted to a single train of oscillations. This was managed by generating the oscillations on a helix surrounding the iron wire. The consequent alteration in pole strength was observed by the deflection of a magnetometer mirror. These processes were all repeated a number of times for each selected point of the cyclic curve. The figures given in the tables below are thus each the mean of a number of observations.

In detail, the apparatus adopted consisted of two straight solenoids each 3,270 turns of No. 20 copper wire wound in six layers on a length of 59 cm. of split brass tube. They were placed on one and the same magnetic east-west line, but on either side of a mirror magnetometer. The magnetometer-needle was in the common axis of the two solenoids. The solenoids were connected in series, and so adjusted in position that when a large current was passed through them the magnetometer-needle was undisturbed. A liquid resistance, a Weston milliammeter, suitable switches and commutators, and a battery of six secondary cells, completed the solenoid circuit. The coil destined to be the seat of the oscillations consisted of 1,252 turns of No. 26 copper wire wound in a single layer on 70 cm. of a glass tube 0·5 cm. in external diameter, and had a resistance of about 3 ohms. The whole coil was wrapped in paraffined paper and pushed into the brass tube of the east solenoid.

The iron wire examined was unannealed Swedish charcoal iron, diameter 0·749 mm., and was used always in lengths of 56 cm. Its characteristic curve is given in Fig. 1. The magnetometer was a silk-suspended mirror carrying four very small magnets; readings were taken on a scale distant 88 cm.

The object in employing twin solenoids is clear. By placing equal amounts of iron wire in each solenoid and adjusting their positions carefully, the magnetometer deflection could be kept very slight, whatever magnetic variations the iron was taken through, the iron in the one solenoid compensating that in the other.

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[*] Abstract of a Paper read before the Physical Society on June 22, 1906.

[†] *Proceedings* Royal Society, LXX., p. 341, July, 1902.

[‡] *Proceedings* Royal Society of Edinburgh, Nov. 20, 1905.

[§] *Elettricista*, IV., p. 145, May 15, 1905.

It was then permissible to exalt greatly the sensibility of the magnetometer. This was done by reducing the controlling field at the needle by means of an auxiliary permanent magnet. As a matter of fact, slight inequalities existing in the construction of the solenoids made perfect balance unattainable; there was always a remanent deflection, which was different in sign and magnitude for different values of the current through the solenoids, and which in the main proved rather useful by furnishing a check on the proper carrying out of the commutating operations involved in a magnetic cycle.

In the experiments, three iron wires insulated from one another and tied in a bundle were used in each solenoid, the group in the east coil lying, of course, in the glass tube on which the oscillation coil was wound. The inner ends of the wires were 9 3 cm. distant from the magnetometer needle. The field at the needle was reduced to 0·034 C.G.S. units. With these arrangements, such a sensibility was attained that on certain days of August last the strokes of distant lightning, not visible in London,* were easily perceptible in the laboratory by their effects on the iron in the oscillation coil.

The oscillations used were produced by leading the free east end of the oscillation coil—that is, the end distant from the magnetometer—to one side of a micrometer spark-gap. The other end of the oscillation coil was left insulated. The poles of the spark-gap were connected to the terminals of a diminutive influence machine, that pole not connected to the oscillation coil being, besides, earthed.

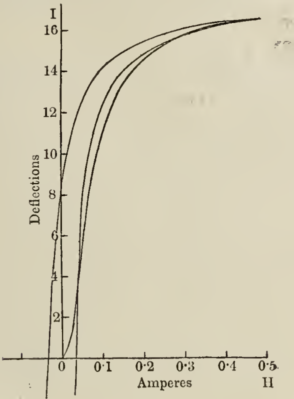

Fig. 1.

Thus, when the handle of the influence machine was turned through a certain angle (depending on the spark-gap) at a speed easily learned, a spark occurred which set up oscillations in the coil. The spark-length finally settled upon was about half a millimetre. It was found possible in this way to get over and over again practically the same magnetometer deflection for every spark, provided the effect of previous oscillations was wiped out by taking the iron through a cycle. As these small sparks were usually inaudible, their occurrence was recognised by the sudden deflection of the magnetometer needle.

The calculated period of the stationary waves on the oscillation coil is $5{\cdot}7 \times 10^{-7}$ second.

A typical set of operations was as follows: The iron was demagnetised by reversals. An amplitude of cycle being then decided upon, the iron was taken a number of times through that cycle. This last operation was stopped at the point settled upon for the observations, and the magnetometer reading taken. A spark was passed, and the magnetometer again read after 30 seconds. A complete cycle was now performed ending at the same point as before, and another spark passed, and so on. Usually, about 20 points on a cycle were examined by four or six observations at each. In this Paper, however, the effects of the spark are recorded as if the observations had been taken only on the ascending half of the hysteresis curve; the figures given being in fact the means of the measured effects at points symmetrical with regard to the origin on the ascending and descending branches.

Table I.

Current in milliamperes.	50 cycle.	100 cycle.	150 cycle.	200 cycle.
−150	..	..	..	0·20
−100	..	..	0·20	0·36
− 75	..	..	..	..
− 50	..	0·27	0·44	0·68
− 40	0·06	..	..	..
− 30	0·10	..	..	..
− 20	0·13	..	..	..
0	0·28	0·68	0·92	1·22
20	0·38	1·08	..	..
30	0·45	..	1·32	1·57
40	0·60	..	..	..
50	0·55	1·26	1·51	1·71
75	..	1·30	1·62	1·75
100	..	1·18	1·57	1·55
150	..	..	1·19	0·93
200	..	..	..	0·83

In this table the figures given can be reduced to absolute measure as follows: The numbers at the top of each column and down the left column representing the current through the solenoids in milliamperes yield when multiplied by 0·0696 the magnetic field in C.G.S. units applied to the iron. The deflections in the body of the table give the change in pole strength, due to the spark, by multiplying by 0·017; or yield the volume-average change of intensity of magnetisation by the factor 1·27; or give change of total magnetic moment of the affected specimen by the reducing factor 0 940.

Fig. 2 is plotted from the above table. The curves show clearly how for increasing cyclic amplitudes within the range here attempted the effect of the same spark is increased. The curves show very distinct maxima. It is evident, moreover, that the magnitude of the effect at any point is closely connected with the slope of the hysteresis curve. On the whole, the curves tend to corroborate the fact—first noted by E. Wilson in his 1902 patent specification—that the sensibility of the iron to oscillations is greatest when in the magnetic condition represented by the point of inflection on the hysteresis curve. To examine this matter more closely these curves, representing the effect of the spark, are repeated in Figs. 3, 4, 5, 6, each alongside the gradient curve—that is, first derived curve—of the corresponding cyclic curve. To assist in picturing the magnetic state of the iron there is plotted on each diagram the proper hysteresis loop. These loops were obtained by independent experiments with the earth's field controlling the magnetometer needle. (Reducing factor for I is 67·5.)

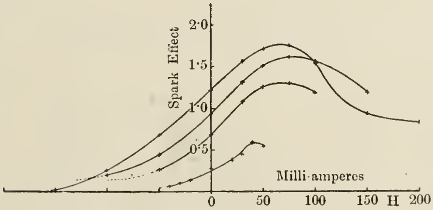

Fig. 2.

In these figures the abscissæ for all the curves are milliamperes (multiply by 0·0696 to get C.G.S. field). The figures have been so constructed that, except in the cyclic curves, equal ordinates on the different figures represent absolutely equal effects. The reducing factors for the spark-effect curves are as given in connection with Table I. In all the slope curves the ordinates give at once very approximately the change of intensity of magnetisation per 0·001 C.G.S. increment of field. But in Fig. 3 the ordinates of the cyclic curve are reduced 21 times, in Fig. 4 42 times, in Fig. 5 63 times, in Fig. 6 84 times; and are thus not directly comparable with one another or with the companion curves. Returning to the spark effect and the gradient curves, however, it is seen that the spark effect is by no means a simple function of the gradient of the cyclic curve.

The curves show, moreover, that the effect of the spark is greater in the cycles of larger amplitude; and not only because the hysteresis curves are steeper in large cycles than in small, but also because in small cycles the effect of the oscillations is, for some unknown reason, much smaller than the diminished gradient would lead one to expect.

It must be mentioned here that during the above measurements the effect of changing the sign of the initial charge given to the oscillation coil was repeatedly tried. On no occasion was there any perceptible difference in the magnetometer deflection. The damping of the oscillations must therefore have been very trifling.

The most important question to which the results set forth in this Paper can be applied is that bearing on the real nature of the phenomena observed. A number of observers have summed up their views by the phrase "hysteresis is annulled by oscillations." The present experiments at first sight bear out that view anew. The effect of the oscillations at every point of the cyclic curve is such as to carry the representative point towards the curve that would be yielded by a substance devoid of hysteresis.

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* The newspapers gave accounts of thunderstorms in Hertfordshire.

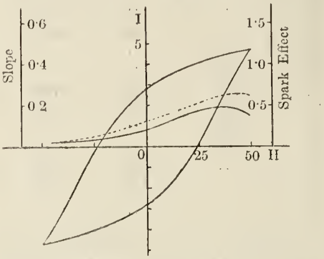

FIG. 3.—The dotted curve shows spark effect.

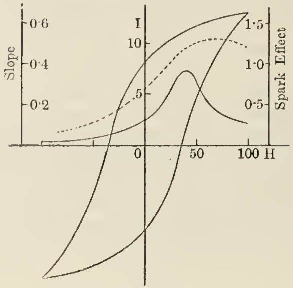

FIG. 4.—The dotted curve shows spark-effect.

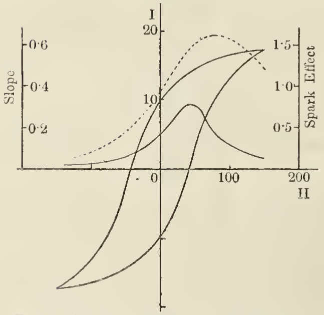

FIG. 5.—The dotted curve shows spark-effect

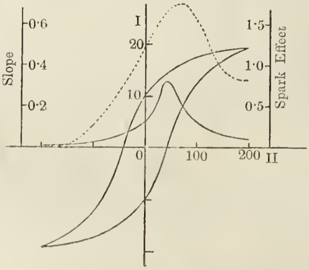

FIG. 6.—The dotted curve shows spark-effect.

This might be interpreted in the same manner as is, usually, the effect of mechanical vibration on iron undergoing varying magnetic forces—the inter-molecular bonds that hold the magnetic molecules in their instantaneous configuration are loosened for a moment, so that the resultant field can have full play in rearranging the molecular groupings. Looking further into the matter, however, on this view that hysteresis is temporarily annulled, it is evident that on the ascending loop of the cyclic curve the external applied field is permitted to do work when the magnetic shaking occurs. On the other hand, similar alterations of intensity of magnetisation occur when the applied field is zero; and, in addition, on the descending loop of the cyclic curve there are alterations in intensity opposite in sense to the applied field. It seems clear, then, that there must exist in the magnetised material intrinsic forces that tend to drag the substance into that presumably more stable magnetic state defined by the "normal curve of magnetisation" before mentioned. Thus this view that hysteresis is annulled, taken with the experimental facts of this Paper, implies that the store of intrinsic energy of magnetisation may possibly be allowed to run down through and during the action of the oscillations. In other words, the action of the oscillations may be analogous to the pulling of a trigger. These considerations threaten to lead us into the often-discussed question of the intrinsic energy of a magnetised material possessing hysteresis. However, the author shows from his observations that the wastage of the intrinsic magnetic energy of the iron, instigated by the oscillations, is less in amount than the initial energy of the oscillations themselves, and he arrives at the conclusion that the work done is practicaly all done by the oscillations, whose efforts appear to be attended with hysteresis loss. Certain other experimental results obtained by the author support this conclusion to some extent.

RADIATION FROM GAS MANTLES.[*]

BY J. SWINBURNE.

The ordinary explanation of the great luminous efficiency of the gas mantle is that rare earths have a property of selective radiation, in virtue of which they send out a larger proportion of their radiant energy in the form of light than ordinary hot bodies. The rare earths also suffer from "luminescence," which may be a disease on its own account, or a symptom of catalysis, or polarisation or something.

Another explanation, first given, I believe, by Ram ("Incandescent Lamp," p. 196), is that the Bunsen flame is really very hot, and that the mantle is of such low emissivity that it gets rid of so little power that there is little difference of temperature between it and the flame, and it is, therefore, hot enough to give the light by pure temperature radiation, without any anomaly.

One reason why the simple temperature explanation has been much questioned, and generally rejected, is that the temperature of the Bunsen is generally taken to be much lower than it is. It is generally measured by means of platinum wires or thermo-couples. These can never rise to the real temperature of the flame, as they are radiating, and must, therefore, be taking in heat by conduction, in which case they must be cooler than their surroundings.

The simple temperature explanation fits the phenomena. If pure thoria has low emissivity it will rise to a temperature near that of the shell of flame bathing it. Having low emissivity it will then give out little light, but the light will have a larger proportion of visible and refrangible rays. If a very little of a body with a high emissivity be added radiation will increase, but the temperature of the mantle will fall, as there must be a steeper heat gradient to supply it. The total radiation is then increased, and though the proportion which is luminous will be diminished, the total light will be increased. Further addition of the emissive substance increases the total radiation and reduces the temperature until the light given is less even than with pure thoria.

It may be urged against this that thoria, zirconia and alumina, for example, are white, and therefore may be expected to have little luminosity when hot, as a white body being a good reflector should be a bad emitter; but ceria, if pure, is also white, about as white as thoria, and, therefore, should have the same order of emissivity as thoria, and adding 1½ per cent. of it cannot, therefore, increase the emissivity of the mantle very much. But it does not follow that a body which is white when cold necessarily remains white when hot. Zinc oxide, for instance, gets yellow when hot, and ceria may emit like a dark-coloured body when hot. According to Féry it has a much greater emissivity both for heat and light than thoria. The ceria of chemistry books is white, but the ceria of commerce is yellow.

Almost anything coloured, however, increases the light of thoria if added in very small quantities. The reason why ceria is used is not that it has any peculiar radiating qualities; it is chosen because it is fairly permanent at the high temperatures, and does not weaken or spoil the thoria mantle. The earlier mantles were of zirconia and yttria in the proportion to make a normal zirconate. Zirconia alone gives very little light, and makes a bad mantle mechanically. The yttria would contain erbia if separated by potassium sulphate. When lanthana was used it would probably contain didymia, and perhaps ceria.

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[*] Paper read before the British Association (Section A) at York on Tuesday, August 7th.

The light of the mantle may thus be purely that due to a hot body at a given temperature, the proportion of components of different frequencies being simply that due to the temperature. The addition of a little more ceria would then increase the emissivity and cause greater radiation, and a fall in temperature so that the light would decrease. A decrease of ceria would diminish the emissivity, so that though the mantle became hotter, it would radiate less of all wave lengths.

Though this simple explanation may be ample, it does not follow that there may not be all sorts of curious things, such as selective emission, luminescence, catalytic action, resonance, unstable oxidation, and other occurrences, whose names are as impressive as vague. They may be discussed in turn.

By selective radiation may be meant that a body at the temperature of a black body emits some rays and omits others, or that it has the power of emitting more refrangible rays than a black body at the same temperature. If two black bodies are in a reflecting envelope, at the same temperature, each radiates to the other, and absorbs power from the other. The heat in each is in a state of degradation corresponding to the temperature, and in a state of equilibrium it must be radiated and absorbed by each without further degradation. Heat radiated from a black body into a closed space in equilibrium is thus not degraded. If a body only emits the portion of the rays of high frequency, though it may radiate less power or energy per second, that energy would seem to be of a higher grade than that of the black body at the same temperature, so that it can be degraded into radiation of lower frequency. If that is so, this sort of selective radiation violates the second law. Emitting more refrangible rays than the black body is worse still. It does not follow from this that a body cannot emit rays of high frequency balanced by another batch at low frequency, so that their degradation corresponds with the temperature. This form of selective emissivity has not been invented by the advocates of this theory.

There does not seem (at present) to be any thermodynamic reason why a hot body should not radiate a selection of rays provided the energy radiated is not less degraded than the heat in the body, or to put it the other way, as long as the energy has no increased "motivity," to use Kelvin's term. For the radiant energy leaving the surface to have a higher motivity than the energy in the body is a violation of the second law. There is an interesting question as to whether the radiant energy leaving a hot surface can start with less motivity. I am not considering increase of entropy of radiation spreading out after it has left the surface, but whether there can be a sudden discontinuous degradation at the surface. Growth of entropy in the case of heat conduction, irreversible expansion and diffusion is a volume increase, and it takes place when the motion of the particles is not the same in all directions, or is not diffused. Thus in heat conduction the particles move quicker when going one way than when going the other, though the distance is the same each way. In diffusion the motion of the particles of the fluids are on the whole directional. Here the speed is the same, but the distance different. Similarly with radiation in space. It seems open to question whether there can be a sudden or discontinuous change of motivity as the energy crosses the surface, changing from sensible heat into radiation. Stokes' law, that a fluorescent body cannot give out radiation on the whole of a higher refrangibility than the radiation that induced it, does not seem to have been proved, but seems to have been rather a sort of automatic statement, unconsciously based on knowledge, sounding as if it must be right.

It may be said that an ordinary spirit or Bunsen flame does not give any light to speak of, though it is hot enough to incandesce a mantle, and it certainly radiates a great deal of heat; and though it is not a surface, if its radiation has less motivity than the hot gases, there must be discontinuous increase of entropy there—perhaps. But, on the other hand, it may make up for its low-frequency radiation by some very high; and the blueness of the flame is significant. Again, in a flame it may be the slower moving particles that combine.

Another theory, very much to the fore in connection with electric lamps, is that different surfaces have different radiating efficiencies. The experimental evidence on this point is very conflicting, and the conclusions are often, I submit, unsoundly drawn. There is direct evidence, due to Féry, that the emissive light efficiency—candles per watt—varies enormously. At 1,400 deg., for example, taking the efficiency of a perfectly black body as 1, lanthana is 17, thoria 9, thoria-ceria mantle 7, platinum 5, chromium oxide 4, carborundum 3, carbon 1·3. On the other hand, chromium oxide and ceria in the reducing flame radiated more total heat per second than a black body, an absurdity which the author himself was the first to criticise. There is apparently a clear instance of selective or preferential emission in the case of erbia. In the flame it shows bright bands in the green. I have not tried a Nernst rod of it.

The next theory is that the mantle gives more light than that due to a simple hot body owing to luminescence. I cannot deal with this theory, because I have no clear idea what luminescence is. If by luminescence is meant the phenomena of a mantle, it is no explanation of the phenomena to call them luminescence.

Catalytic action is also a little vague. The idea often seems to be that, by some action or other, the ceria can convert energy of chemical action directly into light. It must be remembered that chemical energy is not work; it is partially degraded, and may be best regarded as heat, of which only a portion, $(\theta - \theta')/\theta$, can be converted into work. No catalytic action can restore chemical energy to a higher grade. But many of the chemists who advance the catalytic action theory are not men who would make slips of that sort.

The catalytic argument may, perhaps, be put something like this: If a mixture of gas and air is above ignition temperature, and is enclosed in a case from which no heat can escape, the speed of the chemical action will depend on the temperature, the pressure, and the relative amount of air, of fuel, and of combined product. We will take the pressure as constant. The rate of combination then depends on the combustion already completed. Suppose now the combustion takes place in a flame; let us consider a small volume of burning mixture ascending. It can now radiate heat, and the temperature corresponding to a given proportion of fuel burned is lowered. If the reaction constant could be artificially increased, the flame would be hotter and would radiate more heat. The rate of radiation of heat keeps the flame temperature from rising to such a value, that the reaction constant is zero; or that the products dissociate as fast as the fuel burns. If ceria has the power, by catalytic action of increasing the reaction constant, the ceria may be considerably hotter than the flame; and catalytic action may thus cause the mantle to give out rays corresponding to a higher temperature than the flame, though not to a higher temperature than that corresponding to the chemical action. There must always be some degradation of energy.

It is said that ceria acts in a special way by wobbling from one state of oxidation to another. It is quite clear that an oxide cannot create energy or heat or light by wobbling; moreover, it cannot be in equilibrium in both states. If it is in equilibrium in one state it cannot move out into a higher state. Again, chemists who put forward the oxidation theory are not likely to put it in such a form as this, so a more tenable proposition is to be sought. If the rate of combination depends on the collisions of suitable particles at suitable speeds, and if the lower oxide of cerium can hang on loosely to oxygen particles, so that it has a stock of them, any fuel particle hitting the ceria at a suitable speed can combine with oxygen. The ceria would thus heat the mantle above the temperature of the flame, or at any rate to a higher temperature than it would otherwise reach. As an analogy we may consider a matrimonial agency, with a number of women on its books. Any man knocking about who comes there meets a wife at once and combines, or is burnt at once, whereas had he merely knocked about until he met a suitable wife, the probability is that he would have been longer about it. In a stationary population of immortal Americans the state of equilibrium (with the maximum degradation) would be reached when the marriage and divorce were equal. A matrimonial agency, like a true catalist, would then have no effect on the state of equilibrium. This is really only the catalytic theory again, looked at from a molecular point of view.

The next theory is that of "resonance." Particles of gas are vibrating and changing their velocity fast enough to produce light, but somehow do not produce it. Particles of solid, however, get set into vibration synchronously with the gas particles, and thus radiate energy of the same grade as the heat of the flame. But ceria is supposed to be specially timed to vibrate with frequencies corresponding to visible radiation, so it radiates more light than other solids. This really amounts to ceria doing the work of Maxwell's demon, except that it is working on waves instead of particles. It can get outside the second law just the same. Maxwell's demon is apt to come into radiation in many disguises. He is rather fond of being a very thin plate which lets only one wave-length through and reflects all others perfectly. I have seen him mixed up in proof of Wien's law in this disguise.

The explanation that there is nothing anomalous about the mantle, and that it gives light just because it is very hot, has a Jordan simplicity about it which makes it unpopular compared with the Ahana and Pharpar of luminescence and catalytic action; but, all the same, very simple explanations are very often wrong.

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THE POWER PLANT OF THE ELECTRICAL DEVELOPMENT CO., OF ONTARIO.*

BY F. O. BLACKWELL.

The power plant of the Electrical Development Co. was designed to utilise 11,200 cubic ft. per second of water under a head of 135·5 ft. The water is diverted from the Niagara river at Tempest Point, midway between the headworks of the Ontario Power Co. and the Canadian Niagara Falls Power Co.

The general plan of development adopted called for the construction of a wing wall to gather the water from the rapids, the excavation of a forebay of sufficient capacity with the river at its lowest future stage, a wheel pit, and a tailrace tunnel discharging under the centre of the Horseshoe Falls, where the flow of water over the falls is greatest.

In order to uncover the forebay it was necessary to construct a coffer dam 2,200 ft. long in the rapids, where for a portion of the way the cribs had to be sunk in water 26 ft. deep and running at a velocity of 22 ft. a second. This work was started in April, 1903, and proved to be an extremely difficult undertaking, but was successfully completed in about 12 months.

The tailrace tunnel was started in May, 1903, by the sinking of a construction shaft on the bank of the river 150 ft. deep and 15 ft. by 7 ft. inside the timbering. From this shaft a drift 14 ft. wide and 7 ft. high was run 670 ft. to the portal of the tailrace tunnel, work upon which was only actually started in December of the same year. The final opening under the falls proved very difficult on account of the large amount of water encountered near the face and the mass of detritus that had to be cleared away by men exposed to the full force of the wind and spray from the falls.

The wing dam is 785 ft. long, and its maximum height is 27 ft. The elevation of the crest is 527 ft. and there will be from 3 ft. to 8 ft. of water flowing over it, depending upon the condition of the river. Near the power house the dam is cut away for a length of 30 ft. to an elevation of 524 ft., so that there will be 3 ft. additional depth of water to carry away ice from the submerged arches in front of the power house. This question of guarding against ice is one of the most important problems which had to be met. In addition to the first line of submerged arches just referred to, a second wall has been constructed outside of the racks. The spaces between the outer and inner walls, and between the latter and the racks, are arranged each with a spillway at one end, so that such ice as passes through will float out at the north end of the building.

The wheel pit is 416 ft long and 22 ft. in width inside of the brick lining. For the power to be developed the length of the wheel pit is much less than in previous developments of this character. This is due to the penstocks alternately being on the right and left-hand sides of the waterwheels, permitting one hoistway to serve two wheels.

The water after passing through the racks enters a cast-iron bell-mouth, which in turn joins on to a riveted steel penstock 10 ft. 6 in. in diameter.

There are 11 penstocks, and at the head of each there is an electrically-operated gate to control the water. The penstocks are connected at the bottom to waterwheels of 13,000 H.P. capacity, running at a speed of 250 revs. per min. The wheels and penstocks rest on a heavy concrete foundation, which covers the bottom of the wheel pit.

The hydraulic apparatus is being furnished by the I. P. Morris Co., of Philadelphia. Each wheel unit consists of two Francis internal discharge turbines 5 ft. 4 in. in diameter. The discharge of water is to be governed by cylinder gates, and the weight of the moving parts will be partially taken by a water piston in the wheel. There is a single cast-iron draft tube 9 ft. in diameter for each wheel, and the units alternately discharge water underneath the east and west tail race tunnels. The object of the under discharge is to seal the draft tubes and prevent loss of vacuum, no matter what the elevation of the water in the tunnels may be, and without the necessity for a tail race weir. By using two tunnels it is possible to shut off the water entirely from one-half of the wheels without interfering with the other half. By closing down the wheels, discharging water into either tunnel, that tunnel will drain itself, and there is no necessity for closing off the mouth of the tunnel. A gate is provided at the mouth of both tunnels, however, in case of extreme backwater, which has been known to be 50 ft. above normal in the lower river. As the wheel pit is not connected to the tail race, the hydraulic apparatus can never be flooded out.

The tunnels on each side of the wheel pit are 25 ft. deep, and vary in width from 66 ft. to 30 ft., with a velocity of from 15 ft. to 21 ft. a second. At a point about 150 ft. north of the wheel pit the tunnels come together. At the junction the tunnel is 35 ft. wide and 25 ft. 6 in. high, and tapers to a width of 23 ft. 5 in. and a height of 27 ft. 1 in., which section is carried to the edge of the falls, a distance of 1,935 ft. The slope of the main tunnel is 0·005, making the total loss about 10 ft., and the velocity is 26 ft. a second.

The power of the waterwheels is delivered to the electric generators through vertical shafts 150 ft. long, consisting of riveted steel tubes 30 in. in diameter between bearings and solid shafts 14½ in. in diameter at bearings. This shaft is held at three points in the wheel pit by steady bearings resting on concrete arches. At the upper end there is an oil thrust-bearing 37½ in. in diameter, fed by oil under a pressure of 350 lb., which is sufficient to carry the weight of the entire revolving parts should the water thrust fail from any cause.

There will be ultimately 11 8,000 kw. generator units, four of which are now being installed by the Canadian General Electric Co. These are of the revolving field type and run at a speed of 250 revs. per min. They deliver three-phase alternating current at a periodicity of 25 cycles and a potential of 12,000 volts. There are at first to be two 500 kw. waterwheel-driven exciters in a room underground, and two motor-generator sets of the same capacity on the generator floor. Eventually three sets of each type will be installed any two of which will excite all the alternators.

The controlling switchboard for the entire plant, including transformers and transmission lines, is located in the centre of the power house, where the operator can see the generators. It consists of an enclosed compartment with a benchboard in front and doors at the ends. The instruments which are ordinarily employed in the operation of the station face toward the generator room. On the back are the recording instruments and switches, which are only occasionally used or referred to. Dummy 'bus bars and signal lamps on the benchboard clearly indicate to the operator the connections in the station, and the instruments are so located that they are over the switch which controls them. The generator instruments, for instance, are over the generator control switch. The board is so compact that an operator standing in front of it can see all the instruments from one position, and can conveniently reach all the controlling switches. The power house 'bus bars, generator oil switches, instrument and switch transformers are located immediately below the power house floor in brick compartments. The wiring arrangement is such that a generator can either be connected to the 'bus bar or to a separate outgoing cable. In ordinary operation the current from each generator will leave the building by the shortest possible route, and there will be practically no cables running the length of the power house.

The power house will be about 500 ft. long and 70 ft. wide. The height will be 40 ft., except at the centre and end bays. The centre bay will stand out from the face of the building, and, besides being the main entrance, will give room for the offices of the power company. On the inside it will afford space for the switchboard and auxiliary apparatus. The power and transformer houses are 1,817 ft. apart, and will eventually be connected by four underground conduits. One conduit will be in reserve, and the plant will not be crippled unless two conduits should simultaneously fail.

At present two conduits only are constructed, each with 16 4¼ in. ducts placed two wide and eight deep. The manholes are common to the two conduits, but are divided into two parts by a central partition, so that one duct system would not be damaged by a burn-out on the other.

The transformer house is designed to accommodate 15 2,670 kw. transformers, 12 of which are now being installed. These transformers are of the oil-immersed, water-cooled type, and are wound for 10,000, 11,000 and 12,000 volts primary and 60,000, 50,000 and 40,000 volts secondary. They will be connected in delta on both primary and secondary sides.

Each transformer is placed in a separate closed fire proof room, so as to minimise the fire risk and prevent the possibility of trouble in one transformer being communicated to others. The transformers are mounted on rails and arranged to slide out of the compartments into a gangway, where they can be readily handled by an overhead travelling crane.

The piping for oil and water is placed in the basement under the back of the building and on the wall of the transformer compartments. The cables from the power house are carried in ducts to a gallery above the transformers, where the 12,000 volt switches, instrument transformers and 'bus bars are located.

The high potential 'bus bars, wiring, instrument transformers and isolating switches for the 60,000 volt circuits are located in the room behind the transformers, and connected through the gallery floor to the high potential oil switches on the floor above. The outgoing transmission lines leave the building through porcelain bushings at the back, and are protected by lightning arresters on the wall below. The wiring throughout is completely enclosed in brick compartments, the only openings being through asbestos doors placed at points convenient for inspection.

The transmission line to Toronto, constructed by the Toronto & Niagara Power Co., is built on a private right-of-way 80 ft. wide, which can later be used for a double-track railway. With this idea in view, the line was located so that the maximum grade at no point need exceed 1 per cent., and the minimum radius of track curvature can be made as low as a ¼ mile.

Two complete steel tower transmission lines will eventually be constructed, one only being erected at present. Each tower carries two circuits of 190,000 circular mils copper conductor. The standard distance between poles is 400 ft., although much longer spans are used in crossing rivers and ravines. For curves and long spans special extra heavy towers are employed, with double and triple insulators. The height of the standard tower is sufficient to support the lower cable at a height of 40 ft. from the ground. 50 ft. and 60 ft. towers are made by bolting extensions to the bottom of the standard towers, and are used wherever there are depressions along the right-of-way. In two places towers 150 ft. and 175 ft. high are required in order to cross navigable channels at the Welland canal and at Burlington Beach.

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* Abstract of a Paper read before the Canadian Electrical Association, and published in the *Electrical Review* of New York.

The copper cable consists of six strands with a hemp centre, and has a tensile strength of 60,000 lb., and an elastic limit of 40,000 lb. per square inch. It was made by the Dominion Wire & Cable Co., of Montreal.

A large portion of the power is delivered to synchronous apparatus, the Toronto street railway employing rotary converters, and the lighting company synchronous motor-generator sets. The loss of power, when transmitting 10,000 H.P. to Toronto over each circuit, will be less than 16 per cent., and either line can transmit 20,000 H.P. with less than 20 per cent. loss should the other become disabled.

The insulators are 14 in. in diameter and 14 in. high, and are tested for a potential of 120,000 volts complete, or 60,000 volts on each of the three parts of which it is composed. The transmission towers are heavily galvanised after all machine work upon the parts has been completed. At points exposed to severe lightning the line will be protected by 12 ft. extensions carrying galvanised steel cable above the power conductors.

There will be three division houses along the line, dividing it into four sections, any one of which can be cut out for inspection or repair. The length of the line is about 90 miles, and the division houses will therefore be 22½ miles apart. A lineman will control each section daily after the transmission is in operation.

The sub-station in Toronto is designed for 15 2,670 kw. transformers, and is similar to the transformer house at Niagara Falls, except that there will be double low-tension 'bus bars and a much larger number of feeder cables for distributing power throughout the city of Toronto.

The switchboard is located at one end for controlling the transmission lines, transformers and 12,000 volt circuits. This is equipped with dummy 'bus bars with all necessary instruments.

In the plans of the Electrical Development Co. every effort has been made to avoid any interruptions to the power service. The double ice protection, twin tail race tunnels, the extra 8,000 kw. waterwheel, generator and transformer unit, and the duplication of the transmission lines and of all auxiliary apparatus is with this end in view.

COLOUR PHENOMENA IN PHOTOMETRY.*

BY J. S. DOW, B.SC.

The discussion of Dr. Fleming's Paper on Photometry, read before the Institution of Electrical Engineers in 1903, revealed great differences of opinion on the importance of colour phenomena in photometry, and it still does not seem to be generally known to what extent they are noticeable under ordinary working conditions. This may be due to the fact that most of the work done on this subject was carried out with special apparatus, such as the spectrophotometer, and not with the ordinary implements of photometry.

It therefore occurred to the author that some simple experiments on these points, carried out by him at the Central Technical College on an ordinary photometrical bench, might be of interest.

The sources of light were two similar glow lamps, which could be screened with glass of different colours, and which were compared by means of one or other of several different photometers in the usual way. Four photometers were made use of during the experiments—the Lummer-Brodhun, the grease-spot, the Joly, and the Flicker.

The uncertainties which may be introduced by colour phenomena appear to be due to four separate effects:—

1. The difficulty experienced in forming a judgment in the case of differently-coloured lights, and the possibility that the judgments of different people may not be the same.

2. The fact that the apparent relative brightness of two surfaces, illuminated by light of different colour, depends on the part of the retina on which the image of them is received.

3. The Purkinje phenomena.

4. The possibility, when mirrors are made use of, that the coefficient of reflexion may not be the same for different coloured lights.

1. No doubt people differ in their capacity in this respect, but according to the author's experience it is chiefly a matter of practice. After a considerable amount of practice, he has found that it is possible to secure fairly consistent results even when comparing such colours as ruby-red and signal-green, while anyone unused to such work would be quite unable to do so. Extraordinarily consistent results were sometimes obtained, but it was found that if the observer stopped work for an hour or so, his readings afterwards would settle down to another very consistent value, but differing by, perhaps, 5 or even 10 per cent. or so from those obtained before. This seems to suggest that extreme consistency in reading is partly a matter of visual memory. We recall the impression previously received by the eye and involuntarily set the photometer, the next time, so as to produce the same appearance of the field of view.

The difference in sensibility of different eyes to a particular colour certainly introduces another disturbing factor in observations made by different people. The author has not met with any serious differences in judging the colour contrasts which ordinarily occur, but it might be supposed that, in such an extreme case as that quoted above, considerable divergences in judgment would exist, and have, indeed, been recorded by Sir Wm. Abney, Prof. Rood and others.

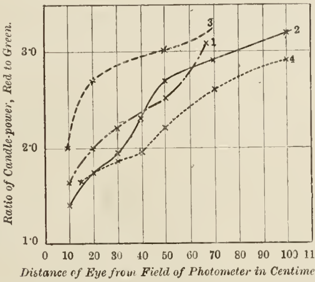
It must be noted, however, that the effect mentioned in (2) must be eliminated, in order to make any satisfactory comparisons. All the figures given in this Paper were obtained by the author himself, though corroborative results from other eyes were obtained in many cases.

2. This effect has been very completely dealt with by Sir William Abney in his investigation on colour vision.

It has long been known that the central portion of the retina—"the yellow spot"—is much more sensitive to the red end, and less sensitive to the blue end of the spectrum, than the surrounding portion of the retina.

It has been suggested that the "yellow spot," being yellow in colour, will obstruct the blue rays, but will allow the yellow rays to pass through practically unimpeded to the light-perceiving organs. This explanation, however, does not explain why the differences observed are distinctly more noticeable at low illuminations.

There appears to be another physiological effect, which will be referred to later.



(1) Lummer-Brodhun Photometer (telescope removed). (2) Joly Photometer. (3) Joly Photometer (linear dimensions of blocks reduced by half). (4) Grease-spot Photometer.

FIG. 1.—RUBY-RED LIGHT COMPARED WITH SIGNAL-GREEN.

Suppose, now, that we compare a red and a green light with a Joly photometer. An image of the illuminated blocks is formed on the retina, and we adjust the position of the photometer until the red and green appear equally bright.

But if we now observe the photometer obliquely, or if we observe it with the eye at a different distance away, the image falls on a different part of the retina where the sensibility to red and green may be different. Consequently the red and green may no longer appear equally bright.

And if a photometer with blocks of a different size were used we might again come to a different conclusion; for, even if the eye were kept at the same distance, the size of the image would be different, and a new portion of the retina would be covered by it.

The position of the photometer, for which we obtain balance, therefore depends upon—

(*a*) The obliquity at which rays from the illuminated surface strike the eye.

(*b*) The distance away of the eye from the surface.

(*c*) The size of the surfaces.

The first point is not very important, for in focussing our eyes on the surfaces we involuntarily look straight at them. But (*b*) and (*c*) may easily affect the readings considerably. This is brought out in the curves in Fig. 1.

These curves were obtained as follows: Two glow lamps, screened with red and green glass respectively, were run at a constant P.D., and compared by means of each of the three photometers referred to above.

In each case a series of readings was obtained with the eye at different distances away from the illuminated surfaces. It should be mentioned that in the case of the Lummer-Brodhun photometer, the telescope was removed while the readings were taken. As will appear later, however, considerable variation is possible even with the telescope in position, as in use.

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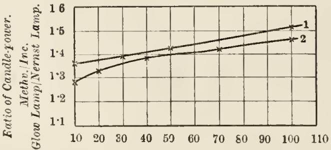
* Paper read before the Physical Society, May 25, 1906. *Phil. Mag.*, August, 1906.

Curves (1), (2) and (3) speak for themselves. They bring out two points. Firstly, that the ratio of the candle-powers of the red and green lights, as thus observed, is quite different for each photometer. Secondly, that this ratio depends on the distance of the eye from the photometer, the red becoming more and more accentuated as the eye recedes. Also the red is most accentuated and the curve is steepest for the Lummer-Brodhun photometer, in which the field is smallest.

Curve (4) was obtained by placing in front of the blocks of the Joly photometer a paper screen which reduced its linear dimensions by one-half. The reduction in size of the blocks corresponds with a still further accentuation of the red.

This effect has been found to be quite distinctly observable in several commonly occurring comparisons. Fig. 2 exhibits the connection between the apparent relative candle-power and the distance away of the eye with a Joly photometer, when a Nernst lamp was compared with a glow lamp (running at 3·7 watts per candle-power), and when an incandescent mantle was compared with a Methven burner.

In the Joly photometer the distance away of the eye is left entirely to the inclination of the observer, and it will be seen from the above that differences of 5 per cent. or more might easily be introduced between the readings of different observers in this way.



(1) Glow Lamp compared with Nernst Lamp. (2) Methven Gas Standard compared with Incandescent Mantle.

FIG. 2.—CURVES FOR JOLY PHOTOMETER.

In the Lummer-Brodhun photometer the distance of the eye is limited, to some extent, by the use of the telescope. But the position of the telescope can be varied between wide limits without putting the field out of focus, and this latitude allows of a considerable difference in the readings.

In the table below the extreme differences are given for these two limiting positions of the telescope :—

Nature ef lights cempared.	Ratio of candle-power.		Percentage difference.
	Telescope in.	Telescope out.	
Ruby red to signal green	1·65	2·20	25·0
Glow lamp (3·7 watts per candle-power) to Nernst lamp	1·38	1·43	3·5
Methven gas standard to incandescent mantle	0·129	0·135	4·4
Harcourt 10 c.p. Pentane standard to Fleming standard glow lamp	0·652	0·657	0·77

Here, again, a distinct difference in reading is produced in several practical cases.

It is also remarkable that a small but distinct effect was produced in the last case, even though the flame of the Harcourt lamp is only very slightly redder to the eye than the light from the Fleming glow lamp.

It is difficult, of course, to speak with certainty of such a small change as this—a change which would be produced by moving a photometer, set midway between two lights 2 metres apart, a distance of less than 2 mm. But the writer has usually found that the mean of a set of readings, taken with the telescope out, worked out to a value slightly different to the mean of those taken with the telescope in, and the difference was always in favour of the redder of the two lights. It need hardly be said that the difference observed might be important in such work as these two standards are used for.

There is one other point that requires mention. It is, of course, often necessary to reverse a photometer in order to correct for any differences between the two sides of the screen, &c. However, for lights of similar colour, very little difference is produced by doing so, as a rule.

But when the lights differ in colour the Lummer-Brodhun behaves differently from the Joly and grease-spot photometers. In the case of the latter, the image the retina receives is unaltered by reversing. But, with the Lummer-Brodhun, the image is reversed. If, before reversing, we see a green disc with a red centre, after reversing we see a red disc with a green centre.

We should, therefore, expect a much greater difference on reversing the photometer in the case of the Lummer-Brodhun.

The following figures, obtained for similarly coloured lights, and for red and green lights, exhibit this :—

Photometers used.	Lights of similar colour.			Red te green light.		
	Ratio of C.P.		Per cent. differ.	Ratio of C.P.		Per cent. differ.
	1st pos.	2nd pos.		1st pos.	2nd pos.	
Jely	0·93	0·91	2	2·24	2·12	5·5
Grease-spot	0·94	0·91	3	1·81	1·70	6·0
Lummer-Brodhun	0·95	0·91	4	2·10	1·75	18·0

3. The Purkinje phenomenon has often been referred to as the chief source of trouble in heterochromatic photometry, but it appears to be only troublesome at very low illuminations.

An experiment was shown illustrating the Purkinje effect. A series of coloured screens, diminishing in size from about 4 ft. square, as shown in the diagram (Fig. 3), were illuminated by a 32 c.p. glow lamp at a distance of about 10 ft. away. All these screens were made from the same identical red and blue paper, but, even at normal illuminations, it could be seen that as the surfaces became smaller the red appeared brighter and brighter in comparison with the blue. The red, however, was distinctly the brighter, even in the case of the very large screen.

The illumination was now weakened by introducing resistance in series with the glow lamp, and the blue began to appear brighter. A point was soon reached when, for the very large screen, the blue was unquestionably brighter than the red. At this stage the difference in appearance of the different-sized screens was much more marked than at the higher illumination, and, in the case of the smaller screens, the red was still much brighter than the blue.

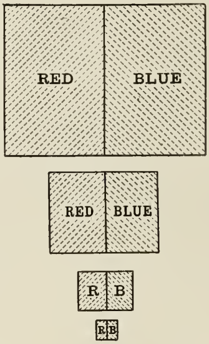


FIG. 3.

As the light was still further weakened the colours began to disappear until, eventually, the red appeared as black, while the blue shone out with a phosphorescent white appearance. After this point the blue also fades away until nothing can be seen.

There is, however, a distinct difference between the behaviour of the very big screen and the very small ones. In the case of the latter the Purkinje effect is much weaker. Both colours seem to fade away together, and, by the time the Purkinje effect is really noticeable on the big screen, the very small screen can scarcely be seen at all.

In fact, to see the Purkinje effect really well, it is necessary to stand quite close up even to the big field.

A very interesting physiological explanation of these effects has been given by M. Sartori in a recent Paper.*

Dotted about over the retina are two varieties of light-perceiving organs, known from their appearance as the "rods" and the "cones" respectively. The rods, it is thought, are sensitive to light but cannot perceive colour. Light of any colour appears to them white, but they are most sensitive to blue light. They are, moreover, sensitive to very weak light; but as the illumination is increased they become, as it were, saturated, and do not respond any further. The cones, on the other hand, perceive colour, but are most sensitive to yellow-green light, and while they do not respond at the low illuminations at which the rods can act, they continue to respond further to increased stimulus, once they have started, long after the rods have ceased to do so.

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* *Electrotechnik und Maschinenbau*, March, 18, 1906.

At normal illuminations, therefore, it is the cones which chiefly act, and we see colour. At very low illuminations the action of the rods is predominent, and we cannot see colour, while light of a bluish colour shines out with a whitish appearance. As the illumination is increased the cones suddenly begin to act and the colours appear. Then takes place what has been called "The Battle of the Rods and Cones." It is while this battle is in progress that the Purkinje effect is noticeable.

But the Purkinje effect is complicated by the fact that the rods and cones are unequally distributed over the retina. At the yellow spot the cones are predominant. Consequently, the Purkinje effect is much weaker when the field of view subtends a small angle at the eye.

This uneven distribution of the rods and cones will also explain the fact, referred to above, that at low illuminations the size of the field of view can produce much greater differences in the results.

In order to gain an idea at what illumination the effect becomes noticeable in practice, the following experiment was carried out:—

Two 100 volt 8 c.p. glow lamps were run in series with a constant P.D. of 190 volts across them.

One was screened with red glass and the other with green glass. The distance between the two lamps was varied from 20 in. to 250 in., and the mean of a set of readings, giving their relative candle-power, taken in each case. In order to avoid the effect mentioned in (2) above, the Lummer-Brodhun photometer was used, and the telescope was kept in exactly the same position throughout the experiment.

Fig. 4 shows the result of plotting the ratio of the candle-power of the two lamps against the illumination of the photometer disc, in candle-metres.

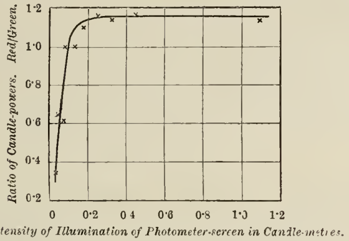

FIG. 4—CURVE EXHIBITING PURKINJE PHENOMENA FOR RUBY-RED AND SIGNAL-GREEN LIGHTS.

From what has been said above, it is clear that we cannot, strictly, define the candle-power of a red light in terms of white-light standard, because this ratio depends upon the distance of the eye from illuminated surfaces.

Nevertheless, in order to give an idea of the order of illumination used, the red lamp was compared against a 2 c.p. Methven gas standard, using the Lummer-Brodhun photometer, and its candle-power worked out to something of the order of 0·25 c.p.

The relative illuminations used in the curve are expressed in terms of this figure.

It will be seen it is only when the illumination has been reduced to about 0·2 candle-metre that the ratio of the red to the green light begins to decrease.

The same experiment was tried on several occasions with lights of different candle-power, and it was always found that fairly consistent results were obtained until the illumination fell to something of the order specified above, when the accentuation of the green light began to appear.

At such illuminations it is very difficult to obtain readings at all, and the mean of a great many should be taken. The eye seems to be in a state of uncertainty, and one receives the impression that the lights are continually varying. In fact the eye seems to be in a state analogous with that of unsaturated iron on the steep part of the magnetisation curve.

It may safely be assumed, therefore, that in all ordinary cases, where the illumination would be at least 10 or 12 times as great as that employed above, where the field of view would subtend a comparatively small angle at the eye, and where we should never meet with such an extreme colour contrast as in this case, the Purkinje phenomena will not materially influence the results.

4. In order to obtain the curve of vertical distribution of light from arc lamps, &c., the beam of light is often reflected in the desired direction by means of a 45 degrees mirror.* When this is done, the question arises, whether the coefficient of reflection of the mirror will be the same for lights of different colour.

The following experiment was carried out with a silvered glass mirror of this type: Two 200 volt 32 c.p. lamps were run in parallel off a constant P.D. of 200 volts. The two lamps were compared against each other direct. They were then compared when the light from one of them was reflected along the bench from the mirror. In this way, the coefficient of reflection of the mirror is easily obtained.

This was repeated when the lamps were screened with red and green glass, successively.

The mean of one set of determinations gave—

Coefficient of reflection, 78·8 per cent. for unscreened lamps.
,, ,, 79·0 ,, ,, red light.
,, ,, 77·8 ,, ,, green light.

Repetitions of the experiment gave slightly differing results, but it was found that the values for the three different colours did not differ among themselves by more than 2·5 per cent. Moreover, no connection could be traced between these differences and the colours, for the difference was sometimes in favour of the red light and sometimes in favour of the green.

We may safely conclude, therefore, that in all ordinary cases, where the difference in colour is less pronounced than that adopted here, the effect is inappreciable.

In any case, the adoption of adjustable photometers of the Simmance-Abady type will probably render mirrors unnecessary in obtaining curves of distribution of light in the future.

The only really important effect, under ordinary working conditions, therefore, is that described under the second heading. It has been shown that this may, apparently, give rise to a perceptible discrepancy even when lights so similar in colour as the Harcourt 10-candle Pentane standard and the Fleming glow lamp standard are compared.

FLICKER PHOTOMETERS.

The interesting question now arises whether photometers of the Flicker type are also influenced by these colour phenomena.

If, as is claimed, the disappearance indicates that the two surfaces appear equally illuminated to the eye, one would suppose that all the conditions which determine this impression must also determine the point of disappearance of the flicker. On the other hand Mr. T. C. Porter and others have come to the conclusion that the flicker, at ordinary illuminations, is independent of colour.

Through the kindness of Messrs. Everett, Edgcumbe & Co. the author has been able to make some experiments on the points referred to, with a photometer of this kind.

It is clear, in the first place, that when comparing lights of different colour, the readings of an ordinary photometer and a Flicker photometer may not agree even if the latter be independent of all colour effects. For instance, when two lamps giving light of exactly the same colour were compared, the results with the Joly photometer and the Flicker photometer were exactly the same. The two lamps were now screened with red and green glass respectively, and the ratio of the red to the green, obtained by the Flicker photometer, was about 1·34; but with the Joly photometer it was found possible to get readings from 0·7 to 1·4 for distances of the eye up to ½ metre. Agreement between the photometers occurred when the eye was about 40 cm. away from the blocks of the Joly.

One difficulty met with in this investigation was as follows: As the effects observed were comparatively small, it was advisable to use lights widely differing in colour. On the other hand the position of minimum flicker, though sufficiently sharply defined in most practical cases, is far from being so when such colours as red and green are observed. In such cases, the method followed was to note the position of the photometer in which a flicker was just visible on either side of balance, and take the mean. There is, however, another method of judging the position of balance for these two colours.

When the photometer is too near the red light, the field of view in the photometer appears reddish in tint. Similarly, a greenish tinge shows that the green illumination is the stronger. When the illumination of the two surfaces, illuminated by light of these two complementary colours, is the same, an intermediate greyish tinge is produced. To the writer's eye the transition from red to grey to green was sharper than the disappearance of the flicker, and a series of tests showed that the result was the same in each case. The method, however, is only applicable to complementary colours.

Some experiments were first made to discover whether a difference of reading could be produced by altering the telescope, as in the case of the Lummer-Brodhun photometer, but no distinct difference was observable. Next the telescope was removed, and readings were taken with the eye about 20 cm. from the aperture. A brass tube was then inserted which allowed the aperture to be inspected from a distance of 60 cm. from the eye. It was then observed that, as the eye was withdrawn, the field became distinctly redder, and readings taken by the "disappearance of flicker" method also showed a change of relative candle-power in favour of the red. The following table exhibits some of the results obtained:—

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* A mirror, that is, which rotates about an axis making an angle of 45 deg. with its plane.

Nature of lights compared.	Eye 20 cm. from aperture.	Eye 60 cm. from aperture.	Percentage change.
Ruby-red to signal-green..	$\frac{\text{Red}}{\text{Green}}=1{\cdot}52$	$\frac{\text{Red}}{\text{Green}}=1{\cdot}70$	12
Ruby-red to light from unscreened glow lamp (white)	$\frac{\text{Red}}{\text{White}}=0{\cdot}70$	$\frac{\text{Red}}{\text{White}}=0{\cdot}75$	6
Methven gas standard to incandescent mantle	$\frac{\text{Methv.}}{\text{Inc.}}=0{\cdot}28$	$\frac{\text{Methv.}}{\text{Inc.}}=0{\cdot}29$	3

The effect is very noticeable when observed in the following way: Supposing we are comparing red and green, and have placed the photometer so as to secure balance. Move the photometer until a distinct flicker can just be seen owing to the green being too bright. It will be found that as the eye is removed the flicker gradually disappears. But if the photometer is put out of balance on the red side, the flicker does not disappear but becomes if anything more distinct as the eye is removed.

It appears therefore that this Flicker photometer is affected by the distance of the eye, but, apparently, not to a sufficient extent to be noticeable when the telescope is used, as in ordinary work.

It is difficult to see why these effects should be so much less noticeable than with ordinary photometers. It almost seems as though, when two differently coloured objects are placed side by side, any change in their relative illumination becomes exaggerated, thus creating a different impression to that received when they are viewed alternately (as in a Flicker photometer).

An attempt was also made to discover whether the Flicker photometer was subject to the Purkinje phenomenon. Now it is well known that the speed required to just make the flicker disappear depends upon the illumination, and the writer has found it impossible to judge the point of disappearance of the flicker with any certainty at the extremely weak illuminations necessary to produce the Purkinje effect.

The plan of "colour-reading" referred to above was therefore adopted. It may be objected that in doing so the real question at issue is avoided altogether. But the method, while admittedly not so satisfactory as the "disappearance of flicker" method from this point of view, has been shown to give the same results at ordinary illuminations, and to the writer it seems impossible that the green illumination could be brighter and yet the field of view appear red.

Two 100 volt 8 c.p. lamps screened with red and green glass in the usual manner were used for the experiments. They were first run at 100 volts, and compared against each other at different distances. The two lamps were then run off 50 volts only, so as to produce a very low illumination, and the experiment repeated. The following table shows very clearly the influence of the Purkinje effect.

At the higher illumination the readings differed among themselves considerably (as was only to be expected with such a great colour contrast), but they do not seem to be connected in any way with the illumination.

The readings at the low illumination can only be regarded as very approximate, but they bring out very clearly the accentuation of the green as the illumination gets weaker.

Lamps run at 100 volts.		Lamps run at 50 volts.	
Distance between lamps.	Ratio $\frac{\text{red}}{\text{green}}$.	Distance between lamps.	Ratio $\frac{\text{red}}{\text{green}}$.
50 in.	2·32	40 in.	2 0
60 in.	2·26	50 in.	1·5
70 in.	2·25	60 in.	1·1
120 in.	2 15	70 in.	0·7
150 in.	2·25	90 in.	0·6

The conclusion the writer draws from these experiments is that Flicker photometers are affected by the same colour phenomena which affect ordinary photometers.

The interesting assertion was made by Messrs. Simmance and Abady, in a Paper before the Physical Society,* that a colour-blind person obtained practically the same results with their Flicker photometer as people with normal sight. On the other hand, Sir Wm. Abney, speaking of colour-blindness, remarks:—†

"We cannot hope, for instance, that the red-blind, who sees no red in the extreme end of the spectrum, would show any luminosity in that region. . . . One of the most striking experiments in colour-vision is to place a bright-red patch on the screen and to ask a red-blind to make a match in luminosity with the white. The latter will have to be reduced to almost darkness—a darkness, indeed, that makes the match almost incredible."

It seems incredible that such a person, when comparing red and green with a Flicker photometer, would obtain the same results as if he had normal sight. However, it appears that, according to Dr. Edridge Green,* colour-blindness is of two kinds. A person may be unable to distinguish, say, red light by colour, but nevertheless a red object may appear as *luminous* to him as to anyone else. On the other hand, the colour-blindness may be due to the fact that the eye is incapable of perceiving red light at all. A colour-blind person of the first variety would presumably make normal photometrical readings. A person of the second class must, surely, obtain abnormal readings with all photometers, Flicker or otherwise.

This is borne out by some of Prof. O. N. Rood's experiments on flicker.† He found that those of his students who were colour-blind obtained abnormal results with his Flicker photometer. Indeed, he actually used the Flicker photometer to investigate not only cases of colour-blindness, but also the difference in sensibility to light of different colours of the eyes of persons with normal sight.

In conclusion, the writer wishes to express his great indebtedness to Prof. Ayrton, and also to Mr. J. M. McEwan, for their assistance and for many valuable suggestions.

LEGAL INTELLIGENCE.

Re Empire Electric Light & Power Co. (Ltd.)

In the Vacation Court on Wednesday before Mr. Justice Sutten application was made for the winding up of the above company on the petition of the Tudor Accumulator Co.

COUNSEL for the company asked that the matter might stand over. The petition alleged that the directors of the company were guilty of a fraudulent preference in favour of a firm of solicitors by issuing to them debentures contrary to an agreement with creditors not to issue any further debentures.

His LORDSHIP: Putting that aside, what is there to prevent me making a winding-up order?

COUNSEL said the money had been owing for about two years, so there could be no great urgency. He was instructed that negotiations were going on for financial assistance, and there was every reason to suppose they would be successful.

Mr. BRAMWELL DAVIS, K.C., for the petitioners, said the money was due and he submitted his clients were entitled to an order.

His LORDSHIP made a compulsory winding-up order.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Sunderland Corporation require an electrical engineer to take complete control of the Municipal electrical undertaking. Candidates must be not more than 40 years of age, must have had a thorough training as mechanical and electrical engineers in some recognised works, also in a recognised technical college or similar institution, have had actual experience in high-tension alternating (preferably three-phase) supply, and be M.I.E.E. Preference will be given to one who has previously held with merit the position of electrical engineer of a borough or well-known supply company, and had experience in designing and controlling extensions; also to one holding the Diploma of the I.C.E. Salary £800 per annum, increasing £50 yearly to £1,000. Applications to the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon, Aug. 29. Further particulars are set out in an advertisement.

Applications are invited from candidates for vacancies on the staff of the civil and mechanical engineering department of the Central Technical College. Workshop, drawing office and teaching experience are necessary. Commencing salary £150 per annum. Applications to Prof. W. E. Dalby, Exhibition-road, London, S.W. See also an advertisement.

The committee of East Ham Technical College invite applications for the position of instructor in electric lighting and power transmission at the classes on Wednesday evenings. Salary 10s. 6d. per evening. Applications to the Principal, Mr. W. H. Barker, B.Sc., Technical College, East Ham. See an advertisement.

A mains and distribution supervisor is required for H.M. Dockyard, Sheerness. Particulars and forms of application from the electrical engineer, Mr. E. T. Williams. See an advertisement.

An electric power supply company has a vacancy for a power engineer, with thorough practical training in engineering shops and at college and some commercial experience. Further particulars in an advertisement.

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* *Phil. Mag.*, VII., p. 341 (1904).

† "Colour Vision," p. 83.

* "The Physical Aspects of a Theory of Colour Vision," by F. W. Edridge Green, M.D., British Association, 1902.

† *American Journal of Science*, 1899, p. 258.

A manager will be required next year for asphalt factories. Knowledge of the French language and of electrical and steam machinery essential. Salary £350 and furnished house. See an advertisement.

An instructor in electrical engineering is wanted at the Crawford Municipal Technical Institute, Cork. Salary £200 per annum. Applications to the head master (Mr. E. A. O'Keofe) by Aug. 31.

An assistant lecturer in physics is required at King's College, Strand, London, W.C. Salary £150. Applications by Sept. 1 to the Secretary.

A lecturer on engineering subjects is required at Rutherford College, Newcastle-on-Tyne. Salary £250. Applications by Sept. 1.

Mr. Frank A. Blood, who has resigned his position in the designing switchboard engineer's department of the British Thomson-Houston Co , at Rugby, has been appointed assistant superintendent of outside switchboard construction with Ferranti Limited, Hollinwood.

Nelson Electricity and Tramways committee have selected Mr. Helm, chief assistant engineer, for the post of borough electrical engineer and tramways manager (in succession to the late Mr. M. B. Henry) at a commencing salary of £150.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 18 and ends on March 28. Students in the engineering and naval architecture departments usually spend the summer months in practical work. Prospectuses of the courses for the B.Sc. and D.Sc. degrees and syllabus of classes from Prof. Barr, James Watt Engineering Laboratories, The University, Glasgow.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Glasgow and West of Scotland Technical College.—The next session begins on Tuesday, Sept. 25, in the new buildings. The diploma of the college is granted in electrical, civil and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed University classes. There are new and well equipped laboratories in the departments of physics, electrical engineering, mechanics, technical chemistry, &c. The preliminary examination for candidates for the diploma begins on Sept. 17, and names of candidates must be lodged by Sept. 14. Prospectuses from the Secretary.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

South Western Polytechnic (London, S.W.)—A complete three years' course in electrical engineering is given in the day classes and a four years' course in the evening classes at this polytechnic. Courses of lectures and practical work are also given in electrical engineering (elementary, intermediate and advanced) and electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting and calculus for engineers. These lectures may be taken separately or as part of a course. Particulars from the Secretary, Manresa-road, Chelsea, London, S.W.

College Calendars.—We have received a copy of the calendar of the Glasgow and West of Scotland Technical College for the 1906-7 session. Particulars are given of the courses of instruction in the day and evening classes in electrical, civil and mechanical engineering, chemistry, mining, architecture, &c. Interesting information is also given as to the history and constitution of the college, the bursaries and scholarships, degrees and diplomas, &c.

The calendar of the Merchant Venturers' Technical College, Bristol, for the 1906-7 session gives full particulars of the courses of instruction in electrical, civil and mechanical engineering, chemistry, physics, &c., and of the degrees, diplomas and certificates conferred by the college. There are day and evening classes, and the college has well-equipped laboratories and workshops for experimental and practical work. There are also a good library, reading rooms, &c.

Argentina.—The "Review of the River Plate" says Buenos Ayres Council have definitely declared as lapsed R. von Wentzky & Co.'s concession for electric tramways. G. Rohtgen & Co. have applied to the municipality for a concession for electric tramways, some of which would traverse routes already occupied by other lines.

The Government has approved the plans of the Port & City of Buenos Ayres Tramway Co. for a line in Pedro Mendoza. Companies having lines in this street have been given 60 days to remove them.

The "Boletin Oficial" notifies that the Ministry of Public Works has submitted to Congress proposals from Messrs. Guesada & Gallo for the construction and operation of electric underground railways in Buenos Ayres, and from the Great Western Railway Co. of Buenos Ayres for the extension underground of their line from the Calle Sadi Carnot to the harbour.

Ashton-in-Makerfield.—The Council have applied for a year's extension of their electric lighting order, 1901.

Australasia.—The "Australian Mining Standard" says that a committee has been appointed to inquire into the efficiency of the magnetic brake in use on the King-street (Sydney) tramways.

The members of the committee are Mr. T. Roberts, chief mechanical engineer of S. Australian railways; Mr. J. S. Badger, manager of Brisbane tramways; Mr. H. J. Somerset, manager and engineer of Perth electric tramways; Prof. J. A. Pollock, Sydney University; and Mr. O.W. Brain, electrical engineer N.S.W. railways and tramways.

The Premier submitted to the Legislative Assembly of New South Wales recently a return showing that the railway commissioners are introducing synchronised clocks at the new Sydney Central Railway station buildings, and have adopted a German system. The cost of three dials and master clock is about £80, against £33 quoted for a British system. The cost of maintenance being 6d. and £1 per clock per annum respectively.

Perth Gas Co. have purchased duplicate electrical machinery for their second station at a cost of about £10,000. During the past half-year 9 miles of electric cable were laid, making a total of 69 miles.

Shareholders of the Adelaide & Suburban Tramway Co. have confirmed the conditional agreement for the sale of the undertakings to the Government.

Melbourne Electric Supply committee have recommended the immediate expenditure of £105,000 upon extensions of generating plant, alterations of distribution system, &c.

On the conversion of the distribution network for public and private supply it is proposed to spend £42,710, for converting the street-lighting plant at the station (including alternating-current private supply plant) £15,530, alterations to engine room buildings £1,455, extensions of boiler house plant £6,900, building improvements £17,175, contingencies £2,000, and direct current supply £19,800. The private supply in the centre of the city has been changed to direct current and the mains have been placed underground, while the public lighting in the same area is also to be changed to the same system. It is proposed to adopt one alternating-current system for public and private supplies. For public lighting 545 arcs and 870 series incandescent lamps are recommended. The committee propose to use flame arc lamps (8 ampere size) for street lighting. Provision is made for installing new 500 kw., 750 kw. and 150 kw. steam turbo-generators. Four old boilers are to be replaced by two new boilers and an overhead coal bunker with a capacity of 2,200 tons is to be put down. A new enlarged chimney-stack will also be built.

Belfast.—The directors of the Palace Theatre of Varieties have declined the terms offered by the Tramways and Electricity committee for the supply of electricity (2¾d. per unit, provided 65,000 units were used per annum) and seek permission to connect the Palace Theatre with the Theatre Royal and erect generating plant of their own to supply both houses. The Council have decided not to grant this request. The town clerk is looking into the question generally as to granting permission to ratepayers to open up streets for other than public purposes.

In connection with the costs of the arbitration proceedings over the purchase of the tramways, the L.G. Board have now surcharged certain members of the Corporation in sums varying from £80 to £153.

Birkenshaw.—The Council have deferred consideration of the Yorkshire Electric Power Co.'s offer to supply current for public lighting.

The application for a further extension of time for carrying out the Spen Valley and Morley Light Railway Order will be objected to by the Council.

Birmingham.—The National Telephone Co., which proposes to erect a large central exchange in the vicinity of New-street station, and suburban exchanges at Aston, Small Heath, Handsworth, Selly Oak, Edgbaston and Moseley, have acquired the necessary sites, and the company's architect is now preparing the plans. The present exchange in Newhall-street, which has 8,000 lines connected, is not, however, to be abandoned, but when the new building is constructed and equipped there will be an additional 10,000 lines at the disposal of subscribers.

Birmingham District Tramways.—The Corporation in 1904 excluded Harborne from the districts to which they proposed to lay tramways, owing to want of unanimity on the part of the Harborne residents and the strong opposition by the inhabitants of Edgbaston, which lies on the route between the city and Harborne. The population of Harborne has rapidly increased and, as railway facilities have not improved, and the horse 'buses are slow and unsatisfactory, Harbornites have become converts to the electric tramway policy. At a meeting on Wednesday of a committee of householders, appointed to bring the matter forward in practical form, 3,000 forms for a plebiscite on the question were issued for distribution, and will be collected on Sept. 22.

Blackburn.—A year's extension has been granted for the completion of the Blackburn, Whalley and Padiham tramways.

Bristol.—The Bristol Tramways & Carriage Co. have commenced the work of extending their tramways from Horfield to Filton.

Cape Town.—The city electrical engineer (Mr. W. F. Long) is making efforts to increase his day load by stimulating the demand for current for heating and cooking. The Council have sent to England for specimens of cooking and heating apparatus, and it is probable the Council may let out motors and fittings on hire.

Carnarvon.—In consequence of a recent decision in the case of Sudbury Corporation *v.* Empire Electric Light & Power Co., the Council have decided to promote a bill to legalise the agreement with the National Electric Construction Co. for the erection and maintenance of electricity works.

China.—There have been two abortive attempts to introduce electric lighting for public and private purposes at Ningpo, but despite these failures a project is now under consideration which is more than likely to have immediate results. It is stated that the Chinese are anxious to have a supply of electric current, and the only doubtful point at issue is whether a concession will be granted to a British or to a Japanese concessionaire.

Dundee.—On Tuesday the Gas committee considered a report of the Electricity committee on a recommendation of the city electrical engineer (Mr. H. Richardson) as to an extension of arc lighting.

Mr. Richardson stated that Dundee was a long way behind other cities of its size in the use of arc lamps for street lighting, and pointed out that if 100 more lamps were introduced the cost would be reduced from £15 to £10 per lamp per annum.

The Gas committee came to the conclusion that the lighting of the city was quite efficient, and decided not to interfere with present arrangements.

Here is another unfortunate instance where a gas committee has the power to bar progress in electrical matters, and it is to be hoped that the full Council will take up the question and decide it upon its merits.

In reference to the report of the discussion on the proposed extensions of the electricity undertaking, given on p. 714 of our last issue, it was Councillor High (and not Mr. Richardson) who advocated the erection at the gas works of suction gas plant for the generation of electrical energy.

Electric Power in Afghanistan.—The Amir of Afghanistan, who has decided to adopt electric driving in his factories at Jabl-us-Siraj, proposes to utilise the large amount of water-power available in the Khoistan. At Jabl-us-Siraj, the Panjshehr is sufficient to provide all the power that is needed, and the preliminary works are being carried out. An electrical engineer has been engaged, and generating plant will be erected in due course. It is believed that the arms and ammunition factories will be eventually transferred to the new town, and it is probable that several manufacturing industries may be started as well.

Greenock.—On Tuesday the Corporation approved the proposals of the burgh electrical engineer (Mr. J. A. Robertson) to proceed with the new battery house immediately, and to erect the condenser ordered for the Dellingburn-street works at Hunter-place, so as to supplement the existing condensing plant.

It was agreed that of the net surplus of £1,786. 12s. 1d. on the electricity department £1,500 should be paid over for the general purposes of the Corporation and the balance (£286. 12s. 1d.) carried forward.

Halifax.—The Tramway committee have refused the demand of the Tramway Workers' Union to reinstate the driver (Chadwick) of the tramcar to which an accident occurred on July 1.

The committee confirmed the action of their chairman in refusing to call a special meeting of the committee to receive a deputation from the union on the question of the dismissal. The committee held that the refusal of the Council to reinstate Chadwick had taken the matter out of their hands, and that if the executive of the men's union desired to take further action they must approach the Council either by deputation or memorial.

A ballot taken on Wednesday of the men employed by the tramways department resulted in a decision to cease work unless employment is found for Chadwick.

Harbour Lighting.—To facilitate the mooring of vessels at the New York quays by night a new channel 2,000 ft. wide and 8 miles in length is to be formed, and electric buoys will be placed along both sides, with red lights on the Brooklyn side and white lights on the Staten side. Large lightships will be stationed in a line with Staten Island beacon light.

Hastings.—Sanction has been received by the Council to a further loan of £8,386 for electricity supply extensions.

Hindley.—The Council are inquiring of Wigan Corporation the terms upon which Wigan will supply electricity in bulk in Hindley.

Huddersfield.—The electricity department is about to undertake the wiring of consumers' premises and the supply of motors and fittings on hire. A scheme is being prepared by the borough electrical engineer, Mr. A. B. Mountain.

Light Railways.—The Mansfield and District Light Railways (Extensions) Order, 1906, has been submitted to the Board of Trade for confirmation. Objections by Sept. 14.

Londonderry.—Messrs. J. G. White & Co. recently inquired if the Council would entertain an offer for the purchase of their electricity undertaking, and by 10 votes to 9 the Council have referred the matter to the Law committee. Messrs. J. G. White & Co.'s proposals include the construction of electric tramways in the district.

At the meeting of the Council last week, Ald. M'Carter, in moving that the letter be referred to the Law committee, said the Corporation had spent about £55,000 upon the electricity undertaking. It had never paid under Corporation management, nor was it ever likely to pay, and now that they had a good offer from a firm of such high standing they should at least consider it.

Ald. Bell said Messrs. White's offer would lower the rates.

Ald. O'Doherty moved an amendment that the Council reply that they were not prepared to sell the plant, but they were willing to negotiate regarding tramways. He said the Corporation had, with creditable enterprise, embarked on an electric undertaking, and to sell it now, when there was a prospect of its paying, would be a disgrace to the city.

Manchester.—The new tramlines from the Old Cock Hotel, Stretford, along Chester-road through Sale and Ashton-on-Mersey and Timperley to Altrincham boundary, near the West Timperley Station, have been opened for traffic.

Mansfield.—The Council have approved the agreement with Mansfield Woodhouse Council for a supply of electricity to the latter.

Margam.—The Board of Trade have deferred the question of the revocation of the Council's electric lighting order (1898) for 12 months. The Mutual Electric Supply Co. have given notice of intention to apply for an order.

Margate.—Electric lighting plant is to be installed at Wingham Waterworks. Mr. J. A. Forde estimates the initial cost at £340 and the annual charge at £18. At the Council meeting last week it was stated that the present system of working in the wells by candle light was not conducive to the health of the workers and did not result in effective work.

Marylebone (London).—The free wiring scheme recently submitted by the Electric Lighting committee has been referred back by the Council for further consideration.

Morocco.—Operations, military and otherwise, which have recently taken place in Morocco are opening up the country and calling particular attention to the want of ready means of communication between various points in the interior, more especially the absence of inland telegraphic facilities. Engineers engaged in the country are discussing the question of providing telegraphic facilities, and it is said to be especially noticeable that French and German engineers are on the spot in connection with these and other public works.

Municipal Telephony.—Glasgow Corporation have approved the accounts of the telephone department abstracted in our last issue.

In reply to questions, the convener of the Telephone committee (Mr. James Alexander) explained that the terms of the agreement with the Post Office were still the subject of negotiation, and the arrangements with regard to the staff would form part of it. The Corporation, in the offer to sell their undertaking, made it a condition that the staff should be taken over on terms and conditions not less favourable than those enjoyed in the service of the Corporation, and the committee would insist upon getting these conditions confirmed in writing.

Norway.—H.M. Legation at Christiania reports that a law, dated June 12, precludes the acquisition or leasing by a foreign subject or company of the right of using waterfalls, forests or mines in Norway, without the permission of the King, and states that such permission will only be granted to companies whose directors meet in Norway and on condition that all the members of such companies are personally liable. Other real property can still be acquired by foreigners under the law of June 9, 1903. A translation of the articles in the laws which affect the question may be seen at the Board of Trade Offices, 73, Basinghall-street, London, E.C.

Obituary.—A link with the past of submarine telegraphy is severed by the death, which occurred at his residence, 35, Manor-park, Lee, Kent, on Saturday, of Capt. Henry Augustus Moriarty, C.B., aged 91 years. Capt. Moriarty represented the Admiralty in the 1857-8 submarine cable ventures, and was on board the "Great Eastern" in 1865-66 as navigating officer. When the first Atlantic cable parted in mid-ocean he immediately set to work to take careful bearings of the vessel's position, and those bearings proved of the utmost utility on the renewal of operations in 1866. For services rendered in connection with submarine cable work Capt. Moriarty received his C.B. Capt. Moriarty, was a Cork man, was born in 1815, was educated at Portsmouth, and entered the Navy in 1829, became a master in 1844, a staff-commander in 1863, and a staff-captain in 1867. He received several medals for distinguished services. His death was due to old age and exhaustion following the effects of the great heat of the last few days.

Obstruction of Tramcars.—Scarborough borough magistrates delivered on Tuesday a reserved decision in a case where a carter had been charged with wilfully obstructing a tramcar.

The main question was whether defendant, in order to let the tramcar pass, ought to have moved his cart from the right to the wrong side of the road. The defence contended that if an accident had happened whilst defendant was on the wrong side of the road he would have been held to blame.

The Chairman said defendant seemed to have thought that he had the absolute right when overtaken by a tramcar to keep on the near side of the road, although by crossing over to the off side he could have obviated the delay of the car. It was clearly the law that there was no such absolute right as defendant alleged; the one paramount rule of the road was that all who used the road must behave reasonably towards each other. Whether in any particular case it was reasonable to expect a driver to cross the lines and go over to the off side depended upon circumstances. In that case, after carefully considering the evidence and inspecting the place where the incident occurred, the magistrates had come to the conclusion that defendant acted unreasonably in not crossing over. There was no traffic coming in the opposite direction or from any side street, and there was nothing in the gradients of that part of the street to make it dangerous to cross the metals with a loaded cart. They, therefore, convicted defendant; but, as the obstruction was neither prolonged nor serious, the fine would be only 10s. 6d., including costs.

Portsmouth.—The Council have increased the salary of the superintendent of the electricity works (Mr. W. S. Foale) from £400 to £500 a year.

Presentations.—The staff of the Melton Mowbray Electric Light Co. have presented a timepiece to Mr. Edmonds who is leaving the company's service to commence business in the district as a wiring contractor.

Mr. W. E. Robson, chief draughtsman of the British Electric Plant Co., has been presented by the staff and employés of the company with a collection of books on electrical subjects and a card indexing cabinet, on his leaving to take up an appointment in the electrical engineering department of the Central Technical College, Exhibition-road, London, S.W.

Proposed Union of Municipal Employés.—At the Trade Unions Congress, which is to be held at Liverpool in the first week in September, the question will be raised whether it is good trade unionism for municipal employés to have an organisation of their own, regardless of their trade organisations.

The matter is raised by a resolution of the Amalgamated Association of Tramway and Vehicle Workers, which includes both municipal and company employés. In conjunction with three other unions (the United Kingdom Society of Coach Makers, the National Amalgamated Union of Labour, and the National Union of Gasworkers and General Labourers) the following resolution has been put down for discussion:—

> That any method of organisation which seeks to divide workmen employed by public authorities from their fellows in the same occupations employed by private firms is detrimental to the best interests of trade unionism, and that the Parliamentary Committee use its best endeavours to prevent such methods being put into operation by any of the societies affiliated to the Congress.

The Municipal Employés Association, which has now a membership of over 5,000, has sent in an amendment to omit certain words and add others, which would make the resolution read:

> That any method of organisation which seeks to divide workmen employed by public authorities from their fellows in the same occupations employed by private firms is not detrimental to the personal interests of the Amalgamated Association of Tramway and Vehicle Workers, the National Amalgamated Union of Labour, and the Gasworks' and General Labourers' Union, by the unskilled workers of municipal bodies having a union of their own, the same as the postal and Government workers, the railway servants, the miners, the builders, the labourers, the cotton operatives, and others.

Selby.—A special meeting of the Council has been called for Sept. 19 to authorise application being made for a provisional electric lighting order.

Shildon (Co. Durham).—The streets of Shildon are now lighted electrically, current being supplied by the Northern Counties Electricity Supply Co. The company are also destroying the whole of the town's refuse free of charge.

Street Work in London.—The clerk to London County Council has addressed a letter to the City Corporation and the London Borough Councils on the subject of the disturbance of London streets by companies and others having legal power to break them up, and inviting the support of the Councils in bringing about a remedy.

The letter states that the report of the Royal Commission on London Traffic laid great stress upon the inconvenience arising from the present state of affairs, and urged the necessity of measures being taken with a view to providing a remedy. The Highways committee of the L.C.C. had again given consideration to the matter and were of opinion that great advantages would result if arrangements could be made for works carried out by different authorities having powers to break up streets to be as far as possible executed simultaneously at certain times of the year. The letter asks whether, in the event of the L.C.C. agreeing to promote legislation to enable it to make regulations to govern the breaking up of streets, with a view to assuring that in the execution of such works regard should be had to the convenience of the public from the point of view of the user of the streets for general purposes, the economy of space in the subsoil of the streets, and other matters affecting the public interest, the various Councils would be prepared to support the Council in its application.

Swinton and Pendlebury.—Mr. T. P. Miller has been appointed consulting engineer by the Council to supervise the laying of electric light mains, &c., in this district by the Lancashire Electric Power Co. at 5 per cent. on the cost price of the work.

Telephone Trunk Service.—As the outcome of an agitation by Norwich traders and other commercial men in the eastern counties the Post Office authorities announce that an additional line is now in course of erection to Ipswich and Norwich.

Train Lighting.—Some new carriages of the G. N. Railway Co., which are used on the non-stop expresses between King's Cross, Sheffield and Manchester are lighted electrically throughout. Artistic clusters of electric lights are fitted to the roof, whilst in the dining cars table lamps with artistic shades are also provided.

Uruguay.—The Government intend to spend £1,000,000 gold upon new machinery to enable them to supply electrical energy to tramways and manufacturers.

The company owning the Paso Molino tramway at Monte Video have commenced the work of converting the line to electric traction, and there are now three companies engaged in similar work in the city. The Commercial Co. has begun the erection of the cable standards in the newer streets, and the lines will be open by the end of October. The Norte Co. is the latest to apply to the municipality for leave to adopt electric traction.

Wages Dispute in Lancashire.—The employers in the engineering trades in Manchester and south-east Lancashire were informed yesterday (Thursday) of the decision of the ironmoulders to come out on strike on Monday next unless an immediate advance of 2s. per week is conceded. The ironmoulders number 1,600, but about 40,000 skilled workmen will be involved in the strike. Among 60 firms affected are Crossley Bros., Armstrong, Whitworth & Co., Mather & Platt, British Westinghouse Co., Cravens (Ltd.), &c.

Walsall.—Sanction has been received by the Council to a loan of £12,694 for electric lighting extensions.

West Ham.—The Corporation electricity supply department have commenced cable laying for the supply of electricity to Silvertown, where it is hoped supply will be available about October.

In view of the fact that there are in this district some of the largest factories in London, it would be worth the while of electric light and power engineers and contractors, as well as manufacturing companies, to vigorously canvass this district. The system of supply will be 200 volts, two-phase, 50 cycles. Supply rates, 1d. per unit, less discounts up to 15 per cent., and specially low rates for long-hour demand. The West Ham electricity department have already secured contracts for several million units per annum, but this does not represent one-tenth of the possible business. In most cases lighting can be supplied at the same rates as power to factories using power. It should, however, be particularly noted that it is of no use sending any but experienced engineers to interview these factory managers and proprietors. Every assistance and information will, of course, be rendered by the borough electrical engineer and manager (Mr. A. Hugh Seabrook) and his staff.

West Hartlepool.—The Finance committee recommended to the Council last week that £500 be set aside out of the surplus of the past year's working of the electricity undertaking to meet any depreciation on machinery and to provide for any obsolescence of plant, and they also recommended that, unless otherwise directed, a similar sum be provided each year.

The chairman (Ald. Wilson) said that with reference to the proposed creation of a reserve fund for the electricity undertaking, there was only a small number of committee members present, and the resolution was carried by a slight majority. He suggested that they pass the first part of the resolution dealing with the £500 already placed to reserve and leave over for further consideration the question of future provision for reserve. There was a difference of opinion as to whether it was proper to draw money from the ratepayers to act as reserve for anything connected with the municipality. He moved that the £500 already placed to reserve be confirmed, and that before the next £500 was required a meeting of the Electricity and Finance committees be called to discuss the question.

Councillor Robson thought that the proposal was financially unsound. If it were necessary to create a reserve, let it be done out of the profits. If that were not possible the price of electricity supply ought to be raised. He did not think it was fair to impose a ½d. rate upon the ratepayers the majority of whom did not use electric light.

Ald. Harrison thought they might very well let the matter stand over until depreciation presented itself. He moved an amendment that the whole of the paragraph be referred back.

After discussion the amendment was carried.

Widnes.—Crompton & Co. have given notice of intention to apply for a provisional electric lighting order.

Yardley.—On Tuesday the Council were recommended to transfer the Yardley Rural District Electric Lighting Orders, 1904 and 1906, to Birmingham Corporation or to the Shropshire, Worcestershire, & Staffordshire Electric Power Co.

The chairman of the Yardly Electric Lighting committee (Mr. Hughes) explained that the recommendation was brought forward with a view to getting the opinion of the Council on the main principle as to whether the Council should work its own order or transfer it. The committee were practically unanimous that it would not pay Yardly to generate its own electricity. The company had already acquired powers to supply electrical energy for power in the district, and he did not think it would pay Yardley to produce electricity for lighting and not for power. All the committee wanted was authority to negotiate.

An amendment to transfer the orders to Birmingham Corporation was lost and the committee was then instructed to submit a full report on the matter with the separate terms of the Corporation and the company, &c.

Sports —Bradford Corporation tramwaymen's sports at Saltaire Park last week were carried out in spite of inclement weather. Numerous and interesting events took place, notably a tug-of-war in which the traffic department defeated the rolling stock department and thus prevented the latter from winning outright the cup which they have held for the past two years. The Tramways Military Band, which was only formed a few months ago, and which is conducted by Mr. Le Grove, gave a very creditable performance.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bath.—The capital expended on the electricity department for the year ended March was £6,633, making the total £152,943.

Revenue was £18,149, working expenses were £9,915, and gross profit £8,234. Interest required £4,635, sinking fund £3,938, and £937 (the amount of the balance brought forward from previous year) has been allocated to reserve. After meeting these requirements there is a deficit of £338. 1,383,440 units were generated, 408,564 supplied to public lamps and 642,024 to private consumers. The total maximum supply demanded was 919 kw.

Burslem.—In our issue of the 10th inst. we stated that the deficit on the past year's working of the electricity department was £197. As a matter of fact the electricity works had only been in operation for six months at the time of making up the accounts, and the figures are, under the circumstances, highly creditable. The electrical engineer (Mr. Ashton Bremner) entertains no doubt that the station will show a profit on the first year's working.

Chesterfield.—At March 31 the capital expended on electricity supply was £53,287, and there has been expended since that date (chiefly on the extension to Whittington) £753, making a total of £54,040.

Of the accumulated profits £2,698 is in hand, and in view of a probable future annual profit of £1,500 the Town Clerk and Borough Accountant consider that, instead of application being made for a loan in respect of past actual expenditure, the accumulated profits (together with the necessary balance to be taken from future profits) should be appropriated for liquidation of the outstanding excess capital expenditure, and that future extensions, &c,, should be paid for out of loan to be raised instead of out of the accumulated profits.

These recommendations were agreed to.

Croydon.—In our issue of 3rd inst. we gave some figures from the accounts of the electricity department for the year ended March 25.

In his report on the ninth year's working the borough electrical engineer (Mr. A. C. Cramb) states that the total revenue was £52,446. 10s. 2d., compared with £49,675. 15s. 5d. for the previous year; and the total expenditure was £27,265. 18s. 7d., compared with £24,799. 12s. 5d. Interest and sinking fund charges were £20,197. 4s. 3d., against £18,054. 8s. 4d. A new pump and a new superheater, costing £323. 10s., have been purchased out of revenue, leaving a net profit of £4,086. 16s. 9d. The average price obtained for the general supply was 3·838d., against 4·076d. in 1904-5. Certain items of expenditure show an increase, including wages at the generating station, due partly to a more liberal scale of salaries inaugurated by the committee some two or three years ago, and also partly to a further allocation to revenue of wages formerly charged to capital account. Generating station repairs show a very large increase over the previous year. The item covers a considerable amount of special work during last year, such as reconstruction of old flues, putting in new foundations and other work rendered necessary by the settling of the buildings, replacing a number of copper pipes in the steam ranges and other special work. The increase in cost of distribution is due partly to a more liberal rate of payment and partly to the allocation to revenue of wages formerly charged to capital. Distribution repairs increase is due to the allocation to revenue of permanent work amounting to rather more than £350. Management expenses (salaries and wages) show an increase owing to revised allocation of wages and to rising salaries. Opposition to the power bills cost £505. 4s. 2d. The difference in price per unit is accounted for by the reduction in charges made to the various classes of consumers, and is equal approximately to £1,851 for the year. The units generated totalled 5,170,572 against 4,842,074, and the units sold to 4,215,434 against 3,917,937. The efficiency of distribution was 83·4 per cent., compared with 77·05 per cent. Supply of electricity to the South Metropolitan Tramways Co. for the Croydon to Mitcham tramways was commenced on May 14, and a further supply for a portion of the Croydon to Sutton tramways will be required during this autumn. To meet the increased demand from the company, and also for the anticipated increase in direct-current supply a 1,000 kw. d.c. set is on order, which will be running about the end of September, also an extra boiler.

In spite of keen competition the sales of electricity during the year have been satisfactory, and with the perfecting of several new types of electric lamps which are now being placed on the market and the consequent decrease in cost of electric current required for those lamps, the use of electricity (continues the report) should increase considerably in the future. There has been a gratifying increase in the number of motors connected to the mains due to the lower prices charged, proving that the electric motor is becoming a favourite form of obtaining power for driving machinery.

Glasgow.—At the Corporation meeting last week the accounts of the electricity department for the year ended May 15 were approved.

The convener of the Electricity committee (Mr. Willock) said the story of the department was again one of progress. Notwithstanding the reduction in charges for current made last year, equivalent to a reduction in income of £19,000, the revenue showed a substantial increase, amounting to £195,842, an increase of £9,470. The increase entirely arose from the sale of current to private consumers, but a large portion of it came from the sale of current for power. The revenue derived from the latter source was £32,126, an increase of £7,121, and there was no doubt that the interest and prosperity of the industrial community of Glasgow were becoming increasingly bound up with the interest and prosperity of the electricity department. The expenses had increased practically in proportion to the units generated, but as the price obtained for the latter had fallen to an average of 2·21d., or 14½ per cent. less than last year, it was not to be wondered at that expenses were apparently out of proportion to income. The amount at the disposal of the committee was £104,425, compared with £111,775 last year, but that was sufficient to meet all charges (interest and sinking fund) as well as to write off depreciation at the same rates as last year. After meeting those statutory and optional charges, the balance was £3,808, to be transferred to reserve. In connection with the sinking fund and depreciation, it was to be noted that, owing to certain statutory requirements, the later borrowings of the department must be repaid within 30 years or at 3⅓ per cent. per annum on amount borrowed, notwithstanding that the rate of depreciation had been maintained at the same rate as was fixed four years ago. The total amount of the sinking fund had been £105,993, and depreciation £208,183, total £314,176. The combined sum equalled 4·10 per cent. per annum on the capital expenditure. That showed the department to be in a thoroughly healthy condition, comparing very favourably with other municipal undertakings.

A report has been prepared by the general manager of the tramways (Mr. Jas. Dalrymple) on extensions of tramways for the construction of which it may be desirable to obtain powers next session. Five sections of line, of an aggregate length of about 4½ miles of double track, are scheduled. The Tramways committee have approved of the proposed extensions to Cathkin Park and Highburg-road, the other three sections being reserved for further consideration.

Kendal.—For the year ended March 31 capital expenditure on the electricity undertaking was only £247. 6s. 11d., making the total £13,792. 5s. 8d.

The revenue from sale of electric current, &c., was £977. 10s. 11d. Total expenses were £803. 15s. 8d., leaving gross profit £173. 15s. 3d. to meet interest (£511. 0s. 2d.) and sinking fund (£352. 7s. 2d.), so that there was a deficiency of £692. 10s. 1d. The equivalent of 4,866 8 c.p. lamps were connected and the load factor was 11·16 per cent.; 57,356 units were generated and 40,808 units sold at an average price of 5·4d. per unit. The charges for current are 6d. per unit for lighting and 3d. for power. The total cost per unit generated was 3·36d.

Oldham.—The accounts of the electricity department for the year ended March 24 show capital expenditure £276,163, an increase of £7,008 on the year.

Revenue was £33,289 (against £28,238 in previous year). Working expenses were £16,965 (£14,447) and gross profit was £15,805 (£14,447). Interest on loans was £9,492 (£9,010) and sinking fund £6,764 (£6,743), the net result being a deficiency of £451 (against £1,306). The average price received for current from private customers was 3·04d. per unit (3·17d). 4,514,729 units (3,682,250) were generated and 4,133,615 (3,407,011) sold, including 20,706 for public lamps, 3,089,135 for traction, 860,367 for private lighting and 163,407 for power. There are 777 (704) private consumers, with the equivalent of 78,125 (66,370) 8 c.p. lamps connected. The maximum supply demanded was 915 kw. (805 kw.) for lighting and 1,485 kw. (1,400 kw.) for traction. The load factor was 19·66 per cent. (17·64 per cent.).

Stirling.—The report of the burgh electrical engineer (Mr. A. C. Hanson) for the year ended May 15 states that the equivalent of 2,512 8 c.p. was connected to the mains during the period, bringing the total to about 20,000 8 c.p.

The maximum demand occurred on Dec. 7, and was 228 kw., compared with 201 kw. in 1904-5. During the year 133,394 units were sold for private lighting at an average price of 4·7d. per unit; while 51,452 were sold for power, at an average price of 2d. per unit. The total income was £4,644. 2s. 4d., compared with an estimated income of £4,613, and last year's revenue of £4,137. The expenses were £2,462. 11s. 6d., and interest, sinking fund, &c., required £2,189. 17s. 9d.

Southampton.—The receipts of the electricity department for the year ended March were £26,548, including £11,480 from private consumers for current for lighting and £1,734 for power, £1,926 for public lighting and £10,877 for traction.

Working expenses were £13,631, and after meeting capital charges the net profit was £2,135. 2,370,235 units were sold, of which 158,470 were supplied for public lighting and 1,338,710 to the tramways. Working expenses were 1·38d. per unit sold and total expenditure 2·472d.

West Hartlepool.—For the year ended March 31 the income of the electricity department was £9,878. 4s. 1d., including £8,631 12s. 2d. from the sale of current, £624 from public lighting and £304. 2s. 8d. from meter rental.

The expenditure was £5,010. 12s. 2d., including £3,337. 7s. 6d. for cost of generation, £3,368. 6s. 4d. for distribution and £720. 6s. 9d. for management. The gross profit was £4,867. 11s. 11d., and after paying interest (£2,475. 16s. 7d.) and sinking fund (£2,410. 4s. 1d.) and taking into account interest upon wiring instalments (£24. 2s. 9d.) and improvement fund revenue (being net charge of £491. 6s. on rates for the year) the balance (£500) has been placed to reserve and depreciation fund. 955,355 units were generated, 801,113 units were sold to private consumers, and 53,701 units were supplied to 39 public lamps. The total maximum supply demanded was 655 kw. There are 578 consumers, representing the equivalent of 65,951 8 c.p. (including 689 H.P. in motors) connected, increases of 68 consumers and 7,633 8 c.p. respectively over the previous year. The works costs were 1·01d. per unit sold (against 1·09d.) and the total costs were 1·32d. (against 1·46d.). The load factor was 14·87 per cent., against 14·18 in 1904-5. The capital expended is £82,668. 12s. 5d., an increase of £7,575. 17s. 3d. (including £5,166. 4s. 4d. on mains) during the year.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Dublin Lighting committee invite tenders for supply and erection of arc lamps and arc lamp pillars. Specifications, &c., from the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders, addressed chairman of the Lighting committee, 3, Cork-hill, Dublin, must be in by Sept. 8. See also an advertisement.

Wigan Electric Light and Tramways committee invite tenders for the supply of cables, overhead line material, electrical accessories, carbons, meters, engine room stores, tramcar accessories, paint, varnish, motors, ironmongery, glass and timber. Specifications, &c., from the engineer and manager (Mr. J. Slevin), Bradford-place, Wigan. Tenders to the town clerk (Mr. Harold Jevons), King-street West, Wigan, by Sept. 5. See also an advertisement.

Rathmines District Council invite tenders for supply of electric mains, house service boxes, house meters, extension of switchboards, extension of accumulators, and battery booster. Specifications, &c, can be inspected at the offices of the consulting engineers (Messrs. Robert Hammond & Son), 64, Victoria-street, Westminster, S.W. Tenders, addressed to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, co Dublin, not later than 10 a m. Sept. 12. See also an advertisement.

Oxford Corporation invite tenders for the reconstruction, extension and electrical equipment of the existing horse tramways in the city and the leasing thereof. Proposals based on the overhead system of working will not be considered. Conditions of tender from the town clerk, Mr. Richard Bacon, to whom tenders at the Town Hall, Oxford, by Sept. 17. See an advertisement.

St. Pancras (London) Borough Council invite tenders for supply of 2,000 kw. steam turbo-generator, switchboard, condensing plant, &c., two three-phase high-pressure 500 kw. motors coupled to direct-current low-pressure generators, switchboards, &c. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-rd., N.W., by noon Sept. 5.

Edinburgh Corporation invite tenders for the wiring, fittings, &c., for the electricity supply installation at the police fire station, Stockbridge. Tenders to the Town Clerk, City-chambers, Edinburgh, by Sept. 12.

Barking Town Urban District Council invite tenders for cleaning, lighting, extinguishing and renewal of lamps, lanterns, fittings, &c., of the whole of the public incandescent, Nernst and arc lamps within the district for one, two or three years. Tenders to Chairman of the Electricity and Tramways committee, Public Offices, Barking, by noon Sept. 12.

Epsom Electric Lighting committee want tenders by noon Aug. 31 for 300 kw. steam dynamo, water-tube boiler, pipework, &c., surface condenser, induced draught fan, &c.

West Ham Guardians want tenders by 10 a.m. Sept. 12 for 12 months' supply of stores, including electrical fittings, engineers' sundries, &c.

Margate Corporation want tenders by 1 p.m. Sept. 3 for electric lighting at Wingham pumping station. Specification from Mr. J. A. Forde, 15, Victoria-avenue, Northdown, Margate.

Stoke-on-Trent Guardians want tenders by Sept. 5 for wiring a portion of the workhouse premises. Specification from the Clerk.

Heston and Isleworth Council want tenders for incandescent lamps, carbons, oil, &c.

Dundee Council want tenders by 31st inst. for the supply of about 300 tons of steel girder tramway rails and fixings and points and crossings.

Bolton Electricity committee want tenders by noon Aug 30 for extensions to three phase e.h.t. switchboard.

Walsall Corporation want tenders by Sept. 4 for 5,500 tons of granite setts.

Bradford Corporation invite tenders by Sept. 10 for various kinds of timber for the tramways department.

Halifax Tramways and Electricity committee want tenders by Aug. 28 for 1 sq. in and 0·6 sq. in. lead-sheathed feeder cable.

The Deputy Postmaster-General, *Melbourne*, Australia, requires tenders by noon Sept. 18 for supply of 5 miles of 78 pair and 2½ miles of 26-pair lead-covered paper-insulated telephone cable with 20 lb. per mile conductors in each case, and 1¼ miles of 26-pair lead-covered paper-insulated telegraph cable with 25 lb. per mile conductors, the conductors to be insulated with two thicknesses of dry Manila paper, the diameter and the capacity of the cable not being limited. Forms of tender, &c., from the General Post Offices, Melbourne, Sydney, Brisbane and Adelaide.

Tenders will be received by the *Postmaster-General*, until noon Sept. 3, for the supply of Swedish, Norwegian, Finland or Russian red fir telegraph poles, to be delivered at any one or more of certain ports. Forms of tender from the controller of stores (Mr. S. C. Hooley), Stores Department, G.P.O., 17–19, Bedford-street, London, W.C.

TENDERS RECEIVED AND ACCEPTED.

Barking Council have accepted the tender of D. T. Jackson for rails, &c., at £598. 5s. 3d., and for constructing the permanent way of light railways in the district at £2,431. 14s. 8d., and that of the British Electric Equipment Co. for overhead equipment at £279. 10s. 2d.

Handley & Shanks, of Birmingham, have secured the contract for the electric lighting of the G.W. Railway Co.'s hotel at Birmingham.

Mansfield Council have accepted the tender of the D.P. Battery Co. for the maintenance of their storage battery for 11 years.

Rochdale Council have accepted the tender of W. T. Glover & Co. for supply of cables for the Castleton extension.

Walsall Council have accepted the tender of the Walsall Electrical Co. for a Tangye engine and pump at £93. 13s.

Sowerby Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting at 28s. per 40 c.p. lamp for 1,380 hours per annum.

The Linolite Co. have received an order for 607 ft. of "linolite" to be installed in the new Sessions House (on the site of Newgate Prison), London. The company have previously supplied 240 ft. for the same building to Messrs. H. J. Cash & Co., who are carrying out the electric lighting contract.

BUSINESS NOTICES.

The new telephone number of Mr. Hy. M. Sayers, M.I.E.E. (39, Victoria-street, S.W.) is 1063 Victoria.

Mr. T. J. Seaman, for many years with Macartney, McElroy & Co., has joined the staff of Thomas L. Scott & Co., 3, London Wall-buildings, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

Lazarus Blumenthal, electrical merchant, 78, Queen Victoria-street, London, E.C., has been adjudicated bankrupt.

At the adjourned examination of John Fell, engineer and tramway contractor, at the London Bankruptcy Court on Tuesday it was stated that the creditors had accepted the scheme submitted (referred to on p. 718 of our last issue) and the examination was closed.

The N.S. Electric Storage Co. (Ltd.) is being wound up voluntarily. Mr. G. Pepper, Pier-chambers, Chatham, is liquidator.

Claims against Christian & Phipps (Ltd.) by Oct. 8 to Mr. F. Beddow, 41, Finsbury-pavement, London, E.C.

Claims against the International Electric Traction & Power Synd. (Ltd.) by Sept. 13 to Mr. John Morris, 33, Brazennose-street, Manchester.

A meeting will be held on Sept. 19 at Donington House, Norfolk-street, London, W.C., to receive an account of the winding up of the Poole & District Electric Traction Co. (Ltd.) (in voluntary liquidation).

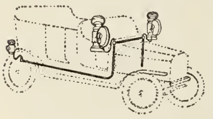
Sale by Auction.—Mr. Geo. N. Dixon will sell by auction without reserve on Aug. 28 and 29, at Mears' Yard, Wyfold-road, Munster-road, Fulham, S.W., some modern tunnel boring plant used in connection with the Brompton & Piccadilly Circus Railway contract. The plant comprises electrically and steam-driven air compressors, portable air compressors, air receivers, vertical and loco type boilers, electrically-driven belt conveyors, five 3 ton steam cranes, seven hydraulic jiggers, &c. Catalogues from Messrs. Walker, Price & Reeves, 8, Sherwood-street, Piccadilly circus, London, W., or from the auctioneer, 89, Hanover-street, Liverpool (Telegrams: "Tenacity Liverpool"). Further particulars are given in an advertisement.

Plant for Sale.—Clacton District Council invite tenders for the purchase of some electric lighting plant which they have for disposal, including two 10 H.P. and two 50 H.P. National gas engines and four Taunton dynamos (two giving 50 amperes each at 135 volts and two 250 amperes at 105-130 volts), two switchboards, E.P.S. battery and one 1,800 gallon tank. The plant can be seen at work by appointment. Offers to the clerk to the Council, Mr. Geo. T. Lewis, Town Hall, Clacton on-Sea, by noon Sept. 5. See an advertisement.

Trade Marks.—An interesting pamphlet on "Trade Marks in the United Kingdom under the new Act of 1905" has recently been published by Mr. H. Allen Pryor (Messrs. Mewburn, Ellis & Pryor, 70-72, Chancery-lane, London, W.C.). The 1905 Act made certain changes in the law relating to trade marks and extended the right of registration to many kinds of marks not hitherto capable of being registered. The subject is a very important and complicated one, and trading firms and companies should read Mr. Pryor's pamphlet, which deals in a clear and cogent manner with the salient features of the new Act. It will certainly render material service to those who wish to select and register marks, as it explains what may or may not be registered and the restrictions imposed on registration. The price of the pamphlet is 6d.

Catalogues, &c.—Johnson & Phillips, of Old Charlton, Kent, have just published a useful booklet describing the electric cable-making machinery manufactured at the company's works at Charlton. Copies of this booklet, which contains interesting particulars of these machines, will be sent to anyone interested. Messrs. Johnson & Phillips have made a specialty of the manufacture of cable-making machinery for many years, and, as they point out in the booklet, being also makers of electric cables and users of the machines, they are in a position to introduce improvements from time to time, gained from practical experience. This particularly applies to the smaller but none the less important details of cable making. Several good illustrations of the machines are included in the booklet, which also deals briefly with the subject of cable gear equipment for submarine cable steamers.

"Motor Car and Carriage Lighting" is the subject of a pamphlet (No. 01114) issued by the General Electric Co. This pamphlet deals with the numerous specialities of an electrical character employed in electric vehicle manipulation. Exterior and interior fittings, head and tail lights, illuminated number boards, waterproof and dustproof switches, cell testing meters, electric direction indicators, inspection lamps, and quite a number of other items connected with the motor vehicle are illustrated and described. The accompanying illustration shows the "Osmi-oil" wiring device, which affords a simple means of wiring motor cars and carriages. It consists of a small spherical elbow joint to which is fitted central pin contacts. The elbows have turned bosses, which fit on to a ¼ in. conduit tubing cut to requirements and of sufficient size to allow of one conducting wire to pass through the metal tube constituting the return conductor.



The G.E.C. "Osmi-Oil" Wiring Device.

Messrs. Lea & Warren, Kettering, are issuing a sheet giving illustrated particulars and prices of the "Easy" pipe-bending machine. It is claimed that this machine will bend cold, without loading, all sizes of electric conduit (¼ in. to 1½ in.) or iron, brass or copper pipes (¼ in. to 1¼ in.).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Aug. 15 to 21, with the ports of destination :—

Africa—Alexandria, £416; Cape Town, £202; Delagoa Bay, £318 (including £115 telegraph material); Durban, £446; East London, £1,965; Port Elizabeth, £672; Port Said, £80; Suakim, £411 (including £23 telegraph material). *Argentina*—Buenos Ayres, £17,511 (including £3,086 telegraph material); Rosario, £946 (telegraph material). *Australasia*—Adelaide, £75; Auckland, £101; Christchurch, £250; Lyttelton, £402; Melbourne, £1,084 (including £570 telegraph material); Otago, £50; Perth, £315; Sydney, £370 (including £150 telegraph material); Wellington, £376. *Belgium*—Antwerp, £15; Brussels, £9; Ghent, £34. Ostend, £45. *Brazil*—Para, £9,940 (including £9,876 telegraph material); Rio Janeiro, £1,427 (telegraph material); Santos, £52. *Burma*—Rangoon, £319. *Canada*—Halifax, £20; Montreal, £50. *Ceylon*—Colombo, £128. *Chili*—Valparaiso, £420 (including £101 telegraph material). *China*—Hankow, £1,207; Shanghai, £223. *Germany*—Cologne, £78; Hamburg, £302. *Gibraltar*, £238. *Holland*—Amsterdam, £109; Rotterdam, £49. *Hong Kong*, £150. *India*—Bombay, £658 (including £222 telegraph material); Calcutta, £1,496 (including £236 telegraph material); Karachi, £336; Madras, £73. *Japan*—Kobe, £196; Nagasaki, £100; Yokohama, £581. *Malta*, £90. *Mexico*—Coatzacoalcos, £35. *St. Vincent*, £1,436 (including £1,286 telegraph material). *Siam*—Bangkok, £62. *Spain*—Valencia, £110. *Straits Settlements*—Penang, £537 (including £172 telegraph material); Singapore, £484 (including £184 telegraph material). *Uruguay*—Monte Video, £101 (including £51 telegraph material). *Zanzibar*, £50 (telegraph material). Total £47,130, against £25,491 in the corresponding week last year (Aug. 16 to 22).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Æther: A Theory of the Nature of Æther and of its Place in the Universe." By Hugh Woods. (London: "The Electrician" Printing & Publishing Co.) 4s. 6d.

"Marine Engineers: Their Qualification and Duties." By E. G. Constantine. Second Edition. (Manchester: Technical Publishing Co.) 5s.

"Air Compressors and Blowing Engines." By C. H. Innes. (Manchester: Technical Publishing Co.) 4s. 6d.

"Polyphase Currents." By Alfred Still. (London: Whittaker & Co.) 6s.

"Proceedings of the Royal Society." Series A. Vol. 78. No. A522. Mathematical and Physical Sciences. (London: Harrison & Sons.) 2s. 6d.

"A First Course in Physics." By Robert Andrews Millikan and Henry Gordon Gale. (London: Ginn & Co.) 5s. 6d.

"Lexikon der Elektrizität und Elektrotechnik." Edited by Fritz Hoppe. Numbers 16 to 20 inclusive. (Vienna: A. Hartleben.) 50pf. each.

"Telegraph Secondary Cell Installations." By Arthur Crotch (London: Guilbert Pitman.) 2s. 6d net.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

July 9, 1906.

15,497 Taylor. Tramcar or other vehicle pressure brakes.
15,499 Binko & Phœnix Electric Heating Co. Electric vulcanising apparatus.
15,500 Binko & Phœnix Electric Heating Co. Electric radiators.
15,501 Fredell. Electrically-controlled optical appliance.*
15,507 Templeton. Turbines.
15,512 Feuchtmeyer & Könitzer. Switch for strong and weak currents.
15,530 Auden. Electrical control for flat-bed printing machinery.
15,581 McIntosh. (McIntosh on the high seas.) Electric tell-tale for engine telegraphs.
15,587 Estler & Drake. Insulators for electric rail or tramways.
15,607 Otis Elevator Co. (Otis Elevator Co., U.S.) Elevators.*
15,613 Barr. Electromagnetic devices. (Date applied for, July 17, 1905.)*†
15,614 Thompson. Electromagnetic devices. (Date applied for July 17, 1905.)*†
15,615 Sharman & De Forest Wireless Telegraph Synd. Electrical signalling apparatus.
15,616 Maskelyne, Jun. & De Forest Wireless Telegraph Synd. Electrical signalling.
15,653 Trube & Baldwin. Brakes for electric vehicles.
15,659 Brooks. Brake to prevent excessive speed by tramcars and other vehicles.

July 11, 1906.

15,662 Scott. Adjustable pendants for hanging electric lamps.
15,669 Krause & Bevis. Multicircuit switch.
15,682 Garstang. Electrical indicator and alarm for fire prevention.*
15,685 Moorwood & Moorwood. Treatment of rails of tramways.
15,704 Electric and Ordnance Accessories Co. and Hall. Intercommunication telephone apparatus.
15,711 Hunt and Sandycroft Foundry Co. Windings for alternating current dynamos.
15,724 B.T.-H. (G.E. Co., U.S.) Fuel supply systems and apparatus for explosion engines.
15,725 Morgan. Brakes and indicating connections for electric vehicles.
15,727 Jungner. Primary galvanic elements. (Date applied for July 12, 1905.)*†
15,731 O'Toole. Search-lights.

July 12, 1906.

15,754 Greenwood. Brakes or safety appliances for tramcars and the like.
15,759 Butterfield. Insulators and non-conducting material for electrical work.
15,784 Rounsevill & Bilms. Time-measuring device for telephone conversations.*
15,785 Dreihardt. Improved connecting means for the pole-plates of the individual cells of storage batteries.*
15,793 Lugo. Electromagnetic self-propelling torpedoes.
15,818 Kaiser. Obtaining metals from ores or furnace products in the electric furnace. (Date applied for July 19, 1905.)*†
15,835 B.T.-H. Co. (G.E. Co., U.S.) Motor-operated electric switches.
15,836 Stave. Indicators for railway and tramway service.
15,839 Wichler & Rennert. Electric driving for machine tools and other machines.*

July 13, 1906.

15,867 Beall. Lever for the more rapid movement of tramway and other points.
15,910 Marconi's Wireless Telegraph Co. & Priddle. Sparking mechanism for internal-combustion engines.
15,915 Nernst & Stockem. Incandescence lamps.*

July 14, 1906.

15,943 Pringle. Brakes for tramways and railways.
15,951 Patterson. Preventing raising of dust by motor vehicles and tramcars.
15,983 Von Planta. Actuating advertising apparatus in vehicles driven by electricity. (Date applied for, Nov. 28, 1905.)*†
15,984 B.T.-H. Co. (G.E. Co., U.S.) Control of electric motor-operated devices.
15,985 B.T.-H. Co. (G.E. Co., U.S.) Electric resistance devices.
15,988 Tilney. Regulation of electric currents subject to large fluctuations of load.
15,989 Tilney. Speed regulation of continuous-current electric motors.

July 16, 1906.

16,010 Morris. Apparatus for ventilating tunnels. (Date applied for, July 14, 1905.)*†
16,011 Irwin. Instrument for observing and recording the instantaneous voltage across two points or the instantaneous current flowing in, or the instantaneous power given to, a circuit.
16,066 Coan. Rests for telephone receivers.
16,072 Eberhardt. Water-driven motors.*
16,093 B.T.-H. Co. (G.E. Co., U.S.) Speed indicators.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

8,655 Beer. Electro-mechanical block signalling systems.
11,141 Errani. Rotary motors. (Date applied for, June 3, 1904.)
12,973 Inglis. Electrical timing apparatus for motor cars, &c.
13,676 Parr. Point shifters for tramways and the like.
13,856 Haigh Electrical steering of ships.
14,044 Lake. (Submarine Signal Co.) Submarine signalling apparatus.
14,297 Mitchell & Dolter Electric Traction. Surface-contact electric traction systems.
14,400 Ruzicka. Electrical resistances.
14,565 B.T.-H. Co. & Woodbridge. Protecting electric distribution systems and apparatus against reversal of energy.
14,641 Greenwood & Andersson. Producing gas mixtures for turbines.
14,641B Greenwood & Andersson. Combined compressor or exhauster and turbine. (Date applied for, July 15, 1905.)
14,641C Greenwood & Andersson. Turbine power plants. (Date applied for, July 15, 1905.)
14,770 Gentili. Telegraphic instruments. (Rights not granted.)
14,889A Coridori. Insulating wires or cables. (Date applied for, 19/7/'05.)
14,972 B.T.-H. Co. (G.E. Co., U.S.) Obtaining thorium for making lamp filaments.
15,022 Balsillie. Receiver for wireless telegraphy or telephony.
15,045 Sundh & Magnuson. Electric train control systems. (Date applied for, Feb. 16, 1905.)
15,050 Parsons. Steam turbines.
15,252 Brown. Operating switches in electric traction surface-contact system.
15,303 Schneider. Audiphones or telephone apparatus for the deaf. (Date applied for, March 27, 1905.)
15,390 Ruzicka. Electrical resistances.
15,435 Oppenheimer. (A.-G. Mix & Geuest.) Employment of telephone meters in common battery system.
15,630 Raworth. Controllers for electric vehicles.
15,860 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
15,860A B.T.-H. Co. (G.E. Co., U.S.) Equalising conductors of dynamo-electric machines. (Date applied for, Aug. 2, 1905.)
15,862 Robinson. Electric bell pushes.
15,942 Breare. Steam or water turbine.
16,143 Orling & Corby. Electro-capillary recording apparatus.
16,435 Eisenstein. Transmission systems for wireless telegraphy and telephony.
17,093 Herman. Magnets and solenoids for electrical measuring apparatus.
17,107 Grote & Ely. Enclosed arc lamps.
17,178 Gredt. Manufacture of iron or steel in an electric furnace.
17,308 Haddan. (Synchronous Static Co.) Apparatus for producing electrical discharges.
17,531 Drury. Polarised electromagnets.
17,763 Norris. Signalling arrangements for electric tramways, railways, &c,
17,772 Hayter. Electric-signal indicator for railway engines.
18,016 Lea. Connectors for cables.

1906 Specifications.

238 Fynn. Single-phase alternate-current commutator motors. (Date applied for, April 15, 1905.)
1,766 Könitzer. Electrode for arc lamps. (Date applied for, 23/1/1905.)
1,903 Couper & Lindsay. Coil-friction clutches and clutch couplings.
1,924 Edison. Storage battery electrode. (Date applied for, Nov. 2, 1905.)
1,928 Edison & Aylsworth. Storage battery electrodes. (Date applied for, April 28, 1905.)
2,244 Justice. (Phönix Elektrotechnische Ges.) Production of arc light.
2,437 Zerning. Manufacture or treatment of filaments for incandescent lamps.
3,000 Hunter. Switches.
3,004 Soc. Electro Metallurgique Française. Electric mixing furnace for mixing steel. (Date applied for, Feb. 11, 1905.)
3,239 Berry & Berry. Quadruplex telegraph systems.
4,163 Pieper. Electro-mechanical regulating arrangements for automobiles and the like. (Date applied for, Feb. 28, 1905.)
4,318 Clarke, Chapman & Co., Walker & Money. Controlling electric capstans, hoists and the like.
4,653 Smith & Bausche. Electromagnetic door-opening apparatus.
4,657 Ganz & Co. Eisengiesserei und Maschinen Fabriks A.-G. Regulating the pressure of alternating-current generators. (Date applied for, May 24, 1905.)
5,371 Howorth. (Holman.) Electromagnets.
5,744 Siemens & Halske A.G. Working telegraphic installations comcomposed of rapidly and slowly working lines. (Date applied for, March 11, 1905.)
6,180 Robinson & Co. & Robinson. Anti-vibration device for electricity meters.
6,216 Mildé, Courtant, Minvielle & Mildé, jun. Luminous electric bell indicators. (Date applied for, March 14, 1905.)
6,423 Canedy. Sparking plugs for explosion engines. (Date applied for, March 16, 1905.)
6,426 Hadfield. Treatment of magnetic materials.
6,644 Holmes. Indicating at a distance pressure in conductors of supply systems.
6,939 Birnbaum, White & Müller. Intercommunication telephone systems.

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—At the meeting on 15th inst. Mr. W. Bannister, J.P., who presided, moved the adoption of the directors' report, which appeared in our issue of 10th inst. He said the profit for the 12 months ended June 30 was £24,702, and during the year the debentures, amounting to £20,000, having matured, were entirely paid off. Dividends of 6 per cent. on the preference and of 10 per cent. on the ordinary shares were declared, the dividend on the ordinary being an advance of 2 per cent. on previous years. £8,000 was carried to reserve. Messrs. R. E. Lloyd and J. R. Williams, who retired by rotation, were re-elected directors, and the meeting closed with votes of thanks to the directors and staff.

COMPANIA ALEMANA TRANSATLANTICA DE ELECTRICIDAD, BUENOS AYRES.—The report of the directors for 1905 states that the share capital has been increased by £700,000 to £1,800,000, to provide for the development of the company's enterprises, and that it is proposed to make a fresh issue, which will make the total capital £3,600,000. The company recently acquired the sub-station of the Buenos Ayres Electric Tramway Co. and made an agreement with that company for the supply of current for the whole period of the concession. The company have leased from La Capital Tramway Co. its central station and plant of 2,075 H.P. and a battery with a capacity of 1,000 ampere hours, for an annual payment of £5,000. The company have leased to the Grand National Co. the Metropolitan undertaking for a yearly payment of £20,000 and two-thirds of the receipts in excess of a total of £22,500. The net profit for the year was £173,246, compared with £88,670 for 1904. A dividend of 9 per cent. has been declared on £1,694,000, against 8 per cent. on £950,000.

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—At the meeting last week Mr. W. Mooney said there had been a falling off of £161. 13s. 1d. in receipts compared with the corresponding period of last year and some increase in expenditure. The decrease in receipts was due to dullness in trade. The sum available for dividend after payment of interest was £875. 3s. 3d., of which £475 was for the half-year's preference dividend.

MATHER & PLATT (LTD.)—The net profit for the year ended June 30, after charging depreciation and making provision for directors' remuneration and expenses, was £103,868. 9s. 10d., which with £21,238. 12s. 5d. from 1905 makes £125,107. 2s. 3d. Preference dividend and interim dividend on ordinary shares for the half-year to Dec. 31, 1905, absorbed £22,000, leaving £103,107. 2s. 3d. The directors recommend payment of the balance preference dividend (£10,000), a balance dividend at the rate of 7 per cent. on the ordinary shares (£16,000), a bonus of 3 per cent. on the ordinary shares (£12,000) and that £40,000 be transferred to reserve, leaving £25,107. 2s. 3d. to be carried forward.

MEXICAN LIGHT & POWER CO. (LTD.)—The interim report states that the original plans of the company involved the installation of a hydro-electric station at Necaxa, the construction of a transmission line to a distributing station to be erected in Mexico City, and the sale of electric energy for power in Mexico City and vicinity. The hydraulic power was to be obtained from the flow of the Necaxa River, the diversion of the Tenango River by a diversion dam in the Tenango and a canal or tunnel into the Necaxa, and the construction of a large dam at Necaxa for the storage of surplus waters of the two rivers. At the time there were three companies carrying on electricity supply business in Mexico City—the Mexican Electric Works, the Mexican Gas & Electric Light Co. and the Compañia Explotodora de las Fuerzas Hidro-electricas de San Ildefonso, all three operating steam stations, but the latter was partly supplied with power from small hydraulic plants close to the city. The undertaking of the Mexican Electric Works was acquired by the company in April, but as the Federal Government was favourable to the consolidation of all electric lighting and power interests in the city the shareholders authorised the organisation of a second Canadian company to purchase all the properties and assets of the Mexican Gas & Electric Light Co. and the Cia Explotodora, and the Mexican Electric Light Co. was formed, with a capital stock of $6,000,000 gold and a first mortgage bond issue of $6,000,000 gold, to which all the properties and assets of the two companies in question have been transferred, all the capital stock of the purchasing company being now owned by the Light & Power Co., the two boards being identical. The directors became impressed with the enormous and growing demand for electric power in Mexico City and vicinity. The Federal Government required 3,000 H.P. for pumping potable water and more for city sanitation and drainage. The tramways company required from 5,000 H.P. to 7,500 H.P. It was evident that Mexico City, with a population of 500,000, growing more rapidly probably than any other city of the same size on the continent, would soon have a population of 750,000 or more, creating a constantly-increasing demand for light and power. The town of El Oro, some 76 miles from Mexico City, the largest gold and silver mining camp in the Republic and one of the richest producers in the world, also required about 10,000 H.P. The directors, therefore, decided to increase the power station under construction at Necaxa so as to contain six turbines of 8,200 H.P. each, and six 5,000 kw. generators, of which three have already been put into successful operation, a fourth is ready for trial and the fifth and sixth will be completed about Sept. 15. Transmission lines, carried on a double line of permanent steel towers, were completed to Mexico City, a distance of 95 miles, and from thence to El Oro, 76 miles, an extension of a single line of towers was constructed. Thoroughly equipped receiving and transforming stations were erected at Mexico City and El Oro, and the operating of the plant at Necaxa and of the transmission lines and receiving stations has been satisfactorily carried on simultaneously with the work of actual construction. The company's system of distribution is now being extended from Mexico City to all the important towns in the Federal district. It has been deemed advisable to construct, in addition to the main dam at Necaxa, a second permanent dam at Tezcapa, about 5 miles further up the river. The Necaxa dam will have a storage capacity of 1,540,000,000 cubic ft. and the Tezcapa dam 630,000,000 cubic ft. A temporary dam is being constructed about 12 miles above the site of the Tezcapa dam, the reservoir having an estimated storage capacity of about 700,000,000 cubic ft., which will be completed about Sept. 1, and which will provide almost sufficient storage for the dry season commencing in December next, and will probably form a part of the proposed second power plant. Inasmuch as all available supplies of water for hydro-electric development are being rapidly taken up in Mexico, the directors recently made application to the Government for rights over the entire upper watersheds of the rivers adjacent to the Necaxa and Tenango, with the result that a concession of these rights was granted to the company by the Federal Government and approved by Congress. The company's engineers estimate that, under the rights now acquired, there can be produced about 200,000 H.P. of electric energy. The company has also acquired valuable franchises, including long terms of exemption from State and municipal taxation from the states of Puebla, Hidalgo, Mexico and Michoacan, through all of which its transmission lines now pass. The contract for supplying light to the public streets of Mexico City has been extended on satisfactory terms to February, 1917. Under agreement with the Federal Government, by which the company reduced the price of lighting in January last from 4 to 3 cents (Mexican currency) per hectowatt, the old franchise for distributing light and power, which the company held for the municipality of Mexico alone, has been extended to cover the entire Federal district, the new franchise having been signed on June 30. Already the company is supplying light and power in the towns of Guadalupe Hidalgo, Atzcapotzalco, Tacubaya, Mixcoac and San Angel, and it is rapidly extending its field of operations to all the other important points in the Federal district. These works have necessitated heavy expenditure, and the distributing lines in the Federal district have been extended more rapidly than was anticipated, also involving heavy outlay. Still further expenditure is absolutely required. The present system of subterranean lines comprises over 500 miles of underground cable. There will be required to complete the work in hand $1,000,000 in excess of the anticipated net earnings for the period ending Dec. 31, 1907. The net earnings from the first installation are estimated by the general manager to reach $190,000 gold per month in January, 1908; and should the growing demand for power continue, the directors must consider the advisability of constructing a second hydraulic installation, with a capacity of about 40,000 H.P. At present, by using approximately 10 per cent. of steam power, chiefly on peak loads, the company is supplying a maximum of 20,000 H.P. daily. The installation at present connected in the Federal district alone is equivalent to 37,500 H.P. The estimated natural increase in current business per annum is 30,000 incandescent lamps, equal to an actual load of 2,000 H.P., and motor units 4,000 H.P., making natural annual increase 6,000 H.P. In addition, the company has entered into a contract to supply electric power for the operation of the tramways of the Federal district for 10 years, commencing in October with about 5,000 H.P., which will rapidly increase to 7,500 H.P. as the existing tramway lines are extended. The mining camps in El Oro will require, in addition to present supply, about 5,000 H.P. so soon as electrical equipments for its use can be installed by the companies. Many contracts for smaller units are under negotiation. The gross earnings of the company during the first six months of the present year, in Mexican currency, were $1,754,833, and during the same period the operating expenses were $722,330, and maintenance charges amounted to $111,772. By January, 1907, the general manager (Mr. R. F. Hayward) estimates that the monthly net earnings, in Mexican currency, will be $314,000. As the contracts now made come into operation during 1907, the gross and net revenues will increase proportionately. On this basis the general manager now estimates the net earnings for 1907 as $3,500,000.

MIDLAND RAILWAY CO.—At the meeting on Friday Sir Ernest Paget said the Burton & Ashby Light Railway was finished and open for traffic; 7 miles belonged to the Midland and the other 3 miles to Burton Corporation. It was at first thought 13 cars would be sufficient, but they were carrying so many passengers that seven new cars had been ordered. The Midland directors had decided to electrify that part of their line from Lancaster to Heysham and Morecambe. Hitherto they had been content to see what other people were doing, but, as it seemed to be the general opinion of experts that the locomotive power of the future was likely to be electricity, they thought their own officers should gain the experience necessary to give advice in the future as to the extension of their electric plant. They had an electric power station which supplied electricity for lighting Heysham Harbour, and they could enlarge it more cheaply than they could establish a new one in any other part of the country.

STATUTORY RETURNS, MORTGAGES AND CHARGES

STATUTORY RETURNS.

BAILY, GRUNDY & BARRETT (LTD.)—Return to July 10 gives capital as £10,000 in 2,000 shares of £5 each, of which 1,031 have been taken up. £5 per share has been called up, and £5,155 has been received. Mortgages and charges, £3,000.

MACARTNEY, McELROY & CO. (LTD.)—In return to Aug. 9 capital is £60,000 in £10 shares, of which 3,332 have been taken up. £10 per share has been called up on 3,312, and £33,120 has been received. £200 is considered as paid on 20 shares. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

BRITISH ELECTRICAL TOOL CO. (LTD.)—£500 6 per cent. debentures, created and dated July 28, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

SIR HIRAM MAXIM ELECTRICAL CO. (LTD.)—Issue on July 24 of £500, on July 25 of £500, on July 31 of £500, and on Aug. 2 of £500 debentures, part of series created May 16, 1906, to secure £10,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £4,500.

UXBRIDGE & DISTRICT ELECTRIC SUPPLY CO. (LTD.)—Issue on Aug. 10 of £1,600 6 per cent. second debentures, part of series created July 10, 1906, to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £6,200.

CITY NOTES.

MEMORANDA (Aug. 23).—Bank rate 3½ per cent. (since June 21, 1906). Price of silver 30⅞d. per oz. Consols $87\frac{7}{16}$—$87\frac{9}{16}$ for money, 87½—87⅝ for account; 2½ per cent. annuities 85¾—86¼. Consols Pay Day, Sept. 3; Stocks and Shares Continuation Days, Aug. 28 and Sept. 11; Ticket Days, Aug. 29 and Sept. 12; Pay Days, Aug. 30 and Sept. 13; Mining Share Carry-over Day, Aug. 27.

ABERDEEN SUBURBAN TRAMWAYS CO.—For the half-year endod July 31 the credit balance is £1,954.

BRITISH INSULATED & HELSBY CABLES (LTD.)—The directors have declared a dividend of 8 per cent. for the past year.

CROSSLEY BROS. (LTD.) The directors have declared an interim dividend at the rate of 10 per cent.

MERSEY RAILWAY CO.—The total receipts for the half-year ended June 30 were £47,129, compared with £43,536 for the corresponding period of 1905. Working expenses (exclusive of charges for pumping, ventilation and lifts) were £31,119, equal to 66·03 per cent., against £30,779 (70·70 per cent.) for the corresponding six months. The charges for pumping, ventilation and hydraulic lifts for the past half-year amounted to £3,926. 3s. 9d. (8·33 per cent.), compared with £3,948. 13s. 6d. (9·7 per cent.) for the corresponding period last year. The balance carried to net revenue account was £12,083, compared with £8,809, an increase of £3,274. The amount payable by the British Westinghouse Co. was only £4,736, against £8,438, the total net revenue of £16,911 being £10 short of fixed charges.

OXFORD ELECTRIC CO. (LTD.)—The directors have declared an interim dividend on the ordinary shares at the rate of 5 per cent. for the half-year ended June 30.

RUSSISCHE ALLGEMEINE ELEKTRIZITATS GESELLSCHAFT, ST. PETERSBURG.—Part of the profit for the past year (220,830 roublos) has been placed to reserve and the remainder has been devoted to writing off capital, no dividend being declared.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to grant a quotation to a further issue of £15,000 4½ per cent. first debenture stock of the *Folkestone Electricity Supply Co. (Ltd.)*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 15	1,569	− 41	11	16,926	− 317
Airdrie	,, 10	220	+ 6	32	6,981	+ 653
Anglo-Argentine	,, 19	15,829	+ 2,725	33	481,711	+ 53,476
Ashton-under-Lyne Corp.	,, 18	391	+ 38	21	7,531	+ 856
Ayr Corporation	...	...	...	...	...	...
Baker St. & Waterloo Ry.	,, 18	1,283	...	7	9,272	...
Barnsley	,, 10	176	+ 2	32	5,115	+ 50
Barrow	,, 10	438	+ 62	32	8,092	+ 484
Bath Electric Trams, Ltd	,, 15	1,917	+ 177	33	26,674	+ 4,476
Birkenhead Corporation	,, 19	1,100	+ 11	...	...	...
*Birmingham Corporation	...	...	...	...	...	...
Birmingham & Mid.	,, 10	12,790	+ 363	32	327,209	+ 18,596
Blackburn Corporation	,, 15	1,027	− 109	¶20	22,037	+ 1,261
Blackpool Corporation	,, 16	3,283	− 364	19	28,715	+ 1,540
Blackpool and Fleetwood	...	...	...	...	...	...
Blackp'l,St.Anne's&Lytham	...	...	...	...	...	...
Bolton Corporation	,, 19	2,263	+ 151	20	44,025	+ 2,832
Bournemouth Corporation.	,, 15	2,484	+ 323	†20	34,660	+ 7,177
Bradford Corporation	,, 18	4,776	− 163	20	94,964	+ 3,802
Brighton Corporation	,, 19	1,350	− 59	20	21,939	− 1,041
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 17	4,976	− 148	1	4,976	− 148
Buenos Ayres & Belgrano	..	...	...	...	...	...
Buenos Ayres Elec. Trms.	July 21	1,323	+ 119	30	39,715	+ 7,258
Burnley Corporation	Aug. 18	1,268	+ 78	20	23,765	+ 1,199
Burton Corporation	,, 19	352	− 35	§20	6,350	− 421
Bury Corporation	,, 12 ,, 19	996 1,030	...	20	20,390	...
Calcutta Tramways Co.	,, 18	R44,728	− R1,002	7	R306,710	+ R6,710
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 11	2,918	+ 211	19	40,977	+ 1,297
Cavehill	,, 10	135	+ 80	32	2,836	+ 1,110
Central London Railway	,, 18	4,976	− 226	7	38,417	− 1,706
Chatham & Dist. Lt. Rys.	,, 16	728	− 52	†33	21,475	− 527
City & South London Rly.	,, 19	2,395	+ 15	7	17,050	+ 1,177
Colchester Corporation	,, 16	240	− 29	...	...	...
Cork Electric Trams Co.	,, 16	562	− 11	33	15,801	− 358
Croydon Corporation	,, 17	1,446	− 25	11	18,279	+ 1,118
Devonport & Dist. Trams.	,, 10	633	+ 20	32	14,468	− 354
Dover Corporation	,, 18	354	+ 23	20	5,627	+ 773
Dublin & Lucan Railway	,, 17	147	− 8	§7	1,018	− 44
Dublin United	,, 17	5,460	− 101	‡7	39,137	+ 318
Dundee Corporation	,, 15	1,077	+ 184	§13	11,701	+ 3,091
East Ham Council	,, 18	877	− 22	20	19,197	+ 1,647
Exeter Corporation	,, 17	340	− 3	20	6,080	− 408
Falkirk and District	,, 15	324	...	...	...	...
Gateshead & Dist. Trams	,, 10	1,111	+ 39	32	30,835	+ 1,730
Glasgow Corporation	,, 18	16,774	+ 1,760	12	189,791	+ 14,122
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 10	414	+ 32	32	7,651	+ 302
Gt. Northern & City Rly.	,, 18	1,483	+ 106	7	10,888	+ 878
Greenock & Port Glasgow	,, 10	794	+ 84	32	21,091	+ 876
Halifax Corporation	,, 15	1,996	− 446	20	34,900	+ 1,092
Hartlepool Tramways	,, 10	475	+ 106	32	9,516	+ 1,136
Hastings Elec. Trams Co.	,, 16	1,375	...	7	7,468	...
Huddersfield	,, 18	1,719	− 8	20	31,363	+ 2,865
Hull Corporation	,, 18	2,285	+ 72	20	45,785	+ 898
Ilford Dist. Coun.	,, 18	471	− 67	20	10,444	+ 2
Ilkeston Dist. Council	,, 15	139	+ 25	21	2,747	+ 221
Ipswich Corporation	...	...	..	...	...	...
Isle of Thanet Co.	,, 18	1,819	− 27	45	23,990	− 1,085
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 10	327	+ 39	32	3,913	− 20
Kilmarnock Corporation	,, 18	154	− 2	14	2,323	− 81
Kirkcaldy Corporation	,, 15	234	+ 11	7	1,789	+ 83
Lanarkshire Trams Co.	,, 16	898	− 56	‡33	28,571	+ 5,601
Leamington	,, 10	294	− 51	32	5,698	+ 2,781
Leeds Corporation	,, 18	6,151	+ 193	20	128,826	+ 6,394
Leicester Corporation	,, 18	2,068	− 32	33	72,821	+ 4,413
Leith Corporation	,, 18	582	+ 209	‡14	7,548	+ 3,967
Lincoln Corporation	,, 18	115	..	20	2,409	...
Liverpool Overhead Rly.	,, 19	1,648	− 57	7	11,289	− 459
Liverpool Corporation	,, 11	12,410	+ 184	32	343,302	+ 5,601
*London County Council	,, 11	28,987	+ 11,699	19	507,143	+ 217,313
London United	,, 17	6,803	− 130	†33	205,266	+ 11,692
Lowestoft	,, 18	460	− 41	47	7,711	− 607
Maidstone Corporation	,, 18	128	− 24	20	2,436	− 279
Manchester Corporation	,, 18	13,680	+ 463	20	277,222	+ 13,186
Mersey Railway	,, 18	1,629	+ 138	7	11,505	+ 962
Merthyr	,, 10	267	+ 14	32	6,237	+ 102
Metropolitan Dist. Railway	,, 19	6,468	+ 655	7	51,554	+ 6,326
***Metropolitan Elec. Trams**	,, 10	5,051	+ 624	32	108,227	+ 26,899
Middleton	,, 10	482	+ 91	32	11,291	+ 381
Nelson Corporation	,, 18	154	+ 1	21	3,052	+ 249
Newcastle-on-Tyne Corp.	,, 18	3,821	+ 117	20	82,903	+ 5,124
Newport (Mon.)	,, 18	618	...	20	13,040	...
Northampton Corporation.	,, 17	453	− 36	20	9,380	+ 5
Oldham, Ashton & Hyde	,, 19	637	+ 25	32	17,983	+ 556
Oldham Corporation	...	...	...	...	..	...
Perth (N.B.) Corporation	,, 15	172	− 16	13	2,227	...
Perth (W. A.) Elec. Trams	,, 17	1,315	+ 29	33	48,635	+ 2,912
Peterborough	,, 10	272	+ 8	32	4,129	− 313
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	,, 18	2,706	− 444	20	41,243	− 2,086
Potteries	,, 10	2,166	+ 124	32	56,809	+ 2,877
Preston Corporation	,, 15	933	− 16	7	5,747	+ 701
Reading Corporation	,, 16	676	− 16	...	...	..
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 16	505	+ 38	20	10,068	+ 950
Rothesay	,, 10	683	+ 32	32	7,215	+ 983
Salford Corporation	,, 20	4,542	+ 123	20	93,242	+ 1,201
Sheerness	,, 8	119	...	32	1,848	− 390
Sheffield Corporation	,, 19	5,191	+ 347	21	111,691	+ 6,375
Singapore Trams	,, 18	$7,538	...	8	$53,020	...
Southampton Corporation.	,, 15	1,118	− 43	19	2,446	...
Southend Corporation	,, 15	757	+ 23	20	8,936	+ 230
Southport Tramways	,, 19	577	+ 59	32	10,139	+ 265

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Stalyb'dge,Hyde,&c.,Jt.Bd.	...	...	...	...	..	...
Stockport Corporation	Aug. 17	1,655	− 74	20	21,492	+ 5,722
Sunderland Corpn.	...	...	...	...	...	...
Sunderland & District	,, 15	422	...	33	12,976	...
Swansea Trams	,, 10	1,450	+ 182	32	26,303	+ 4,691
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 10	68	− 19	32	1,435	− 146
Tynemouth and District	,, 10	619	+ 77	32	8,325	− 128
Tyneside Trams Co.	,, 15	439	− 17	33	15,017	+ 1,010
Wallasey District Council	,, 18	941	− 4	20	17,278	+ 552
Walsall Corporation	,, 18	496	− 48	30	16,988	+ 893
Warrington Corporation	,, 16	364	− 3	20	7,485	+ 598
West Ham Corporation	,, 16	2,145	− 105	20	46,574	+ 13,151
Weston-super-Mare	,, 8	682	+ 111	32	4,397	+ 237
Wolverhampton Corpn.	,, 15	815	...	7	6,831	...
***Worcester**	,, 10	523	+ 20	32	9,031	− 702
Wrexham	,, 10	163	+ 28	32	3,250	+ 19
Yorkshire W.R. Trams	,, 19	859	+ 36	33	27,401	...
Yorkshire Woollen District	,, 10	1,048	+ 284	32	28,733	+ 8,557

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Aug. 22.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Aug. 22. Highest.	Business, Week to Aug. 22. Lowest.
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.			
5	5/0	Anglo-Argentine Ord. Shs.	7½—7⅝	5 9 0	Ap, Oct	7¼	6$\frac{15}{16}$
5	2/9	Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	5¾	5⅝
St.	6%	Do. Permanent 6% Deb. Stock	139 —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 16 3	—	103½	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	1½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—4⅝	5 0 0	—	4⅝	4$\frac{9}{16}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	101¾	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117 —120	5 0 0	—	..	—
St.	5%	Do. Pref. Ord. Stk	108 —111	4 10 0	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	105 —108	4 13 0	—	107½	106½
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3⅜—3⅝	4 16 6	—	3$\frac{15}{32}$	3⅜
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5¼—5¾	5 4 0	—	..	—
5	8/0	Do. "B"	5 —5½	5 0 0	—	5¼	..
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	99 —101	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	102	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8 —8½	4 15 0	—	8¾	8$\frac{5}{16}$
5	2/6	Do. Nos. 105,001 to 137,610	7⅞—8⅜	4 15 6	—	8$\frac{5}{16}$	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	104¼	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	88 —93	6 9 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	1⅜—1$\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 —103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	100 —102	4 8 0	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	140 —142	5 12 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	98⅞	97⅞
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞—5⅜	5 2 0	..	..	..
5	5/3	Calcutta Elec. (1-30,000)	8½—9	4 9 0	..	8¾	8⅝
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	85 —89	5 12 4	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	110 —113	5 6 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	¾—⅞	7 8 0	—	..	..
1	1/6	Rand Electric	1$\frac{1}{16}$—1$\frac{3}{16}$	..	—	..	..
1	..	River Plate Electricity Co. Ord.	1$\frac{9}{16}$—1$\frac{11}{16}$	..	..	..	..
1	1/2⅖	Do. 6% Non. Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	5⅛—5⅜	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Aug. 22.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 22. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	5/0	†Bournemouth & Poole Elec. Sup. Ord.	10¼–11¼	6 4 0	..	..	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9¾–10¼	4 8 0	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10¾–11¼	5 2 0	—	—	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛–8⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	—	102½	—
5	5/6	†Brompton & Kensington Elec.Sup.Ord.	7¾–8¾	5 14 0	—	..	..
5	8/6	† Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup.Co.4%Guar.Db.Stock	100 –103	3 17 9	—	..	..
5	2/6	†CharingCross(W.End&City)El.Sup.Co.	4 –5	5 0 0	Feb, Aug	..	..
5	2/8	† Do. 4½ per Cent. Pref.	4⅝–4⅞	4 12 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 6	—	103½	104
5	2/8	Do. City Undertaking 4½% Cm. Pref.	4 –4½	5 0 0	—	..	..
5	2/8	Do. Do. (1903)	4 –4½	5 0 0	—	..	..
5	3/9	Chelsea Electric Supply Ord.	5½–5¾	5 6 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10½–10¾	5 10 6	Feb, Aug	10 17/32	10⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	100 –103	4 7 6	..	..	..
5	4%	County of Durham Elec.P.D.Ord. £3 pd.	31/32–1 1/32	3 19 10	April, Oct	..	..
5	5%	Do. Do. 5% non cum. pref.	5 7/16–5 9/16	4 5 3	April, Oct	..	..
10	4/0	†County of London Elec. Supply Ord.	8 –8¾	5 14 0	—	—	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	108½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	103½	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	6 2 6	..	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	—	—	..
5	5/0	Hove Electric Lighting Ord.	7⅝–8⅛	5 10 0	—	..	..
St.	4½%	I.of W.Elec.Lt.&Power4½%Db.St.(red.)	98 –101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	—	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 0	..	..	..
St	4%	Kensingtn.& Kngtbg.Co.&NottingHill Co.(Joint Station) 4% Deb. Stck.(red.)	101 –103	3 17 6	—	..	..
3	2/4½	London Electric Supply Ord.	1⅞–2⅜	4 4 0	—	—	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	—	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr,Jn,S,D	..	..
5	4/0	†Metropolitan Electric Sup. Ord.	8 –9	5 10 0	April, Oct	8 7/16	8⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 9	Jan. July	—	..
St.	4½%	Do. 4½ per Cent.Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	—	..	..
100	4½%	MidlandElec.Corp.for P.D.1stMort.Db.	98 –101%	4 9 1	—	..	..
10	7½%	†Newcastle & Dist.Elec.Ltg.Ord.£9 paid	10¾–11	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	103 –104	4 7 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 1 3	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾–5⅞	4 5 1	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	—
1	8%	Northern Counties Elec. Sup.	1 7/32–1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	..	—
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	Do. 4 per Cent. 1st Mt, Debs.	97 –99	4 1 0	..	..	—
5	4/6	Oxford Electric Ord.	6¼–6¾	4 19 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	—	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	10½–11½	5 11 1	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 4	Feb, Aug	7⅛	7
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	—	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 8 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16–⅞	..	..	11/16	—
1	0/8¾	Do. 7% Cum. Pref.	1⅛–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3½–4	6 10 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	98 –101	4 9 0	..	99¾	99
5	5/6	†Westminster Elec. Sup. Ord.	9½–10½	6 8 0	Mar, Sept	10 5/16	10
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 7/16	..
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	—	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	31/32	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	—	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	—	102½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	8½%	†Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	9⅞–10⅛	3 19 0	..	—	—
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	5½–6	5 0 0	—	5 11/16	5 9/16
10	6/0	† Do. 6 per Cent. Cum. Pref.	9¼–9¾	6 3 0	Feb, Aug	9⅝	9⅜
St.	5%	Do. 5 per Cent. Perpetual Debs	113 –116	4 6 0	..	115	113¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	90 –93	4 16 9	..	93	92½
St.	4%	†Central London Ordinary Stock	85 –87	4 12 0	June, Dec	86½	85½
St.	4%	† Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	98	..
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	75	74¾
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	109½	—
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	2¼%	†City and South London Rly. Con. Ord.	44 –46	4 7 0	Feb, Aug	46	44½
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	118 –121	4 2 9	Feb, Aug	—	..
St.	5%	† Do. (1896)	112 –115	4 7 0	..	..	..
St.	5%	† Do. (1901)	112 –115	4 7 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½–4	10 0 0	..	..	—
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db.St.	100 –103	4 7 6	..	..	..
10	9%	‡†Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16–8 15/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8⅝–9⅛	5 10 0	—	9	8⅝
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 8	—	94¾	..
St.	..	Mersey Con. Ord. Stock	5 –7	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 –10	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–3/16	..	—	⅛	..
1	0/6	† Do. 5% Cum. Pref.	13/16–15/16	5 9 0	—	13/16	..
St.	4½%	Do. 4½% Deb. Stock	99 –101	4 9 0	—	100	99¾
5	..	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¾	5 5 0	..	..	..
10	5/0	† Do. 5 per Cent. Cum. Pref.	7¼–8¼	6 2 6	Feb, Aug	7⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	—	..	..
100	5%	Sunderland Dst.Elc.Trms.5%1stMt.Db.	89 –92	5 8 8	—	90⅛	90
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 –92	5 8 8	—	90	..
St.	3%	†Waterloo and City Ord.	101 –104	2 17 9	June, Dec	..	—
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	—	—	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	—	..	—

Shre.	Last Dividend	Name.	Price Wed., Aug. 22.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 22. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El.Met.6%Cm.Pf.	½–⅝	..	—	..	..
1	2/4½	Babcock & Wilcox Ord	4 –4½	4 11 0	..	4⅛	4
1	7½d.	Do. Pref	1⅜–1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6¾–7¼	5 10 0	July, Feb	6⅞	..
5	3/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	—	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 0	..	..	..
5	..	British Westinghouse 6% Pref.	1½–1¾	..	..	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	..	..
2	1/0	Brush Electrical Engineering	¾–1	..	March	..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1½–1¾	6 17 0	Mar, Sept	..	—
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 1 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	108½	..
1	3¾d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	—	100	—
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1 3/16–1 5/16	7 10 0	—	..	—
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	—
8	1/6	†Crompton and Co. (Nos. 1 to 54,000)	1 11/16–1 15/16	3 13 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–97%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1 1/16–1 3/16	5 12 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	1¼	1 3/16
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	—
5	1/6	Edison & Swan United ("A" Sh.)(£3 pd.)	1½–1¾	4 5 6	Feb, Aug	1 11/16	1 9/16
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	2⅝	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	—	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3¼–3¾	9 12 0	H'lf-yearly	3 5/16	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅞–5⅜	5 11 6	..	5	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	—	..	—
2	1/7½	Electric Construction Co.	½–¾	14 0 0	July	9/16	17/32
2	2/9¾	Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	86 –89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 8	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –97	4 2 6	—	..	..
5	10/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	12¾	..
5	4/6	Do. 4½ per Cent. Pref.	5⅜–5⅝	4 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	..	..
St.	12/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17⅜	..
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	101⅛	100½
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	—
1	1/2⅜	Richardsons, Westgarth & Co., Ltd. Ord.	15/16–1	6 0 0	..	1	31/32
1	7½d.	Do. 6% Cum. Pref.	15/16–1 1/16	5 15 6	—	..	..
St.	4½%	Do. 4½% Perp. Deb. Stock	99 –101	4 9 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33½–35½	5 12 6	Mar, July	35	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2½–2⅝	5 16 6	..	2⅝	2 17/32
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1 3/16	4 5 0	..	..	..
St.	5%	Do. 5% Non-Cum. Preferred	113 –116	4 6 0	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	104½	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	—	106½	..
5	—	Willans and Robinson Ord.	¾–1¼	..	Apr, Oct	..	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾–3¼	..	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	..
		TELEGRAPHS.					
10	—	Amazon Telegraph	3½–4	..	Jn, Dec	..	..
100	5%	Do. 5% Debs. (red.)	87 –92	5 8 8	..	88¾	89¼
St.	15/0	Anglo-American	66 –68	4 15 9	F,My,Ag,N	67½	66
St.	30/0	Do. Preferred	114 –115	5 4 0	F,My,Ag,N	115½	113¾
St.	10/0	Do. Deferred	24¼–24½	2 1 0	F,My Ag,N	24 11/16	[illegible]
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–98½	4 0 6	Jn.Ap,Jy,O	98½	98⅛
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	—	—
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	6/8	Direct United States Cable	15½–16	4 18 6	Ja,Ap,Jy,O	15 13/16	15⅝
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..	..
St.	6/0	Eastern Ordinary	144 –147	4 15 0	Ja,Ap,Jy,O	146	144¾
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 17 9	Ja,Ap,Jy,O	91¾	91¼
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	107½	..
10	2/6	Eastern Extension	14¼–14¾	4 15 0	Ja,Ap,Jy,O	14⅝	14 5/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 –107	3 14 9	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37½–38½	6 0 0	Jan, July	38¾	38
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	55/6	Indo-European	58 –60	5 8 4	May, Nov	..	..
100	4%	Mackay Companies Common	76 3/16–78 3/16	5 8 9	Jan, July	—	..
100	4%	Do. Preference	74 11/16–75 3/16	5 6 6	Ja,Ap,Jy,O	..	—
1	—	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	..
2½	—	West Coast of America	¾–⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..	..
10	—	West India and Panama	⅜–½	..	May, Nov	15/32	..
10	4/0	Do. 6% 1st Pref.	6½–6¾	3 18 0	May, Nov	6 9/16	..
10	—	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr,Jn,O,D	14 9/16	14½
100	5%	Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	—
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	..	..
		TELEPHONES					
—	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 –103	4 17 0	..	..	..
5	5/0	Chili Telephone (fully paid)	6¼–6¾	5 16 0	August	6 7/16	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	—	—	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	108 –110	5 9 0	—	109⅜	108½
St.	5%	Do. Def. Stock	108 –110	4 11 0	—	109¼	108¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	11 9/16	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½–5¾	4 7 0	Feb, Aug	..	..
St.	3½%	Do. Deb. Stock 3½ per Cent. (red.)	97½–98½	3 10 8	June, Dec	98	97¾
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 7 0	—	103¾	..
1	0/9⅜	Oriental	1 1/16–1 7/16	4 8 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16–1 5/16	4 11 0	—	..	..
St.	4%	Do. 4% Red. Deb. Stock	97 –99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	..	..
5	5/0	United River Plate	7 –7½	5 6 8	July	7 5/16	7 3/16
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–5¾	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 –112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5	6 0 0	—	..	..
10	2/0	Globe Telegraph and Trust	10½–11	5 0 0	Ja,Ap,Jy,O	10 13/16	10⅝
10	3/0	Do. 6 per Cent. Pref.	14½–14¾	4 1 6	Ja,Ap,Jy,O	14⅝	14½
10	6%	Submarine Cables Trust (Cert.)	159 –162	4 11 0	April, Oct	..	—

* In calculating the yields, allowance has been made for accrued interest but not for redemption. † Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

As shown by Mr. WAUGH'S report, which we publish on another page, it is reassuring to find that the electric brake alone was quite capable of controlling the car which recently got out of control at Halifax and overturned with disastrous effect. Even when running at a speed of 28 miles per hour down a gradient of 1 in 22, the car was brought to rest in 120 yards by the use of the electric brake alone. In emergencies the slipper brake can always be used in addition. As pointed out by Mr. WAUGH, the two essential conditions of success under such circumstances are, first, that the wheels of the car must not be locked by the use of the hand or wheel brake, and, second, that a supply of sand must be available. The mistake in this case seems to have been that the electric brake was regarded as an emergency brake, whereas a brake of this kind should be kept in regular use so that the men are familiar with its working, and do not proceed to lock the wheels by a hand brake in case of emergency.

JOURNALISTIC imagination in Sydney is highly developed, with the result that the efficiency of the Westinghouse-Newell magnetic brakes used on the tramcars has been called seriously in question. The Railway Commissioners, therefore, requested a Board, consisting of Mr. T. ROBERTS (South Australian Railways), Mr. J. S. BADGER (Brisbane Tramways), Mr. H. J. SOMERSET (Perth Tramways), Prof. POLLOCK and Mr. O. W. BRAIN (New South Wales Railways and Tramways) to investigate the whole question. A request that tramway employés should attend the inquiry and give evidence was met by an objection on the part of the Tramway Employés Union as to the composition of the board. Finally, however, a number of employés appear to have attended, and stated, as a rule, that they had little or no knowledge of the electric brake, and had made no statements of the kind attributed to them by the Press. Possibly prejudice may be due to novelty. Apparently the electric brake is somewhat of an innovation, over 14 million car-miles having been run with air brakes as compared with about one million with the electric brake. It is, perhaps, not quite fair to compare their freedom from breakdown so soon; but so far the comparison is favourable to the electric brake, which gave trouble only every 17,133 miles, as compared with 8,570 miles for the air brake. As to general reliability, the Board found the electric brake to be quite satisfactory, and exceptionally powerful in making emergency stops; so the inhabitants of Sydney may feel reassured.

A GOOD many hard things are said from time to time about municipalities; but whatever their shortcomings, they do not interfere, directly at least, with private enterprise. In America this is otherwise. Two years ago the City Council of Columbus, Ohio, passed an ordinance to the effect that the Columbus Railway & Lighting Co. should not charge more than 2½d. per unit for energy supplied for light and power. As this meant that the company had to supply energy at cost price to 75 per cent. of their consumers, and at less than cost price to most of the others, the ordinance was by no means relished by the company. Relief has now been sought in litigation, with the result that the ordinance has been declared unconstitutional, and a perpetual injunction granted against the Council.

THROUGH greater freedom of action the interurban railways in America are finding opportunities for supplying power in a way that would probably not be permitted in this country. Where such lines pass through agricultural country, quite a demand is springing up for electric energy for driving farm appliances, such as grinding machinery. The only alternative sources of power are the windmill, the results of which are too uncertain, and the oil engine, which may require rather more attention than the farmer cares to give to it. Consequently there is much in favour of a simple overhead line run from the railway to the farm buildings, where a motor is installed, usually in a water-tight shed of its own. This can generally be done at a cost of about £120 for a 15 H.P. motor complete, the railway company charging for power at the rate of 2d. per unit. There appears to be quite a number of such installations along the Aurora Elgin & Chicago Electric Railway.

* * *

UNLIKE some of our London railway companies, the North-Eastern Railway Co. considered that local traffic was worth catering for, with the result that the Tynemouth line was converted to electrical working, and a deal of traffic was taken from the Tyneside Tramways & Tramroads Co. At the meeting of the latter on Tuesday last the chairman remarked that good progress had been made towards recovering this lost traffic. The Tramways Company is one of those which prefers to purchase energy rather than sink capital in generating plant, and stress was laid upon the fact that for this reason depreciation was a less important item than it would be otherwise; for a power station becomes antiquated more rapidly than any other part of a tramway system. Altogether, there is now a brighter outlook for the Tramway Company, but it remains to be seen how the Railway Company will be able to adapt its policy of competition.

* * *

WE note that the statutory general meeting of the London Electrobus Co. has been held, and passed off with mutual congratulations between the directors and the shareholders. The chairman announced that 30 omnibuses are on order, and that satisfactory contracts have been entered into for tyres and accumulators; so that apparently the company will shortly enter into the practical stage of working, which we shall follow with much interest. The criticisms, which were so freely made at the time the company was floated, were brushed aside with the remark that electrical engineers, like medical men, are apt to differ.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	—
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906	—
Falmouth—Bilbao	Aug. 14, 1906	Aug. 30, 1906
Môle St. Nicholas—Port au Prince	Aug. 16, 1906	—

Radium.—According to the *Pall Mall Gazette* of yesterday the Vienna Imperial Academy of Sciences has been carrying on a systematic investigation into the possibility of obtaining radium from the State mines in Joachimsthal, with the result that radium compounds have been extracted to the value of £40,000, presumably at current prices

Electric Oven for Baking Armatures.—According to the *Street Railway Journal* an inexpensive form of electric oven is being used by the Clinton Electric Railway Co., Ia., for baking armatures and field coils. It consists of a sheet iron case lined with asbestos, and contains seven coils of No. 7 wire wound on 1¼ in. gas pipe covered with asbestos. The temperature rises to 220 deg. and then remains constant.

The Telharmonic System in New York.—According to the *Electrical Review* of New York, the first set of apparatus for the production of music electromechanically under the Cahill telharmonic system is being installed in Park and Tilford's store on West Thirty-ninth-street. The apparatus will be operated by a 200 H.P. motor taking current from the Edison service. A second plant is now being constructed for shipment to the Pacific coast.

Lighthouse Administration.—The King has appointed a Royal Commission, consisting of the Right Hon. G. W. Balfour (chairman); Sir Frank Forbes Adam, C.I.E.; Col. I. J. C. Herbert, C.B., C.M.G., M.P.; Vice-Admiral W. H. Henderson; Mr. M. A. Ennis; and Capt. C. Bigham, C.M.G. (secretary), to inquire into the existing system of management of the lights, buoys and beacons on the coast of the United Kingdom by the three general lighthouse authorities, and as to the constitution and working of these authorities; and to report what changes, if any, are desirable in the present arrangements.

The Word "Telegraphone."—In this country the word "telegraphone" is not likely to cause much confusion, but in America the word is in more general use, so that there is good reason for the following protest by the *Telegraph Age*:—"The misuse of the word 'telegraphone' is apt to create wrong impressions as to its true meaning, and consequently lead to confusion and error. For instance, the term as it is generally employed in this country, especially in railroad and telegraph circles, where, indeed, it is most frequently met with, applies in brief to a telephone circuit attached to an ordinary telegraph line. In Europe, on the other hand, and even to a certain extent here in America, an understanding of the word is held to denote the device of Poulsen, which is, as a matter of fact, no more or less than a form of phonograph or graphophone, for the instrument records speech on a metal band. As the definition of the word now coming more freely into usage is so diverse in meaning, it would seem that a change might properly be made by the adoption of a new title for one form of interpretation."

Electrical Power in Gold Dredging.—An article in *l'Electricien* describes some of the applications of gold dredging as carried out to a large extent in the West of the United States. One example is a dredger which has been in use for some time at Oroville, in California, and which is capable of treating 66,512 cubic metres per month. Current is supplied by cables from a distant water-power station at 4,000 volts three-phase and 60 cycles, transformers on the dredger reducing the pressure to that required for the motors. The bucket conveyor is driven by a 15 H.P. induction motor and the washer is driven by another motor of similar power. A sand pump, driven by a 30 H.P. motor, is also provided, with a small charging pump driven by a 3 H.P. motor. The centrifugal pump which supplies the washing water is driven by a 40 H.P. motor. The raising and lowering of the conveyor frame is effected by a 50 H.P. motor, and two capstans actuated by 15 H.P. motors are also provided. Each bucket has a capacity of 0·08 cubic metre and 85 buckets are used, passing at the rate of 20 to 25 per minute. The whole dredger is 30 metres long and 12 metres wide, and draws 1·8 metres of water. Two keels are provided, one of steel weighing 15 tons, and one of wood weighing 9 tons. A number of dredgers of this type, and also some of the suction type electrically driven, are in use by various mining companies. Assuming the cost of power to be 0·05fr. per kilowatt-hour, the expenses of working come to about 0·2 fr. to 0·3 fr. for every cubic metre treated, which is considerably less than was the cost with steam-driven apparatus under equivalent conditions

Cable to Iceland.—The Great Northern Telegraph Co. announces that the first section of 215 nautical miles of the telegraph cable to Iceland was laid from the Shetland Islands to the Faroe Islands and was completed in 10 days, the final splice being made on the 29th ult. Correspondence with the Faroe Islands was opened on the 1st inst. The first telegram which passed over the cable was a message from King Frederick of Denmark greeting his subjects on the distant islands. In reply, the King received an address from the people of Faroe containing 192 signatures. On Wednesday President Roosevelt sent a telegram to the King of Denmark, congratulating him on the opening of the cable, and upon the completion of so important and valuable a work. This section is worked from the Post Office stations at Lerwick (Shetland Islands) and Thorshavn (the capital of the Faroe group). The last section of the cable, 327 nautical miles in length, has just been completed, and connects Thorshavn with Seydisfjord on the east coast of Iceland. It is worked between those two stations, both of which belong to the Great Northern Telegraph Co. The Iceland Government is constructing the land-lines across the island connecting Seydisfjord with all the main towns and ending at Reykjavik, the capital of Iceland. It is expected that these land-lines will be completed before October 1st, when the official opening of the connection will be made between the Danish and Icelandic Governments. The rates for messages are: Between London and Thorshavn 5½d., and between London and Iceland 8½d. per word. The cable was manufactured and laid by the Telegraph Construction & Maintenance Co., the laying being carried out by that company's c.s. "Cambria." Telegrams for Iceland are accepted at all postal telegraph stations and at the company's London office, 3, St. Helen's-place, E.C.

Interference with Wireless Telegraphy.—An amusing story of attempted interference with wireless telegraphy comes from Chicago. Apparently the object was to interfere with the wireless telegraph gambling boat, the "City of Traverse," and to that end the police set to work with their best scientific ability. But the idea was to eliminate the wireless communication with the craft, depriving it of race results by sounding a huge fog horn, of which the vibrations would "blur" the wireless message. The results were grotesquely disastrous. The gamblers laughed at the police in the tug "Andy." The life-saving crews from Jackson Park and South Chicago, believing the sounds to be distress signals, hurried to the Hyde Park crib; sailboats, launches, motor-boats, and an armada of small craft rushed to the rescue, while the shore from Kenwood to South Chicago was lined with persons fearing an excursion boat disaster. Chief of Police Collins denied knowledge of any plans for a marine raid upon the "City of Traverse," and stated that if there were police in the tug "Andy" they were from some outlying station, and were experimenting without his knowledge. The Smith-Perry-White syndicate, which operates the boat, attributes the attempt to "Mont." Tennes, their jealous rival. Needless to say, no difficulty with the wireless apparatus was found on board the "Traverse"; the messages of the race results came without mishap and with regularity. The chief inconvenience suffered was the blatant noise sounded from the foghorn of the "Andy," which hovered close to the side of the larger boat all the afternoon and made the deck of the ship a bedlam.

Electric Steel Cars for the Pennsylvania Tunnel.—For the Pennsylvania Railroad in its new electrical régime all its passenger car equipment is to be of steel throughout. 1,000 of the new cars will be ready when the New York tunnel is completed. There will also be some 500 Pullman cars, which will also be of a completely non-combustible construction. At the request of the Pennsylvania Railroad, the Pullman Company is now building the first all-steel sleeping car ever constructed. According to the *Electrical World*, the new standard Pennsylvania car weighs 103,550 lb., against 84,900 lb. for the standard wooden coach, but it is found that the added weight greatly reduces the vibration and adds to the comfort of the passengers. No inconsiderable part of the additional weight is due to the burden involved in carrying storage batteries and battery boxes. All the new cars are to be lighted by electricity, and the Pennsylvania will carry no gas illuminated cars of any kind into the New York tunnel. The electric wires in the new cars are insulated in heavy metal conduits, thus adding to the safety. The new car is non-collapsible. Its hidden frame is like a cantilever bridge, suspended on the trucks as piers. This safety against telescoping is secured by the use of enormous steel girders, the principal feature in the body of the car being a central box girder, 24 in. wide by 19 in. deep, extending throughout the length of the coach. The flooring throughout the car and platform consists of an imitation of stone, spread while in a plastic state over the steel plates of the car. The framing above the windows is composed of steel plates. The doors are composed of steel plates pressed into a shape imitating the wooden doors used in other cars and filled with cork to deaden the sound. The roof is constructed of composite boards covered with copper sheathing. The inside lining consists of composite boards covered with fireproof paint.

Electric Power in Farming.—The *Electrical World* gives an interesting account of the electrical utilisation of water power on the farm of Mr. E. B. Miner, in the State of New York. Through the farm runs a stream of water having a normal flow of about 4,000 cubic ft. per minute. Across this a rough dam was thrown which gave a head of 4½ ft. This proved sufficient to operate a 17½ H.P. waterwheel, running at 113 revs. per min., which was coupled to a 12½ kw. Westinghouse generator designed for 250 volts. The generator is connected to the farm buildings 500 yds. away by means of a bare overhead aluminium cable equivalent to No. 2 B. & S. copper, which is strung on cross-arms mounted on cedar poles, set about 100 ft. apart, the insulator pins and the cross-arms being 24 in. apart. The plant has been running since December last, night and day, with but very little attention, and without a governor of any kind for regulation. The electric energy is used for lighting and heating, and for a motor to run the cream separator, churn and grindstone. It is proposed to do the cooking as well as to furnish power for all suitable farm machinery as soon as it is possible to make the necessary changes for electric driving. This plant has been the cause of numerous inquiries from different people, asking if it were not possible to put down similar plant on their property. There are many places in the country where small water powers of from 10 H.P. to 50 H.P. could be utilised, and plants similar to the above could be installed. It is interesting to note that quite recently a small manufacturing industry has been established near this farm, attracted by the available power and other conditions, so that we have here a novel illustration of the "return to the soil" idea, as opposed to the tendency to drift to the cities.

Wireless Telegraphy Notes.—The *Figaro* announces that the French Minister of War has applied to the Paris Municipality for the grant of a site in the Champ de Mars upon which it is proposed to erect a building to form a permanent centre for French military wireless telegraphy operations.

The Bureau of Equipment of the United States Navy Department has compiled a list, which will be published in book form, of the wireless telegraph stations in the world; particulars are also given of the systems used and names of merchant ships equipped for wireless telegraphy. The number of stations in each country is given as follows: Belgium, 1; Denmark, 4; Germany, 13; France, 6; Great Britain and Ireland, 43; Holland, 8; Spain, 4; Portugal, 1; Gibraltar, 2; Italy, 18; Malta, 1; Montenegro, 1; Norway, 1; Austria-Hungary, 2; Roumania, 2; Russia in Europe, 8; Sweden, 3; Turkey, 6; Argentina, 5; Brazil, 5; Canada, 5; Chile, 1; Costa Rica, 1; Mexico, 2; Panama, 2; Uruguay, 1; United States, 88 (of which 10 are in the possessions of the United States and 32 directly under the control of the navy); Trinidad, 1; Tobagol, Andaman Islands, 2; Burma, 1; Hong Kong, 1; China, 5; Hawaii 6; Japan, 2; Dutch East India, 5; Russia in Asia, 1; Egypt, 2; Morocco, 2; Mozambique, 2; Tripoli, 1.

It appears that at no distant date the United States Navy will have the Pacific Coast efficiently equipped with wireless telegraph stations. So far, stations have been completed and equipped at San Diego, Arquello, Faralona and Mare Island. Faralona is just outside San Francisco harbour, and the station was located there in order to have the communication over sea, as much as possible, from one station to the other. According to the *Electrical World* stations are now being constructed at Table Bluff, Cape Blanco, North Head and Cape Flattery. The stations are from 130 to 210 miles apart, and when they are all erected and the apparatus installed, it will be possible to communicate the whole length of the Pacific Coast, either in the day or night. In this connection it may be noted that after thorough experiments the Government has determined that the earth formation at Montank Point is not suited to successfully operate a wireless telegraph station. The present station is to be abandoned and all apparatus shipped to Fire Island, where a new station will be built. A De Forrest wireless telegraph station is being constructed at Saulte Ste. Marie, Ontario. It will have, it is claimed, a capacity of sending and receiving 600 miles over land and 2,000 miles over water.

Water Power in Scotland for the Manufacture of Aluminium. The British Aluminium Co., having fully utilised the power from the Falls of Foyers in Inverness-shire, now find that, owing to successful working, they require more power, and have therefore commenced a far more ambitious scheme. In the neighbourhood of Kinlochleven, on the borders of Argyllshire and Inverness-shire, is an area which has one of the largest rainfalls in the whole of the British Isles. The catchment basin in the position chosen by the company has a large area, in the centre of which is the site for the reservoir, at an elevation of 1,000 ft. above the sea-level, and only distant about 5 miles from the coast. According to the *Scotsman* the reservoir will be about 7½ miles in length, with an average breadth of ½ mile, and will probably be the largest artificial reservoir in Europe. It will obliterate three small lakes or lochans—bearing difficultly pronounceable Gaelic names—and its approximate capacity will be about 20,000 million gallons. The dam will be formed of concrete and will be over ½ mile in length, and its greatest height in the centre will be about 80 ft. The water will be led through a concrete conduit along the hill face for a distance of about 3½ miles, following the natural contour of the ground, to the head of the pipe line. The conduit will be 8 ft. square and is to be built entirely of reinforced concrete and roofed over with slabs of the same material. The total fall in the conduit to the head of the pipe line is about 20 ft. At this point the water discharges into a Penstock chamber where the valves supplying the pipe line are located. The pipes leading the water from the power house will be six in number and have a diameter of 39 in. The head of water at the turbines is stated as 900 ft. The power house is to be supplied with all necessary workshops, stores, &c., and will contain the turbines for driving the eight or more dynamos which will be required to work the furnaces. Close by the head of Loch Leven, a short distance to the west of the power house, the company are going to construct a model village for the accommodation of their employés. A large number of workmen are at present actively engaged in the work of laying down streets. A portion of the conduit is almost completed, and the excavations for the foundations of the dam are also in an advanced state. In order to expedite the transport of the plant and material required in the construction, the contractors have erected an aerial ropeway between Loch Leven and the wharf, a distance of some 5 miles. For the conveyance of heavy machinery and material an overland route has been constructed, the steep portions being worked by wire-winding winches. A small temporary power scheme has been arranged for working the ropeway and for generating current to work the crane, drills and other machinery. This scheme is practically a miniature of the larger scheme, and the power for it is obtained from two turbines at the falls of the Leven, which are capable of developing nearly 1,000 H.P. The cost of the undertaking will probably exceed £500,000, and it is expected that the construction will occupy about three years. Sir John Jackson (Ltd.) are engineers for the reservoir, conduit, dam and pipe track, and Thomas Meik & Sons are engineers for the scheme. In giving details of the scheme our contemporary is not quite correct in stating that to obtain aluminium "a heat is required greater than can be got from an ordinary furnace, and these degrees of heat are readily obtained from electric furnaces." The heat is only required to be sufficient to keep the cryolite fused, and if this were all it would not be necessary to employ electricity. The object of the electric current is, of course, to electrolyse the fused electrolyte, and thus deposit the metallic aluminium at the cathode.

Power-operated Hatches in the U.S.A. Navy.—Armour hatches on ships have been a rather difficult problem ever since the protective deck was introduced. Means must be provided for raising and lowering the hatch plate quickly and safely under all circumstances, and as the plate weighs sometimes as much as ½ ton the problem is by no means simple. Block and tackle has been used in the past, but is inconvenient and dangerous, because the plate is likely to become unmanageable when the ship is rolling. Accidents from this cause have been frequent. The one thing essential to the safe handling of these heavy plates is that they be mechanically held at all times so that they cannot drop or swing back. This result has been accomplished in the "Long Arm" electrically-operated hatch gear, of which a new model has just been approved by the Bureau of Construction and Repair of the United States Navy Department. This gear is so designed that the hatch plate while being operated is always under control and held firmly, at whatever angle the plate may be to the deck. The two essential parts of this apparatus are the hatch lift, a cast-steel box containing the motor, controller and gearing, and the lever system for connecting the hatch lift with the plate for operation and for locking the plate watertight when closed. The hatch lift is secured under the deck by the side of the opening. Projecting from the side of the hatch lift is a heavy crank which can be rotated either by the motor or by an auxiliary hand wheel, above or below deck. From this crank power is derived to open, close and lock the hatch plate. The lever system consists of a substantial fulcrum shaft rotating in a bearing bolted to the underside of the protective deck, almost under the hinges of the plate. The fulcrum shaft carries a bent lever standing out beneath the hatch plate and connected to the locking mechanism on the hatch plate by a substantial link. The bent lever does not obstruct the clearway when the hatch is open. The locking mechanism is an important feature, consisting of a number of bars all connected to one shaft across the centre of the plate, and so arranged that when the shaft is rotated the bars are forced out beneath the deck and draw the hatch plate firmly down to its seat. The mechanism is actuated by the lift, and does not require separate manipulation. When the hatch is closed and locked and the operator starts to open, either by hand or by power, the lift first unlocks the plate, after which it opens to any desired extent. A mechanically-operated stop prevents the locking gear from throwing out the bars except when the hatch plate is completely closed. The motor and controller of the hatch lift are connected with a central emergency station located above deck and form a part of the system by which the main bulkhead doors of United States warships are controlled from the central station. The hatch lift, in common with the "Long Arm" system doors, possesses a "liberty action," which enables a man who may desire to pass through the hatch while it is being closed from the central station or after it is completely closed to arrest and reverse the power action. This is accomplished easily and safely simply by turning the controller handle. When this lever is manipulated the closing operation is suspended and the hatch opens sufficiently to allow passage through the opening. As soon as the controller handle is released the hatch automatically closes again, as though no interruption of the emergency closing had taken place. The great importance of this feature of the mechanism is that it eliminates danger and gives freedom to those who may be compelled to pass through the hatchway while it is being closed from the emergency station. The hatch lift is provided with an automatic cut-out, so that in case an obstruction prevents the complete closure of the hatch plate the current to the motor is cut off, preventing injury. After the obstruction is removed, the motor is automatically started, this follow-down action doing away with the possibility either that the apparatus will be injured or that, after an emergency-closing is interrupted, the hatch will be left open by some one passing through it. The "Long Arm" hatch gear thus offers three methods of operation—namely, by power which is brought into action by means of the controller handle, by means of the hand gear intended for use in case the electric power should fail, and, lastly, from the emergency station on the bridge by means of which the closing of all power-operated hatches on the ship is always instantly possible.

THE SUDDEN SHORT-CIRCUITING OF ALTERNATORS.

BY F. PUNGA.

As there is always a possibility in large power transmissions and chemical works of the sudden short-circuiting of the generating station, it is often specified that the single-phase or multi-phase generators shall be able to withstand a short-circuit without damage, at least for a short time. Such conditions are considered as quite normal in America, but in Europe it is only occasionally that such a clause is found in a specification. Nevertheless, many cases have occurred in Europe, where very great damage to a generator has been caused by a sudden short-circuit. The end connections of the armature become twisted or sometimes destroyed, the whole insulation is damaged by the intense mechanical forces produced, and the winding is often burned out. Even where no visible displacement of the end connections is produced the micanite tubes may be slightly damaged, and may totally break down when a voltage rise occurs.* Also, the rotating field very often receives a dangerous blow, though a generator, if gradually short-circuited, may receive no damage.

It seems of interest, therefore, to study the factors that effect the difference between a *gradual short-circuit* and a *sudden short-circuit*.

As the matter is rather complicated, and an exact solution of the problem seems quite impossible, a rough approximation to that which actually happens is all that is claimed in the following treatment of the subject. We will denote by M_o the flux passing from one pole shoe of a generator into the armature. If the generator is short-circuited with such an excitation that the short-circuit current is equal to the full-load current, the field ampere-turns will have a certain value which we will denote by F. In this case a very small flux, M_s, is still passing from each pole to the armature, just sufficient to compensate for the armature self-induction; in the pole and yoke we have the flux M_s and the leakage flux M_f as produced by the F ampere turns between adjacent poles. If the generator is short-circuited with full-load excitation (F_o field ampere turns), the armature current is F_o/F times larger than the full-load current. In this case the flux passing from poles to armature has increased in the same ratio; therefore, $M_{so} = \frac{F_o}{F} M_s$ and the leakage flux $M_{fo} = \frac{F_o}{F} M_f$.

The flux in the armature, therefore, as well as in the pole, has to change by the amount $M_o - M_{so}$, on a sudden short-circuit, and it is this change of flux which causes many of the phenomena to be observed on the occasion of a sudden short-circuit. During the time this change is taking place, a larger flux is entering from the pole-shoes into the armature than after the end of the change, and therefore a higher E.M.F. is also produced.

At the very first moment this E.M.F. is M_o/M_{so} times larger than at the normal short-circuit; and if the current could at once follow this voltage, the short-circuit current would be M_o/M_{so} times larger than the normal short-circuit current I_k. In reality, however, the flux has decreased by a certain amount before the current reaches its maximum value, and therefore we may expect that maximum value to be smaller than $\frac{M_o}{M_{so}} I_k$.

This maximum short-circuit current can reach a value 20 times larger than the full-load current. That such a current may produce enormous forces between the different end connections must be admitted at once, seeing that those forces are proportional to the square of the current. Owing to the change of flux an E.M.F. proportional to dM/dt is induced in the field winding, acting in the same sense as the exciter voltage. The exciter current, therefore, will be increased.

Let us denote the self induction per pole of the exciter circuit by L, the ohmic resistance by R and the voltage of excitation (also reduced to *one* pole) by e, the field current by i', then we have the following equation:—

$$e - z\frac{dM}{dt} \cdot 10^{-8} = L\frac{di'}{dt} + Ri'$$

(z = number of field turns per pole).

If
$$i = i' - \frac{e}{R} = i' - i_o,$$

i.e., if by i is denoted the increase of the field current above its normal value, then

$$-z\frac{dM}{dt} \cdot 10^{-8} = L\frac{di}{dt} + Ri.$$

Let us consider for a moment the case of R being very small compared with L, then Ri can be neglected and we obtain

$$-z\frac{dM}{dt} \cdot 10^{-8} = L\frac{di}{dt},$$

and by integration

$$i = -\frac{z}{L}(M - M_o)10^{-8}.$$

$\Delta M = M - M_o$ is the change of flux at any time, and $-\frac{z}{L}\Delta M \cdot 10^{-8}$ the increase of the field current at the same moment.

Generally, by far the greatest part of the self-induction of the field-circuit is due to the leakage flux between adjacent poles. We know already that for full-load excitation ($F_o = zi_o$) the leakage flux has been denoted by M_{fo}; therefore

$$L = \frac{zM_{fo}}{i_o} \cdot 10^{-8},$$

and
$$i = -z\frac{\Delta M \times 10^{-8}}{\frac{zM_{fo}}{i_o} \times 10^{-8}} = -i_o \frac{\Delta M}{M_{fo}}.$$

If, for instance, the flux M_o is decreased to one-half of its normal value, then

$$\Delta M = -\frac{1}{2}M_o,$$

and at the same moment

$$i = \frac{i_o}{2}\frac{M_o}{M_{fo}}.$$

The leakage flux varies between 5 per cent. (in large two-pole turbo-dynamos) up to 30 per cent. (in very slowly running generators of small capacity). A case very often met with is 15 per cent. leakage flux; using the above formula for this case we see that i has a value of 3·3 times i_o, as soon as M_o has decreased to half its normal value.

We shall very soon see that such an increase of the field current occurs even if the resistance of the field circuit cannot be neglected; and this phenomenon deserves a very careful consideration.

If the generator were standing still, a change in the field flux, of course, would induce the same effect in the armature winding as in the field winding; as, however, the field is rotating, the current induced in the armature circuit due to the change of flux is displaced by nearly 90 deg. with respect to the armature current already mentioned at the beginning of the article. This latter current is in a demagnetising direction, and the current due to the change of field flux produces a torque opposed to the rotation. In the case of the armature circuit having at the time of short-circuit a considerable amount of resistance, a component of the second current produces a magnetomotive force opposite to the magnetomotive force of the normal short-circuit current.

It can, however, be shown that the effect of the second current is comparatively small, and in order to simplify the treatment of the question we propose to neglect it altogether.

The relation between the field ampere-turns and the armature ampere-turns is given by the following simple equation:—

Field ampere-turns = effective armature ampere-turns.
+ magnetising ampere-turns.

The flux M_o may have dropped to M, in which case the effective armature ampere-turns $= \frac{M}{M_s}F$, and the magnetising ampere-turns (approximately) $= \frac{M}{M_o}F_o$. Therefore

$$zi' = \frac{M}{M_s}F + \frac{M}{M_o}F_o \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

---

* M. B. Field, in his Paper on "Idle Currents," read before the Manchester Section of the Institution of Electrical Engineers (see *The Electrician*, Vol. LVI., p. 845), gives some striking examples of the forces produced in such cases.

For the field circuit there exists the second equation

$$-z\frac{dM}{dt} \cdot 10^{-8} = L\frac{di}{dt} + Ri. \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

By differentiating (1) we obtain:

$$z\frac{di'}{dt} = \frac{zdi}{dt} = \frac{dM}{dt}\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right). \quad . \quad . \quad . \quad . \quad . \quad (3)$$

By combining (2) and (3) it follows that

$$z\frac{di}{dt} = -\left(L\frac{di}{dt} + Ri\right)\frac{10^8}{z}\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)$$

or

$$\left[L\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right) + z^2 \cdot 10^{-8}\right]\frac{di}{dt} + \left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)Ri = 0.$$

The solution of this differential equation is

$$i = Ce^{wt} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where $w = -\dfrac{\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)R}{\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)L + z^2 \cdot 10^{-8}}$, and C is a constant.

We have, however, to consider that the armature current does not immediately reach the value corresponding to the induced E.M.F. In general, the armature current requires one-quarter of a period to grow from zero to its maximum value. The equation (4) holds good only after one-quarter of a period has passed—*i.e.*, after the armature magnetomotive force has reached the value $\frac{M}{M_s} \cdot F$. During the first one-quarter of a period, however, the flux M_o will drop to $\frac{M_s}{M_f + M_s} \cdot M_o$, as will be evident later on.

The variation of the flux

$$M_o - \frac{M_s}{M_f + M_s} \cdot M_o = \frac{M_f}{M_f + M_s} M_o$$

appears as leakage flux in the field circuit, because, in that very short time, the effect of the resistance is quite negligible and thus our former equation—Decrease of main flux = Increase of leakage flux—holds good.

The increase of leakage flux can only be caused by an increase of the field current; and as M_f magnetic lines are produced by F field ampere-turns, we can conclude that the field ampere-turns must have increased by $\frac{M_o}{M_f + M_s} F$ ampere-turns, or the field current by $i = \frac{M_o}{M_f + M_s} \frac{F}{Z}$ amperes.

This is the maximum increase of the field current; after this value has been reached—*i.e.*, after a quarter of a period—the current follows the equation (4), which now reads

$$i = \frac{M_o}{M_f + M_s} \frac{F}{Z} e^{wt}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

in which $w = -\dfrac{\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)R}{\left(\frac{F}{M_s} + \frac{F_o}{M_o}\right)L + z^2 \cdot 10^{-8}}$ and t is reckoned from the close of the first quarter period.

Equation (5) can be expressed more simply. F_o/M_o is 8 to 20 times smaller than F/M_s, and therefore, for an approximate formula, it is permissible to write

$$w = -\frac{\frac{F}{M_s} \cdot R}{\frac{F}{M_s} L + z^2 10^{-8}} = \frac{R}{L + \frac{M_s}{F} z^2 10^{-8}}.$$

If we have denoted the self-induction of one field spool, as formed by the leakage flux, by L, we may denote $M_s/Fz^2 10^{-8}$ by L′, as it represents the self-induction of one field spool represented by the flux M_s, or, in other words, L is proportional to the leakage from pole to pole and L′ is proportional to the armature self-induction, but reduced to one field coil.

We can, therefore, write equation (5) in two different ways—namely,

$$i = \frac{M_o}{M_f + M_s} \frac{F}{Z} e^{-\frac{R}{L+L'}t} \qquad \text{or} \qquad i = \frac{zM_o}{L + L'} 10^{-8} e^{-\frac{R}{L+L'}t}.^*$$

The influence of the various factors can be clearly seen from this formula. L and L′ may be considered as the total self-induction in the field circuit during short-circuit.

$e^{-\frac{R}{L+L'}}$ is the well-known expression for the decrease of a current in a circuit having self-induction and resistance. The factor $\frac{z M_o}{L + L'} 10^{-8}$ allows of the following explanation: At short-circuit, $\frac{L + L'}{z} 10^{-8}$ magnetic lines are linked with z turns for 1 ampere in the field circuit. The number of lines produced by the current $i_{\text{max.}}$ or $\frac{z M_o}{L + L'} 10^{-8}$ is

$$\frac{L + L'}{z} 10^8 \times \frac{zM_o}{L + L'} 10^{-8} = M_o.$$

Considering now that $i_{\text{max.}}$ is only the increase of the field current, the normal current of excitation, of course, produces the leakage flux M_{fo}; it is evident that the total number of lines linked with the field-turns is $M_o + M_{fo}$—that is, practically the same as before the short-circuit.

The author had deduced the drop of the main flux from M_o to $\frac{M_s}{M_f + M_s} M_o$ during a quarter of a period after the short-circuit in a more complicated way, but he believes that the simpler method given above shows the correctness of the assumption in a clearer manner. The total number of lines linked with the field-turns cannot be altered considerably, because the loss of energy in the resistance during a quarter of a period is too small to cause any appreciable decrease in the magnetic energy of the field circuit.

The above main result can be repeated in the following terms: *After a sudden short-circuit the field current increases within a quarter of a period to a maximum value. The number of lines that would be linked with the field circuit if the generator were gradually short-circuited with the preceding maximum value as excitation would be just as large as with normal excitation before the short-circuit.* In the same way as the maximum field current has been found, the armature current may also be calculated. The maximum armature current is $M_o/M_f + M_s$ times larger than full-load current. After a quarter of a period it decreases very nearly proportionally to the field current. The curve of main flux and of the current of excitation after a sudden short-circuit is shown in a general way in Fig. 1.

The effect of a sudden short-circuit may be briefly summarised as follows:—

1. The excitation current is increased. (Maximum increase $= \frac{zM_o}{L + L'} 10^{-8}$.)
2. The exciter is overloaded momentarily to a considerable extent.
3. The armature current reaches a value considerably higher than the normal short-circuit current (maximum armature current $= M_o/M_f + M_s$ times full-load current).
4. As a consequence of the very high armature current, a considerable force is produced on the spool heads. If the force exerted on a spool head at full load is h, then at the time of a sudden short-circuit the force is $\left(\frac{M_o}{M_f + M_s}\right)^2 h$.
5. The load of the generator is represented by the I^2R losses in the armature circuit. If the armature contains a comparatively large ohmic resistance, or if the short-circuit occurs at a distance from the generator, thus inserting an external resistance into the armature circuit, the armature current may still become considerably higher than the normal short-circuit current, and the I^2R losses may represent a dangerous overload of the generator.

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[*] The influence of the eddy currents in the massive poles has been neglected in this formula; their effect is to reduce the increase of field current, acting like an additional field winding.

Mr. Hobart and the writer had occasion recently to study the behaviour of a 5,000 kw. three-phase generator on sudden short-circuit, and data of this machine have been kindly put at our disposal by Messrs. Siemens-Schuckert for publication in a book on "Three-phase Generators." A very short extract of these tests will be given here, in order to show that the formulæ approximately agree with the reality.

The generator had 20 poles and a flux of 15·2 megalines at normal voltage. The lines required to compensate the armature self-induction can be calculated to be $M_s = 0{\cdot}75$ megaline.* The field ampere turns F for a short-circuit current equal to the full-load current were experimentally determined and it was found that F = 4,800 ampere turns. 1·4 megalines are produced by these 4,800 ampere turns as leakage flux between adjacent poles.* Therefore, $M_f + M_s = 1{\cdot}4 + 0{\cdot}75 = 2{\cdot}15$ meg.

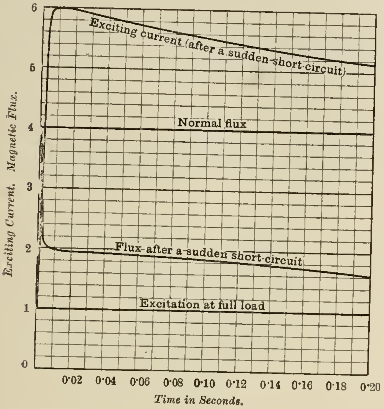

FIG. 1.

The maximum increase of the exciter ampere turns at a sudden short-circuit is $\frac{15{\cdot}2}{2{\cdot}15} \times 4{,}800 = 34{,}000$ ampere turns. As one field spool had 63 turns, and as the full-load excitation at which the machine was suddenly short-circuited corresponded with a field current of 185 amperes, it would follow that the field current ought to have increased from 185 to 185 + 540 = 725 amperes. A dead-beat moving coil instrument was put into the exciter circuit, and the maximum deflection was about 650 amperes. In Fig. 2 observed values are given for several tests at various excitations.

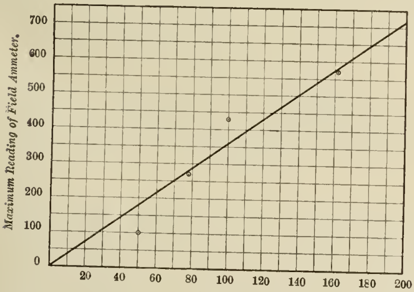

FIG. 2.—MAXIMUM READING OF FIELD AMMETER AFTER A SUDDEN SHORT-CIRCUIT.

In Fig. 3 the normal short-circuit current and the sudden short-circuit current are given for various field currents. In this case a hot-wire instrument was placed in the armature circuit, and the values, in Fig. 3 are only the maximum deflection of this instrument. As a hot-wire instrument requires a longer time to follow a sudden variation of the current, we may fairly conclude that the maximum value of the armature current was considerably higher than that given in Fig. 3. The calculation gives a maximum armature current of $\frac{15{\cdot}2}{2{\cdot}06}$ = about seven times full-load current. The observed maximum deflection of the hot-wire instrument is 4·9 times full-load current. In Fig. 4 the momentary values of the armature current are shown as recorded by means of the Siemens-Schuckert ondograph; they show the gradual decrease of the armature current. These tests should be sufficient to verify the theoretical deductions, at least in a general way.

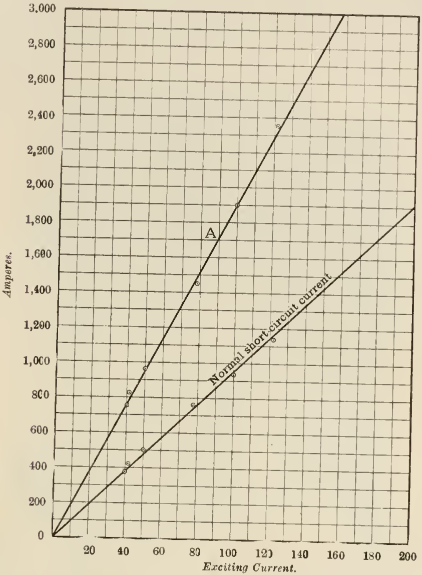

FIG. 3.—MAXIMUM INDICATION OF THE HOT-WIRE AMMETER (WHICH IS PROVIDED WITH A SHUNT) IN ARMATURE CIRCUIT AT TIME OF SUDDEN SHORT-CIRCUIT (CURVE A).

It seems therefore advisable to protect a generator against the effects of a sudden short-circuit. Mr. Hobart has proposed to put a quick-acting maximum cut-out into the field circuit. This cut-out could be conveniently arranged so that a resistance is inserted into the field circuit as soon as the field current increases by more than 30 to 50 per cent.

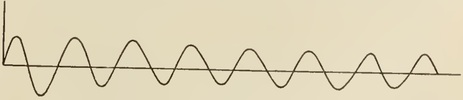

FIG. 4.—CURRENT OBSERVED IN ONE OF THE PHASES OF THE ARMATURE AFTER A SUDDEN SHORT CIRCUIT, THE EXCITING CURRENT BEING 60 AMPERES.

Note.—The ordinates of this curve could not be determined with great accuracy, but the final value of the short-circuit current was observed to be between 2·5 and 2·8 times smaller than the initial value.

It would also be advisable to clamp the spool head firmly together in order to prevent a displacement. If micanite ducts are used great care should be devoted to the place where the ducts leave the iron, as it is here that the greatest danger is experienced as regards damage to the insulation.

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* The self-induction of the armature and of the leakage flux between adjacent poles was calculated after the method shown in a Paper read before the American Institute of Electrical Engineers in 1904 on "The Theory of the Regulation of Alternators," by H. M. Hobart and F. Punga.

SOME NOTES ON THE MECHANICAL DESIGN OF ELECTRICAL GENERATORS.*

BY R. LIVINGSTONE.

(Continued from page 689.)

Pedestals.—Although the load on a pedestal is normally in a vertical direction, the pedestal should be designed for the maximum load on the bearing in *any* direction. Unbalanced magnetic pull may act in any direction, and centrifugal forces, due to the "out of balance" of the rotor, act in every direction in the plane of rotation.

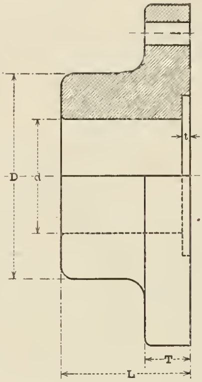

Fig. 10.

Small machines up to about 250 H.P. are often belt driven, and it is essential that the pedestals for such be designed for the maximum load which the bearing will stand in any direction. The greatest load on such bearings is the belt pull, and this belt pull may act in *any* direction, depending on the position of the belt drive. Even upward belt pulls on motor bearings are not uncommon.

Couplings (Fig. 10).—As the coupling is a portion of the shaft and the shaft is designed for stiffness, it follows that the coupling should be designed for bending, and made as strong as the shaft. Assuming that the coupling is made of cast iron one-fifth of the strength of the steel shaft, then

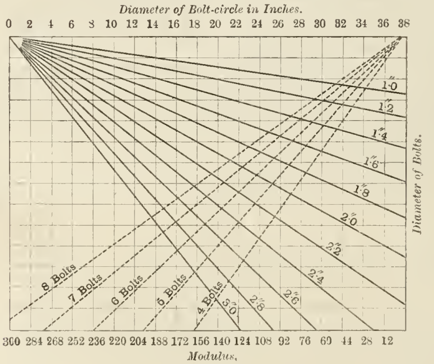

Fig. 11.

$$5d^3 = \frac{D^4 - d^4}{D}.$$

Now let $D = cd$, then $5d^3 = \frac{c^4d^4 - d^4}{ca}$ $\therefore c^4 - 5c + 1 = 2$,

From which $c = 1{\cdot}77$ . . . . (12)

To allow for the weakening of the section by the $\frac{1}{4}$ in. should be added to the dimension obtained with $c = 1{\cdot}77$.

$\therefore D = 1{\cdot}77d + \frac{1}{4}$ in.
L may be made $1\frac{1}{8}d$,
T ,, ,, $0{\cdot}35d + t$,
t ,, ,, $0{\cdot}03d + \frac{1}{8}$ in.,
when T becomes $0{\cdot}38d + \frac{1}{8}$ in.

The above dimensions are also suitable when the coupling is formed by an extension of the hub of the rotor spider. This certainly forms a very rigid attachment to the rotor as the number of joints between the engine flywheel and generator rotor is reduced. The coupling bolts should also have the same strength as the shaft, and so the modulus of the bolts should equal $\pi/32d^3$.

The curve shown in Fig. 11 gives the bolt modulus fairly accurately. For example: Required the bending modulus of six bolts, 2·1 in. diameter, on a bolt circle 22 in. diameter. From where the diagonal line corresponding to diameter of bolt cuts the vertical line corresponding to the diameter of bolt circle, move along the horizontal line until you meet the other diagonal corresponding to the number of bolts; from there drop in a vertical direction to the bottom scale, where the desired modulus will be found—namely, 114·5 (say, 114). Quite recently some makers have gone so far in large generators, as to bolt the engine flywheel directly to the spokes of the armature spider, or even to the rim of the spider, as shown in Fig. 12. This design should not be used unless the shaft is made continuous right from the engine bearing to the outboard generator bearing. If the shaft is not continuous, as in the ordinary direct-connected set, extremely large bending moments are set up in the spider arms, due to the weight of rotor and flywheel, and the design of the spider would have to be very special indeed to withstand them. It almost seems unnecessary to lay such stress upon this point, yet the writer *has* seen a design similar to that shown in Fig. 12, where the spider arms did not seem to be materially stiffened. It was one of the "barbarous" designs one meets with occasionally in the mechanical construction of electrical generators.

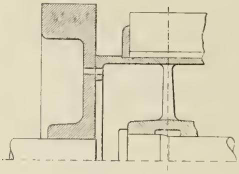

Fig. 12.

(To be concluded.)

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* Based on a Paper read before the Dick Kerr Engineering Society.

MR. WAUGH'S REPORT ON TRAMCAR BRAKES AT HALIFAX.

The following report by Mr. John Waugh to the Town Clerk of Halifax, dated July 24th, gives the results of tests carried out upon car No. 94, which is the one that overturned in the recent disaster. The car was fitted with three brakes, namely, a hand brake, a slipper brake acting upon the rails, and an electrical brake, the latter being of the type in which the motors are converted into generators more or less short-circuited. In the following tests, which were carried out on the car in the same condition as when found after the accident, the electric brake alone was used, the object being to determine what it was capable of doing without the assistance of the hand brake, or the slipper brake.

On the 22nd inst. I made a test of the electrical car No. 94.

Test No. 1.—Gradient, 1 in 11; speed, 16 miles per hour. From the application of the brake the car was brought to a stand in 4 seconds and in a distance of 16 yds.

Test No. 2.—Gradient, 1 in 11; speed, 21 miles per hour. From the application of the brake the car was brought to a stand in 10 seconds and a distance of 57 yds. 2 ft.

Test No. 3.—Gradient, 1 in 11; speed, 22 miles per hour. From the application of the brake the car was brought to a stand in 9 seconds and a distance of 57 yds. 2 ft.

Test No. 4.—A reversal of the current. Gradient, 1 in 11; speed, 21 miles per hour. Car brought to a stand from the application of the brake in 10 seconds and a distance of 58 yds. 2 ft.

Test No. 5.—Electrical brake. Gradient, 1 in 22; speed, 24 miles per hour. Car brought to a stand from the application of the brake in 16 seconds and a distance of 120 yds.

Test No. 6.—Gradient, 1 in 22; speed, 28 miles per hour. Car brought to a stand from the application of the brake in 13 seconds and a distance of 120 yds.

On arriving opposite the infirmary, on a grade of 1 in 16, the slipper brake was applied at both ends of the car and the current was switched on. The wheels began to spin round, yet the car did not move, and there was no appreciable lift on the car wheels, which proves that it is practically impossible to lift the car by means of the slipper brake, as has been stated.

The above tests show conclusively the potentiality of the electrical brake, and that the car is equipped with the means of bringing it to a stand even when a high speed has been attained, without the aid of the other brakes. In emergencies the slipper brake can always be used in conjunction with the electrical. The two essential conditions of success, under such circumstances, are: First, the wheels of the car must not be locked by the use of the hand or wheel brake; and, second, a supply of sand must be available.

THE ELECTRICAL DISCHARGE IN AIR AND ITS COMMERCIAL APPLICATION.*

BY WILLIAM CRAMP AND SIDNEY LEETHAM.

It was in 1903 that Mr. Sidney Leetham discovered, after experimenting with the bleaching of flour by means of ozone, that a much more powerful bleaching agent than ozone was produced if air that had been ozonised were passed through boxes in which electrical discharges between spark points were taking place. It was evident from the smell of the gas that the new product was different to the old, and some time was spent in noticing and attempting to ascertain clearly what this new product was. Dr. H. E. Armstrong made an analysis and about that time wrote: "I am much struck with the nature of the results obtained—viz., the rapidity and certainty with which the effect is produced and the improved bleach as compared with that produced by oxides of nitrogen. I believe . . . . that it is a joint effect of ozone and oxides of nitrogen, which I find are both present, though the total amount is not more than 2 parts in 10,000. I am satisfied that by this mixture an effect is produced which is so far better than anything that can be attained by either of the constituents as to be accounted a *new technical effect.*"

From that date to this the authors have been engaged in developing and perfecting a form of apparatus for the production of this gas, and incidentally have touched upon points about the electrical discharge which have not hitherto received attention. For convenience the account of this work is subdivided into four sections—namely: Sec. I., the construction and application of the apparatus; sec. II., the electrical phenomena; sec. III., the electrochemical phenomena; sec. IV., the chemical phenomena.

SECTION I.

The apparatus as at present used is illustrated in Fig. 1, and consists of a steel plate case, in which is fixed an alternator, transformer, switchboard, ozoniser and sparking device; the whole being compact, self-contained and enclosed, occupies very small space and incurs no extra insurance risk. Besides the apparatus already mentioned, a small Roots' blower is used for supplying air to be ozonised, and a small filter for cleaning this air. The action of the apparatus is as follows:—

Pure air cleared from dust particles by passage through the filter is supplied by the blower to the ozoniser (situated behind the switchboard), where it becomes ozonised, and also to some extent sterilised. The ozonised air then passes on to the spark box—seen across the middle of the switchboard—where a very small proportion of oxides of nitrogen appears to be produced by the sparks between the points in the box. From the spark box the air passes through a valve flange (seen at the left-hand end of the case) straight to the reels through which the product to be bleached is passing. The actual electric circuits are as shown in the diagram of connections (Fig. 2); where the high-tension and low-tension coils of the transformer are denoted by HT and LT respectively; O is the ozoniser of the Andreoli pattern; SB is the spark box, in which are a number of spark gaps in series; AA is the alternator armature and EA is the exciter armature; F_1 and F_2 are the field coils and R_1 and R_2 the regulating rheostats. It will be noticed that the ozoniser and spark box are in series, and this is a great advantage in rendering the apparatus automatic to a certain extent. For every increase of current affects both ozoniser and sparks, so that within certain limits the proportions of the gas remain constant: though, of course, the yield becomes greater, as more fully discussed later.

It may be stated here that with the normal amount of air used, which is approximately 100 cubic feet per minute, the resulting gas, which issues from a point some 3 ft. beyond the end of the delivery flange of the iron case, is made up about as follows: Air, 40,000 parts by volume; ozone, three parts by volume; oxides of nitrogen, one part by volume (when four sparks are used, each $\frac{1}{16}$in. long, and the LT current is 8 amperes).

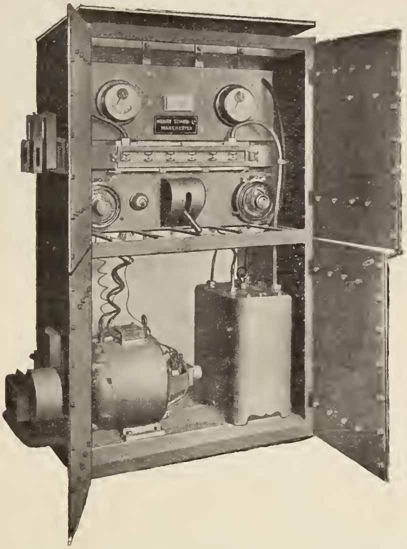

FIG. 1.—COMMERCIAL FORM OF THE ELECTRICAL APPARATUS.

This result is the average of a large number of analyses made by Mr. F. S. Sinnatt, of the Manchester School of Technology, and will be seen to agree fairly well with Dr. Armstrong's rough estimate. It will, however, be clearly understood that variations in the above result are immediately introduced by change in any of the following factors:—

1. Frequency.
2. Air stream.
3. Distance apart of spark points and number of these.
4. Shape of points.
5. Temperature.
6. Current.

Of these the two last influence the chemical phenomena chiefly. From a scientific point of view the interest lies in the question of how these various items affect not only the gas produced but also the type of discharge which produces it. We shall take the latter point first.

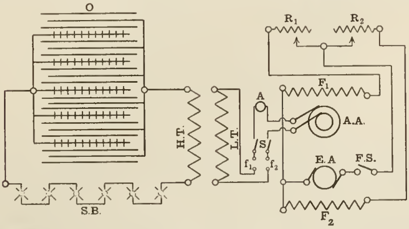

FIG. 2.—DIAGRAM OF CONNECTIONS OF THE APPARATUS SHOWN IN FIG. 1.

SECTION II.

Hitherto all types of alternating electrical discharges have been divided into three great classes: (1) the ordinary alternating-current arc, (2) the high-tension discharge between spark points, (3) the silent discharge. These three have usually been considered as separate and distinct phenomena, but they have never been individually defined. In reality they are not separate, but all stages of the same phenomenon—namely, the breakdown of air as an insulator when strained electrically. Roughly, the three types have been usually classified by the effect which they produce. In this way the arc has been recognised as that type of discharge which gives great heat and light. The sparking discharge has been recognised as that which is much less hot, though still luminous, and is known to produce Hertz vibrations. The silent discharge is usually referred to as that which produces ozone.

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* Paper read before the British Association (Section B) at York on Thursday, August 2nd. Amended and revised by the Authors.

Now, if a pair of metal points be insulated and separated in air by a small distance, and an electric P.D. be applied across the gap, we have the following series of events as the pressure is increased:—

(*a*) The air is put into a state of stress.

(*b*) Small conducting paths appear through the air as the resistance gives way, giving rise to small blue streamers issuing from the points.

(*c*) The blue streamers get thicker, eventually joining the points up.

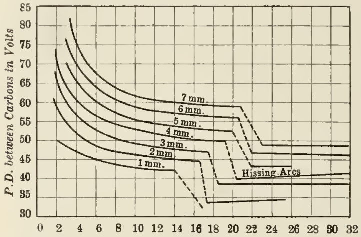

Fig. 3.—P.D. and Current for Different Lengths of Arc (Mrs. Ayrton). Positive, 11 mm.; Negative, 9 mm.

(*d*) The thicker streamers become a discharge very like the ordinary arc At the final stage the points heat up, and the current passing may be gradually increased till the discharge is practically the alternating-current arc.

Throughout the changes given above the relation between current and P.D. across the gap is very remarkable. It has been known for a long time that an arc, either direct or alternating current, cannot be maintained on a constant potential circuit unless a steadying resistance or its equivalent is kept in series with it. This has given rise to discussion as to whether a back E.M.F. is present in the arc or not, though it is generally held now that change of air resistance alone is sufficient to account for the peculiarities observed. Whether a back E.M.F. exists or not hardly comes into the province of this Paper; but it is perfectly certain that the *apparent* resistance of the arc changes as the current through it changes. In the case of ordinary arc lights the results immediately met with are generally very like those in Fig. 3, which represents the relationship between P.D. and current in the direct-current arc, as given by Mrs. Ayrton in her book "The Electric Arc," and reproduced here by special permission. Now, the very same sort of relationship is found to exist with both the other forms of discharge. It will be recognised that the cycle of changes given in *a*, *b*, *c*, *d* above includes not only the spark discharge but also the so-called silent discharge. In Figs. 4 and 5 are shown curves connecting the P.D. and current for cases which include both the silent and the spark discharge. It will be seen that just as in the case of the arc the fall of potential is very rapid as the current increases, but finally settles down until it almost becomes proportional to the current.* The diagrams not only show the agreement between the shape of the curves of Figs. 4 and 5 and that given in Fig. 3, which is very important, but also emphasises the fact that it is very difficult to draw any hard-and-fast lines between the different types of the discharge. It should be explained that as it was desired to act upon air with the various forms of discharge a current of air had to be kept passing through the apparatus. This is why most of the curves above are taken with a certain air velocity, which is given in terms of the blower speed. Thus in Fig. 5, the numbers 420 and 250 refer to the speed of a $2\frac{1}{2}$ in. Roots' blower, and correspond to an air stream through the spark box of about 3,200 ft. and 1,900 ft. per minute respectively. The effect of this air velocity is (as shown) to increase the P.D. with a given current; but this will be discussed more fully directly. The earlier portion of the curves—that is, those parts in which the P.D. is high—usually refer to that discharge which produces chiefly ozone. Directly the curve has turned round, so that there is no longer a large fall in P.D. for a given current, very little ozone is produced.

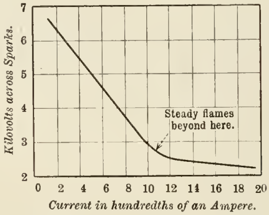

Fig. 4.—Sparks Only: Three in Series $\frac{1}{16}$ in.

It is clearly seen from the curves: (1) That the P.D. across the spark-gap gradually decreases as the current increases, showing clearly that the resistance of all electric discharges varies in a similar manner to that well known to exist in the case of the ordinary arc. (2) That the character of the product of the discharge depends upon the voltage at the terminals for a given current; thus with the conditions shown in Fig. 4 practically no yield of oxides of nitrogen occurs until a point is reached marked with an arrow on the diagram. To the right of this arrow the discharge would be a small but rather hot arc, were it not for the presence of the air stream which blows the discharge into a short flame. In other words, up to this point the discharge is to be considered practically as a silent discharge, afterwards as the so-called sparking discharge. The change, however, from one form to another takes place fairly gradually. (3) Any character of discharge may be obtained by simply regulating the fall of potential at the discharge points or terminals, so as to fulfil the following requirements: Since the resistance (or impedance) of the air gap across which the spark passes appears to depend not only upon its length but also on the current passing (being lower with a larger current), it follows that if there were a constant pressure on the arc, having once started the discharge, the current would rise till the product $C \times R = E$, where R is the resistance or impedance of the arc, E the applied P.D. and C the current. If R tends to decrease faster than C rises, the conditions are quite unstable and result in a long series of flashes across the points, which were observed often in the case of these experiments. These flashes are produced by a large rush of current which is only limited by the armature reaction of the generator. In consequence of this, beyond a certain point the E.M.F. and P.D. of the latter fall, so that the current almost instantly falls to zero. As soon as this has happened the E.M.F. rises again, the spark is re-established, another rush of current takes place with a similar result. Often this would take place as frequently as 60 times a minute. To steady the discharge then it is only necessary to arrange the circuit so that an increase of

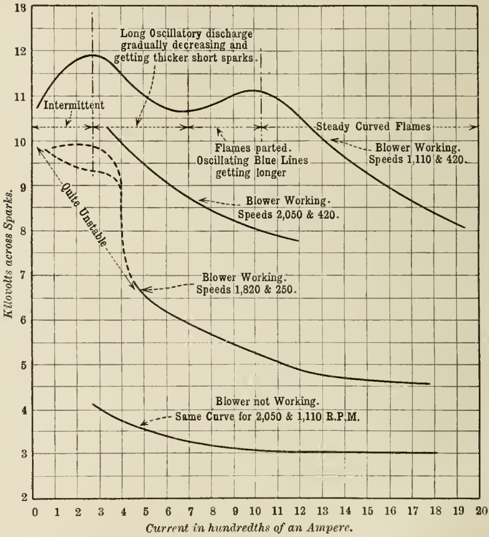

Fig. 5.—Five Sparks, each of $\frac{1}{16}$ in. Gap.

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* In all the curves connecting P.D. and current, where the P.D. is in kilovolts the current is in hundredths of an ampere.

current shall produce at the spark terminals a fall of P.D. sufficiently great, and in this way, by proper adjustment of the circuit, a perfectly steady result will be obtained. The only other conditions necessary for producing and maintaining the discharge are (1) that the maximum P.D. of the E.M.F. wave shall be capable of crossing the spark gap, (2) that the current ensuing shall be great enough to so lower the resistance of the gap that the vapour column set up shall not entirely die away before the zero point is crossed and the current re-established. The adjustment of the circuit just shown to be necessary may be carried out in many ways. In the authors' apparatus it is obtained by the use of a heavy synchronous armature impedance, but it may be almost as well obtained by resistance or choking coils. The higher up the scale the discharge the greater must be the resistance employed; thus, if a silent discharge is required, the resistance drop will need to be from one-third to one-half of the terminal voltage. An instance of such an ozoniser is the well-known Schneller ozoniser shown in Fig. 6, where the potential drop is obtained by means of a tube of glycerine, through which the current passes to those plates, between which the silent discharge takes place. If the ordinary constant potential arc is required, an impedance drop of about one-quarter the terminal voltage is used, while the characteristic of the alternator used by the authors for their purpose is as shown in Fig. 7. The amount of steadying resistance for any type of discharge is affected by:—

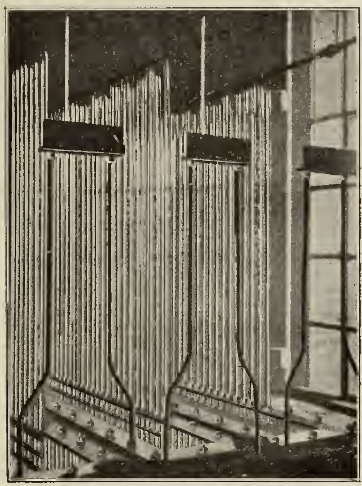

FIG. 6.—SCHNELLER OZONISER.

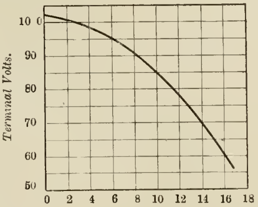

FIG. 7.—ALTERNATOR CHARACTERISTIC.

1. *The Frequency Employed.*—The higher the frequency the less likely is the discharge to be interrupted, and hence the lower is the pressure for a given current. This is well shown in Fig. 5. It is, however, curious that in some cases for very small currents the pressure required is actually raised by raising the frequency. In the apparatus as used by the authors, where the ozoniser and spark box are in series, though, as is shown later, the yield of ozone per ampere may be increased by raising the frequency, yet because the spark seems to have some difficulty in starting, and because the instability of the circuit does not seem to be reduced by higher frequencies, a practical limit is reached at about 150 to 200 periods per second.

2. *Air Velocity.*—The general effect of increased air velocity is to increase the apparent length, and hence, also, the apparent resistance of the spark, and with high air velocities the spark becomes blown out or extended into a flame. The general effects of the air velocity are shown in Fig. 5, and again in Fig. 8. In these diagrams the meaning of the figures 420, 250, 240 has already been referred to. Fig. 5, however, has a second set of figures upon it—viz., 1,110, 2,050, and 1,820. These refer to the alternator speeds, and correspond to frequencies of 148, 273 and 243 respectively. In this way, while Fig. 8 shows the effect of change of air velocity only, Fig. 5 combines with this the effect of change of frequency. The obvious deductions from these curves are that higher frequencies conduce to lower the pressure for a given current, and higher air velocities conduce to higher pressure for the same current. It may be observed that, besides these obvious results, it is also found that a high air velocity sets up very serious oscillations in the circuit, which have many times been responsible for breaking down the high-tension transformers used in these experiments. One would almost expect this result from the fact that the higher the air velocity the more likely is the spark to be very unsteady and very often extinguished. These oscillations show themselves in the curves in giving rise to the unstable portion and causing it to exist at higher currents; and, finally, on account of their disastrous effects it was found necessary to limit the air velocity in the apparatus as at present used to a maximum of 2,500 ft. per minute, with the distance between spark points, say, $\frac{1}{16}$ in.

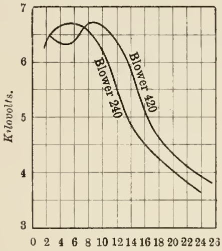

FIG. 8.

3. *Distance Apart of Spark Points.*—Many tests were taken with different spark lengths, as, for instance, five sparks $\frac{1}{16}$ in. long in series were compared with four sparks of $\frac{1}{8}$ in. long and one of $\frac{1}{16}$ in. In the latter case the oscillations in the circuit are found to be greater than with the former, and this general result is true whenever the length of spark is increased. Again, the P.D. with the long spark gaps is always greater than in the case of the shorter but this effect is not proportional to the number of sparks in series in the apparatus, nor so marked as the increase in oscillations, especially with low currents. So important is the latter that in certain instances it is not possible to measure the voltage across the sparks at all.

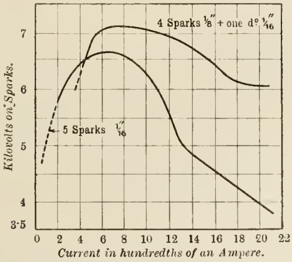

FIG. 9.—EFFECT OF SPARK LENGTH (BLOWER, 240 REVS.)

It might be expected that the voltage would be almost proportional to the number of sparks in series but this is not found to be the case at all. On the contrary, Fig. 10 shows that the voltage required for three sparks (each $\frac{1}{16}$ in. long) in series, is quite different to that required for one spark $\frac{3}{16}$ in. long; further, Fig. 9 shows that four sparks, $\frac{1}{8}$ in. long in series, and one of $\frac{1}{16}$ in. long, do not take, with small currents, anything like twice the voltage of five sparks $\frac{1}{16}$ in. long, as might have been expected. From a great number of experiments the phenomena above detailed seem to be largely explained by the following considerations:—

1. If the spark is a long one the air velocity has more effect upon the discharge, since the points protect it less.

2. Any capacity effect due to the points themselves is more marked when the points are close together.

3. If a vapour column is set up, the longer it is the more easily is it cooled.

These three causes, even taken with others referred to above, do not explain all the effects observed. We must assign to other causes the small increase of pressure for increase of spark length, for instance; also the comparative ease with which the discharges start if no air stream is present (see Fig. 5). The tests given in section 3 upon the question of ionisation will perhaps afford a clue to these points. In the meantime we may mention that the surface leakage over the insulating porcelain has many times been responsible for starting one spark of a series before the others begin, so that it is usually found that four sparks $\frac{1}{16}$ in. in series will start at a much lower voltage than one spark $\frac{1}{4}$ in. long. But this fact alone will not explain the phenomenon that to restart the discharge after it has been running for some time requires a much lower pressure than to start the discharge at first; which must also be referred to the state of so-called ionisation in which the gas exists.

Effect of Shape of Points.—The shape of the point changes very considerably the apparent resistance of the discharge, and also, in consequence, the type of discharge produced.

It is well known, in connection with high-tension discharges, that the sharper the points between which the current passes the lower is the pressure at which the discharge will commence. As an example of this we can give some results obtained at the Manchester School of Technology by Mr. Bertram Scott. In these tests three types of electrodes were used, viz.:—

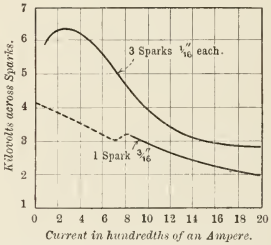

Fig. 10.—Effect of Spark Length: Blower Running at 265 revs. per min.

1. Flat electrodes with rounded edges (in pairs).
2. Flat electrodes with sharp edges and spherical electrodes (one of each).
3. Sharp or pointed electrodes (in pairs).

The results, so far as they influence the pressures used in this apparatus, are as follows:—

1. Flat electrodes with rounded edges.

Kilovolts.	Sparking distance in cm.
18	1·8
29·5	3·9
40	6

2. Flat electrodes with sharp edges and spherical electrodes.

Kilovolts.	Sparking distance in cm.
15	2
24	4
29	5
38	7
46	9

3. Sharp electrodes.

With these it was found that the effect of the sharpness was more marked the less the angle at the apex. The most marked results were obtained with needle points, and it will be noticed that, with such shaped points, the voltage required for a sparking distance of 2 cm. is about half that given in the first case. The figures are as follows:—

Kilovolts.	Distance in cm.
9	2·0
20	4·0
28	6·8
36	9·0
45	10 9

All the above results, of course, would change slightly with change of wave-form; in these cases an alternator was employed whose wave had a form factor of 1·54, so that the shape was approximately sinusoidal. Fig. 10A illustrates these readings graphically.

The voltages given are not applicable to the actual apparatus under consideration, since no air current was present except that which would be produced by the actual heat of the discharge; and, since the results were taken when the points were vertical, this would have very little effect. When, however, an air current plays on the discharge, a result similar to the above is always experienced, but the voltage for a given sparking discharge is higher, the actual increase of voltage being of the order of that shown in Fig. 5. It was, therefore, most advantageous for this particular plant, where low voltage is desirable, that the shape of the points should be as sharp as possible. The final shape has been determined by the question of the life of the spark points—that is, they are so proportioned that they will dissipate the heat generated between them fast enough to necessitate no adjustment of the points, at any rate more often than once a month. The point used now is made from a screw $\frac{1}{2}$ in. in diameter, with an apex angle of 90 deg., very slightly rounded at the extreme point. It is found that up to 0·2 ampere, with the normal air velocity as already given, six pairs of these points in a spark box do not materially change when at work night and day for a period of three weeks.

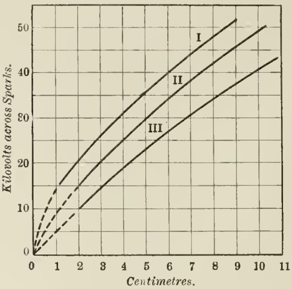

Fig. 10A.—Sparking Distance in Air.

The foregoing discussion has been confined chiefly to those portions of the curves where the discharge produced is of the type known as "sparking." It is necessary now to refer to the upper parts, where, as has been already said, ozone is produced. The figures show quite clearly that in these steep parts the discharge is very unstable, and in consequence a large steadying resistance is necessary, for the current is, in any case, extremely small. This large steadying resistance (or impedance) in commercial ozonisers takes the form of either:—

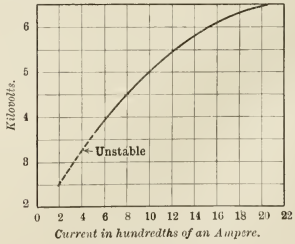

Fig. 11.—Speed 1,200.

1. A dielectric between the points.
2. Very high resistances in series with the points, such as the glycerine tubes of Schneller.
3. A capacity in series with the points.

Examples of No. 1 are the ozonisers of Siemens, Andreoli, Elworthy, &c., which usually consist of two conductors, either plain or carrying points separated by mica or glass. In cases like this the fall of potential, which has been shown is necessary to maintain this silent discharge, takes place across the dielectric itself.

Where the points are placed upon sheets, and separated by sheets of mica (Andreoli), the ozoniser may have a large capacity, and in this case the effect of the breakdown of the resistance is very clearly marked. By the laws of condensers, if the ozoniser works as a capacity alone, the current would be proportional to the terminal

P.D.; and in this case, therefore, the "curve" connecting voltage and current would be a straight line. If, then, such a curve be drawn for an ozoniser, and it is found to depart from the straight line, we should expect to find the yield of ozone increase as the curve turns over. This effect is clearly shown in Fig. 11, and it was always found that the yield of ozone increased as the curve departed from the straight line, until the vigour of the discharge caused the temperature to rise to such an extent as to partially destroy the ozone produced.

Ozonisers of the second type are not as a rule so efficient as the former. They are, however, easy to construct, and, as a rule, less bulky. An ozoniser of this type was constructed by Mr. Cramp, which consisted of a number of serrated strips of aluminium, placed with their serrated edges about $\frac{1}{2}$ in. apart. It was found that the minimum air gap between these edges, at which a steady silent discharge, producing large quantities of ozone, could be obtained, was about $\frac{7}{16}$ in.; and in the experiment in question $\frac{9}{16}$ in. actually gave about the best result.

In order to steady the discharge a glycerine resistance had to be included in the circuit, of such dimensions that the drop across the resistance was practically equal to the drop across the air gap. By gradually lowering this resistance the discharge could be changed from the silent distributed discharge to the located spark. A large fall of potential was always observed as the discharge changed from one form to the other.

Ozonisers of the third form are not made commercially, and the reason is probably that with any tendency of the air gap to break down, the condenser immediately discharges through the circuit, assisting the breakdown; hence the type cannot be recommended, but it has been found possible to use, in series with the gaps described above, a small condenser which, by the fall of potential which it produced across the gaps, is enabled to a certain extent to steady the silent discharge. Of course, the capacity of the condenser must be of such a value that it cannot (by causing a leading current) raise to any extent the alternator voltage by means of armature reaction.

SUMMARY.

Summarising now the general results of this investigation we have:—

(*a*) All the types of electrical discharge in air behave similarly, and may be steadied by similar means.

(*b*) Between a pair of spark points in air any type of discharge may be obtained by suitable regulation—from the silent-type producing ozone down to the alternating-current arc.

(*c*) Increasing the number of air gaps in series raises the voltage, but not proportionally to the number of gaps.

(*d*) An air current, impinging on the electric discharge, increases the mean length of path of the discharge; with large currents, blows it into a flame, renders the spark unable to pass without increased pressure and always sets up oscillations in the circuit.

(*e*) The effect of increasing the frequency is to lower the voltage required to maintain the spark, but this does not necessarily hold at starting.

SECTION III.—ELECTRO-CHEMICAL EXPERIMENTS.

So many of the results obtained, both electrically and chemically, seemed inexplicable on ordinary grounds, that it was thought advisable to try the gases produced by the electrical discharge for *ionisation*.* Accordingly a series of curves were taken, which show the time required to discharge a good electroscope:—

(*a*) By allowing the stream of air alone to impinge on the knob of the electroscope.

(*b*) By substituting for this a stream of air which had passed through the ozoniser.

(*c*) By substituting a stream of air which had been modified by passing through the spark box.

(*d*) By combining *b* and *c*.

The results are very clearly shown in Fig. 12. They indicate that the air, after having passed through the chambers in which electrification was proceeding, is always in a state of ionisation. This result is much more marked in the case of air issuing from the spark-box than in the case of air which has simply passed through the ozoniser. It is to be considered in connection with the chemical phenomena, but may also be discussed here with reference to the electrical effects.

Suggested Further Theoretical Explanation of Results Obtained.—It seemed almost impossible to imagine that these discharges, which require so small a current, could, by any possibility, produce enough heat to set up a vapour column sufficient to maintain a conducting path for the electric current; but, on the other hand, in the absence of the vapour-column theory, there seemed to be no reason why, first, the discharge should be more difficult to start when the air current was flowing, and, secondly, why it should be so much more difficult to maintain with an air current. Admit, however, that ionisation is established and we immediately have an explanation for all the phenomena.

Thus, under electrical stress, the air is ionised between the points, and begins to tend to conduct. Small currents make their appearance as blue lines, but whether these blue lines are actually heated particles or not cannot be determined. Further increase of the current results in further ionisation, with a better conducting path; but this conducting path is, under any circumstances, easily removed if a current of air is maintained past and around the points. Thus, the discharge would be more difficult to start and more difficult to maintain. Going still a step further we get towards the ordinary arc, and find that a vapour column is set up, which, of course, continues to behave very much as the ionised air column already suggested.

This is, in brief, the theory put forward by the authors to explain the facts already related, and it accords well with previous knowledge of the same subject. Of course, "ionisation" would be immediately admitted by many as sufficient explanation for the whole of the phenomena, and we wish to insist upon the point that without some such theory some of the above facts are inexplicable, especially the point that the discharge starts more easily after it has been at work some time and then extinguished than it does when first set to work. This characteristic is very marked with low air velocities and when the time between stopping and restarting is short. The same may be noticed with a high-tension electrostatic voltmeter. If it flashes over once, the case must be opened and fresh air introduced, or it will go over again at a comparatively low pressure. We think also that this phenomenon will almost certainly account for the extraordinary differences in so-called "sparking-lengths," which have been so often observed and commented upon. Such differences have often been put down to damp and dust, but the authors' experience is that these factors will not altogether account for them. More especially the chemical results, the union of oxygen and nitrogen particularly, seem impossible without reference to some such theory, as will be seen presently.

SECTION IV.—CHEMICAL PHENOMENA.

It has hitherto been usual to speak of the silent discharge as though it were a perfectly well-known effect, producing a chemical result, well defined. The following experiments will dispel this idea: If an Andreoli ozoniser, such as that whose characteristic is shown in Fig. 11, be connected to alternate-current mains, and the pressure be gradually increased, it is found that a violet glow is set up between grids and mica which produces an excellent yield of ozone; increase of pressure increases the yield of ozone up to a certain point, beyond which the discharge becomes gradually more yellow, and finally quite a large percentage of oxides of nitrogen is produced, the yield of ozone being diminished. Whether ozone is really formed and afterwards destroyed, or actually never formed, is uncertain. Further increase of current still further increases the yield of oxides of nitrogen, though usually by this time long leakage discharges appear over the dielectric.

The effects are still more marked if an ozoniser without a dielectric other than air be used, as then the discharge can be gradually increased till practically no ozone is produced; thus the silent discharge becomes the sparking discharge, yielding chiefly N_2O_4; and however much the current be increased after this, even to the flaming arc, the gas produced is still N_2O_4. We have found no type of discharge, however silent, which yields no oxides of nitrogen.

We can offer no explanation whatever for the production of ozone by the initial types of discharge. But there are some suggestions we can make as to the formation of oxides of nitrogen. It has been generally assumed that oxides of nitrogen are formed electrically by nitrogen burning in the air, the heat necessary being supplied by the flame of the arc or spark, as pointed out in 1898 by Crookes. Now the temperature of burning nitrogen is supposed to be about 2,000°C.; and though it is impossible to see if this temperature ever exists in the sparking discharge, it seemed almost incredible that such could be the case. In order to try and settle this point, recourse was had to the following rough tests:—

Temperature Effect.—A spark box with five pairs of points $\frac{1}{16}$ in. apart was placed in circuit and the current adjusted to 0·1 ampere. Tests were then made while the spark box was cold (20°C.) and again when heated to about 120°C., but no definite increase in the percentage of oxides of nitrogen was observed. It would therefore seem that the yield is not altogether a matter of temperature. With four $\frac{1}{16}$ in. sparks in series, an air velocity of 2,000 ft. per minute, and a current of 0·06 ampere, the yield of oxides of nitrogen was 1 part in 40,000, as tested by Mr. Sinnatt many times.

Again, it is always found that when air with a small percentage of ozone is passed through the spark box the chief production of oxides of nitrogen does not take place in the spark-box, but a little further on, in our case after the gas has passed through about 3 ft. of pipe; pipe, too, which is perfectly cool. Or again, if in such a case the small sparks be replaced by white-hot Nernst filaments, no oxides of nitrogen are formed at all. And if further confirmation of the formation being independent of the temperature be needed, we can say that if pure oxygen mixed with 2 per cent. of nitrogen be sent through a water-cooled Berthelot ozoniser, peroxide of nitrogen is still found to be present.

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* The term "ionisation," as used throughout, indicates simply capability of discharging an electroscope.

Current.—On the other hand, it is always found that the yield of oxides of nitrogen does not increase proportionately to the current, but more slowly. Indeed, in the spark box above referred to there is scarcely any change in the yield of oxides of nitrogen between 15 and 25 amperes, which is very remarkable, inasmuch as not only is the current so much greater, but the temperature is also so much higher. On the other hand, between 5 and 10 amperes, the yield is very much increased.

The reasons for these effects the authors consider to be as follows :—

The best yields per ampere are always found to exist when very thin arcs are used, and this is confirmed by Bradley and Lovejoy, in America. That means, the air used must have easy access to the sparks if a large yield of oxides of nitrogen is desired ; this condition accounts for the amount produced not being proportional to the current.

Now in Fig. 12 it has been shown that the air modified by a sparking discharge is more highly ionised than that obtained by a silent discharge. Hence we suggest that ionisation of the air allows of the combination of oxygen and nitrogen at fairly low temperatures to produce oxides of nitrogen, but it is very necessary that the air should be in intimate connection with the discharge to become thoroughly ionised.

This theory would seem to be well supported by the fact that replacing the sparks by apparatus which must surely be hotter—such, for instance, as a Nernst filament or a white-hot electric radiator—has no effect at all.

With regard to the effects produced on the gas by electrical variations in the circuit, it may be said that a great number of experiments have been carried out, but only the general results can be given here. These are :—

Increase of frequency increases the yield of ozone, as shown by Prépognot (Fig. 14), and lowers the pressure for a given current through the spark box.

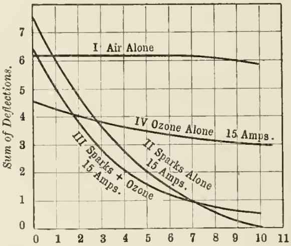

Fig. 12.—Ionisation Experiments.

Increase of air velocity does not seem to lower the yield, but only the concentration.

Any increase in spark length increases the yield of oxides of nitrogen.

So much for the independent effects of different types of discharge. We come now to the most important part of the Paper—viz., the discovery that, though the gas produced by the sparks (N_2O_4) is valuable as a bleaching and sterilising agent, and the gas produced by the ozoniser (ozone) is valuable in the same way, a combination of the two is far more valuable than either.

Reference to the first part of this Paper will show the arrangement of the apparatus by which the Leetham gas is produced. It is obtained by passing air modified by an ozoniser through a box in which a sparking discharge is produced. An analysis of the gas produced has already been given, and it only remains to discuss its peculiar characteristics.

It has been pointed out as a curious fact that the chief modifications produced by the spark box are not discernible at the end of the spark box itself, but at a point in the pipe situated about 3 ft. therefrom. This supports the theory already given for the production of N_2O_4. Beyond this 3 ft. or 4 ft. the gas analyses show no change, and it is an undoubted fact that, even after the gas has passed through many feet of pipe, ozone and oxides of nitrogen are still traceable. We regard this as very important, for eminent chemists (Sir James Dewar and others) have stated again and again that such a state of things is impossible—*i.e.*, that oxides of nitrogen and ozone cannot exist side by side. This simultaneous existence of two gases well known to be mutually destructive is probably the key to the whole extraordinary activity of the compound. As an instance of the great effect the gas has, it may be said that modified air, having a composition as shown in sec. I., will, if supplied at the rate of about 100 cubic ft. per minute, bleach to a beautiful white colour as much as 3 tons of flour an hour ; a wonderful effect when the proportions of bleaching agents present are considered.

In order to try and discover the means whereby this electrical product yields such astonishing effects, very many experiments have been carried out both by the authors and Mr. J. S. Peachey, of the Manchester School of Technology. It is of interest to inquire, firstly, whether the bleaching action is due to oxidation. In order to test this, ozone, most carefully freed from oxides of nitrogen by thorough washing with pure concentrated sulphuric acid, was allowed to come into contact with flour. *Result : the flour was bleached.* An exactly similar effect was produced if the colouring matter of the flour was separated from the other constituents and treated with pure ozone. Therefore the action may be ascribed to oxidation.

Secondly, it is interesting to know whether the ozone and oxides of nitrogen act similarly as bleaching agents. So far this is not quite certain ; but it is perfectly certain that the ultimate effect of the two bleachers is different For ozone, however often applied, never has any other effect than that of bleaching, while oxides of nitrogen only bleach up to a certain point, beyond which they turn the flour darker and darker until it is a sepia colour. The latter effect is probably due to the presence of nitric acid.

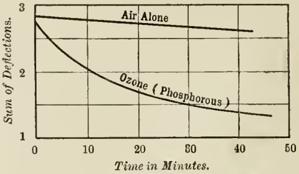

Fig. 13.—Ionisation Experiments.

So far as we have yet discovered oxides of nitrogen and ozone bleach flour similarly, though the former has other effects besides that of bleaching.

Thirdly, we ask why are the two gases when electrically produced so much more powerful than either gas alone.

Two theories are possible. (1) That the little proportion of oxides of nitrogen acts as a carrier between the ozone on the one hand and the flour on the other. It may be that by such means ozone is split up more easily, and the authors have certain reasons for inclining to this view. The action is then oxidation, but partially catalytic oxidation.

(2) That by passage through the spark box the ozone is rendered much more active because much more highly ionised. Fig. 12 shows how much more ionisation takes place in the spark box than in the ozoniser. It was thought that this question might be settled once and for all by producing the ozone chemically instead of electrically. Pure ozone was, therefore, carefully prepared by Mr. Peachey by means of the well-known action of phosphorus, and this was found to bleach effectively ; but on testing with the electroscope it was also found to be in a state of ionisation as shown in Fig. 13, so that the test was quite inconclusive. Work on this subject is still in hand, and the authors can only ask those chemists who have any experience of this kind of work to express their opinions of the possibility of each of the theories above suggested.

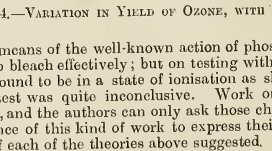

Fig. 14.—Variation in Yield of Ozone, with Frequency.

We may, however, collect, for the benefit of the commercial chemist, the results which have been obtained in this investigation and which will be of use to all those who are seeking to solve the problem of the electrical fixation of nitrogen or the economic production of ozone.

The conclusions to which our experiments point are—

(*a*) In order to obtain good yields of oxides of nitrogen from the air, it is not essential that a very high temperature should be used. Very thin electric discharges existing between many pairs of points (the latter being as far apart as insulation will allow and supplied by alternating current of high frequency) will give, probably, the most economical results. By this means long flames of burning nitrogen may be produced which do not appear to have a temperature approaching that of the arc, but yield, nevertheless, as much oxides of nitrogen with a smaller expenditure of power. Good results are to be looked for, not by increasing the current supplying those points so much as by increasing the number of pairs of points used.

The use of a current of air to extend these discharges is certainly to be advocated, but the limit of the velocity of this air current is determined by the oscillations set up in the circuit thereby; for above a certain point no commercial insulator will stand the effect of these latter.

The points used should be conical in shape, of such proportions that they do not readily burn away. Steel is, perhaps, the best material.

(*b*) In order to obtain good yields of ozone electric discharges should be allowed to take place between edges or points, these discharges being controlled by a high steadying resistance or impedance so that they cannot possibly develop into that form of discharge which is so concentrated that it may be blown into a flame. An alternating current of high frequency should be used, and to avoid the production of oxides of nitrogen, the air supplied should be dry, clean and cold, and every precaution should be taken to keep the whole apparatus cool, as, with high temperature, ozone is immediately split up. The current may be increased so long as no yellow discharges appear, and no sensible heating of the apparatus takes place. In order to make the apparatus as economical as possible, the air gap used should be long, for then the loss in the steadying resistance is proportionately less, but the over-all pressure is proportionately higher. The authors consider that the observance of the above conditions will materially tend to economy in the commercial application of the electric discharge.

Biological Tests.—A number of tests have been made to prove the sterilising effect of the gas, and the following are the chief results, as given by Dr. F. M. Blumenthal. The quantity of micro-organisms in 1 gramme was:

Bleached rye meal.	Unbleached rye meal.	Bleached wheat flour.	Unbleached wheat flour.
1,600	2,400	170	540

The flour is thus seen to be partially sterilised, and this fact is found to increase very materially the value of the process, since it improves so much the keeping properties of the material treated.

EVERSHED'S BRIDGE-MEGGER.

Messrs. Evershed & Vignoles have modified their well-known "Megger" insulation testing set, so that it can now be used either as an ohmmeter in the usual way, or as a Wheatstone bridge. The range of measurement is thus very much increased, the lower limit being quite small and the upper one 40 megohms.

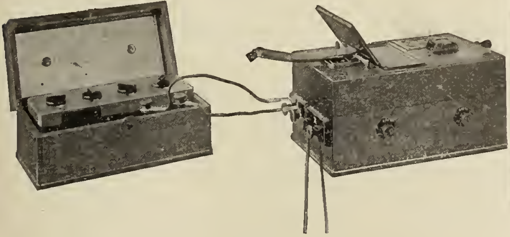

Fig. 1.

Fig. 1 gives a general view of the instrument, the ohmmeter being on the right-hand side and the resistance box on the left. Two switches are fitted on the ohmmeter; one of these is a two-way change-over switch, which can be set either to "Megger" or "bridge," while the other is a ratio switch for varying the proportion of the two ratio arms when the instrument is used as a Wheatstone bridge. By turning the "change-over" switch to "bridge," the connections of the instrument are altered in such a way as to convert the ohmmeter of the Megger into the galvanometer of a Wheatstone bridge. When coupled in this manner and used with the resistance box, any resistance from a fraction of an ohm to nearly 1 megohm may be determined. In addition to changing the ohmmeter into a galvanometer and switching the arms of the bridge into their appropriate places in the circuit, the "change-over" switch couples the two windings, with which the generator is wound, in parallel in order to increase the current which it is possible to obtain from the machine; when the windings are in series the machine gives 500 volts.

The "ratio switch" alters the proportion of the ratio arms of the bridge from equality to one-tenth or one hundredth as desired.

The resistance box, which is direct reading, contains four sets of coils—units, tens, hundreds and thousands—and consequently reads up to 9,999 ohms. By the use of the ratio switch, differences of 0·01 ohm in the resistance under test can be represented by units in the box. The adjustment of the resistance in the box is effected by four multiple point switches, each carrying a figure dial arranged to show (through a window in the top plate) a digit representing the position of the switch. The total resistance of the box, from terminal to terminal, is thus given directly in a row of figures, and is very easily read. The switches are entirely enclosed, and are not affected by dust or dirt.

When used as a bridge, the pointer oscillates about a line at the infinity end of the scale, being on one side of it or the other according as the resistance inserted in the box is too large or too small. No levelling is necessary in using the instrument, and the handle of the generator is simply turned with increasing speed until the clutch is felt to slip, which occurs at about 100 revs. per min.

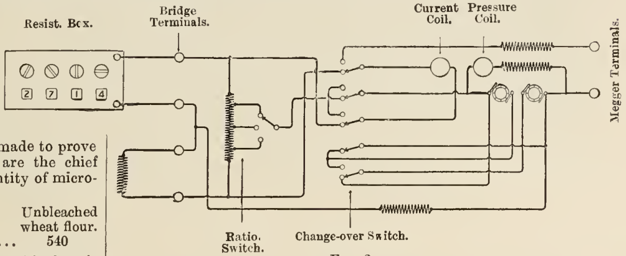

Fig. 2.

The internal connections in the instrument are clearly shown in Fig. 2. Here the change-over switch is set for working as a bridge, so that the two generator coils are connected in parallel, and the ohmmeter is converted into a galvanometer.

THE APPLICATION OF LARGE GAS ENGINES IN THE GERMAN IRON AND STEEL INDUSTRIES.*

BY K. REINHARDT.

(*Concluded from page 731.*)

Double-acting Four-cycle Engine by the Dingler'sche Maschinenfabrik, Akt.-Ges., Zweibrücken.—The Dingler construction differs from the former other modern four-cycle engines principally in the retaining of a cylinder open at one end. Double-acting is not arrived at in one cylinder, but properly in two single-acting cylinders, whose compression chambers are bolted together (Fig. 19). Thereby the cylinder ends, which contain the valves in their outer and inner casing, and, as a continuation of the latter, are cast together with the liner, and this is inserted into an outer jacket in such a manner that opposing stresses are avoided. Towards the crankshaft bearing, this outer jacket continues in the form of cross-head guides and frame.

Both pistons are on the same piston rod, which must traverse the cooled distance piece between the compression chambers through packings. This packing appears to me to be a very difficult detail of the Dingler engine; moreover, if it is an advantage, the tightness of the working piston can, at any time, be examined and adjusted, by reason of the cylinder being open. This, however, is impossible with this arrangement of the rod. It will be seen from Fig. 19 that at the moment in which the explosion takes place on one side of the distance piece the packing rings are at the other end of the same, therefore the hot gases can penetrate to nearly the whole length of the bush. Consequently, the lubrication is very much affected.

The manner in which the piston is fastened to its rod is peculiar. A split collar is provided with a series of projections on its inner surface. These projections engage similar parallel grooves that have been turned on the rod. This collar is covered by a cylindrical sleeve, which has an outside flange to attach to the piston face, and an inside flange to pull upon the collar. On screwing up the outside flange to the piston face, the collar projections tighten upon the back face of the grooves, thus putting the piston rod in tension, and rigidly fixing it to the piston.

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* Paper read at the joint meeting of the Iron and Steel Institute and the American Institute of Mining Engineers on July 24th. Slightly condensed.

The advantage of this method of fastening is the facility with which it can be disconnected. A number of spring rings are inserted between the rod and a bush placed in the boss of the piston, to make a gas-tight joint against the pressure in the cylinder. The valve gearing actuates in each case an inlet valve situated at the top and an outlet valve situated at the bottom of the cylinder, whose motion is obtained from a common cam on a shaft. A second shaft is placed in front of this shaft, which rotates with the same number of revolutions as the crankshaft, and carries an adjustable regulating cam controlled by a Dörfel flat governor. The action of the adjustable cam gives a very equal opening of the inlet valve for all loads, while the lift and duration of the opening of the mixture valve is variable. The governing is, therefore, a quantity governing with throttled mixture. The ignition is also adjusted by the governor. The outlet valve is not as accessible as it should be.

The engine constructed according to Dingler's arrangement is only slightly longer than double-acting engines with closed cylinders, its advantages consisting above all in the ease with which the piston is taken off.

In Germany the only *two cycle engines* to be taken into consideration are the Oechelhäuser system and that of Körting.

The first is represented by the engines constructed by the Aschersleben Maschinenbau-Akt.-Ges. and by A. Borsig, Berlin, the latter engines by Körting Brothers themselves and their concessionaires, who are: Gutehoffnungshütte, Oberhausen, Donnersmarckhütte, Zabrye Siegener Maschinenbau-Aktiengesellschaft, and Maschinenbau-Aktiengesellschaft, formerly Klein Bros., Dahlbruch.

Two-cycle Engine Oechelhäuser System.—The author assumes that the manner of working and the advantages of these engines are known. They depend upon the use of the open cylinders and of inlet and outlet ports automatically controlled by the working piston, avoiding the exposure of valve heads and valves, and also of stuffing boxes and piston rods in contact with fire, the balancing of the masses and the disappearance of the stress of the frame and foundation; so far, a blowing cylinder is not arranged tandem with the main cylinder.

As compared with former examples of the Oechelhäuser engine, the principal modifications are to be found in the formation of the mixture and the manner of governing.

The charging pump, which is usually placed behind the gas cylinder, consists of a cylinder with automatic valves, the piston of which compresses, on the one side gas and on the other side air to the necessary charging pressure.

The scavenging and charging of the working cylinder takes place during and shortly after the air-compression stroke of the charging pump, so that air enters through the first open ports in the working cylinder, and after the piston has overrun the gas-inlet ports an equalisation of pressure in the charge holders and pipes takes place and causes, at a definite moment, air and gas to enter together. The mixture is thereby formed after the admission of air and gas in the cylinder itself.

The regulation of the speed—that is, the variation of the charge corresponding to the load by the governor—is arranged differently by the two firms. In engines by the Aschersleben Maschinenbau-Akt.-Ges., the admission of gas only is regulated by the governor, and by means of König's patent return valve, which puts the chamber situated round the gas ports—that is, the pressure vessel for the gas compressed in the charging pump—in communication with the gas suction pipe of the charging pump, for a longer or shorter period at each revolution of the engine. For all loads the same quantity of air is employed, and the quantity of gas and the time of admission is varied according to the load. If the return valve is so regulated that when the gas ports are opened by the working piston it is immediately closed, no gas or mixture can pass over in the gas-return pipe. During the simultaneous admission of gas and air, both are at the same pressure; nevertheless, only a variable mixture can be formed, because during formation the area of the air inlet is constant, but that for the admission of the gas varies continuously. The governing of the Aschersleben engine resembles approximately the quality method in four-cycle motors. It gives a variable mixture, and, when running without load, a weak mixture.

Nevertheless, according to information received from the firm, engines governed in this manner, which are coupled to alternating-current electric generators, can be connected in parallel without difficulty.

The method of governing employed by A. Borsig differs from that described above, in that—(1) both the quantity of gas and of air admitted to the working cylinder are controlled by a return flow valve, each valve being actuated by a Neuhaus-Hochwald gear. These valves are placed below the engine floor, and are situated in front of the engine, in the gas and air mains. Further, the air admitted is divided by throttling into air for scavenging and for the mixture; (2) a circular valve or sleeve encircles the admission passages, which, with a diminishing load, and also when the engine is running without load, gradually closes the openings situated opposite the point of ignition, so that when running without load there are only a few openings for the quantity of gas where the ignition takes place. This circular valve is moved by gearing controlled by the governor, and represents an indirect method of governing, the disadvantages of which are known, and in this connection could only be ascertained by experiment.

A. Borsig states that a simultaneous variation, in this manner, of the quantities of air and gas and of the areas of the inlet passages, was found to be necessary, otherwise the quantity of gas admitted to the cylinder in proportion to the quantity of air, when the engine was working almost without a load, was so small that, when it was distributed throughout, the whole volume was incapable of forming a mixture strong enough to be ignited.

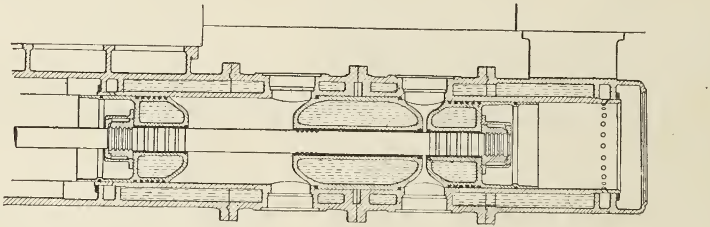

Fig. 19.

The experience gained by the Aschersleben Maschinenbau A.-G. and by A. Borsig with reference to the governing is of such a contradictory nature that, to those unacquainted with the subject, it would appear to be unintelligible.

It must here be mentioned that in engines up to 1,000 effective H.P. in a single cylinder, A. Borsig arranges one charging pump, which is placed in the axis of the working cylinder, but for powers above 1,000 H.P. in one cylinder employs two double-acting charging pumps for gas and air, driven by one piston rod, and situated below the floor of the engine house.

As compared with former types, the Oechelhäuser engine as now constructed is much narrower, owing to the disappearance of the superfluous outside bearings for the flywheel.

Double-acting Two-cycle Engine by Körting Bros.—The innovations which the above-named builders of Körting engines have introduced in the last few years consist in the satisfactory design of several parts, principally of the cylinder heads and of the cylinder, also the simplification of the charging pump and of improved methods of governing.

The double-acting in the Körting engine takes place on both sides of a piston, in a cylinder whose ends are closed by cylinder heads. The piston automatically regulates the exhaust ports, while the inlet of the air and the mixture takes place through an admission valve situated in the upper portion of the cylinder head. The cylinder itself stands on two side-frames, which, continued forward, form the crankshaft frames. Between these side-frames the flat crosshead guide is arranged.

Two separate double-acting charging pumps, one for air and one for gas, are situated at the side of the working cylinder. The author has described elsewhere the principle on which these pumps work.*

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* *Stahl und Eisen*, 1902, No. 21.

From these pumps the air and the gas-pressure pipes lead into two concentric circular chambers above the inlet valve, and as these chambers are constantly in communication with one another, the gas and air are always at the same pressure in the admission passages.

According to the quantity of gas required, by the action of the governor, air, compressed to the charging pressure, and always in equal quantity, enters from the circular air chamber, and for some distance into the gas passage, so that, at a definite moment depending on the load, when the inlet valve is opened, air first, and then gas and air, enter the working cylinder together at the same pressure, but in quantities proportional to the respective areas of the air and gas pistons of the charging pumps, until the inlet valve closes.

The formation of the mixture, as described, is ideal, and cannot be surpassed, for an entirely constant quantity is formed, with the proportion of gas and air, as intended by the design, and entirely independent of the pressure, or of the variation of pressure in the suction pipes of the charging pumps. In the Körting engine these variations of pressure, in reality, have no influence on the working of the motor, at least only to a slight degree at the time when the engine is working at full load.

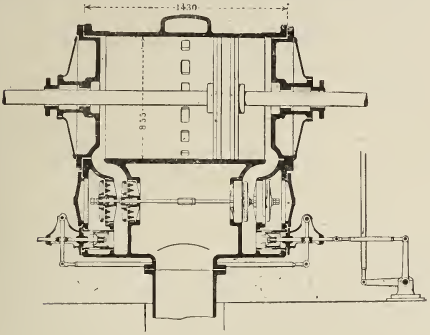


Fig. 20.

At all loads and speeds of the engine a good mixture is always to be found, after compression, next to the ignition point.

The compression varies with the load, while the quantity of air admitted is constant, and the quantity of gas is reduced with the load.

The inlet valve is controlled by cams, and in most cases closed by springs. Considerable acceleration resistances are caused by the rapid opening and closing of the valves, and for this reason the gearing for closing the valves should also be arranged with cams and roller levers.

To govern the speed of the engine—that is, to regulate the admission of gas, with corresponding loads—the Körting engine was originally fitted with a governor with a return-flow valve, in such a manner that a throttle valve, controlled by the governor, allowed more or less gas to return to the cylinder of the charging pump from the gas-pressure passage (between the cylinder and the charging pumps) during the period of suction.

Though this system of governing makes extra work for the gas pump, it is, even in the latter types of Körting engines, still employed, owing to its simplicity, as shown by the charging pump by Klein Bros. (Fig. 20).

The charging pumps were originally worked by an eccentric valve motion with a circular valve, both for inlet and outlet.

In more modern engines the charging pumps have direct-acting piston slide valves for the inlet valves and also for the outlet, and by adjusting a double slide-valve motion the quantity of gas can at the same time be regulated.

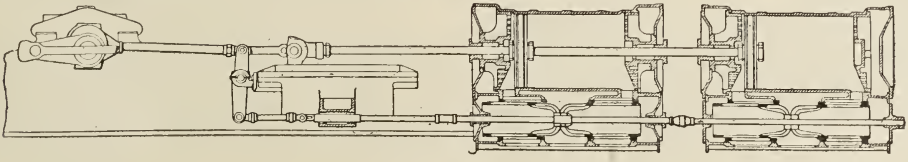


Fig. 21.

The charging pumps manufactured by Klein Bros. and the Siegener Maschinenbau Co. are much more simple. The first have no eccentric valve motion, but only automatic valves (Fig. 20). In this pump Klein Bros. have taken advantage of the peculiarity of the Körting engine, namely, that the air pump compresses during the complete stroke, and the gas pump commences to compress in the middle of the compression stroke. For this reason the cylinder of the gas pump is provided in its middle portion with ports, which communicate with the gas suction. The gas can return to the suction pipe through these ports during the first half of the compression stroke. This regulation of the charging pump avoids the unnecessary consumption of oil and power that obtains in the former slide-valve motion.

The charging pump gearing of the Siegener-Maschinenbau-Aktien-Gesellschaft is shown in Fig. 21. The eccentric motion is here retained; but a single eccentric with a slide-valve rod moves all the inlet valves of the gas and air pumps. The exhaust valves of the charging pumps are placed in the cylinder covers.

The valves situated under the pump cylinders are provided with tapered openings, and work in casings with similar openings. When the gas slide is moved by the action of the governor, the tapered openings of the slide and of the casing are brought nearer to, or farther from, each other. Thereby at the beginning of the suction period a variable "after opening" of 0 to 10 per cent. takes place, and the suction pipe is closed during the pressure stroke (after an admission of from 35 to 80 per cent.). A diagram from this charging pump is reproduced in Fig. 22. The air pump can be regulated in a similar manner by hand. This simple motion avoids the return of compressed gases.

With clean gas this motion could probably be actuated by the governor; but if the gas is not very clean, and at the same time is wet, the friction of the throttle slide, and, at times, the resistance of the inlet valve, will be excessive.

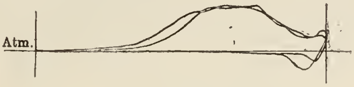


Fig. 22.

In newer Körting engines the liners of the working cylinders and the jackets are no longer cast in one piece; they are more frequently made in two halves, inserted into the jacket, so that the outer and inner cylinder liners can expand independently.

All builders of the Körting engine have retained the cylinder heads bolted to the cylinder, and from the modifications as shown in Fig. 23, as compared to the usual constructions, it may be concluded that they gave trouble by cracking.

The newer designs of the cylinder heads avoid the pressure of the stuffing-box chamber on the outer wall of the cylinder head.

The long pistons are cast in one piece, and have either a boss extending throughout their whole length or a short boss at each end. In large engines the pistons are supported by back or front guides; in smaller engines the back guide is also dispensed with, and in its place the middle of the under surface of the piston is lined with anti-friction metal.

The Körting engine is specially suited for driving blowing cylinders, because it starts easily when loaded, and is certain in its working at great variations of speed, and moreover when the speed is very low.

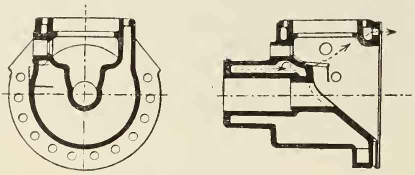
The author wishes here to remark that most of the ironworks have answered his question as to the most practical size of the engines—viz., for driving dynamos 1,000 B.H.P. to 1,200 B.H.P. per unit; for driving blowing cylinders for each blast furnace, a separate engine, usually, say, from 1,000 B.H.P. to 1,200 B.H.P., or in some cases larger units, say from 1,600 H.P. to 3,600 B.H.P., according to the efficiency of the furnace. Concerning the size of the engines, it may be observed that with a few large units, as compared with a larger number of smaller units, the reserve power of the plant, also the safety of the apparatus, for example, of the pistons and cylinder covers, diminishes; and further, that the cleaning of the large engines is more complicated and takes more time.

Units larger than 1,000 to 1,200 effective H.P. are only to be found in very large plants, or where the space is limited.

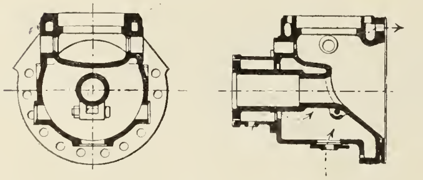
From the answers received to his last question concerning the possibility of connecting alternating-current dynamos in parallel, when driven by gas engines, this, stated generally, can be done without special difficulty. From several sources it is gathered that sometimes the practice of switching in, at the moment that the engine is running without load, occasions difficulty; that naturally depends not only upon the degree of uniformity of the engine, on the momentum of oscillation of flywheel, and on the construction of the dynamo, but above all upon the action of the governor and the formation of the mixture at the time named, and for this reason will vary with the design of valve gear.

After considering all these various types, the question as to which system—*two-cycle, or double-acting four-cycle*—should be adopted, the author wishes to make the following statement:—

When the double-acting two-cycle engine was introduced by Körting Bros. in the year 1902, a number of engines made by them met with general success; this engine, as compared with the then existing single-acting four-cycle engines, showed such marked progress in this line that many considered that the four-cycle system was no longer a serious competitor. The builders of four-cycle motors were, however, guided by the success of the Körting engines in the right direction—namely, of reconstructing their engines as double-acting engines in a single closed cylinder and to arrange two of these cylinders, the one behind the other, with the object of increasing the mechanical duty. Prof. Meyer had already at that time called attention to the fact that, in view of the large negative work expended in the charging pump of the Körting engines, the double-acting tandem four-cycle engine would, without doubt, again seriously compete with the Körting engine. That this forecast was a correct one may be seen from the statistics given at the commencement of this Paper.



Former Construction of Cylinder Head



New Construction of Cylinder Head

Fig. 23.

Many persons at the present time, in judging the question of system, go so far as to prophesy that the gas engine will return to its original starting point—viz., the four-cycle system—while others, equally convinced, affirm that the four-cycle will not continue to be adopted by ironworks and other manufactories.* Even with the experience gained up to the present time, it is impossible to give an opinion, based upon sufficiently trustworthy evidence, in favour of either of these opposing views. It is impossible to come to a conclusion from the total horse-power, for up to March of this year engines totalling 260,000 B.H.P. were at work, or on order, for double-acting four-cycle, as against 91,000 B.H.P. for two-cycle, without further considering the proportionate value of the two systems. If these figures prove that the competition of the two-cycle engine must not be neglected, on the other hand, the importance and connection of the builders of the four-cycle types must be considered advantageous to the latter.

The builders of two-cycle engines will themselves admit that these motors are less adapted for the high speeds required for driving dynamos than for driving blowing engines and pumps, because, with a reduced time of charging, the resistance of the charging pump cannot be kept low enough, and principally, owing to the relatively larger number of explosions (especially with gases of high calorific value, such as coke-oven gas), the flow of heat through the metal walls, and thereby affecting the security of the explosion chamber against breakage and the occurrence of premature ignitions, create uncertainty; as, moreover, the governing hitherto employed in two-cycle engines for dynamo driving is, as a rule, inferior to that of the four-cycle engines. For this reason it may be explained that several firms who build two-cycle engines have lately decided to adopt also the manufacture of double-acting four-cycle engines.

On the other hand, the two-cycle engine is, without any doubt, most suitable for driving blowing cylinders; for, as already stated, it permits, within wide limits, a variation in the number of revolutions per minute; it starts easily against a load, and at the low speeds of the blowing piston the work of the charging pump is not excessive. Klein Bros., for instance, state that the work of their charging pump with valves is from 6 to 7 per cent of the work of the power cylinder, so that the difference, compared with the negative work of the four-cycle motor, no longer preponderates.

Theoretical discussions concerning the correct or the incorrect mechanical efficiency, which during last year created such a stir in Germany, can for the present contribute nothing to elucidate the question of the systems. For the managers of works, in addition to inquiring about the price and power of a gas engine, above all inquire about the security in working, and least of all about the quantity of gas consumed per brake-horse-power. They do not trouble themselves at all about the mechanical efficiency.

Suitable trials concerning the consumption of gas in more recent engines are not available for comparison, therefore it is not known how far the two-cycle engine is at the present time, in this respect, still inferior to the four-cycle engine. Should the ironworks now be compelled to consider an economy of gas, the author does not believe that the larger consumption of the two-cycle engines would for long have any great influence on the question of systems; for then the ironworks would probably first consider a more thorough cleaning of the gas employed for heating the blast and for burning under the boilers, thereby increasing its value, and in this manner to save gas. So long as these conditions remain as they are, and so long as the four-cycle engine is not more secure, under average working conditions, than the two-cycle engine, so long will the question of systems not be decided by general and theoretical considerations, but in such cases by the ironworks and mining industries themselves.

The situation was well summed up by a manager who, referring to this very point, told me personally that he himself preferred double-acting four-cycle, but his engine drivers preferred double-acting two-cycle.

As regards other industries, they need not at present be considered to such an extent that they could assist in deciding the question.

In conclusion, it is my duty to state that the present position of the application of gas engines in German ironworks shows the value the managers of these undertakings attribute to the better and less dangerous utilisation of the waste gases of their furnaces, and the successful efforts that have been made by the German engineers in order to meet the requirements suddenly demanded by ironworks. It also proves that German ironworks are obliged to utilise to the uttermost the sources of power at their disposal in order to ensure their existence and their participation in the trade of the markets of the world. In other richer countries, with more favourable conditions, the matter is not so urgent.

ELECTRIC FURNACES FOR TEMPERING STEEL.*

BY L. M. COHN.

Many attempts have been made to simplify the process of hardening steel, and to make the work less dependent on skill and experience. Steel is iron which contains from 0·3 up to 2 per cent. of carbon. If the steel is heated, the carbon is dissolved and finely and evenly distributed throughout the iron, just as a salt is dissolved in water. The more the steel is heated, the more perfect the solution becomes. If the steel is slowly cooled, either pure iron or an iron carbide (Fe_3C) is separated out; the amount of carbon present determines the chemical process; in any case the carbon is no longer evenly distributed but is combined with a portion of the iron only. (For a simple and graphical explanation of the process, a lecture by J. H. van't Hoff, before the Verein Deutscher Ingenieure, in 1901, entitled "Tin, Gypsum and Steel," and published by Oldenbourg, in Munich, should be consulted.) On the other hand, if the steel is suddenly cooled, there is not sufficient time for the chemical action described above, and the carbon remains in the same evenly distributed state in which it was during the time it was dissolved in the iron. Besides carbon, the metals tungsten, nickel, chromium and manganese have the effect of hardening steel.

The disadvantages of coke and gas furnaces are well known. As for furnaces of an electric type, the firm of Heraeus, in Hanau, make one, having platinum wires imbedded in fireclay, arranged symmetrically on either side of the opening in which the steel tool is placed. Fig. 1 shows a furnace of this kind in which a temperature of 1,250°C. can be reached. But this furnace still has the disadvantage that the steel comes in contact with the air.

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* Güldner, "Entwerfen und Berechnen der Verbrennungsmotoren," 2nd edition, p. 190.

* Abstract of a Paper in the *Elektrotechnische Zeitschrift*, August 2nd, 1906.

Molten baths of lead or potassium cyanide have been used, which certainly protect the steel from the air. In the case of lead, small particles are apt to adhere to the steel and interfere with the cooling action, besides which impurities in the lead may be harmful to the steel. Moreover, both lead and potassium cyanide volatilise somewhat, even at fairly low temperatures, and their poisonous vapours make the work of a dangerous nature. Fused metallic salts seem at present to be the most suitable for baths. The steel is kept from contact with the air both during the period of heating and during the time in which it is taken to the hardening tank. As it is taken from the bath of the fused salt, it is protected by a thin coating of the latter, which immediately flies off when the cooling process is performed. The surface appears clean, smooth and metallic at the end as well as at the beginning of the operations. The best method requires a bath which can be evenly heated up to 1,300°C. without any of the inequalities of temperature which arise when the heating is applied from without. The higher classes of steel require the highest temperatures, and are consequently exposed to the greatest risks, and it is very important to be able to deal with these steels without danger of overstepping the exact temperature required.

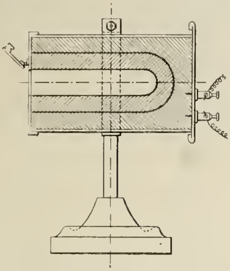

FIG. 1.—ELECTRIC FURNACE BY HERAEUS.

The following bath, manufactured by Messrs. Körting Bros., of Berlin, appears to answer all the above requirements. Fig. 2 shows a section of the apparatus. A body of the best fireclay is encased in a cast-iron framework. Within the fireclay chamber is a layer of asbestos, surrounding a refractory crucible, which is intended to contain the bath of fused salt. The sizes, of course, depend on the purposes to which the furnace is to be applied. Supposing the dimensions of the bath to be 250 mm. by 250 mm. and the depth to be 270 mm., the dimensions in Figs. 2 and 3 would be $a=700$, $b=705$, $c=250$, $d=300$. The iron electrodes are built into the apparatus, and for the purpose of avoiding electrolytic effects alternating current is at present used. The fusion of the salt is effected in the following way. An auxiliary electrode is connected to a short length of ordinary carbon, which is made to touch the opposite electrode. In this way the bath is short-circuited and an arc formed, fusing a small portion of the salt. If the auxiliary electrode is slowly moved towards the one to which it is connected, a small streak of fused salt is formed connecting the two main electrodes. The auxiliary electrode is then removed and the whole bath soon reaches a state of fusion. The temperature of the bath depends on the current, which is controlled by a regulating transformer. The temperature can be regulated with certainty by noting the ammeter, if careful measurements are once made with a pyrometer, and with suitable salts, such as barium chloride, it is possible to go to 1,300°C. Even higher temperatures could be used with a salt which does not volatilise. Measurements have been made on a bath which has been used by the Allgemeine Elektrizitäts Gesellschaft, and show the temperature to be the same throughout, except for a thin layer at the top in contact with the air. The inside measurements of the bath were 160 mm. by 160 mm., and it was 175 mm. deep. For temperatures above 1,000°C. barium chloride was used, which fuses at about 950°C., and for lower temperatures a mixture of barium and potassium chlorides, in the proportion of 2 to 1, which fuses at about 670°C. It took about half an hour to heat the bath, the final voltage across the electrodes varying from 13 to 18 with temperatures from 750°C. to 1,300°C. The power consumed was 5·4 kw. at 880 deg., 8·5 kw. at 1,140 deg. and 12·25 kw. at 1,300 deg. The temperatures were then carefully taken with a calibrated pyrometer with the following results, the planes *a*, *b* and *c* being respectively 10 mm., 87 mm. and 145 mm. below the surface, as indicated in Fig. 3 :—

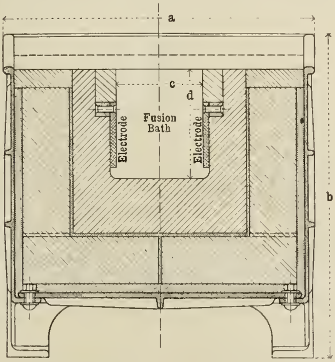

FIG. 2.—VERTICAL SECTION OF KÖRTING FURNACE.

Depth.	Position.								
	1	2	3	4	5	6	7	8	9
a......	1,110	1,110	1,110	1,110	1,109	1,109	1,109	1,109	1,108
b......	1,120	1,120	1,120	1,120	1,120	1,120	1,120	1,120	1,120
c......	1,123	1,123	1,123	1,123	1,123	1,123	1,123	1,123	1,123

Naturally, the measurements required a certain amount of time, and consequently the variations of primary voltage may have, to some extent, affected the readings as shown in the different planes.

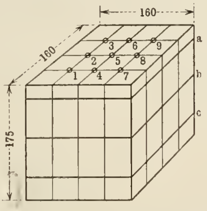

FIG. 3.—DIAGRAM SHOWING POSITIONS OF TEMPERATURE MEASUREMENTS.

It was, therefore, determined to take the temperatures at different depths under the figure 5 by merely sinking the pyrometer, and these showed that for a depth greater than 15 mm. the temperature was absolutely constant throughout.

The steel tools intended to be hardened are kept in the bath till they reach the same colour as the fused salt, and it is easy in practice to determine when this point is reached. The Allgemeine Elektrizitäts Gesellschaft have used two of these furnaces for the last eight months, and their experience shows that any sort of tool can be hardened with certainty, and that any kind of failure is a most unusual occurrence. Lengthened tests on hardening milling cutters, which required a temperature of 1,150 deg., showed that with this form of bath it was possible to do five times as much work in a given time as with the best gas furnaces. The iron electrodes require occasional renewal. Being made of soft iron, they are gradually attacked by the alternating current at 100 cycles. The dissolved iron settles to the bottom and can be removed with a ladle. The tests show that the electrodes require renewal after 100 working hours at 1,300°C., and after 1,000 hours at 850 deg. The salts remain in use for long periods; if a temperature of 1,300 deg. is used, about 1kg. of salt is lost per day of 10 working hours. The tools are best heated to a very dull red in an ordinary furnace, and then plunged into the bath, in which case the full heat of 1,300 deg is reached in 62 seconds with a tool weighing 1·35 kg.

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COMMERCIAL RESEARCH IN AMERICA.

The report of the Westinghouse Company of America, which was presented recently to a meeting of the stockholders of the company, and which we reproduce at some length on another page, is of more than usual interest. It differs from the reports to which we are accustomed in this country by covering a period of six years. In this time the number of employés has increased from 7,971 in 1901 to 14,705 in 1906, and although there was a drop in the number employed in 1904, the increase in 1906 was 2,811. Similarly, the sales show an increase from about £2,500,000 in 1901 to nearly £5,000,000 in 1906, although some falling off is noticeable in 1904 and 1905. Sales of railway motors have increased 51 per cent those of multiple control apparatus by 60 per cent., and turbo-generator plant 94 per cent. over those of previous years.

It is not, however, so much as a record of progress that the report is of interest, but rather by the insight it gives into the methods pursued by a successful competitor. In the words of the second Vice-President, who reports on the engineering and sales departments, "it is of interest to note that at least 45 per cent. of our engineering force is continuously engaged on development work—that is, in work for the future. To be effective, this work must be carried on by highly specialised and experienced engineers. The character of this work determines the success of the company's future product. To judge the future by our past accomplishments leads us to have no misgivings. This work will in the future increase rather than diminish, due to the rapid extension of electrical applications and to the fact that the requirements of electrical design are becoming daily more exacting.

"Among the multitude of problems which have been successfully solved by our engineers and which have resulted in new applications and new outlets for the company's products, one development stands out, which, by reason of the brilliancy of its accomplishment, exceeds all others. I refer to the development of the single-phase alternating current system for railway operation.

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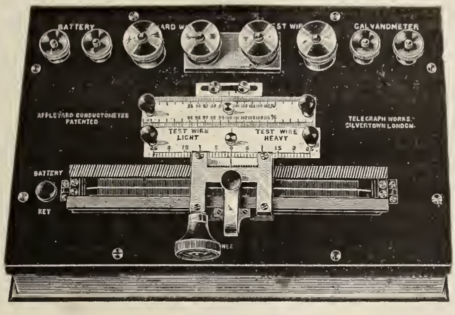

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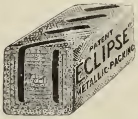

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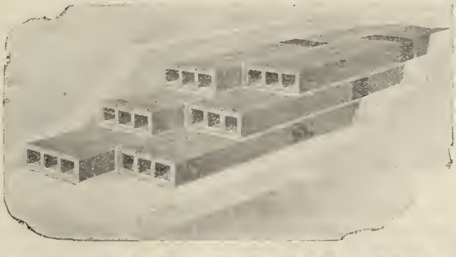

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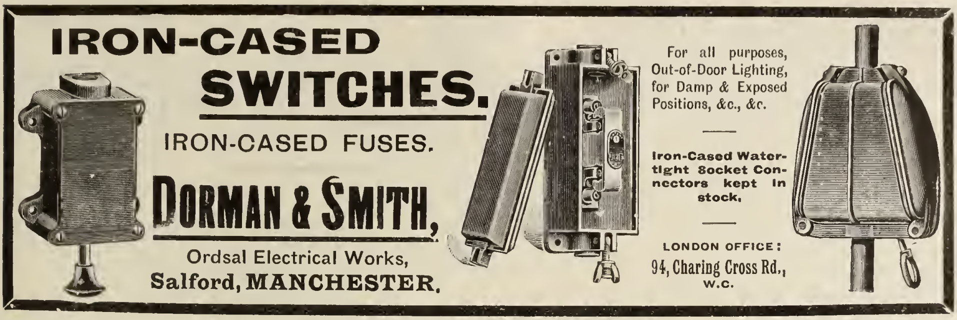
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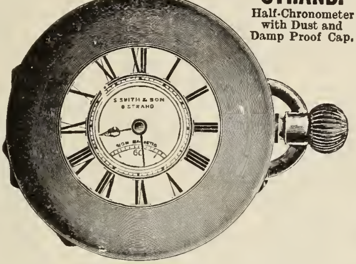

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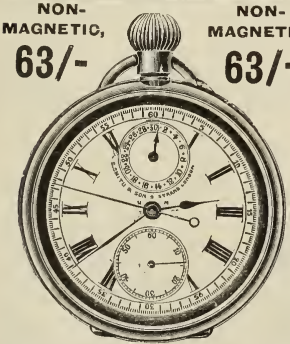
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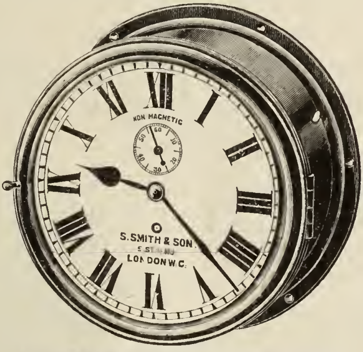

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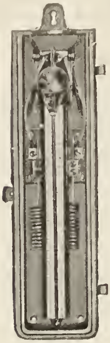

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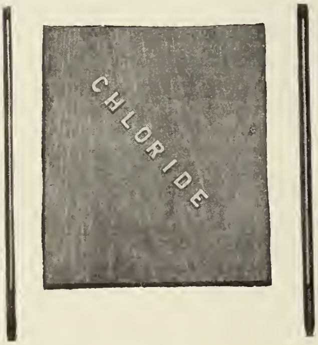

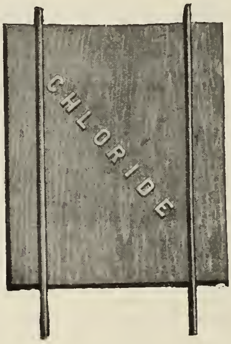

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The fact that the Westinghouse Company employs so large a proportion as 45 per cent. of its engineering staff on experimental work shows the very great importance that is attached by the company to work of this kind. Such work may be quite unnecessary so far as the present is concerned, but it is all-important as regards the future. Recognising this fact, the company has provided a "Research Division" for carrying on advanced electrical work and research, and to investigate to an exact degree materials and processes, so that the best information may be placed in the hands of the designing engineers. There are chemical and physical laboratories for facilitating the general development work, and for determining the suitability of the materials in use. There is a Materials Committee to ensure the study of the requirements in raw materials, and there is a "Division of Standards" to control the calibration of all instruments of precision.

Thus there is no reliance on merely what may be of value to-day, though possibly more or less useless to-morrow, whether goodwill or property of any kind. Of all property, probably the most uncertain in value is the patent. It may be superseded at any moment by some further invention, and at best its life is limited. The only certain method of maintaining its value is by development, so that competition is discouraged in every possible way. By such means the running out of a patent may be reduced to a matter of no very great importance to the holder.

There is, of course, the old question—Does it pay? There is not much doubt that the directors of the Westinghouse Company are firmly convinced that it does; and some satisfaction must be felt by them in making such announcements as that an improved arc lamp has been so far developed as to satisfy them that the lamp in question will revolutionise existing practice, and will soon form a valuable addition to the business.

In his recent Paper on Glow Lamps, Sir William Preece remarked that it is somewhat humiliating that nearly all the recent advances in developing the electric and gas light in this country have emanated from Germany or America, and he concluded by saying that "something is wrong somewhere." We think the report of the Westinghouse Company throws some light on what is wrong. Spasmodic individual effort cannot compete against organised research.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Lehrbuch der Allgemeinen Elektrotechnik. By K. Zickler. (Leipzig and Vienna: Franz Deuticke.) 1906. Vol. I. 10s.

In the preface of this book we are informed that it is intended for the use of students of electrical engineering at the commencement of their study of the subject, and with the object of giving them a general theoretical grounding before they attempt to specialise. After reading this statement the general arrangement of the subject matter and the manner in which it is treated is certainly surprising. Indeed, the very first chapter contains such subjects as the resolution of periodic functions into their simple harmonic components by Fourier's theorem, and the method of Steinmetz of representing harmonic functions by complex algebra. Even supposing that the student is sufficiently advanced to study such questions with advantage, he would scarcely be helped by finding various geometrical and analytical methods of resolving periodic functions placed before him as rules, without the reasoning by which they are obtained, and he might be expected to be bewildered by finding three different methods of representing harmonic quantities explained in as many pages.

The second chapter treats of magnetism and the magnetic effects produced by currents on generally accepted lines, but insufficient care has been taken in defining fundamental quantities clearly. For instance, the magnitude of the force exerted on a magnetic pole by an element of current is given without specifying the direction in which it would act; further, several figures (Fig. 15, chapter II., and Fig. 34, chapter IV.), the object of which is to show the relative directions of currents flowing in circuits of various kinds and the magnetic fields produced by them, are drawn in such a manner that the direction of the fields produced, as shown by arrows, is ambiguous. It is no doubt an unfortunate misprint that gives the permeability of air as zero.

The third chapter is devoted to the technical units, in which electrical quantities are measured and their relations to the units of the electrostatic and electromagnetic systems.

Both in this chapter and the following one, considerable space is taken up by information which is usually to be found in engineering pocket-books, such as expressions for the capacity of various assemblages of conductors, and the coefficients of self and mutual induction of circuits of various dimensions and relative positions, and which cannot be said to have an educational value when given merely as results without any indication of the methods by which they are arrived at.

The fourth chapter, concerning self and mutual induction, calls for little comment, but the classification of induction in a conductor as "useful" in a linear conductor and "harmful" in a massive conductor seems a somewhat awkward and unnecessary distinction.

The first section of the volume closes with a chapter on the alternating-current circuit, in which the relations between the various voltages and currents for a number of typical circuits containing resistance, inductance and capacity are fully worked out by solution of the differential equations for each case, by vectorial methods and by the method of complex algebra. An interesting graphical discussion of the effect of distributed capacity in cables connected to an alternating E.M.F. is given, and the phenomenon of skin effect is discussed in an instructive manner. The simpler properties of the various polyphase systems are derived from a discussion of the general polyphase system of *n* phases.

The second section of the book contains descriptions of electrical instruments and the methods of using them to carry out electrical and magnetic measurements. Throughout the book references are made in foot-notes to the sources from which more particular information may be obtained, if required. The second volume, which has not yet appeared, will treat of generators, transmissions, lamps and accessory apparatus.

Monographien uber Angewandte Elektrochemie: Elektrolytische Alkalichloridzerlegung mit flussigen Metallkathoden. By Dr. R. Lucion. Pp. viii., 206. (Halle: Wilhelm Knapp.) 1906. 7m.

These monographs, which have from time to time been noticed in the columns of *The Electrician*, have now reached the 23rd volume, and when seen together make a very large book upon the subject of applied electrochemistry. One begins to notice a certain amount of overlapping; but taken on the whole there is, considering that each volume is written by a different author, not much to complain of in that respect. The volume before us deals with the electrolytic decomposition of alkali chlorides with fluid metallic cathodes.

The first part of the book is devoted to electrolytic processes in which a kathode of mercury is employed. A very good description of the different methods of employing the mercury kathode in the Castner-Kellner process is first given. In Chapter II. the author discusses the difficulties which are met with on a commercial scale—difficulties that only arose when the process which was so successful in the laboratory was tried technically. There is the difficulty of finding suitable electrodes; when carbon is used in the laboratory it appears to be satisfactory, but when continuously employed for weeks or months great difficulties begin to crop up. Another difficulty is with the mercury; it is not possible to work with an amalgam which contains more than ½ per cent. of mercury, because, with amalgams containing a higher percentage, the mercury will not flow. Generally speaking the working strength is about 0·2 per cent. This means that to obtain 2 kg. of sodium 1 ton of mercury must be employed, and to produce 4 tons of caustic soda per day 50 tons of mercury must be circulated per hour. It is at once seen what an expensive item the mercury kathode is. It is also necessary to use pure sodium chloride, and this, of course, adds to the expense. A further difficulty is to obtain permanent electrolysing vessels. The author very clearly sets out the difficulties met with, and then shows how they have, to a large extent at any rate, been combatted and overcome. The different processes in which a mercury kathode is employed are then given in alphabetical order, but seeing that these are not all commercially successful processes, the author might have considerably curtailed this portion of the monograph.

Chapter IV. is historical, and contains an interesting photograph of the first plant put up by Castner at Oldbury. There are also some very good drawings of the Solvay plant in Jemeppe. Castner and Kellner originally had separate patents, that of Castner being more in connection with the use of the mercury kathode, whereas Kellner's had more particularly to do with the electrical connections. By the union of Castner and Kellner the process was worked out to a successful issue, neither process being quite complete when worked separately.

The next chapter deals with the commercial side of the subject. The cost of the plant and of the process are very fully gone into, and in this connection it will be noticed that the repair and renewal cost is very considerable. There is no doubt, however, that the process would be a much greater success if one could find a wider use for the chlorine. The chlorine, in fact, is a bugbear; a small amount of it is employed for chlorinating organic compounds, but by far the greatest quantity is converted into bleaching powder; and as for every 300 kilos. of caustic soda produced 700 kilos. of bleaching powder are obtained, it is small wonder that bleaching powder is becoming a drug in the market.

The last portion of the book treats of fused metallic kathodes and a fused electrolyte. The methods of Hulin, Ashcroft, Vautin and Acker are fully described. It would appear, however, that the only process which can at present be termed a commercial success is that of Acker. Owing to this fact the process of Acker has naturally been much more fully described than the others.

Taken as a whole the monograph is very well written, and the author has evidently taken very great pains in the compilation. The only objection which we have to make is the tendency in these monographs to describe methods and processes which are not commercial, the more so seeing that all the monographs are intended to be devoted to applied electrochemistry.

Aufuahme und Analyse von Wechselstromkurven. By Dr. Ernst Orlich. (Brunswick: F. Vieweg & Son.) 3m. 50.

This work forms the seventh part of the series entitled "Elektrotechnik in Einzel-Darstellung," edited by Dr. G. Benischke. A short introductory chapter deals generally with the mathematical representation of currents of any wave form, but the greater part of the book is a collection of the various methods which have been used by different experimenters for the actual determination of wave forms of alternating currents. The older step-by-step methods, the Hospitalier ondograph and similar instruments, are first described, together with the potentiometer methods of Rosa and Callendar and the apparatus of Goldschmidt and Ryan. Electro-chemical and optical methods, and those involving the deflection of cathode rays and similar phenomena, are then dealt with, after which a few pages of theoretical considerations introduce the oscillograph proper. The forms due to Blondel, Duddell, Siemens & Halske and others are described and illustrated. The latter portion of the work is devoted to the analysis of curves and includes descriptions of the principal mechanical harmonic analysers which have been introduced from time to time. The little work is well arranged and well illustrated, and the mathematical and experimental treatments are well balanced.

Les Procédés de Commande à Distance au moyen de l'Electricité. By R. Frilley. (Paris: Gauthier-Villars.) 3fr. 80c.

This addition to the volumes of the "actualités scientifiques" series consists of a collection of descriptions of various systems in which the motion of some body or part of a machine is controlled as to its magnitude, direction, and sense from a distance by some method or other involving the use of electricity. Naturally a very large field is covered, and the purposes of the numerous appliances outlined include widely different applications of electric working, such as starting and speed control of motors by ordinary controllers, telegraph apparatus, and the steering of torpedo boats by Hertz waves. The classification is based on the means of transmission rather than the nature of the mechanism to be controlled, and the subject is divided under the following headings: Apparatus for direct control, apparatus involving the use of relays, apparatus with a rotating magnetic field, apparatus based on the principle of the Wheatstone bridge, apparatus in which an electric spark is employed, apparatus using the step-by-step action of an escapement, and apparatus depending on Hertz waves. Many well-known, and some out-of-the-way devices are described, but the work can hardly pretend to be complete, as to do full justice to the subject it would be necessary to embody no small proportion of the matter contained in the records of the Patent Office library. Numerous diagrams of connections are given, but practically no actual details of the construction of the apparatus, as the description of each system is necessarily brief.

Practical Motor Car Repairing. By E. W. Walford. (London: Percival Marshall & Co.) 1s.

There is much in this little manual which deals with the prevention as well as the cure of the ills of motor vehicles. The hints offered are eminently practical so far as they go, but the maintenance of motor cars is a subject that cannot be learnt from a book without years of actual experience under all conditions. There is, however, a good deal that may help a novice while he is gaining his experience. The chapter on electric ignition would have been more complete with some reference to magneto ignition systems, which are now in quite as general use as battery coils, and the adjustments of which are not so well known.

Properties of Matter. By C. J. L. Wagstaff. (London: W. B. Clive.) 3s. 6d.

This addition to the University Tutorial series is intended to complete the volumes of "Tutorial Physics" by treating of those branches of the subject not covered by the manuals on Light, Sound, Heat and Electricity. As might be expected, the arrangement is a little haphazard, and the contents of the book consist principally of a mixture of elementary mechanics and the experimental methods of measurement, and illustrations of fundamental laws which are commonly included in works on "practical physics." There is little or nothing original in the arrangement or treatment of the subject to distinguish it from scores of similar works, but the book should be capable of succeeding in its object of imparting to the pupil with a minimum of mental effort that "little knowledge" which is just sufficient to enable him to pass the examination which he has in view.

Electric Goods Locomotives in America.—Comparatively few of the large number of "intercurban" electric railways have made a feature of goods traffic, but an example of a line on which special goods locomotives are provided is found in the working of the Des Moines Railway, Iowa, which is described in the *Street Railway Journal*. The electric locomotives were built in the shops of the railway itself. The larger one weighs 60,000 lb. and is equipped with four G.E. 73 motors. The cab is in the centre, and contains the air compressor as well as the control apparatus. The contactors and rheostats are installed above the floor under the sloping ends of the body, and ordinary air brakes are provided. This locomotive handles trains up to 15 cars in length without difficulty. The smaller locomotive is chiefly employed for shunting purposes.

THE MEASUREMENT OF PHASE DIFFERENCES.

BY CHARLES V. DRYSDALE, D.Sc.

(Concluded from page 728.)

II.—P.D. OR VOLTMETER METHODS.

Ever since the commencement of alternate-current measurements every effort has been made to dispense with the use of the wattmeter. The three-voltmeter and three-ammeter methods were the first attempts in this direction, and both are equivalent to finding the three sides of a vector triangle, from which the phase angles are determined. Where the triangles approximate to the equilateral form such methods may be conveniently employed, but whenever they are at all obtuse angled no accuracy is obtainable. Mr. Field's modification of the three-voltmeter method is a great improvement in principle, but, unfortunately, there seems to be no way of employing it without using a transformer, which may introduce appreciable phase differences.

The first attempt at modifying the three-voltmeter method for measurements of small phase differences appears to have been made by Dr. Sumpner, who arranged his circuits as in Fig. 5, and measured the minimum voltage obtainable between the junction of the inductive and non-inductive loads, and a sliding contact on the non-inductive resistance, giving the vector diagram, Fig. 6. This, again, is in principle capable of excellent results. In practice, however, as is well known, it is somewhat difficult to measure small alternate current voltages, especially without taking an appreciable current. In order to get over this difficulty Dr. Sumpner* has employed a synchronously rotating commutator to rectify the small voltage, and has measured it with an ordinary galvanometer. By this means he has made several interesting measurements, and the method is very sensitive. It suffers, however, from the usual troubles of rotating contacts and from the fact that two adjustments are necessary, one of the angle of commutation to get correct rectification, the other of the point on the non-inductive shunt. Unfortunately, as is obvious, any alteration of the latter alters the phase as well as the magnitude of the voltage, and hence of the angle of commutation, so that the adjustment would be somewhat tedious and uncertain. Dr. Sumpner has therefore used a commutator running with an induction motor and thus with a small slip, and measures the maximum voltage.

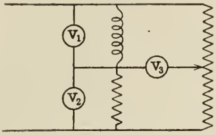

Fig. 5.

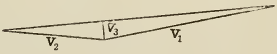

Fig. 6.

When this method was brought forward the writer devised a means of measuring the low voltage without difficulty, and this device may be employed for nearly all alternate-current P.D. measurements. If an ordinary wattmeter or other form of dynamometer has a constant alternating current in one of its coils, and a variable P.D. in phase with the current is applied to the terminals of the second coil, the deflection of the instrument is proportional to this P.D. A very convenient arrangement for calibrating low-reading voltmeters is shown in Fig. 7, where V_1 is a voltmeter which need only be standardised at a single point, enabling the voltage of supply to be controlled. The main and shunt circuits of the wattmeter are connected as shown, and the wattmeter shunt, which must be fairly non-inductive, is in parallel with the instrument to be tested. A phase displacement of a degree in either circuit is not of importance, as the reading would only be affected by the cosine of the angle of phase difference. As by this means the reading of the wattmeter is directly proportional to the P.D. V_2 instead of to its square, and the sensitiveness may be varied over wide limits by the current in the main coil and the resistance of the shunt, such a device is very convenient and accurate. With the writer's ordinary form of wattmeter $\frac{1}{400}$ of a volt corresponds to 1 mm. of the ordinary scale, and by using a reflecting instrument this could be increased probably a hundred times. Although this is much less sensitive than the galvanometer, it must be remembered that there are no contact troubles and that it gives the effective voltages directly instead of the maximum.

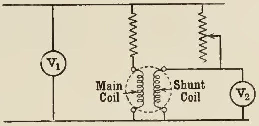

Fig. 7.

A modification of Dr. Sumpner's method, which has been found very convenient, is shown in Fig. 8. The load to be tested is connected in series with a non-inductive resistance, as before, and spanning the same mains is the resistance, which may conveniently be a potential divider or Ayrton-Mather shunt. The wattmeter is connected as shown. It will be seen by the diagram, Fig. 6, that when the voltage V_3 is a minimum it is in quadrature with the main voltage. With the switches in the position shown, therefore, the correct point on the non-inductive resistance is given when the wattmeter deflection is zero, and this point is most critical, instead of being somewhat ambiguous as with the galvanometer method. The reading on the potential divider immediately gives then the ratio in which the main P.D. is divided by the load and series resistance (incidentally it may be remarked that this method gives much more definite results in measuring electrolytic resistances on a Kohlrausch bridge). By now throwing over switch B to the second phase of the supply the voltages in the two coils are almost exactly in phase and the reading of the wattmeter gives V_3. A switch, A, enables the measurements to be made without knowledge of any of the actual voltages, as it is evident that the phase difference depends only on the ratios of the voltages, and not on their absolute values. The actual procedure will be described in a further communication. It should be mentioned that, even if a small error were made in finding the position of the contact on the potential divider, no error is caused in the result, as the error in the voltage is exactly compensated for by the consequent shift of phase. This is not the case with the commutator method.

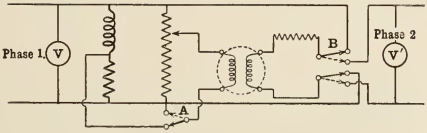

Fig. 8.

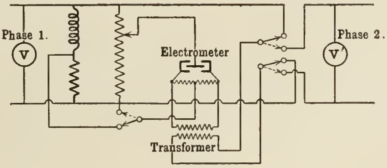

Fig. 9.

Electrometer or Electrostatic Wattmeter Method.—Wherever a wattmeter is used for a test a suitably connected electrometer may be substituted, and is of advantage when the current taken by the wattmeter is of importance. In the last case the resistance of the potential divider must not be too high compared with that of the wattmeter shunt. By connecting an electrometer as in Fig. 9 exactly the same results are obtained, but the resistance of the potential divider is of no importance. A high degree of sensitiveness can be secured by applying a sufficiently high voltage to the quadrants of the electrometer, which can be done by transforming up if necessary. A large number of tests have been made by this method, which has given very good results with little trouble.

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* Loc. cit.

Measurements at Other Power Factors.—The voltage methods above described are equally applicable for loads of any power factor, provided that the series non-inductive resistance is replaced by a circuit of nearly the same and known phase displacement. If the load is inductive the difference between its phase displacement and that of a coil of known resistance and inductance can be made in exactly the same manner.

III.—Wattmeter Null Methods.

There are two ways in which a zero method of reading can be secured with a wattmeter: either by obtaining currents in quadrature in the two coils, or by having a third coil or double wattmeter and balancing the torque between the moving and fixed coils produced by the load under test by passing a current in phase with that in the moving coil through the auxiliary coil. The latter forms the basis of nearly all the methods of Dr. Rosa.* He uses a wattmeter having two main coils magnetically similar. When testing the power factor of condensers the shunt coil and one of the main coils is connected to the condenser as for power measurement, but a current derived by various methods so as to be in phase with that in the swinging coil is circulated through the auxiliary fixed coil; the power factor then being simply the ratio of the auxiliary current to the condenser current when balance is secured. Dr. Rosa has made a number of careful measurements on Stanley condensers at about 1,200 volts, and obtains power factors approximating to 0 005, which is a very low value.†

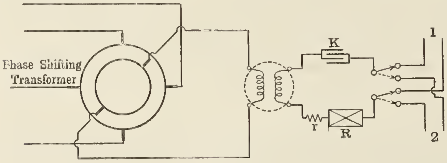

Fig. 10.

A very convenient method of measuring the power factor of condensers is to use a variable known inductance in the wattmeter shunt. This method has been employed by the writer, and also by Dr. Rosa. It involves, however, the use of a costly variable standard of inductance, which must be of suitable range for the wattmeter.

The writer has come to the conclusion that the simplest way of measuring small differences of phase at any power factor is the arrangement shown in Fig. 10. Here the wattmeter consists simply of a fixed and moving coil, with a mirror or pointer and zero mark. One of the coils is provided with some device for passing a steady current through it at any desired phase, while the other is in series with a resistance box and condenser. Since the condenser current is approximately in quadrature with the P.D. at its terminals the *shift of phase* introduced by a resistance, R, in series with it will be KpR radians, if R is small. In order, therefore, to find the difference of phase between any terminals 1 and 2 all that is necessary is to use a phase-shifting transformer, or any combination of resistances or inductances to get approximate balance of the wattmeter—*i.e.*, approximate quadrature of the currents in the coils. By altering the small rheostat r exact balance can be obtained with circuit 1, and the switch is then thrown over to 2, and resistance inserted in the box R till balance is again secured. This resistance, multiplied by the quantity Kp, which is a constant for a given frequency, gives the phase difference directly, without any measurements of voltages or currents. The writer is having the single-pivot galvanometer of Mr. Paul modified to form a wattmeter, or, more strictly, a quadrature detector, and hopes to be able to make a very simple direct-reading device for phase-difference measurements in this way. The measurements of such small phase differences are likely to be of great commercial importance in connection with cables, instruments, and transformers.

In a succeeding article the writer proposes to give some measurements of phase displacements produced by resistance coils, transformers, and electrolytes made by these methods.

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* *Loc. cit.*

† *cf.* "Dielectric Losses in Condensers and Cables," by C. V. Drysdale. *The Electrician*, Vol. XLVI., p. 890.

ON THE ELECTRIC INDUCTIVE CAPACITIES OF DRY PAPER AND OF SOLID CELLULOSE.*

BY ALBERT CAMPBELL, B.A.

(From the National Physical Laboratory.)

Although dry paper is widely used as a supporting and insulating material in telephone cables, the published data with regard to its specific inductive capacity (or permittivity) appear to be very meagre. For this reason Mr. Gavey, C.B., Engineer-in-Chief of the Post Office, asked us to investigate the matter, and sent for test a large number of samples of paper obtained from four different cable manufacturers. All the samples consisted of what is known as "chemical wood paper," presumably free from lignified fibre. This type of paper, according to the Society of Arts Report on the Durability of Papers, is better in lasting quality than "mechanical wood paper" or paper made from straw, jute, or esparto grass. Mr. Gavey, in addition, has kindly supplied the results of some tests on actual cables and further data for some of the samples of paper. This information is embodied in Part II. of the present paper.

Part I.—Tests on Dry Paper.

One of the main difficulties in the testing of paper lies in the fact that it absorbs moisture so readily; and the presence of moisture has a large effect on the specific inductive capacity and an enormous effect on the insulation resistance. The nature of these effects is well illustrated by the curve in Fig. 6 (in Part II.), which shows how the capacity increases and the resistance decreases as a well-dried cable is allowed to absorb moisture from the atmosphere.

Methods of Testing.—In all cases small squares of the samples (each about 10×10 cm.) were dried in an electrically-heated oven, the mean temperature of which was kept at about 110°C. The dry paper was then made to form a part of the dielectric of a small plate condenser and the capacity of this was measured. Two distinctly different arrangements were used in forming the small condenser, and two series (A and B) of results were obtained. In the first method (A), the specimen to be tested was placed while still hot between indiarubber discs (of area 50 sq. cm.) covered with tinfoil also dry and warm. A weight of 15 kg. was placed on the upper disc (being insulated from it) and the resulting condenser was tested as it cooled down. In method (B)† a small air condenser was formed from two well-trued circular brass surface plates (each of area 50 sq. cm.) placed horizontally and separated from one another to a distance of about 0·6 mm. by three very small accurately-gauged distance pieces of ebonite. This small condenser was kept in a desiccator, and out of this the leads were carried in an air-tight manner through ebonite tubes ringed with sulphur for better insulation. The capacity of the air condenser was first measured and then the dry sheet of paper was slipped between the plates and the altered capacity was tested. From these measurements the specific inductive capacity k of the paper was deduced as follows:—

Let b = distance between the plates;
$= b_1 + b_2$, where b_1 and b_2 refer to air and paper respectively;
s = area of paper between plates.

Let K_1 and K_2 be the observed capacities. If K = capacity for area s with air only, then, neglecting edge action,

$$K = \frac{s}{4\pi b \times 900{,}000} \text{ mfd. and is thus known; let } K = \frac{a}{b}.$$

$$\text{Now} \qquad K_1 = x + \frac{a}{b}, \quad \text{and} \quad K_2 = x + \frac{a}{b_1 + b_2/k}.$$

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* Paper read before the Royal Society.

† This method was used by Mr. Packer, of the British Insulated Wire Co., in a series of paper tests made in 1901.

Let $$Q=\frac{K_2-x}{K_1-x};$$

then $$Q=\frac{b}{b_1+b_2/k},\quad\text{or}\quad k=\frac{b_1}{b/Q-b_1}.$$

Hence $$k=\frac{K_2-K_1+K}{Kb_2/b_1-K_2+K_1}.\quad.\quad.\quad.\quad.\quad.\quad(1)$$

Measurement of Capacity.—The measurements of capacity were made by Maxwell's method,* the connections being shown in Fig. 1.

By a rotating contact-maker, the moving part of which is represented by m, the condenser p is charged and short-circuited with a frequency of n per second; during the charge only it forms one arm of the Wheatstone's bridge shown. A moving coil galvanometer of slow period is used, the resistance r is set so as to give nearly a balance, and then the speed of the contact maker is kept at such a value as to hold the light spot at zero. The capacity was calculated by the usual formula, a deduction being made for the capacity of the commutator and leads (found by a blank experiment). The voltage used was about 40 volts.

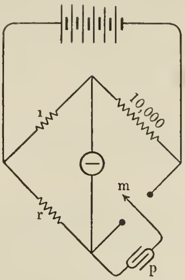

FIG. 1.

Correction for Conduction.—In nearly every instance readings were taken with at least two frequencies (usually about 20 and 40 ∾ per second). Sometimes the apparent capacity was found to vary with the frequency, being greater at the lower frequency; this is due to conduction in the condenser, which behaves as a pure capacity shunted by a high resistance. When the conduction was not negligible, a correction for it was applied, the capacity and resistance being separated in the following way:—

Let K and R be the true capacity and resistance respectively; and let K_1 and K_2 be the apparent capacities for frequencies n_1 and n_2.

The commutator inserts the condenser in one arm of the bridge during a certain fraction of each revolution; let this fraction $=\sigma$. The value of σ may be obtained by measurements at the rim of the commutator.

We have $$\frac{\sigma}{n_1R}+K=K_1,\quad\text{and}\quad\frac{\sigma}{n_2R}+K=K_2.$$

Hence $$K=K_1-\frac{n_2}{n_1-n_2}(K_2-K_1),\quad.\quad.\quad.\quad.\quad.\quad(2)$$

and $$R=\frac{n_1-n_2}{n_1n_2}\left(\frac{\sigma}{K_2-K_1}\right).\quad.\quad.\quad.\quad.\quad.\quad(3)$$

In order to test these formulæ a condenser of capacity 1·011 mfd. (with high insulation) was shunted (*a*) by 100,000 ohms, (*b*) by 10,000 ohms, and the apparent capacity in each case was measured for two frequencies (about 14 and 38 ∾ per second). Case (*b*) was chosen as an extreme one, the apparent capacities rising to about 2·3 mfd. and 4·7 mfd. respectively. The values of K obtained by equation (3) from tests (*a*) and (*b*) were 1·020 mfd. and 1·009 mfd. respectively.

From (*a*), taking $R=0{\cdot}1$ megohm, σ was found, by equation (3), to be 0·463, whilst measurements of the commutator gave $\sigma=0{\cdot}446$. From the results of (*b*), using $\sigma=0{\cdot}463$, the equation gave $R=0{\cdot}00100$ megohm, agreeing with its known value. These results show that even in extreme cases the equations (2) and (3) may be used.

Test with Small Air Condenser.—The capacities which had to be measured were all very small, being from 0·0002 mfd. to 0·001 mfd., and the correction for the leads and commutator amounted to about 0·00001 mfd. Besides, no correction was applied for the edges of the plates,† which were without guard rims.

For these reasons the method was checked by applying it to test a small air condenser, the capacity of which was of the same order as the paper condensers to be tested This air condenser was built up of two pieces of plate glass (each of about 100 sq. cm. area) silvered on the sides that faced one another, and separated by minute distance pieces of ebonite or dry paper. The distance between the plates was from 0·03 cm. to 0·05 cm., and was measured by gauging the distance pieces. The conduction by surface leakage over the distance pieces was relatively considerable, and had to be corrected for as described above. The values found by experiment were compared with those calculated from the measured dimensions, and the agreement was quite satisfactory, *e.g.*:—

Calculated, mfd.		Observed, mfd.
0·000243	....	0·000244
0 000153	....	0·000153

Measurement of Thickness.—The thickness of each sheet was tested immediately after the capacity measurements. As the surface of the paper presents much irregularity, it is a very difficult matter to find the average thickness. After several other arrangements had been tried it was decided that an ordinary screw gauge was as good as any, and it was used throughout. The contact ends of this gauge had each an area of about 0·2 sq. cm., while the safety ratchet head applied a pressure of about 1 kg. per square centimetre. As this pressure is about three times that applied to the indiarubber discs in method (A), it is probable that the increased compression will tend to make some allowance for the tinfoil penetrating the irregularities of the paper surface.

Results of Tests.—In Table I. are given some of the results. A few of the samples were tested by method (A), both with a single sheet and with a pile of three sheets; the latter tests are included in the table.*

Table I.

Sample number.	Approximate thickness.	Specific inductive capacity.		
		By tinfoil clamps.		By plate condenser.
		From 1 sheet.	From 3 sheets.	
	mm.			
14	0 08	2·5	2·6	..
15	0·12	1·8	..	1·8
54	0 13	1·9	1·9	..
49	0·18	2·1	2·2	..
9	0 19	2·3	..	2·1
17	0·25	1 9	..	2·0
18	0·25	2 0	..	1·8
56	0·28	1·8	..	1·7
58	0 28	2·0	..	1·9
2	0 5	2 2	2·3	..

From the foregoing table it will be seen that the two methods show as good agreement as could be expected from the nature of the material, but there is considerable variation from sample to sample. By weighing six samples it was found that their specific capacities were nearly in the order corresponding to that of their densities, which varied from 0·55 to 0·78. It was suggested that it would be of interest to compare the above values of specific inductive capacity with that for solid cellulose. As no data for the latter appeared available, a research (which forms the third part of this Paper) was undertaken upon the electrical properties of solid cellulose. Its specific inductive capacity was found to be about 6·8. Now, when the cellulose fibres (which we shall assume to form the whole solid part of the paper) are assembled with a certain amount of air space between them, the specific inductive capacity k_p of the resulting paper depends very largely upon the relative arrangement of the air and the cellulose. The following simple investigation will illustrate this point:—

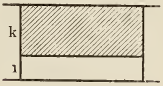

FIG. 2.

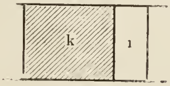

FIG. 3.

Let d = density of cellulose (about 1·50), D = that of paper, 0 = that of air, q = ratio of cellulose volume to air volume.

Then $$q=\frac{D_1}{d-D_1}=\frac{D_1}{1{\cdot}50-D_1},\quad.\quad.\quad.\quad.\quad.\quad(4)$$

and thus q can be found by experiment.

Now, for a given value of q, it will be found that k_p is least when the cellulose and air are in strata parallel to the condenser coatings, and greatest when these strata run at right angles to the coatings. These cases are represented sufficiently by Figs. 2 and 3. Let k_1 and k_2 be the resulting specific inductive capacity in these cases respectively.

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* As used by Prof J. J. Thomson, Mr. Searle, Dr. Glazebrook and others.

† It appears that no complete mathematical treatment of the simple plate condenser has yet been carried out.

* A sample of special black paper (partly parchmentised), kindly supplied by Mr. Clayton Beadle, gave $k=2{\cdot}3$.

It is easy to show that

$$k_1=\frac{(1+q)k}{q+k}, \quad \ldots \ldots \quad (5)$$

and

$$k_2=\frac{1+kq}{1+q}. \quad \ldots \ldots \quad (6)$$

By weighing and gauging a number of the samples the value of q was found for each; from these values the minimum and maximum k_1 and k_2 were calculated. From Table II. it will be seen that the actually observed values of k_p all lie below the mean of k_1 and k_2. This indicates (electrically) that the fibres of cellulose are arranged more in a direction parallel to the surfaces of the paper than at right angles to it, which is otherwise known to be the case.

Table II.

q.	k_1.	k_2.	$\frac{1}{2}(k_1+k_2)$.	Observed k_p.
0·577	1·45	3·12	2·28	1·93
0·629	1·49	3 23	2·36	1·89
0·843	1·64	3·65	2·70	2·21
0·930	1·70	3·79	2·75	2·25
1·078	1·79	4·02	2 90	2·30

It is clear that the law of mixtures found by L. Silberstein[*] does not apply here.

Table II. is of interest in connection with practical telephone work in which the lowest possible value of the mean specific inductive capacity is aimed at. From the values of k_1 and k_2 we see that the mean resultant k depends very much on the relative positions of the paper fibres and the air spaces. The numbers in Table I. give about 2·0 as a mean value for the specific inductive capacity of dry telephone paper, and this is in fair agreement with results already published by other observers. Signor E. Jona, by testing dry paper between metal plates, found k approximately equal to 2·0. Herr M. S. von Pirani[†] gives $k=2·0$ to 2·6, but he does not indicate clearly the conditions of his tests.

Part II. (supplied by Mr. Gavey).—Additional Data and Tests on Cables.

The undermentioned samples of oven-dried paper have been tested, with the results shown in the following table:—

Table III.

Sample number.	Weight of ash, per cent.	Proportion by volume.	
		Fibre, per cent.	Air space, per cent.
9	1·37	49·0	51·0
15	1·45	35·0	65 0
17	1·80	36·0	64·0
18	1·11	36 5	63·5
56	0 96	32·5	67·5
58	1·70	36·0	64·0

The thickness of the papers was measured with a screw gauge which exerted a pressure of about 1·5 kg. per square centimetre on the paper when the safety ratchet was used. It was found that the thickness of the paper measured with this pressure, and also with that of a light touch with the fingers on the screw gauge, differed by 10 per cent.—*i.e.*, the air space figures given above would have been 6 per cent. higher if the ratchet were not used. It was also found that the thickness of the paper when several sheets were measured together was 2 to 3 per cent. less than when measured in single sheets.

The method finally adopted was to measure single sheets, using the ratchet referred to above, which it was thought would approximate as closely as was possible to the conditions observed by the National Physical Laboratory.

The figures used for the density of fibre and ash were 1 5 and 2·0 respectively. From the weights per cubic centimetre and the respective densities, the volume of fibre and air space in each paper was calculated.

The samples of paper, although classed commercially as "Manilla" papers, on microscopic examination proved to be composed of mixtures of chemical wood pulp and hemp in different proportions. There was no trace of lignified fibres or mechanical wood. The minimum breaking stress specified by the Post Office for papers of this class is 4,000 lb. per square inch, but 7,000 lb. per square inch is about the average value obtained (*i.e.*, about 490 kg. per square centimetre).[‡]

With the kind assistance of Messrs. W. T. Henley's Telegraph Work Co. (Ltd.) an attempt has been made to determine the effect of temperature on the electrical properties of the combination of air and dry paper as found in telephone cables. The results are indicated graphically in the curves in Figs. 4 and 5, showing the variation of insulation resistance and capacity respectively with temperature.

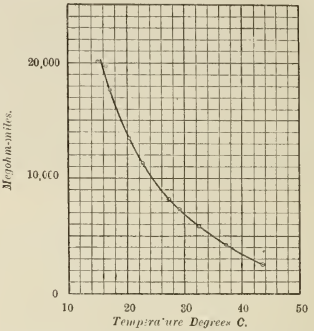

Fig. 4.—Variation of Insulation-Resistance with Temperature in Air Space Paper Core Cable (P.O.).

The proportion of air space and paper in the cable to which these tests refer was approximately 36 per cent. air, 74 per cent. paper.

The curve in Fig. 6 was obtained with the kind assistance of the British Insulated & Helsby Cables (Ltd.), and shows the variation of capacity with the amount of uniformly distributed moisture in a cable as measured by the insulation resistance. Each wire in this cable was insulated with paper, and then covered with a copper tape wrapped on spirally. The cable was tested before being sheathed with lead, the copper tape making a sufficiently good earth.

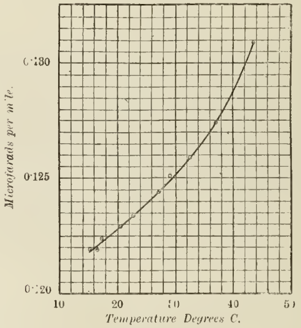

Fig. 5.—Variation of Capacity with Temperature in Air-spaced Screened Cable (Post Office Type).

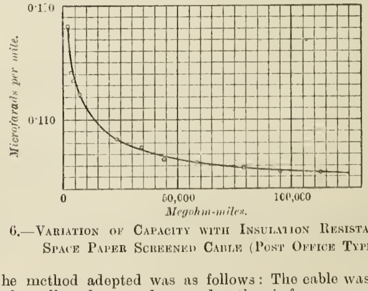

Fig. 6.—Variation of Capacity with Insulation Resistance in Air Space Paper Screened Cable (Post Office Type).

The method adopted was as follows: The cable was first dried and then allowed to stand exposed to the air for over a week. The moisture in the air penetrated through the interstices in the copper tape, making the paper damp, and tests were taken periodically to determine the capacity and insulation resistance. The ends were kept well waxed, and tests taken with and without a guard wire showed there was no leakage at the ends.

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[*] *Wied. Ann.*, Vol. LVI., p. 661, 1895. [†] *Berlin Dissertation*, 1903.

[‡] The construction of a paper-screened telephone cable is as follows: The conducting wires are wrapped loosely in longitudinal (not spiral) strips of thin paper; two or more wires thus covered are placed together and thoroughly dried in an oven. While they are still dry and warm a covering of lead is applied by a lead press, and in this way the moisture from the outside air is excluded. The paper merely acts as a mechanical separation between the conductors (and the lead sheath). As the lowest possible electrical capacity is desirable, anything that tends to decrease the permittivity of this separating medium is of practical advantage.

The proportion of air and paper in this cable was about 31 per cent. air, 69 per cent. paper.

The capacity in each case was measured by the comparison on a galvanometer of the charge deflection from the cable with that from a standard condenser. No correction has been applied for leakage, but the error was found to be about 1½ per cent. on the capacity corresponding to 5,000 megohm miles, and 2½ per cent. on the capacity corresponding to 2,000 megohm miles. This would reduce the alteration in the temperature-capacity curve between the limits of temperature shown from 7½ to 5 per cent.

It is suggested that the reason of the alteration in the capacity with increasing temperature may in some part be due to the absorption of the moisture in the paper by the hot air, thus altering the distribution of the dielectrics in the cable. This view is somewhat borne out by the fact that another cable which was dried to an insulation resistance of 140,000 megohm-miles, and therefore contained less moisture, has only 2 per cent. difference in the capacity between the same limits of temperature.

(*To be continued.*)

THE VALUE AND EFFECT OF HIGH-EFFICIENCY INCANDESCENT LAMPS.*

BY F. W. WILLCOX.

We are face to face with epoch-making developments in the electric incandescent lamp, by which, without reduction in life, materially higher efficiencies are obtained, and still higher efficiencies are in prospect.

The discovery by Dr. Whitney at the General Electric Co.'s research laboratory of the so-called "metallising" or graphitising of carbon filaments has already given a veritable 2·5 w.p.c. filament, with promise of still higher efficiencies to come. The discovery and development of the tantalum filament gives a practical lamp of an efficiency of 2 w.p.c., which is now in regular commercial production in Germany and will soon be manufactured in this country. Experiments carried on in this country and Europe indicate the possibility of manufacturing a 1·5 w.p.c. or even a 1 w.p.c. lamp so that there is a substantial basis for the belief that within a few years such lamps will be on the market. For the purpose of this Paper, however, the question of who invents the lamps, or when they will become marketable, is immaterial. The point is that they are a commercial possibility to be reckoned with in the future.

These remarkable developments possess naturally a special and vital interest to every electric lighting company, and it behoves each central-station manager to study the effects that will follow from the introduction of higher-efficiency lamps and to consider what policy it is wisest and best for them to adopt.

Anyone would naturally expect electrical men to rejoice over an advancement in the art by which the electric incandescent lamp may be enabled to hold its own against the Welsbach and other improved competitive illuminants, but there are some central-station managers who regard the higher-efficiency lamp as not an altogether unmixed blessing. Even when regarded favourably, opinions as to the value of higher-efficiency lamps and the effects that will be produced by them differ very greatly among central-station managers.

The time is ripe, therefore, for a full discussion of this very important question. The endeavour will be made in this Paper to present a clear analysis of the situation, so that the deducible results can be correctly traced. This analysis, in connection with costs and data on the new improved lamps, will provide a good basis for the study and discussion of the conjectural effects on the electric lighting business. The new General Electric metallised, or G.E.M., filament lamp, as it is termed, will be taken as the subject for this discussion.

The G.E.M. filament gives a lamp with a mean initial horizontal efficiency of 2·5 w.p.c. and a useful life practically the same as the present 3·1 w.p.c. lamp, so that it saves 20 per cent. in energy consumed for the same life and candle-power service, and it gives 25 per cent. more candle-power for the same energy consumed and equal life and candle-power maintenance. In Fig 1 are given two curves of efficiency and life for the ordinary lamp and for the G.E.M. The probable cost of the new lamps will be more than the cost of the present lamps, and for the purpose of this Paper we will take the cost of the 16 c.p. to 20 c.p. G.E.M. filament lamp as 20 cents, as compared with 16 cents for the present lamp, in order to have a definite basis for calculation. From this information as to the lamp we can determine the saving the new lamp will secure to users, and therefore its value.

Value of the High-efficiency Lamp to the Consumer.—The saving to the consumer paying for current on a regular meter basis is readily calculated. Assuming that the central station is supplying free renewals of the present 3·1 w.p.c. lamps, we find that the consumer could buy his own renewals of the new 2·5 w.p.c. lamps at 25 cents each and save money at all rates above 5 cents per kilowatt-hour.

In the case of the isolated plants of the country the substitution of the new 16 c.p. lamp of the same useful life as the present 16 c.p. 3·5 w.p.c. lamp would result in an annual saving of over $1,000,000, covering power and apparatus costs. The additional annual cost for lamp renewals of the new lamp would not, however, exceed one-fourth of this saving.

Value to Central Station Companies.—The value of a higher-efficiency lamp to central-station operating companies is a complicated question. With companies selling current by meter at various rates per kilowatt-hour and limited to the same number and candle-power of lamps supplied, and the same hours of use, there would theoretically appear to be somewhat of a reduction in income, and a somewhat increased cost of lamp renewals, but as I will show later I do not expect to see the income reduced, but on the contrary largely increased.

Where companies are selling by the lamp-hour, or flat rates per lamp per month, the new higher-efficiency lamps have a distinctly positive value. This value lies in the saving a higher-efficiency lamp will secure (for a given lighting output) in the station capacity and in generating costs that are strictly proportional to the output.

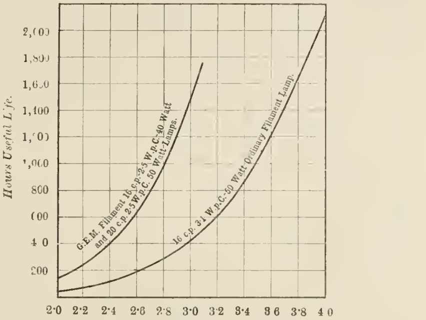

FIG. 1.—USEFUL LIFE CURVES OF NEW GEM-FILAMENT LAMP AND PRESENT CARBON-FILAMENT LAMP.

This saving is made up of two items:—

(*a*) The saving in generating costs that are strictly proportional to the output.

(*b*) The saving in fixed charges on the investment in generating equipment.

As regards the generating costs that are strictly proportional to the output, the principal item is boiler fuel. Engine and boiler-room labour and repairs are affected slightly. Assuming that boiler-room labour alone is affected, it would be about the equivalent of the slight changes in various other expenses. So that we can take fuel and boiler-room labour costs to represent the total of those generating costs that are strictly proportional to output, and calculate therefrom the value of the current consumed by the new high-efficiency as compared to the present lamp. These costs should be taken at their value at the lamp—*i.e.*, the costs obtained by dividing the fuel and boiler room labour costs for incandescent lighting by the output delivered and metered at the lamp.

For this purpose let us assume several values for fuel and boiler-room labour costs per kilowatt-hour of current delivered at lamp—viz., 1 cent, 0·5 cent and 0 cent per kilowatt-hour, covering the cases of steam-operated plants down to water-power plants, for which these charges are taken as nothing.

With respect to the saving in fixed charges, the items are taxes, interest and depreciation on boilers, engines and dynamos. Should a station introduce higher-efficiency lamps, say a 40 watt lamp for a 50 watt lamp, it would have available for the same number of lamps supplied 20 per cent. more capacity of generating equipment. This added capacity of apparatus, considered as an asset, might be converted into cash to reduce investment account; or, more logically, it would serve to provide needed capacity for increased business. As time goes on and the demand for light increases, this excess station capacity is realised on without adding to investment, and therefore central stations can consider this a saving.

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* Abstract of a Paper read before the National Electric Light Association at New Jersey in June.

We can take taxes, interest and depreciation charges at a total of 12 per cent. The investment per kilowatt for the increment or decrement of generating equipment will vary for different stations, but we can assume $125 as a safe value. On this basis we obtain, with our total fixed-charge percentage of 12 per cent., $15 per year as the fixed charge per kilowatt of station capacity.

This annual fixed-charge cost of $15 per kilowatt can be reduced to the value per lamp per year as shown in the following table :

Lamps considered.	Useful life in hours.	Lamps per kw.	Candles per kw.	Fixed charge cost per year in cents. Per lamp.	Fixed charge cost per year in cents. Per 1,000 candles.
G.E.M. filament lamp, 16 c.p., 40 watts	500	25·0	400·0	60·0	37·5
Ordinary filament lamp, 16 c.p., 50 watts	500	20·0	320·0	75·0	46·8
G.E.M. filament lamp, 20 c.p., 50 watts	500	20·0	400·0	75·0	37·5
G.E.M. filament lamp, 16 c.p., 45 watts	1,000	22·2	355·5	67·5	42·2
Ordinary filament lamp, 16 c.p., 56 watts	1,000	17·84	285·4	84·0	52·5
Tantalum filament lamp, 25 c.p , 50 watts	800	20·0	500·0	75·0	30·0

The Cost of Producing a Candle-hour of Light with Lamps of Different Efficiencies.—To determine the cost on the candle-*hour* or kilowatt-*hour* basis it is necessary to determine how long the lamps are used. For this purpose we can assume several values for the annual hours' use of lamp per year and determine the candle-hour cost therefrom by dividing the fixed charge per 1,000 candles (in above table) by the assumed hours' use per year. We can now make up a table, giving for the lamps of various efficiencies the lamp-renewal costs, fixed-charge costs, fuel and station labour costs, and their sum or total cost for the assumed hours' use of lamp per year. This basis is the theoretically correct one, as it covers the change in candle-power of lamp.

If we take the cost of the present 16 c.p. 50 watt carbon filament lamp as a basis of 100 per cent., and plot the values for the other lamps under comparison in percentages of the present 16 c.p. 50 watt lamp for different hours' use per lamp per year, we obtain these results graphically, as shown in Fig. 2. In studying this diagram it should be noted that the average hours' use per lamp by consumers does not in general exceed 1,000 hours per year or three hours per day.

Effect upon the Question of Selling Light by the Kilowatt-hour.—This is an interesting comparison of values of lamps of different efficiencies, but it must not be overlooked that the basis of comparison assumed is equal light or number of lamps. The comparison is a true one for a factory, or building, or a street railway, requiring a certain lighting result without reference to any sale to consumer. Where central stations are selling by the lamp or candle-hour, this comparison also holds for actual results. Unfortunately, however, the majority of central-station selling is done by the kilowatt-hour, so that our actual comparisons of the new and present lamps must be made on the basis of kilowatt-hours absolute instead of by kilowatt-hours per lamp or by candle-hours.

On the absolute kilowatt-hour basis with load factor unchanged, the change to higher-efficiency lamps would theoretically appear to increase the central-station kilowatt hour costs by the slight amount of increase in cost of lamp renewals for the new lamp. For the same light and hours of use the total kilowatt-hour output with higher-efficiency lamps would be reduced and the total cost probably in a similar proportion, so that the cost per kilowatt-hour would not theoretically be reduced, but might remain either unchanged or slightly increased. So far as the central station is concerned with a given output in kilowatt-hours to sell, and paid for only by the kilowatt hour, it would appear to make practically no difference in the economy of the station whether it be sold in high or low-efficiency lamp units (or in high or low candle-power units), except in cost of lamp renewals.

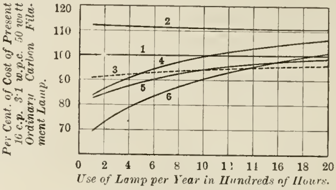

FIG. 2.—CURVES SHOWING RELATIVE COST OF PRODUCING A CANDLE-HOUR OF LIGHT WITH LAMPS OF DIFFERENT EFFICIENCIES. EXPRESSED IN PER CENT. OF COSTS GIVEN WITH PRESENT 16 C.P. 3·1 W.P.C., 50 WATT LAMPS.

Fuel and station labour costs. 1 cent. per kilowatt-hour.
Lamp costs—New G.E.M. filament, 20 cents.
Tantalum ,, 60 cents.
Present ,, 16 cents.
1. Present carbon-filament, 16 c.p. 3·1 w.p.c. 50-watt lamp.
2. ,, ,, ,, 16 ,, 3·5 ,, 56 ,,
3. New G.E.M. ,, 16 ,, 2·8 ,, 45 ,,
4 ,, ,, ,, 16 ,, 2·5 ,, 40 ,,
5. ,, ,, ,, 20 ,, 2·5 ,, 50 ,,
6. Tantalum ,, 25 ,, 2·0 ,, 50 ,,

Table Showing Relative Costs of Producing a Candle-hour of Light with Incandescent Lamps of Different Efficiencies Covering Lamp-renewal Costs and those Station Costs which would be Effected by Change in Lamp Efficiency for the same Amount of Light Supplied.

Lamps compared.	(1) First cost of lamp in cents.	(2) Efficiency of lamp in w.p c.	(3) Useful life in hours.	(4) Fixed charge cost in cents per lamp per yr.	(5) Cost in cents of lamp renewals per 1,000 c.p.-hrs.	(6) Fixed cost in cents per 1,000 c.p.-hrs. on the basis of use of lamp for 100 hrs. per yr.	(6) 1,000 hrs per yr.	(7) Fuel & station labour expense in cents per 1,000 c.p.-hrs. at different assumed costs per kw.-hr.	(8) Total costs in cents per 1,000 c.p. hrs. on the basis of use of lamp for 100 hrs. per yr.	300 hrs. per yr.	500 hrs. per yr.	1,000 hrs per yr.	1,500 hrs per yr.	2,000 hrs per yr.
G.E.M. filament 40 watt lamp, 16 c.p. 2·5 w.p.c.	20	2·5	500	60·0	2·50	37·5	3·75	@ 1c. = 2·5 c.	42·50	17·50	12·50	8·75	7·50	6·875
								@ ½c. = 1·25c	41·25	16·25	11·25	7·50	6·25	5·625
								@ 0c. = 0 00c.	40·00	15·00	10·00	6·25	5·00	4·375
Ordinary carbon filament 50 watt lamp, 16 c.p. 3·1 w.p.c.	16	3·1	500	75·0	2·00	46·8	4·68	@ 1c. = 2·11c.	50·91	19·71	13·47	8·79	7·23	6·450
								@ ½c. = 1·05c.	49·85	18·65	12·41	7·73	6·17	5·390
								@ 0c. = 0·00c.	48·80	17·60	11·36	6·68	5·12	4·340
G.E.M. filament 50 watt lamp, 20 c.p. 2·5 w.p.c.	20	2·5	500	75·0	2·00	37·5	3·75	@ 1c. = 2 50c.	42·00	17·00	12·00	8·25	7·00	6·375
								@ ½c. 1·25c.	40·75	15·75	10·75	7·00	5·75	5·125
								@ 0c. = 0·00c.	39·50	14·50	9·50	5·75	4·50	3·875
G E.M. filament 45 watt lamp, 16 c.p. 2·8 w.p.c.	20	2·8	1,000	67 5	1·25	42 2	4 22	@ 1c. = 2·82c.	46·27	18·07	12·47	8·29	6 87	6·180
								@ ½c. = 1·41c.	44·86	16·66	11·06	6·88	5·46	4·770
								@ 0c. = 0·00c.	43·45	15 25	8·24	4·06	2·64	1·950
Ordinary carbon filament 56 watt lamp, 16 c.p. 3·5 w.p.c.	16	3 5	1,000	84 0	1·00	52·5	5 25	@ 1c. 3·50c.	57·00	22·00	15·00	9·75	8 00	7·125
								@ ½c. = 1·75c.	55·25	20·25	13·25	8·00	6·25	5·375
								@ 0c. = 0·00c.	53·50	18·50	11·50	6·25	4·50	3·625
Tantalum filament 50 watt lamp, 25 c.p. 2·0 w.p.c.	60	2·0	*800	75 0	3 00	30·0	3·00	@ 1c. 2·00c.	35·00	15·00	11·00	8·00	7 00	6·500
								@ ½c. = 1·00c.	34·00	14·00	10·00	7·00	6·00	5·500
								@ 0c. = 0·00c.	33·00	13·00	9·00	6·00	5·00	4·500

* Approximate value on direct current.

The figures in column 6 are proportional to the hours of use, and those in column 8 are the sum of those in 5, 6 and 7. Thus for the ordinary carbon filament 50 watt 16 c.p. 3·1 w.p c., assuming 1 per cent. per kilowatt-hour for fuel and station labour expenses, we have the following total costs in cents per 1,000 c p.-hours, for the number of hours' use of lamp per annum as given :—

100 hrs.	300 hrs.	500 hrs.	800 hrs.	1,000 hrs.	1,500 hrs.	2,000 hrs.
50·91 ..	19·71 ..	13·47 ..	9·91 ..	8·79 ..	7·23 ..	6·45

From the station-cost standpoint, therefore, the logic of the situation would seem to point to the use of the lamp of the lowest renewal cost, *i.e.*, the extreme of low-efficiency lamps. But from the point of view of business success, a high-efficiency lamp is important. Whether a central station supplies free lamp renewals or not, and whether its costs are thereby changed or unaffected, the success of the business demands the lowest practicable cost to consumer—that is, it requires the use of high-efficiency lamps—of that efficiency which gives the lowest cost of light (including power and lamp renewals) at the rate paid.

The value, then, of the new 2·5 watt lamp (or any higher-efficiency lamp) lies in the general stimulus it will give to the growth of electric light service resultant from the 20 per cent. improvement in efficiency for the same candle-power (or a 25 per cent. increase in light for the same wattage), equivalent to a 20 per cent. reduction in rates. This value is, in a measure, of course, conjectural, as it cannot be fully and definitely determined, but it should be none the less an actual and positive value. The new lamp will enable central stations (now on a free-renewal basis), by increasing their total expense only about 1 per cent., to give an equal volume of light at 20 per cent. lower cost to their consumers, or 25 per cent. more light for an equal expenditure.

The value of this improvement in service in meeting and resisting competition, in adding desirable business, in improving the load factor and in increasing net earnings—this is the important point of the whole question, which should be fully discussed from the point of view and experience of central-station managers.

It will assist here, perhaps, to consider the general question of what constitutes the best efficiency for central-station service. In my Paper on the subject of efficiencies before the 1902 Convention I stated the following:—

"The best efficiency for central-station service is the one securing the greatest amount of net earnings. Net earnings are the product of per cent. of profit by amount of business. There is a point of balance between these two factors at which their product, the net earnings, becomes a maximum.

"The largest profits are not secured by exacting the highest per cent. profit, but, on the contrary, are generally secured by low prices and small per cent. of profit, thereby increasing the gross business and swelling the total profit. In other words, we are concerned not so much as to the cost of our commodity (costs may be, and frequently are, increased with advantage); not so much with per cent. of profit, but chiefly with so fixing the selling price, and pushing the business as to increase the sales to the point of securing the maximum profit.

"Applying this idea to the question of lamp efficiency, we would say that the most desirable efficiency is not the efficiency which will return the highest per cent. of profit from customers; but rather is it that efficiency which for any given rate will secure to the electric lighting company the greatest amount of profit, swelling the gross profitable business, not only by augmenting the number of lamps connected, but also by increasing the average hours of use so as to bring in the fullest net returns."

It is particularly in the improvement in load factor through increased hours of use resulting from reduced costs of lighting that central-station companies can look for the improvement in their net earnings.

The general effect of reduction in rates should cause a broadening of load peaks and consequent material improvement in load factor. This would seem to be so because, if the cost of electric lighting is reduced to an equality with gas and other illuminants, it should insure a more extended use of electric light fully equal to that obtained by any other illuminant.

(*To be concluded.*)

LARGE WATER-POWER PLANT AT DULUTH, U.S.A.

The water-power plant now under construction at Duluth, Minnesota, for the Great Northern Power Co., which is described in the *Electrical World*, is a good example of the present trend towards the use of a small number of large units and general simplification of arrangement noticeable in many modern power houses. The undertaking is of considerable size, and when complete the total power distributed will amount to 200,000 H.P., of which the present station will supply 80,000 H.P. The first instalment of plant, now being put in, is for 30,000 H.P. The district to be served by the company is rich in industrial opportunities, containing some of the most important iron mines in the United States, as well as copper mines. A considerable demand for power may also be expected from the large harbours and docks of Duluth and Superior, as well as for railways, lighting and ordinary power purposes. Water is taken from a point on a lake on the St. Louis river, 2·8 miles from the power house. About 2 miles of the course is canal and forebay. Over the remaining distance the water is carried through about 3,800 ft. of wood stave pipe and about 1,000 ft. of 7 ft. steel pipe for each waterwheel unit. The difference in elevation between the forebay and the power house is 378 ft.

The power house is situated on the river itself. The generators are grouped on one side of the building, the transformers are in the centre, and on the opposite side from the generators are the high-tension 'bus bars, oil switches, lightning arresters, &c., arranged in fireproof cement compartments. In that part which will eventually be the centre of the building are two waterwheel-driven exciter units, with space provided for duplicate motor-driven sets.

The switchboard also occupies the centre of the building on a gallery or mezzanine floor from which the entire station can be seen at a glance. Behind the board, on the same level, are the low-tension 'bus bars and oil switches. Every switch is arranged for remote control from this benchboard, there being no heavy current wiring on the board.

The initial hydraulic apparatus consists of three turbine waterwheel units, each of 13,000 H.P. maximum output, built by the Allis-Chalmers Company after designs of Messrs. Escher-Wyss & Co., of Zurich. The generators are mounted on an extension of the vertical shaft of the waterwheels. Each consists of a 7,500 kw. three-phase 25 cycle 6,600 volt General Electric machine of the vertical type, similar to those at Niagara Falls. These generators are of the revolving-field type, and run at 375 revs. per min.

The total weight of the revolving field is carried by the step bearings and the hydraulic thrust piston of the waterwheel, the upper bearing of the unit serving merely to keep the revolving parts in alignment. This guide bearing is 15 in. in diameter and 30 in. long, and is split so that it can be easily removed. Lubrication is provided from a detached circulating oil system. Each generator is rated at 7,500 kw. at 375 revs. per min., but will deliver continuously 821 amperes at 80 per cent. power factor, at rated speed and at a potential of 6,600 volts. The rise in potential when a non-inductive load is thrown off is guaranteed not to exceed 8 per cent. with constant speed and excitation. Exceptionally high efficiencies have been obtained for these generators, the actual efficiency under test, including total losses for windage and friction, being 97·5 per cent. The total weight of the generator, including field, stationary armature and bedplate, is approximately 212,000 lb. Excitation current for the generators is furnished by separate waterwheel-driven vertical excited sets, each having a capacity of 250 kw. Two machines will be provided, which will take care of the eight main generators eventually to be installed. Each wheel is of the impulse type of 500 H.P. capacity. Each generator is an eight-pole 125 volt machine running at 500 revs. per min., and designed to withstand a speed of 1,000 revs. per min. The total weight of each machine is 16,200 lb.

Current from each of the main generators will be delivered to a single transformer, the largest three-phase high-voltage transformers ever built. Each transformer has a capacity of 7,500 kw., and owing to their large size embodies several new features of design. The transformers are oil insulated and water cooled, but no water enters the containing tank of the transformer; the heat is taken from the oil in a specially-designed surface cooler outside the transformer case. The warm oil is drawn from the transformer through this cooler by a pump, which also delivers the cooled oil to a compartment in the base of the core from which it rises through the core and windings, keeping the temperature within the fixed limit of a 35 deg. rise for a normal run. The oil in the transformer tank then rises to the level of an overflow pipe, through which it again returns to the cooler. This overflow pipe is equipped with a safety valve which closes if the oil level in the tank falls below that fixed as essential for proper insulation of the transformer. Fresh oil is supplied to the system from a tank located above the highest level of oil in the transformer. This supply tank is always connected to the system, and an oil pressure is thus maintained which is much greater than the pressure of the water used in cooling, and so precludes the possibility of the transformers being injured by water entering the oil pipes.

The transformer windings are arranged to step up the generator voltage (6,600 volts) to 30,000 or 60,000 volts for transmission as may be required. Each transformer is placed in a separate fireproof, air-tight compartment, and the low-tension leads are carried to the transformer from the controlling oil switch through wall insulators in the side of the transformer compartment, while the high-tension leads pass out through the back wall. The overall dimensions of each transformer are 14 ft. 10 in. high, 14 ft. long and 5 ft. wide. The total weight is 171,300 lb. each, and 4,800 gallons of oil are required for insulation. Six transformers will be installed, three at the generating station and three at the receiving station at Duluth.

All the main oil switches are electrically operated from a distance and are designed to be capable of opening on short-circuit with the entire completed plant in parallel. The 60,000 volt transmission lines are connected to the high potential 'bus bars by oil switches which will automatically cut out a short-circuited line when three or more lines are in parallel at both ends without interrupting the service over the remaining lines. The whole switching equipment is operated by remote control from a benchboard complete with indicating switches, instruments, &c. The instrument transformers are housed in separate compartments in the usual way, so that there is no high-tension wiring of any nature on the operating-board. The general arrangement of the complete board will be as follows:—At the centre is a station lighting panel, on the ends the panels for the motor-generators and waterwheel-driven exciters, and between these end panels and the centre panel, four generating panels governing the operation of the eight generators with their respective transformers. The compactness of the entire switching arrangement can be understood when it is stated that the whole switchboard for controlling 80,000 H.P. when completed will be less than 19 ft. in length.

At present two transmission circuits operating at a potential of 60,000 volts will run to Duluth on a steel tower line. The towers will be spaced 400 ft. to 500 ft. apart and have a central extension carrying a steel cable, the same size as the conductors, for lightning protection. Single pole lightning arresters, each with a choke coil and a disconnecting switch, all mounted on porcelain bases, are provided for each conductor.

THE MEASUREMENT OF THE CAPACITY AND INDUCTANCE OF TELEGRAPH LINES.*

BY M. DEVAUX-CHARBONNEL.

The accurate knowledge of the capacity and inductance of telegraph lines is indispensable for the study of the propagation of the current. These two elements play, indeed, a predominant part in the modern transmission processes, where the signals succeed each other with such rapidity that the continuous-current conditions are never attained. Their value has hitherto remained uncertain on account of the difficulties presented by their determination. We have to do with single-wire lines earthed at both ends, which take up the currents from industrial establishments, electric tramways or neighbouring telegraph offices. Besides, since the aerial arteries are in constant use, neighbouring wires interfere with each other. These two circumstances contribute to the creating of parasitic currents which interfere with the measurements.

Still, by taking certain precautions, it is possible to arrive at satisfactory results. Here is a method which was finally adopted after several trials:—

Capacity.—The capacity was measured by means of a ballistic galvanometer. The influence of parasitic currents was eliminated by operating with a high E.M.F. of about 100 volts, charging the wires and taking the mean of a large number of measurements.

The imperfections in the insulation had also to be taken into account. The charging current had to be abandoned from the first, for the waste current falsifies the reading, and it is impossible to determine the necessary correction. The discharge current of the line was therefore utilised. A portion of the charge disappears without traversing the ballistic galvanometer, during the time which the discharge key takes to move from the button corresponding to the battery to that corresponding to the galvanometer, and also during the time of the discharge itself. This last time is reduced as much as possible, and is made negligible by operating on short lines. As regards the loss occasioned by working the key, we have already indicated how this can be measured by means of a condenser. The time is about a thousandth of a second, and the corresponding correction is generally below 1 per cent.

The numbers obtained show that:

1. The capacity of aerial wires is greater than their theoretical value. This is due to the fact that the theory does not take into account the presence of neighbouring conductors other than the soil.

2. It varies with the moisture of the air, increasing in the wet, which is natural, since a greater number of surfaces near the wire become conducting.

I quote some figures in microfarads per kilometre:

	4 mm. wire.	5 mm. wire.
Theoretical capacity	0·0058	0·0060
Actual capacity, wet	0·0105	0·0120
,, ,, dry	0·0087	0·0090

Inductance.—The measurement of inductance is well-nigh impossible unless all direct connection with the earth is suppressed. Otherwise strong parasitic currents are superimposed upon the make-and-break currents of the battery and change it entirely.

A satisfactory experimental arrangement is obtained by means of a purely metallic coupling, consisting of two wires of different runs, but with a common termination. A Wheatstone bridge is used, with an adjustable inductance in the fourth branch. For making and breaking the circuit of the battery a rotary switch is used which reverses at every revolution the connections of the poles of the battery and of the galvanometer, so that the make-and-break currents always circulate through the latter in the same direction. The switch may revolve 60 times per second, which gives the arrangement some sensitiveness and greatly reduces the importance of the current induced by neighbouring wires.

But care must be taken that the inductance thus measured is not an apparent inductance. The capacity must be taken into account in order to get the true inductance. The correction amounts to $\frac{1}{3}KR^2$ for a homogeneous line earthed at both ends, if K and R are the total capacity and resistance. If the line includes sections of different specifications the correction is $\frac{K}{3R}(R_1{}^3 - R_2{}^3)$ for a section of capacity K and resistance R, with the two ends separated from the earthing device by resistances R_1 and R_2. How must these corrections be calculated when there is no earthing? The capacity being always measured with respect to the earth, the resistances must be determined with respect to that point of the line whose potential is zero. The position of this point is not known *a priori*. Preliminary experiments of earthing one point and changing its position have shown that a certain symmetry is established in the circuit, and that the point which equally divides the resistance of the line is that which is at zero potential in the absence of earthing.

Here follow the figures which we have found for copper lines, which are non-magnetic, in henrys per kilometre:—

Aerial lines	0·00205
Underground lines insulated with gutta-percha	0·00243
,, ,, ,, paper	0·00198

For iron lines the figures are higher, on account of the permeability of the metal. This permeability varies with the different specimens tested, and also with the current strength.

The following figures are deduced from the actual inductances of two iron lines:—

First line. Current.	μ	Second line. Current.	μ
5 milliamperes	112	10 milliamperes	140
20 ,,	75	35 ,,	91

In practice, the telegraphic currents are comprised between 20 and 30 milliamperes, so that on the average we may ascribe the value 80 to μ, which gives an inductance of 0·0060 henrys per kilometre.

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* Translated from the *Comptes Rendus*, 143, p. 112, July 9, 1906.

LEGAL INTELLIGENCE.

Evans and Another v. National Telephone Co.

At the City of London Court last week plaintiffs (Thos. Evans and his wife) sought to recover (under the Employers' Liability Act) £180 damages for the loss of their son (T. O. Evans), aged 18, who was killed while in the service of defendant company. Evans was working on some premises, fixing new stays to a telephone pole, when one of the stays gave way and he was thrown to the ground and killed. Plaintiffs alleged that the company did not exercise sufficient care, as they knew the stays were defective and were therefore dangerous. They were warned 12 months previously. It was urged that two men should certainly not have been sent up the pole as was done.

Defendants called many witnesses to show that the stay was not defective, that it had been in its present position for 10 years, and that its place was being altered because an adjoining building was coming down.

Judge LUMLEY SMITH said he believed the cause of the accident was sending two men up the pole. He believed the appliances were defective, but there was no evidence of negligence on the part of anyone for whom defendants were responsible. Judgment must therefore be given for defendants, with costs.

Plaintiffs then made a claim under the Workmen's Compensation Act, and the Judge said he would consider whether the case came within it; if it did not, he thought it would be better if it did.

Plaintiffs (it was stated) had refused an offer by the company of £60 in settlement.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited from candidates for vacancies on the staff of the civil and mechanical engineering department of the Central Technical College. Workshop, drawing office and teaching experience are necessary. Commencing salary £150 per annum Applications to Prof. W. E. Dalby, Exhibition-road, London, S.W. See also an advertisement.

A mains and distribution supervisor is required for H.M. Dockyard, Sheerness. Particulars and forms of application from the electrical engineer, Mr. E. T. Williams. See an advertisement.

An electrician-in-charge is required at the Coronet-street electricity works of Shoreditch (London) Borough Council. Applications to the chief electrical engineer (Mr. C. Newton Russell), Coronet-street, Hoxton, N., by Sept. 5. See an advertisement.

An outdoor representative is required by a London electric supply company. See an advertisement.

The committee of East Ham Technical College invite applications for the position of instructor in electric lighting and power transmission at the classes on Wednesday evenings. Salary 10s. 6d. per evening. Applications to principal, Mr. W. H. Barker, B.Sc.

Mr. T. H. Saul, of Fulham, has been appointed general clerk and commercial assistant at Acton (London) electricity works.

EDUCATIONAL NOTICES.

University of Birmingham.—The 1906-7 session commences on Monday, Oct. 1. The full course in the department of engineering extends over four years. The technical engineering classes include lectures on the strength of materials, the theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing the course includes the design of tools, prime motors, dynamos and other forms of machinery. The engineering laboratory course includes determination of strength of materials, experimental study of the steam engine and boiler, frictional efficiency tests, the flow of water over weirs, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work includes the testing of continuous and alternating-current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing work. The courses also include mathematics, physics, chemistry, geology and metallurgy. Detailed syllabus can be obtained from the secretary.

University of Liverpool.—The 1906-7 session commences on Oct. 9. The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng. (or the certificate in engineering) are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are also afforded for postgraduate work and research. Prospectuses may be obtained from the Registrar.

King's College, London.—The 1906-7 session commences on Wednesday, Oct. 3. In addition to the ordinary day courses in engineering and applied science there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Prospectuses from the dean (Prof. D. S. Capper), or the Secretary, King's College, Strand, W.C.

University College, Bristol.—The 1906-7 session begins on Oct. 2. Lectures on inorganic, organic and physical chemistry will be delivered during the session. The laboratories are fitted with the most recent improvements for study and research in chemistry and metallurgy. Prospectuses of the lectures, &c., may be obtained from the registrar and secretary, Mr. James Rafter, and copies of the calendar, which contains particulars of scholarships, prizes, lectures, &c., are published post free at 1s. 4d.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Glasgow and West of Scotland Technical College.—The next session begins on Tuesday, Sept. 25, in the new buildings. The diploma of the college is granted in electrical, civil and mechanical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow, after attendance for at least one session at prescribed University classes. There are new and well equipped laboratories in the departments of physics, electrical engineering, mechanics, technical chemistry, &c. The preliminary examination for candidates for the diploma begins on Sept. 17, and names of candidates must be lodged by Sept. 14. Prospectuses from the Secretary.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

University College of South Wales and Monmouthshire, Cardiff.—The next session will commence on Tuesday, Oct. 9. Particulars of the courses in engineering (electrical, mechanical and civil) can be obtained from the registrar, Mr. J. Austin Jenkins, B.A. These courses qualify for the B.Sc. degree (in engineering) of the University of Wales and for the college diplomas in engineering.

City and Guilds of London Institute.—The entrance examinations to the Institute's Colleges are held in September. Particulars of the entrance examinations, scholarships and courses of study in electrical and mechanical engineering, chemistry, &c., may be obtained from the colleges at Exhibition-rd., S.W., and Leonard-st., City-rd., E.C., or from the head offices of the Institute, Gresham College, Basinghall-st., E.C.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Battersea Polytechnic, London, S.W.—The term commences on Sept. 17. There are technical day courses in electrical, mechanical, motor and chemical engineering, as well as evening courses in preparation for the London University engineering degree and in all mechanical and electrical engineering subjects, including motor car engineering. The evening courses begin on Sept. 24. Prospectuses from the Secretary.

Hackney Technical Institute.—The session commences on Sept. 24. There are evening courses in electrical engineering subjects, including alternating currents, dynamo design, wireless telegraphy, &c. Prospectuses from the secretary of the institute, Dalston-lane, London, N.E.

College Calendar.—We have received a copy of the calendar of the East London Technical College, giving full particulars of the courses of instruction, fees, scholarships, &c. The engineering department and other portions of the college premises have been enlarged at the expense of the Drapers' Company, who have made a further grant of £5,000 for the purpose. Michaelmas term commences Oct. 1.

Tuition by Correspondence.—Prof. Andrew Jamieson, 16, Rosslyn-terrace, Kelvinside, Glasgow, announces that he prepares students by correspondence for engineering appointments in the various Government departments, for the City and Guilds of London Institute, the Student and A.M.Inst.C.E. examinations, &c., and also for the B.Sc. in engineering at different universities. Prospectuses (price 6d. each) can be obtained from Prof. Jamieson.

Argentina.—The Public Works committee of Congress have reported favourably on the petition of Buenos Ayres Western Railway Co. for a concession for the construction and operation of an underground electric railway from Calle Sadi Carnot, Buenos Ayres, to the harbour.

Australasia.—The Commonwealth Postmaster-General (the Hon. A. Chapman), who recently returned from a visit to Europe, states that his visit has confirmed him in the opinion that it is desirable to introduce the toll system of charging for telephonic facilities.

The Postmaster-General is prepared, however, to make some concessions by giving 1,000 calls (instead of 750) per annum and to reduce the message rate from ½d. to ¼d. per call after 2,000 calls.

Brisbane and Bundaberg (Queensland) are to be connected by telephone, a distance of 318 miles. The fees will be 3s. 2d. for three minutes and 2s. for every additional three minutes.

Guildford (W.A.) Council have obtained tenders for the erection of electricity works.

Mount Bischoff Tin Mining Co. (Tasmania) are putting down electrical plant.

The estimated profit on the Sydney municipal electricity undertaking for this year, after paying 4 per cent. interest and 1 per cent. sinking fund and taking into account £1,000 received under the water and sewerage contract, was £9,000, of which the electrical engineer (Mr. T. Rooke) desired £7,000 to be placed to depreciation. Street lighting now costs £21,249, an increase of £6,774 per annum, of which only £3,643 was for electric lighting. The Electric Lighting committee consider that the net return (5¾ per cent.) on the £250,000 capital employed is very satisfactory. The committee recommend the duplication of the order recently given for additional plant.

At Wellington (N.Z.) a poll of ratepayers was recently taken upon the various loan proposals of the City Council. Among the questions which were decided in the affirmative were proposals to borrow £100,000 for electricity supply works, £10,000 for additions to the public lighting, £30,000 for power for lifts, machinery, &c., and £52,052 for tramway extensions, additional cars, &c.

Baker Street & Waterloo Railway.—To-morrow (Saturday) through bookings will be brought into operation between the Baker Street & Waterloo and the London & South-Western Railways.

Billinge (Lancs.).—The Council is to apply for a provisional electric lighting order.

Blackpool.—The salary of the works superintendent of the electricity department (Mr. W. Parkinson) has been increased to £200 and that of the chief clerk (Mr. P. Baxter) to £136 per annum.

The electricity department has made considerable progress during the past two years, and the borough electrical engineer (Mr. Furness) has reported that the maximum demand during the past few weeks has exceeded all previous records both for lighting and traction, and he advises that the time has arrived when additional plant should be installed. The Electricity committee have decided to adopt this suggestion and to instal an 800 kw. turbo-alternator for lighting and a 405 kw. direct-current generator for traction.

Mr. Furness also advises that the present charges for current should be reduced to 6d. and 1½d. for private lighting some time before 1908, and that the charges for power should be reduced to 3d. and 1d. per unit, provided a minimum guarantee of one hour's daily use at 3d. per unit is given.

The tramways department has experienced some trouble owing to the breakage of wires at the point where they are soldered on to the ears of the supporting standards, and the Electricity committee have decided, on the recommendation of the tramway manager (Mr. J. Lancaster), to experiment with a contrivance which will prevent a wire from falling to the ground, even though it should give way at the junction with the ear.

Brazil.—A report prepared by the special agent of the United States Government, and recently presented to Congress, states that there are particularly good openings for the supply of electrical machinery in Rio de Janeiro, Sao Paulo and many of the smaller towns of Brazil.

Camberwell (London).—A lengthy report upon the history of electricity supply and of the companies supplying current in the district has been prepared by the town clerk (Mr. C. W. Tagg) in order to give the councillors an idea of the position of affairs when they will, on Sept. 19, discuss the question of applying for a provisional electric lighting order.

Chili.—The report recently issued on the trade of Chili for 1905 (prepared by Mr. Acting-Consul-General Rowley), was received in England some time before the recent disastrous earthquakes in Chili. The report shows a greatly increasing import and export trade, the United Kingdom contributing 37·71 per cent. of the imports and 38·20 of the exports, Germany following with 25·23 per cent. and 27·58 per cent. respectively.

The Chilian Congress recently granted concessions to two separate companies to build and equip electric tramways between Valparaiso and Santiago. Probably these concessions will be considerably interfered with by the recent catastrophe.

The electric railway concession between Valparaiso and Santiago (via Placilla, Casa Blanca and Curacava) which was granted in August, 1905, to Señor A. Olivos has been purchased by the Compania Chilena de Invenciones, of Valparaiso. Electric power will be obtained from a waterfall with a head of 176 metres, situate about 34 km. from Santiago, and it is estimated that 18,000 H.P. will be available from this source.

The electric light and traction company is a German undertaking. The company's generating station at Sauces is now completed and the whole of the power required in the company's operations is obtained from that station. Valparaiso and Viña del Mar are now connected by the company's electric tramway service which runs parallel with the line of the state railway.

In the town of Pisagua, which suffered somewhat from the earthquake, oil has been the source of illumination, despite the fact that the municipality own an electric lighting plant. Elections are shortly due to be held, and it is anticipated that the incoming municipality will early proceed to the discussion of a revival of electric lighting.

Customs Duties.—The Japanese Board of Customs have decided that under the forthcoming new Japanese tariff telegraph or galvanised wire of iron or mild steel will continue to pay duty at the conventional rate of 0·256 yen per 100 kins (8s. 10d. per ton). Other overhead electrical conductors, made of copper, insulated, single or twisted, or in cables containing any number of strands, whether outwardly protected by lead, iron, hemp, &c., or not, will pay the conventional rate of 5 per cent. ad val., but all kinds of underground or submarine cables for telegraph or telephone purposes will be dutiable at the general rate of 20 per cent. ad val. (under No. 390 of the new tariff).

Damascus.—The local tramways company of this city are greatly extending their system, and amongst the materials imported in 1905 (to the value of £38,500) electric cables and wires stand for £12,100, electrical appliances £8,100, cars £4,100, posts £2,000, girders, rails, &c., £12,200. Nearly the whole of these goods came from Belgium and Germany.

Damascus figures as the first Turkish city to engage in electrical enterprise. A Belgian company (the Société Imperiale Ottomane des Tramways, d'Eclairage et de Force Electrique de Damas), with a capital of £240,000, has obtained a concession through a Turkish functionary covering the introduction of electric tramways, electric lighting and electric power. £160,000 of the capital of the Société Imperiale is held by the Société Générale de Chemins de Fer Economiques, the Société Belge d'Enterprises Electriques and the Cie de Tramways et de l'Electricité. In addition to its monopoly of electric light and power, the company possesses a virtual monopoly of the sale of electric appliances, the right to establish a telephone service should such be deemed necessary and to establish agencies in any part of Damascus. The company will take 1,200 H.P. in water power from the falls of the river Barada at Et Tekiyé, 22 miles from Damascus. For the present about 3½ miles of electric tramways are to be constructed and equipped out of an ultimate length of 5 miles. The water power station is nearly completed, the track of the tramways is nearly finished, and the other branches of the company's operations are in a fair way towards inauguration. The population served by the tramway system is over 250,000. Much interest is taken locally as to the success of the company, which is considered to have engaged in a venturesome enterprise.

Durham Tramways.—The Board of Trade have granted a year's extension for carrying out the Bishop Auckland, Shildon and Spennymoor tramways order.

Ecuador.—The British Consul at Guayaquil (Mr. A. Cartwright) has sent to the Board of Trade, London, copy of a decree relating to the encouragement of manufacturing and agricultural industries in Ecuador, and conceding the free use of streams, waterfalls and natural waterways to persons establishing new factories employing hydraulic or electric power. This concession is not to interfere with existing rights or with the right to draw off water for irrigation purposes. The decree grants to such establishments concessions of Government lands up to 25 hectares, with at least 200 metres frontage to the water supply used by the enterprise. If the factory be started on private lands, these can be expropriated legally by paying the value of such land as may be required, on the valuation of two appraisers, according to law. Applicants who obtain concessions of Government lands on the pretext of establishing industrial factories, and who do not fulfil their project within two years of the date of the grant lose their concession.

Electric Traction on the L. & N.W. Railway.—In further reference to the proposal of the directors of the L. & N.W. Railway Co. to construct a new electric line between Euston and Watford, a distance of about 17 miles, the new railway will be a surface line for about three-quarters of the distance, and will run more or less parallel with the existing line. On the London side of Willesden Junction it will leave the surface and become a tube railway throughout the rest of its length. The tube will be so constructed at the London terminus as to describe a loop under Euston station, entering on the east side and leaving on the west. It will thus be possible to maintain a continuous service of trains, at two-minute intervals, if necessary. The underground station will be in connection with the City & South London and the Charing Cross, Euston & Hampstead Railways, and by this means the facilities for inter-suburban traffic will be greatly increased. It is proposed to place several additional stations on the electric line between Willesden Junction and Watford.

Electrical Manufacture of Steel.—Several German companies, including the Oberschleische Eisenindustrie A.-G. and the Poldihütte, have decided to experiment with the Kjellin electrical process for the manufacture of steel. The electrical installations will be carried out by the Siemens & Halske A.-G.

The rumour, to which we gave publicity last week, that Messrs. Vickers, Sons and Maxim, Ltd., had acquired the British rights in the above process is, we are informed, without foundation.

Exhibition.—A health, electrical and gas exhibition will be held at Portsmouth from Nov. 5 to 27 inclusive.

Halifax Tramways Dispute.—Strenuous efforts are being made by the trades unionists here to settle the dispute which has arisen between the tramway men and the Tramways committee over the dismissal of the driver Chadwick in their own peremptory fashion. Particulars were given in our last issue.

It is now proposed by the unionists that Chadwick should be provided with employment by the Tramways committee (either as conductor or in the shed) until the Board of Trade inspector's report on the accident has been received. It has also been suggested as an alternative that Chadwick should be found employment in some department of the Corporation other than the tramways. Of course the opportunity is taken to put forward other claims on the men's behalf. Meantime the November elections are in sight

Harrogate-Knaresborough Tramway.—The Wakefield & District Light Railway Co. propose to construct an electric tramway between Harrogate and Knaresborough. The line will commence at Oatlands, and serve Little Wonder, Harlow Hill, Starbeck, Knaresborough and Scriven. Knaresborough Rural Council, who appear to view the scheme with favour, have referred the matter to a committee for consideration.

Hindley.—The Council are collecting information concerning electricity supply matters, and particularly as to the desirability of leasing their electric lighting order, 1901.

Wigan Corporation have been asked to state the terms upon which they would be prepared to give supply in bulk.

India.—The Municipal Council have objected to Messrs. D. J. & R. J. Tata's application to the Government for a licence to supply electrical energy in Bombay on the ground that the Council have already entered into agreements with the Brush Electrical Engineering Co. and the Bombay Electric Supply & Tramway Co. in regard to electricity supply and tramways. The Council urge that if a licence be granted to Messrs. Tata, overhead mains should be forbidden, and that provision should be made for the ultimate purchase of the undertaking by the Corporation and for the supply of current for lighting and power to the Corporation by applicants at a price not exceeding 1d. per unit.

Italy.—The "Official Gazette" for Aug. 18 contains a decree authorising Milan municipality to construct and work an electric tramway between the Piazza del Duomo and the Piazza del Ippodromo di San Siro.

Japan.—In the imports into Nagasaki for 1905 submarine cables and underground wires and cables stand for a value of £254,658, compared with £46,759 in 1904. No precise details as to the lengths or the use to which these goods are to be put are obtainable. We may state, however, that the entire import in 1905 was from Great Britain.

The Mitsubishi Dockyard Co. have recently made vast extensions to their docks and works. The company has recently taken up a licence for manufacturing the Parsons steam turbine, and preparations for manufacture are being made on a large scale to meet the demand for these engines. Plants and tools for the works have been ordered from Great Britain. The same company are greatly enlarging their electric power works at Akunoura. Two large turbo-generators and one large motor-generator are being installed in the extension buildings now under construction. Seven Babcock & Wilcox boilers are included in the new plant.

Keighley.—The Council will promote a bill next session for powers to run motor omnibuses within the borough and in the districts of Bingley, Haworth, Oakworth, Oxenhope, &c.

A recommendation of the Tramways committee to apply for powers to construct additional lines has been referred back.

Leyton.—The portion of the North Metropolitan Tramways in High-road, Leytonstone, and through Whipps Cross to Epping Forest, which was recently acquired and converted to electric traction by the District Council, was opened for traffic on Monday.

Light Railways.—The Board of Trade have confirmed the Bath Electric Tramways (Light Railway Extensions) Order, 1906, authorising lines in Keynsham.

Loughborough.—With commendable energy the borough electrical engineer (Mr. W. H. Allen) is circulating among tradesmen and householders in this borough a number of leaflets on the advantages of electricity supply. One sheet gives particulars of the prices charged for lighting and power and of the schemes of free-wiring, hire-purchase of motors, &c. Another sheet brings home to the householder in a graphic manner "what a pennyworth of electricity will do." Two leaflets deal with electric fans and radiators respectively, while a number of leaflets containing the testimonials of tradesmen and others as to the economy and convenience of electricity for both lighting and power make up a batch of literature which should have the effect of greatly increasing the load of the electricity department at Loughborough.

Mails on Tramways.—The Sunderland & District Electric Tramways have this week commenced to carry the mail bags under contract with the Post Office authorities.

Newcastle-on-Tyne.—The report of the tramways manager (Mr. E. Hatton) was under consideration by the Tramways committee on Tuesday.

The report recommended that £18,000 be placed to reserve, increasing this fund to £28,000.

An amendment was moved to the motion for the adoption of the report that a sum equal to 1d. in the £ (£6,200) be placed to reserve.

A further amendment was moved that £6,200 be set aside as a reserve for the provision of workmen's cars at the dinner hour, and an extension of hours in the morning, &c.; but this amendment was not seconded, and the report was adopted by eight votes to three.

Ossett.—The L. G. Board have refused to reconsider their decision to sanction a loan for the erection of municipal electricity works.

Presentations.—The Brighton staff of the National Telephone Co. have presented a case of silver to Mr. H. J. Maclure, contracts manager, on his removal to Birmingham, and a brass fire set, Gladstone bag and chair to Mr. Fredk. Jas. Frost, traffic manager, on his marriage.

Mr. G. R. Blackburn has been presented by the staff of the Bradford tramways department with a Shannon bookcase on the occasion of his leaving to take up the position of rolling stock superintendent at Manchester.

Preston.—The Council are considering a scheme for the electric lighting of some of the tramway routes in the central portion of the town, and also the municipal offices and other public buildings, current to be taken from the tramway power station.

Provisional Order Transfer.—Tottenham District Council give notice of intention to transfer to the North Metropolitan Electric Power Supply Co. the powers conferred upon the Council by their 1902 electric lighting order. The consideration is £1,252. Objections to the Board of Trade before Sept. 24.

Pudsey.—An inquiry was held last week into the application of the Council to borrow £2,000 for electricity supply.

The Town Clerk gave evidence as to the borrowing powers, outstanding loans, &c. He said the £2,000 included £917 for a transforming station, which had been in use for six months, and £750 for extensions of mains, &c.

Saloon v. Compartment Railway Carriages.—The Metropolitan Railway Co. are fitting up three trains on the compartment car system for use on the St. John's Wood line. It is stated that some of the officials are inclined to think that an error was made in adopting the American saloon car, as the cost of the extra train staff is higher than was realised at the time. To cut down expenses the directors of the District Railway have been experimenting with a train having only two men, one in front and one behind, these two to have control over the whole of the doors on the train. Among the most popular trains on the Underground are the luxurious compartment trains provided by the L. & N. W. Railway for their Broad-street–Mansion House traffic.

South Africa.—The directors of the Rand Central Electric Works have decided to proceed with the scheme for putting down additional generating plant at their electricity works. The present capacity of the station at Brakpan is 2,800 kw., with a reserve of 400 kw. The projected extension will, it is estimated, enable the company to supply power at as low a figure as any of the alternative power schemes now being discussed. The ultimate expansion contemplated is up to 15,000 kw. in three sets of two units of 2,500 kw., which will be put down from time to time. The total cost of the scheme is estimated at £475,000, of which the company has now some £140,000 in hand. Tenders for the erection of the first two units of 2,500 kw. each have been called for.

Tramcar Guards.—An inquest was held at Manchester on Monday into the death of a child, who, while rushing across the road in front of a tramcar, was knocked down on Friday and killed.

Deceased (with another child) was on the footpath. It was alleged that delay was caused in extricating the child from beneath the car on account of alleged defects in the jacks used to raise the car.

Mr. Gilson, who witnessed the accident, said that jacks were brought from other cars, and two of them were, in his opinion, useless. He threw one away as it was entirely out of order. A jack was eventually brought that lifted the car. He knew how to work jacks and at the time of the accident the catches of two of the jacks were immovable. They were corroded with rust. All the jacks he used were, he believed, brought from other cars.

The Driver said only 10 minutes elapsed before the boy was extricated, and the jack on his car was used and was successful in raising the car. Two jacks were used before the car was raised.

Mr. F. E. Handy, superintendent of the car sheds, said no report had been made to the officials about any of the jacks being useless. He produced the jack which was on the car concerned in the accident, and that, he said, worked properly. He did not think any driver would leave the shed without knowing how to use an instrument of that kind and it might have been that in the excitement the driver had not pushed the catch back.

The Coroner told the jury that they might take it that a quarter of an hour elapsed before the boy was extricated, and it was a shocking thing that it should take that length of time. There was a conflict of evidence as to the condition of the jacks used, but the evidence of an independent witness was that two out of four used were useless.

The jury returned a verdict of accidental death, and thought no blame attached to the car driver. They came to the conclusion that either two of the jacks were out of order and could not be used, or that the drivers were not instructed how to use them. They thought the attention of the tramway authorities should be called to the necessity of having jacks in readiness which could be used freely, and for all drivers being instructed how to use them in cases of emergency.

Willington.—The Council have referred to their Works committee an application of the County of Durham Electrical Power Distribution Co. for permission to erect overhead wires for supply of electricity in the district.

Wireless Telegraphy in China.—A new company, entitled the Telefunken Ostasiatische Gesellschaft für Drahtlose Telegraphie (m.b.H.), Tsingtau, has been formed by the Gesellschaft für Drahtlose Telegraphie, of Berlin, for the exploitation of the Telefunken system of wireless telegraphy in China, Corea and the East. The capital is 100,000m. (£5,000) and the business manager is Herr W. Bargman, of Berlin.

Sports.—The employés of the General Electric Co. at Peel Works, Salford, held their tenth annual sports at Belle Vue, Manchester, on Saturday. A fire brigade competition and a 60 yards handicap for employés with over 10 years' service were new features in the programme. Mrs. Bevis distributed the prizes, which included everal for the ladies of the party.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Finchley.—The accounts of the District Council's electricity department for the year ended March 31 show receipts £7,261. Working expenses were £4,407 and gross profit was £2,854. 5s. 3d. After paying interest and sinking fund (£2,747) there was a net profit of £106. 15s. 10d.

Keighley.—The report of the working of the electric tramways department for the year ended June 30 shows the total receipts to have been £7,659. 6s. 4d. (6·92d. per car mile), compared with £4,648. 13s. 5d. from the date of the electrification of the system (October, 1904) to June 30, 1905.

Working expenses were £5,320. 11s. 10d., interest on capital £1,352. 2s. 9d. and sinking fund £1,421. 6s. 10d. The passengers carried numbered 1,771,974, against 1,091,409 in the previous nine months, and the car-miles run were 265,492. There has not been a single case of a trolley wire falling, not a single wheel or axle has been broken, and no fatal accident occurred.

Surbiton—The accounts for last year of the electricity undertaking, which is worked by Callender's Cable & Construction Co. under contract with the Council, show capital expenditure at March 31 of £49,734, an increase of £9,155 on the year.

The total revenue was £3,181. Working expenses were £1,151, leaving £2,030 to pay interest (£1,586) and instalment of principal (£1,186), showing a deficiency of £742, which Callender's Co. provide under the terms of their agreement.

Wigan.—The accounts of the electricity department for the year ended March 31 show capital expenditure £175,692, an increase of £15,154.

The revenue was £26,583 (against £18,207 in previous year), including £24,908 (£17,114) from sale of current, £700 from sale of apparatus and £961 (£972) for hire of motors. Working expenses were £14,343 (against £8,944), including £9,081. 14s. 6d. for cost of generation, £854. 18s. 8d. for distribution, and £1,122. 7s. 4d. for management. Gross profit was £12,240 (£9,262). After taking credit for £257 from previous years and paying banker's interest (£775), interest on loans (£4,640), sinking fund and repayment of loans (£5,229), allowing £692 for current consumed on works, and transferring £256 to district fund, the net profit was £730 (£257) which has been carried forward. The profit on the Wigan undertaking was £4,567, and the deficit on the Pemberton works £3,837. The equivalent of 70,323 8 c.p. lamps is connected, against 65,166. The motors connected number 192 (1,405⅛ B.H.P.), of which 138 (966½ B.H.P.), are on hire. 2,846,897 units were generated (against 1,994,757) and 2,679,486 sold (1,769,620). The total capacity of the plant is 1,960 kw., and the maximum supply demanded was 1,524 kw. The total working cost of the Wigan combined undertaking was 0·81d. per unit sold.

The capital expenditure on the tramways undertaking is £491,075, an increase of £87,421 on the year. Revenue was £53,352 (against £37,751), including £51,080 (against £35,133) in fares, £376 (£274) for parcels, and £1,896 (£2,343) from sundry receipts. Working expenses were £35,400 (£23,749), including £9,569 for current (£5,092), the gross profit being £17,952 (£14,001), and after paying £20,122 for interest and sinking fund there is a deficiency of £2,170, which is attributed to portions of the track having been closed for reconstruction. 9,880,435 passengers were carried and 1,241,256 car-miles run, the average fare was 1·24d., and the passengers per car-mile were 7·96. Total revenue per car-mile was 10·30d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Dublin Lighting committee invite tenders for supply of 500 single phase and three-phase alternating-current meters. Specifications, &c., from the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders to the chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon Sept. 8. See an advertisement.

Dublin Lighting committee also want tenders for supply and erection of arc lamps and arc lamp pillars. Tenders to the Chairman, 3, Cork-hill, Dublin, by Sept. 8.

Johannesburg Town Council invite tenders for supply and delivery f.o.b. (at a port suitable for shipment to South Africa) of one-phase alternate-current motors with accessories. General conditions, specification and forms of tender may be obtained (after Sept. 3) from the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Tenders to the town clerk, Municipal Offices, Johannesburg, by Oct. 15. See an advertisement.

Oxford Corporation invite tenders for the reconstruction, extension and electrical equipment of the existing horse tramways in the city and the leasing thereof Proposals based on the overhead system of working will not be considered. Conditions of tender from the town clerk (Mr. Richard Bacon), to whom tenders by Sept. 17.

St. Pancras (London) Borough Council invite tenders for supply of 2,000 kw. steam turbo-generator, switchboard, condensing plant, &c., two three-phase high-pressure 500 kw. motors coupled to direct-current low-pressure generators, switchboards, &c. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-rd., N.W., by noon Sept. 5.

Wigan Electric Light and Tramways committee invite tenders for the supply of cables, overhead line material, electrical accessories, carbons, meters, engine room stores, tramcar accessories, paint, varnish, motors, ironmongery, glass and timber. Tenders to the town clerk (Mr. Harold Jevons), King-street West, Wigan, by Sept. 5.

Rathmines District Council invite tenders for supply of electric mains, house service boxes, house meters, extension of switchboards, extension of accumulators, and battery booster. Tenders to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, co Dublin, by 10 a.m. Sept. 12.

Barking Town Urban District Council invite tenders for cleaning, lighting, extinguishing and renewal of lamps, lanterns, fittings, &c., of the whole of the public incandescent, Nernst and arc lamps within the district for one, two or three years. Tenders to Chairman of the Electricity and Tramways committee, Public Offices, Barking, by noon Sept. 12.

Edinburgh Corporation invite tenders for the wiring, fittings, &c., for the electricity supply installation at the police fire station, Stockbridge. Tenders to the Town Clerk, City-chambers, Edinburgh, by Sept. 12.

West Ham Guardians want tenders by 10 a.m. Sept. 12 for 12 months' supply of stores, including electrical fittings, engineers' sundries, &c.

Tenders will be received until Sept. 30 at the Stadtischer Bauvorstand II., *Zurich*, for supply and erection of turbines and electrical plant at Zurich municipal electricity works.

TENDERS RECEIVED AND ACCEPTED.

Stratford Electric Supply Co. have placed an order with Johnson & Phillips for complete electric lighting plant, which includes supply and erection of gas plant, engines, generators, battery, switchboard and vulcanised bitumen cables.

Bolton Corporation have placed orders with the British Thomson-Houston Co. for 10 roof-covered single truck cars, with standard B.T.-H. double motor equipments, Brush car bodies and Brill trucks.

The Postmaster-General's Department, Perth, W.A., have placed orders with the following firms for telegraph material, &c.:—

India Rubber, Gutta Percha & Telegraph Works Co. (Perth), for brackets, poles, screws, wire, insulators, washers, telephone cross-arms, draw-tongs, pole climbers (Kücke's pattern), german silver, battery brushes, mops, bells (with coils and cases), sal ammoniac, cells and electrodes, switchboard, induction coils, switches, automatic call boxes, transmitters, ear-caps, diaphragms and mouthpieces for transmitters, &c.

W. T. Henley's Telegraph Works Co. (Melbourne), for steel aerial wire at £3 per mile.

J. M. Ferguson & Co. (Fremantle), for insulating tape, Ericsson's wall telephone sets, table sets, junction switches, wall switches, transformers, hand micro-telephones, bells, four-point plugs, handles, opal glass tablets, dry cells, wall fittings, protectors, fuses, manganese, carbon plates, rubber bands, zinc rods, insulators, &c.

Unbehaun & Johnston (Perth), insulated and braided wire, insulators, cam levers, operators' sets, lightning arresters, switches, transformers, &c.

Leslie & Co. (Perth), for zincs and hangers and caps for same.

General Electric & Engineering Co. (Perth), for brackets, copper wire, tinned, insulated and cotton covered twin wire, galvanometers, ebonite, draw-vices, Leclanché cells and zincs, &c.

Zwicker, Todd & Co. (Melbourne), for sulphate of magnesia, Cordeau insulators, &c.

Edmiston & Co. (Perth), for condensers, with plug switch and wood case, at 8s. 6d. each.

C. R. Hodson (Sydney), for Leclanché cells and porous pots.

Johnson & Phillips have secured the contract for supplying and laying of cables for Handsworth District Council.

An order has been placed with Veritys Limited for 64 Aston-Worsley arc lamps for public lighting at Melbourne (Australia).

BUSINESS NOTICES.

Messrs. Johnson & Phillips ask us to state that the company's telegraphic address for all departments is now "Juno Charlton Kent."

Siemens Bros. Dynamo Works (Ltd.) will open a branch office at 196, Deansgate, Manchester, on Sept. 1, which will attend to their interests in the counties of Lancashire and Cheshire and in North Wales.

We are asked to state that, owing to pressure of private business, Mr. C. S. Northcote, M.I.E.E., director of Veritys Limited, has taken an office at 22, Queen Anne's-chambers, Broadway, Westminster, S.W. (Telephone 807 Westminster), where he will be pleased to receive correspondence from members of the electrical profession and trade.

James Gordon & Co. are removing on Sept. 3 to their new offices at 81 and 83, Knightrider-street, Queen Victoria-street, London, E.C. The removal is due to largely increasing business in hydraulic Pelton wheels and turbines, water softeners, Ferguson's patent superheater and Combe Barbour's agency for Corliss steam engines.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Charles Chadwell, civil engineer and contractor, Mervyn, Gorse-road, Blackburn, the first meeting of creditors and public examination will take place on Sept. 5 at the County Court House, Blackburn.

Claims against Alfred John Earp, electrical engineer, 12, Palmerston-road, Boscombe, by Sept. 12 to Mr. W. F. J. Hunt, Midland Bank-chambers, High-street, Southampton.

Claims against the McGuire Mfg. Co. (Ltd), 2, Queen Anne's-gate, London, S.W., to be sent by Sept. 10 to Mr. F. W. Pixley, 58, Coleman-street, London, E.C.

Business for Sale.—Mr. D. McIntyre, C.A., 13, Albert-square, Dundee, has for sale (by private bargain) the plant, machinery, service tools, stock-in-trade, goodwill and tenant's fixtures and fittings of the old-established firm of James Maxwell & Son, electrical and mechanical engineers and brassfounders, 17, King's-road, Dundee. Inventories as at July 31 (date of dissolution) and particulars from Mr. McIntyre, to whom offers 14 days from Aug. 25. See also an advertisement.

Plant for Sale.—By order of the trustee under a deed of assignment the stock and plant of an electrical engineer are advertised for sale by tender. Further particulars may be obtained from the trustee (Mr. Oscar Berry), Monument-square, London, E.C., to whom tenders by Sept. 4. See advertisement.

Agency Wanted.—Mr. John Eades, A.M.I.E E., late rolling stock superintendent of Manchester Corporation tramways, who has commenced practice as a consulting engineer at 11, Mansfield-chambers, St. Anne's-square, Manchester, is prepared to take up an agency for Lancashire and Yorkshire.

Tantalum Lamps.—We are informed that the price of the Tantalum Sun lamp with gallery and holophane shade will be reduced, as from Sept. 1, from 8s. 6d. to 7s. 6d and the bulb only from 4s. 6d. to 3s. 6d.

Catalogues, &c—Messrs. Johnson & Phillips have ready a new electric arc lamp price-list (H), which describes and effectively illustrates open and enclosed type J. and P. arc lamps, and also gives particulars and prices of the "Juno" flame arc lamp, which has now obtained a large sale. Copies of this list can be obtained by anyone interested. It is claimed for the "Juno" flame arc that it is a marvel of simplicity and neat design and possesses many points of novelty. It is of small size, and, consequently, suited for use in positions where larger lamps cannot be employed. There are only three moving parts, and no shunt coils, wheels, sliding rods, clockwork, dashpots, brakes, clutches or other mechanism likely to get out of order. Any number of lamps of this type can be run in series on either alternate or direct-current circuits, each lamp taking about 48–50 volts.

The Union Electric Co. have a number of new lists ready, dealing respectively with high-tension switchboards, searchlights and protectors for direct current, and hot wire ampere and voltmeters for direct and alternating current of the switchboard and portable types. In the first mentioned list the illustrations show some recent up-to-date work constructed in the company's switchboard factory. An excellent example of a high-tension five-way distribution board designed for use in mines is a notable illustration. The method of construction of this switchboard allows for its being taken down the mine in parts and readily re-mounted and re-connected. There are a number of other good illustrations in this list. In the searchlight list several types of this apparatus are listed and priced. In the third list a wide range of volt and ampere meters is shown.

The Edison & Swan Co. are issuing a leaflet illustrating and describing a "Non-inflammable Solution." We are all aware of the difficulties in storage and carriage of the ordinary solution on account of its extremely inflammable nature. This new solution is guaranteed to be made only of finest Para or plantation rubber combined with the necessary solvents, and is claimed to be not dangerously affected by ordinary temperatures or by exposure to flame. This is a bold claim, but the company offer a sample tube for practical test. They suggest that a small quantity of ordinary solution be squeezed on to some fireproof surface side by side with a little of their non-inflammable solution and a light applied. Nothing certainly could be more convincing than this offer, and our readers will desire to make themselves practically acquainted with such a solution. The price, either in collapsible tubes or in tins, is very low.

Hodgson Wright & Wood, Halifax, forward their lists No. 18, 19 and 20, which give prices and particulars of continuous-current open-type dynamos, two and three-phase motors, and single-phase motors respectively.

Exports of Electrical Apparatus and Material—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Aug. 22 to 28, with the ports of destination :—

Africa—Alexandria, £126 (including £41 telegraph material); Beira, £310 ; Cape Town, £210 (telegraph material) ; Durban, £1,064 (including £625 telegraph material) ; East London, £10 ; Port Said, £10 ; Sekondi, £65 ; Sierra Leone, £18 (telegraph material). *Argentina*—Buenos Ayres, £2,253 (including £2,158 telegraph material) ; Rosario, £850. *Australasia*—Adelaide, £901 ; Auckland, £355 ; Fremantle, £153 (including £16 telegraph cable) ; Melbourne, £133 ; Napier, £26 ; Otago, £80 ; Perth, £680 ; Sydney, £125 ; Wanganui, £53. *Azores*, £115 (telegraph material). *Belgium*—Ghent, £54 ; Ostend, £101. *Brazil*—Pernambuco, £109 (telegraph material). *Burma*—Rangoon, £1,120. *Canada*—Hamilton, £26 (telegraph material) ; Montreal, £46. *Ceylon*—Colombo, £32 (including £26 telegraph material). *China*—Foochow, £27 ; Chefoo, £45 (telegraph material) ; Shanghai, £1,232 (including £818 telegraph material). *Crete*—Candia £33 (telegraph material). *Denmark*—Copenhagen, £9,777 (submarine cable). *Faroe Islands*, £26,000 (telegraph material). *France*—Boulogne, £12. *Germany*—Hamburg, £9 ; Bremen, £14. *Gibraltar*, £75. *Holland*—Amsterdam, £81 (including £18 telegraph material); Rotterdam, £17. *Hong Kong*, £85 (including £20 telegraph material). *India*—Bombay, £550 ; Calcutta, £2,157 (including £257 telegraph material) ; Karachi, £36 ; Madras, £219. *Japan*—Kobe, £4,662 (including £632 telegraph material) ; Nagasaki, £147 (including £49 telegraph material) ; Tokio, £1,196 ; Yokohama, £228. *Malta*, £27. *Mexico*—Vera Cruz, £2,145. *Philippines*—Manila, £164. *Russia*—St. Petersburg, £52. *Siam*—Bangkok, £110. *Spain*—Malaga, £72. *Straits Settlements*—Penang, £87 (including £31 telegraph material) ; Singapore, £1,027 (including £311 telegraph material). *Sweden*—Gothenburg, £125. *Syria*—Beyrout, £320, *U.S.A.*—New York, £211. Total £59,967 against £18,597 in corresponding week last year (Aug. 23 to 29).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

July 17, 1906.

16,120 HOLLIER. Electric shock protectors.
16,159 ROLLET. Battery zinc.
16,160, 16,161 & 16,162 JANDUS ARC LAMP & ELECTRIC CO., JONES & DRAKE. Arc lamps.
16,166 MARTIN. Magnetic brakes for tramcars or like vehicles.
16,176 KNOTHE. Apparatus for administering hydro-electric baths.*
16,178 DIETZ & SHEHADI. Car windows.*
16,182 COGHLIN. Tie plates for railways and tramways.*
16,187 GREGORIE. Operating turbines by flow of liquids.*
16,195 B.T.-H. CO. (G.E. Co., U.S.) Overload protective devices.
16,200 MOLLOY. Dry tramcar seats and the like.

July 18, 1906.

16,204 DAVIS. Globe attachment for glow lamps.
16,219 WOOD & HOWE. Means of trolley wheel catching overhead live wire.
16,225 PICHT. Horse-power hour meter.
16,227 GLOVER. Suspending the anodes and cathodes of electrolytic baths.
16,244 ELECTRIC & ORDNANCE ACCESSORIES CO. & HALL. Propellor fans.
16,247 WALKER. Systems of electrical distribution.
16,260 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Interlocking mechanism for railway points and signal and lever apparatus.*
16,263 WRIGHT. Automatic switch for installations electrically lighting trains.*
16,269 CRÖNDAL KJELLIN CO. & HÄRDEN. Electric-induction furnaces.*

July 19, 1906.

16,313 CRAMP & DIAMANT. Turbines.
16,314 WESTWOOD & JONES. Terminals of electrical machinery or apparatus.
16,315 LAPHAM. Spark arresters.*
16,342 STOTHERT & PITT & HEATH. Magnetic control appliances.
16,357 ELEKTRIZITÄTS A.-G. VORM. W. LAHMEYER & CO. Direct-current dynamo-electric machines. (Date applied for, July 20, 1905.)*†
16,358 B.T.-H. CO. (G.E. Co., U.S.) Air-brake systems.
16,359 ALLGEMEINE ELEKTRICITÄTS GES. Electromagnetic switches operated by alternating current. (Date applied for, July 19, 1905.)*
16,360 WARWICK MACHINERY CO. (G.E. Co., U.S.) Governing mechanism for turbines.
16,361 B.T.-H. CO. (G.E. Co., U.S.) Electric circuit controlling devices.
16,366 ASUWORTH. Indicator for trams, trains and the like.

July 20, 1906.

13,782A LEITNER. Motor-generators. (Date applied for, June 15, 1906.)
16,379 MILBOURNE. Emergency brake for tramcars and other vehicles.
16,389 TODD. Automatic brakes for vehicles and the like.
16,404 ROSE & CATT. Brake mechanism for tramcars and other vehicles.
16,406 FINGLAND, GREENWOOD & HOLMES. Brake for tramcars and other road vehicles.
16,410 BROCKIE. Enclosed arc lamps.*
16,425 MARKS. (Boström, Sweden.) Apparatus for laying electric conductors and the like.*

16,439 Scetrini & Bridger. Brakes for tramcars and similar vehicles.
16,452 Boult. (Baron, France.) Flexible hose supporting devices for electric lamps.
16,455 Justice. (Melms & Pfenninger G.m.b.H., Germany.) Reversible turbines.*

July 21, 1906.

16,456 Hides & Burrell. Electrically-illuminated mirrors.
16,459 Wiles. Brakes for controlling the speed of vehicles.
16,497 Sullivan. Colour route indicators for vehicles.
16,505 Williams & Fife. Means for transmitting power.
16,517 Electric & Ordnance Accessories Co. & Hall. Fuses for explosive projectiles.*
16,528 B.T.-H. Co. & Holden. Prepayment mechanism for coin-freed electricity meters.

July 23, 1906.

16,568 Jandus Arc Lamp & Electric Co. & Jones. Arc lamps.
16,581 Tuckfield & Garland. Turbine.
16,582 Boult. (Baron, France.) Fittings for electric lamps.
16,584 Steller, junr., & Waldron. Cutout.*
16,590 Martin. Railway train electric lighting apparatus.
16,597 Storer & Cooper. Systems of control for electric motors. (Date applied for, July 24, 1905.)*†
16,601 & 16,602 B.T.-H. Co. (G.E. Co., U.S.) Switches.
16,627 Wheatley. (Lorenz, Germany.) Harmonic ringing machine for telephone exchange systems.*

July 24, 1906.

16,646 Reid. Combined automatic electric clock switch.
16,668 Proctor. Arc lamps.
16,670 Bley & Williamson. Automatically turning on and off electric switches.
16,690 Berglund, Hjorth & Ljungman. Electric apparatus for the ignition of mines.*
16,693 Ciri. Automatic electrical signalling apparatus for railways.*
16,696 Thompson. (Gesellschaft für drahtlose Telegraphie, m.b.H., Germany.) Wireless telegraphy applicable to railway trains.*
16,702 Mills. (Hale & Kilburn Mfg. Co., U.S.) Car seats.*
16,711 Dawson. Section insulators for electric railways and tramways.*
16,712 Dawson. Double catenary suspenders for electric railways and tramways.*
16,713 Dawson. Clip for connecting trolley wires to catenary suspension wires.*
16,729 Ketchum. Dynamo electrical machines.*
16,745 Johnson & Johnson Secret Wireless Telegraph & Telephone Testing Synd. Apparatus for producing electric waves in a telegraph system.
16,746 Johnson & Johnson Secret Wireless Telegraph & Telephone Testing Synd. Apparatus for use in telegraph systems.
16,747 Hellyar & Johnson Secret Wireless Telegraph & Telephone Testing Synd. Receiving apparatus for use in wireless telegraph systems.

July 25, 1906.

16,760 Abel. Electrically lighting and extinguishing gas burners.*
16,785 Moseley. Electric smelting furnaces
16,793 Braun. Brakes for vehicles.
16,814 Dawson. Current collectors for electric railways or tramways, with overhead conductors.*
16,818 Allgemeine Elektricitäts-Ges. Alternating-current electricity meters of the induction type. (Date applied for, July 25, 1905.)*†
16,819 Allam. Electric starting switches and regulators.
16,820 Highfield. Direct-current electric supply systems.
16,823 Rutledge. Steam turbines. (Date applied for, July 25, 1905.)*†

July 26, 1906.

16,837 Welsh. Pulleys for the trolleys of electric railways, tramways, &c.*
16,856 Norris. Braking devices for tramcars and other vehicles.
16,870 Greenfield. Anodes for electrolytic purposes.
16,874 Becker. Steam turbines.*
16,895 B.T.-H. Co. (G.E. Co., U.S.) Transformers.
16,897 Young. Electrically illuminating letters, advertisements, and the like.
16,905 Basset. Thermo-chemical generator of electricity. (Date applied for, July 27, 1905.)*†

July 27, 1906.

16,930 Hunt. Moulds and centerings for conduits.
16,941 Charles & Watson. Electrical contact breakers of explosion engines.
16,949 Porter. Device for clearing out the groove of tram-rails.
16,957 Taylor, Eaton & Schwarz. Starting and controlling electric motors.
16,934 B.T.-H. Co. (G.E. Co., U.S.) Air-brake systems.
17,018 Aron. Prepayment electricity meters.*

SPECIFICATIONS PUBLISHED.

1905 Specifications.

18,448 B.T.-H. Co. (G.E. Co., U.S.) Controlling automobiles.
18,484 B.T.-H. Co. (G.E. Co., U.S.) Arc lamp electrodes and making same.
18,646 Hirst & Collings. Universal ball joint for electric light fittings.
18,676 Kolb. Condensing steam by injection; specially applicable to steam turbines.
19,264 B.T.-H. Co. (G.E. Co., U.S.) Filaments for incandescent lamps.
19,368 Mawdsley. Brush holders for dynamo electric machinery.
19,967 Mensing & Bruce Peebles & Co. Insulator device for connecting electric lamps to their supports.
20,184 Woodyer & Woodyer. Electrically operated mechanism for advertisements.
21,439 B.T.-H. Co. & Wedmore. Switches.
21,661 Lebiedzinski. Sound boxes for telephones and the like.
22,261 B.T.-H. Co. (G.E. Co., U.S.) Electrical distribution employing rectifiers.
22,611 Stuart. Turbine engines.
22,673 Knight. Storage batteries. (Date applied for, Nov. 16, 1904.)
24,682 Brown & Crosta. Machine for shaping and grinding tramway rails, points and crossings.
24,724 Clark. (Darmstädter.) Electrolytic manufacture of metal tubes and other bodies.
25,153 Soc. Industrielle des Telephones, Constructions Electriques, Caoutchouc Cables. Protecting electric apparatus against currents of excessive strength of voltage. (Date applied for, 13/12/04.)
25,287 Petersson. Apparatus for striking arcs between electrodes.
25,405 B.T.-H. Co. (G.E. Co., U.S.) Systems of electrical distribution.
26,815 Einfeldt. Turbine engines. (Date applied for, Dec. 23, 1904.)

1906 Specifications.

7,255 Siemens Bros & Co. & Toplis. Cooling the commutator of a dynamo-electric machine and constructing the commutator therefor.
7,375 Bassett. Thermo-chemical generator of electricity. (Date applied for, March 27, 1905.)
7,414 Warwick Machinery Co. (G.E. Co., U.S.) Blade fastenings for turbines.
7,416 Ffingst. Electric brakes.
7,597 Allmänna Svenska Elektriska Aktiebolaget. Electrically-heated shaft furnaces. (Date applied for, March 30, 1905.)
7,598 Allmänna Svenska Elektriska Aktiebolaget. Electrically-heated shaft furnaces. (Date applied for, March 30, 1905.)
7,663 Gibson & Brooker. Electrical advertising devices.
7,891 McMahan. Synchronising apparatus for alternating-current dynamos. (Date applied for, April 10, 1905.)
7,919 Milch. Dynamo-electric machines. (Date applied for, April 3, 1905.)
8,057 Kuzel. Manufacturing incandescence bodies of difficultly fusible conductive materials and uniting such bodies to supply conductors. (Date applied for, Aug. 3, 1905.)
8,289 Moores. Stopping tramcars or motor vehicles in emergency.
8,425 Metz. Tramway rails.
8,434 Finzi & Tallero. Brush-holders for electrical machines. (Date applied for, April 8, 1905.)
8,612 Hewitt. Vapour electric apparatus. (Date applied for, 25/4/1905.)
8,614 Ehrhart. Turbines. (Date applied for, April 21, 1905.)
9,313 Pieper. Automatic regulation of continuous-current motors driving variably or intermittently-working machines.
9,767 & 9,768 Westinghouse. Turbines. (Date applied for, May 2, 1905.)

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL & FLEETWOOD TRAMROAD CO.—Mr. R. H. Prestwich stated at the meeting last week there had been an increase of £1,043 in traffic receipts. That was satisfactory because it had hitherto been their experience that the traffic, in spite of all influences (good or bad) had remained year by year very much the same; they had been able to declare the same dividend, and put aside very nearly the same sums to reserve. Company's prospects were never so good as at present. He referred to their appeal against the mode of assessing their tramways, and said they had reasons for anticipating that the decision of Quarter Sessions would be reversed. Some £800 a year was involved, and the directors were impressed with the importance of the action they were taking, and would, if necessary, carry it to the House of Lords for final decision. They would be able to pay the usual dividend of 4 per cent., and they could increase the general reserve and depreciation reserve by £560 and £500 respectively.

BANK FUR ELEKTRISCHE UNTERNEHMUNGEN.—The report states that considerable progress was made during the past year; the chief manufacturing companies were well occupied with orders, and the prices obtained for finished work were higher than in the previous year. Further progress has been made with the application of electric traction to standard railways. In Germany the electrification of the State railways in and near Hamburg has been undertaken, whilst Brown, Boveri & Co. have equipped the Simplon Tunnel Railway at their own expense by way of experiment. The initial difficulties in connection with the latter have, it is reported, been overcome, and the railway is now working well Several other proposals are made for the electrification of the Swiss State and other railways. Additional waterfalls are being utilised, especially for generating energy for electrochemical and electrometallurgical works. The outlook is considered to be very good.

LONDON ELECTROBUS CO. (LTD.)—At the statutory meeting on Wednesday the chairman (Mr. J. T. Musgrave) is reported to have stated that satisfactory progress was being made towards placing electric omnibuses on the streets. Notwithstanding the large number of withdrawals there still remained on the books of the company nearly 50,000 shares, in respect of which only £170 was owing for calls made. He thought that fact proved that the shareholders were in accord with the directors on the question of the future of the electric omnibus. It was announced that 30 omnibuses were on order, 10 of which were being pushed forward rapidly. It was also stated that satisfactory contracts had been entered into for tyres and accumulators, and that the company already had a suitable garage.

Mr. Beechcroft (a director) stated that the fact of the directors meeting their shareholders was sufficient answer to the criticisms that had been levelled at the company and its officials. Some of the contracts had been amended greatly to the advantage of the shareholders. Experts' opinions varied just as much on electrical matters as in medical matters. In regard to electric traction, this country was very backward, and in America some hundreds of electrically-propelled public-service vehicles were in constant and successful use, thus proving that it was possible to run them at a profit.

MATHER & PLATT (LTD.) At the meeting on Wednesday Sir Wm. Mather said the result of the year's working was fairly satisfactory. A great number of changes had taken place in the business, chiefly owing to a constant disturbance in their foreign trade and to the considerable improvement in the home trade. The large amount of work done by electrical engineers for corporations and other large bodies was not likely to continue for any great length of time, and as many new companies had been started and others had enlarged their power of production competition at home was not likely to decrease. He believed that the company must continue to look largely to foreign countries, where they found business more profitable and where they had already placed a considerable amount of capital.

MERSEY RAILWAY CO.—At the meeting yesterday (Thursday) the chairman (Mr. James Falconer) said that the report showed a substantial improvement from every point of view. The number of passengers, compared with the corresponding period of last year, had increased practically by half a million and the increase in traffic receipts was £2,604. The total increase of revenue from all sources had been £3,592, and if they took the averages for the past 3½ years the figures showed an improved ratio of increase, and that ratio had been maintained since the closing of the half-year. Therefore, he thought, they might reasonably infer that a steady development in the traffic was going on. If they compared the results with those of the half-year immediately preceding the adoption of electric traction the results were very striking. The number of passengers had increased by 2½ millions, an increase of 88 per cent. on the number of passengers carried in the last half-year of 1902. The receipts from passengers had increased by £14,190, or an increase of 59 per cent.

PERTH ELECTRIC TRAMWAYS (LTD.)—For the half-year ended June 30 the receipts were £39,273, an increase of £2,659 over the corresponding period of 1905. Operating, maintenance and general expenses were £19,694, a decrease of £449. Since June 30 the traffic receipts have shown an increase each week over the corresponding week in the previous year, the total increase for the eight weeks ended 24th inst. being £699.

TYNESIDE TRAMWAYS & TRAMROADS CO.—Lord Armstrong, who presided at the meeting on Tuesday, said that very considerable progress had been made by the company towards recovering the loss of traffic sustained through the electrification of the N.E.R. line to Tynemouth. The receipts exceeded the expenses by a greater amount than they had done during any previous half-year. They had been able to recommend a dividend of 1½ per cent. to place £900 to depreciation and contingency fund and to carry forward £607. As no further capital expenditure was in contemplation, they had reasonable grounds for anticipating that the dividend would shortly become more satisfactory, provided that the present rate of progress was maintained. Their expenses per car-mile had gone down slightly compared with the past, being for the last half-year 5·55d. That figure was a very low one, and the directors had satisfied themselves by detailed analysis of all the items of expenditure that the utmost economy was being observed in all departments, and that it would not be wise to further reduce the expenditure as that could only be done by lowering the standard at which the track and cars were maintained, and would merely result in increasing the future cost of renewals. The question of depreciation was in their case affected by the fact that their tramways were only purchasable at a fair market value as a going concern, and by the fact that considerable sums had been expended on land. They approached more nearly railway companies than did the average tramway company. They had, besides, carried out all repairs and renewals to railway stock and permanent way out of revenue, and as they purchased their electricity from outside sources they had to make no allowance for the depreciation of a power station, which certainly tended to become antiquated more rapidly than did any other portion of a tramway system. The £747 increase in traffic receipts was an all-round one, being made up of £547 from their own cars and £200 received from Newcastle Corporation tramways department. Their running power agreement with Newcastle Corporation provided for through traffic facilities over three routes, but up to the present those facilities had only been given on two routes. As the expenditure for securing the running-power agreement was heavy and as the results from the through traffic on the two routes had been satisfactory to the public themselves and the Corporation, they were naturally anxious to get the third route opened as speedily as possible. The latter section raised grave engineering objections, so that, although the company had everything in complete readiness, two years had elapsed since the agreement was signed without the line being opened. He was glad, however, to be able to report that the Corporation were carrying out such alterations to their lines as would enable a through service to be given before the end of the year. The service would, they anticipated, beneficially affect their profit.

WESTINGHOUSE ELECTRIC & MFG. CO. (U.S.A.)—At the recent meeting of the stockholders in America the president (Mr. Geo. Westinghouse) said the general operations of the company were set forth in the reports of the first vice-president (Mr. E. M. Herr) and of the second vice-president (Mr. L. A. Osborne), while the financial conditions were shown by the balance sheet as of March 31 and by the statement of income and profit and loss for the six years intervening since the report submitted at the last meeting of the stockholders, held Feb. 20, 1901. During that period the requirements for additional manufacturing facilities and working capital had demanded extraordinary efforts and care on the part of the directors and managers in order to maintain a well-earned reputation for excellence of apparatus and such a financial standing as would ensure temporarily the large amounts needed to carry on the widely increasing operations of the company until a complete financial plan could be evolved. Such a financial plan was ratified at a special meeting of the stockholders in March last. The president had been especially charged with the creation and development of the company's interests in foreign companies. These large interests were in the British Westinghouse Electric & Mfg. Co., Ltd. (London), the Société Anon. Westinghouse, of Paris (covering France, Spain, Portugal, Italy, Belgium, Switzerland and Holland and their dependencies), the Westinghouse Electricitäts Actiengesellschaft (Berlin) and the Westinghouse Electric Co., Ltd. (London). All shares of the latter company were owned by the American company and had all territory not covered by the companies named. Keen competition with manufacturers in Europe and the usual difficulty in starting new plants had thus far prevented returns upon the money invested in those foreign enterprises, but it might be stated with confidence that the business of each of those interests would, in the near future, be brought to a condition which would make those investments profitable. The recent securing of important contracts, aggregating $6,000,000, from the municipal authorities of St. Petersburg for the construction of electric tramways in that city resulted in negotiations between French bankers, who controlled a suitable modern electric manufacturing plant in Moscow. Those negotiations had resulted in the formation of the Société Westinghouse Electrique de Russie, to purchase those works and the electrical business which had been developed by the electric department of the Société Anon. Westinghouse (of St. Petersburg) on a most favourable basis, and which would cover all expenditures in developing the electrical department, besides increasing the American Co.'s assets by nearly $1,000,000. The immediate working capital for the new company had been supplied by the financial interests referred to, and the new company thus started in business with large orders in hand under exceptional favourable conditions, and with a strong board of direction and experienced Russian officials. There were further important pending operations which might soon result as favourably for the company as had the business in Russia just referred to.

The report of the first vice-president (Mr. E. M. Herr) said that for the fiscal period from March 31, 1900, to March 31, 1906, the East Pittsburg works were twice increased in size and capacity (in 1901-2 and in 1904-5); those additions gave the East Pittsburg works nearly four times their original floor space. The Cleveland (Walker) works were changed in 1904 into an admirably-equipped iron foundry, and since then used for the more important foundry work. The Newark works had been completely rebuilt since 1902 and additions were made providing a total floor space of 185,000 sq. ft. All those additions to the works in East Pittsburg, Cleveland and Newark were now fully equipped with machinery. Special attention had been given to provide adequate facilities for taking care of the rapidly growing and important business in turbo-generators as well as the building of electric locomotives of all sizes and types, both for special and regular railroad service. The total number of employés (exclusive of selling organisations) had increased from 7,971 in 1901 to 14,705 in 1906. During the last year a line of railway between East Pittsburg and Trafford City was completely equipped by the company with the latest type of catenary suspension trolley line for high-tension alternating-current transmission, and was being used in testing single-phase electric locomotives manufactured by the company. That railway was also fitted with the third rail and adequate sub-stations for testing locomotives using direct current, thus affording complete facilities for thoroughly testing under service conditions that important and rapidly increasing branch of the product of their works. To provide for the rapidly increasing business of the Sawyer-Man Electric Co. ground was recently purchased in Watsessing (N.J.), on which entirely fireproof buildings containing 206,700 sq. ft. of floor space are being erected. Those buildings will be equipped with the most modern appliances for the manufacture of incandescent lamps. A large addition to the main factory of the Bryant and Perkins companies in Bridgeport was rapidly nearing completion and would afford needed relief to the increasing manufacturing requirements of the business of those companies.

The report of the second vice-president (Mr. L. A. Osborne) stated that in probably no other industry was the product subject to such frequent and complete change as in their own. Apparatus was now in daily use in sizes and of dimensions which but a few years ago it would have been thought folly to attempt. The fields wherein the applications of electricity might be profitably employed were constantly increasing. The pre-eminent success of their business, a success which had been achieved by leading and not following, had been and was primarily due to the excellence of their engineering. The number of persons employed in the engineering department in 1901 was 420 and in 1906 627. The *Research Division* was designed to carry on advanced electrical work and research and to investigate to an exact degree materials and processes, so that information might be placed at the disposal of their designing engineers that would enable them to attain a maximum of efficiency in the design of commercial apparatus. The *Chemical and Physical Laboratories* provided means for facilitating their general development work and for determining the adaptability and sufficiency of the materials entering into their finished product. Their *Materials Committee*, which also included representatives from the manufacturing department, ensured the careful study of their requirements, and by specifying a definite basis for the purchase of raw materials had enabled large savings to be effected, and had resulted in securing a more definite and better class of materials. The *Division of Standards Department* controlled the calibration of all instruments of precision, and its work had enabled the company to maintain the first position in the instrument business and the reputation for high-grade, careful and accurate work. In the *Development Department* it was of interest to note that at least 45 per cent. of their engineering force was continuously engaged on development work—that was, in work for the future.

To be effective that work must be carried on by highly specialised and experienced engineers. The character of that work determined the success of the company's future product. To judge the future by past accomplishments led them to have no misgivings. That work would in the future increase rather than diminish, due to the rapid extension of electrical applications and to the fact that the requirements of electrical design were becoming daily more exacting. Among the multitude of problems which had been successfully solved by their engineers and which had resulted in new applications and new outlets for the company's product, one development stood out, which, by reason of the brilliancy of its accomplishment, exceeded all others—viz., the development of the single-phase alternating-current system for railway operation. The single-phase system, which was made possible by the genius of their chief engineer (Mr. B. G. Lamme), was developed and made a complete success in the face of the incredulity of practically the entire engineering world. The system furnished the only means to-day by which existing steam roads could be economically operated by electric power, and its general adoption, which was at hand, would open an enormous field for the products of their company. The system had for more than a year been in successful operation on a number of important inter-urban roads. It had been adopted by the New York, New Haven & Hartford Railroad for the operation of trains on its main line from New York city to Stamford, Conn. That contract was now in process of execution. Two other important railroads had placed contracts with them—namely, the Grand Trunk Railway of Canada, for the electrification of the Sarnia Tunnel, and the Spokane & Inland Railway of the state of Washington, for the complete operation of its lines by that system.

The present state of the art in long-distance transmission of power was largely due to the investigations and skill of their designers. Their company had been foremost in that field and had many important projects under consideration at present involving new and radical extensions of existing practice. Their lines of apparatus for the industrial applications of electricity were adequate and were being constantly increased as the demand arose. They had been particularly successful in the application of electric power to the needs of railroad shops, cotton mill and textile industries, and they had many large and important installations. They had under process of development important improvements in arc lamps, which had proceeded to the point where they were satisfied that their application would revolutionise existing practice and would soon form an important and valuable addition to their business. Their measuring instruments and instruments of precision represented the most advanced state of the art. In the *Sales Department* for the year ended March 31, 1901, the sales were $12,516,071, and in 1905-6 $24,939,602. For the first five months of the present year the sales had averaged above $2,850,000 per month. Those sales did not include the sales of the subsidiary companies, the Bryant and Perkins Cos., the Sawyer-Man Electric Co. and the R. D. Nuttall Co., which for the fiscal year 1905-1906 amounted to about $3,500,000. All these subsidiary companies showed large increases for the current fiscal year. The policy of establishing district offices wherever conditions of trade in any particular section of the country justified the maintenance of permanent representatives was being continued. In addition to district offices they had established a number of subsidiary branch offices (reporting to contiguous district offices) in locations where conditions of trade did not justify a larger permanent force.

The *Railway and Lighting Department*, which directed the sale of apparatus for railways and central stations for both power and lighting, had been highly successful in extending the company's business. The sales of railway motors during the past year increased 51 per cent. over any previous year in the company's history. The sales of the electro-pneumatic unit switch system of multiple control showed an increase of upwards of 60 per cent. over any previous year. The central-station business, including long-distance transmission plants, had been characterised by the more general use of steam turbine direct-driven generators. Their business in turbine-driven generators had been very large, and was constantly on the increase. The turbo-generator business had increased during the past year 94 per cent. over that of any previous year. In long-distance transmission work their business continued to increase. Higher voltages continued to be used and specified, and they had been very successful in securing recognition for the superiority of their apparatus. Their engineers had under consideration an installation involving the transmission of electrical energy up to 150,000 volts, and they had several commercial plants in operation and under contract involving voltages of 60,000 to 80,000 volts.

The *Industrial and Power Department*, which directed the sales of apparatus for industrial application (including machine shops, mills, mining motors and generators for resale), had shown an increase during 1905-6 of 46 per cent. over the best previous year, and for the early months of the current fiscal year the sales had been on a basis largely in excess of last year's increase. Many of the sales of the department had involved new and novel applications of electricity to mill practice. These installations had been highly successful and had opened fields heretofore closed.

Their *Detail and Supply Department*, which directed the sale of meters, transformers, fan motors, arc lamps and accessories, had during the past year largely increased its sales over any previous year. The sales for the first five months of the present year were over 90 per cent. greater than during the same period of any previous year.

The *Export Department* (in New York), which handled the sales in their export territories, had, during the past year, greatly extended the scope of its operations and had closed many large and important contracts. Their export business for the current fiscal year had shown such increases as justified them in believing that it would exceed many times the amount obtained in any previous year, and it was their further belief that that branch would constitute an extremely important proportion of their business.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

EAST AFRICA & UGANDA CORPN. (LTD.) (89,933.)—Reg. Aug. 22, capital £100,175 in £100,000 shares of £1 each and 3,500 shares of 1s. each, to promote and conduct companies for carrying on in Uganda, British East Africa and elsewhere, banks, railways, canals, docks, telegraphs, telephones, electric light and power works, industrial and exploration undertakings, &c., and to acquire from the East African Exploitation Synd. the benefit of negotiations for the formation of a bank, the construction of railways, the production and distribution of electric power, the exploitation of forests, and cultivation of rubber, &c. First directors, R. C. Abdy, Sir Ernest Cable, C. S. Cox, Sir F. W. R. Fryer, R. P. Sellon, W. P. James Fawcus, E. Gedge and Lord Hindlip.

R. G. E. SYND. (LTD.) (89,925.)—Reg. Aug. 21, capital £20,000 in £100 shares, to own, work, control and turn to account tramways, railways, hydraulic works, wharves, &c., in South America.

WESTINGHOUSE METAL FILAMENT LAMP CO. (LTD.) (89,948.)—Reg. Aug. 23, capital £10,000 in £1 shares, to adopt an agreement between Felix Kuschenitz, G. Westinghouse and the company, and to carry on the business of manufacturers of and dealers in electric lamps and other apparatus, electricians, engineers, makers and suppliers of and dealers in electricity, &c. First directors, G. Westinghouse, J. H. Lukach, G. Leve, Felix Kuschenitz and R. Belfield. Reg. office, Westinghouse Building, Norfolk-street, Strand, W.C.

WESTINGHOUSE COOPER HEWITT CO. (LTD.) (89,947.)—Reg. Aug. 23, capital £10,000 in £1 shares, to enter into any arrangements or contracts or take any licences from the Cooper-Hewitt Electric Co. (of New York), and in particular with regard to the Cooper-Hewitt mercury vapour lamp and other apparatus, and to carry on the business of electricians, engineers, makers and suppliers of electricity, &c. First directors, G. Westinghouse, N. Carlton, F. E. Drake, F. Hessenberg, R. Belfield, J. H. Lukach, A. E. Scanes and Max von Rechlinghausen. Reg. office, Westinghouse Building, Norfolk-street, Strand, W.C.

STATUTORY RETURNS.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Return to July 18 gives capital as £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each, all of which have been taken up. £1 per share has been called and paid up on the ordinary and £5 per share on the founders' and preference. Mortgages and charges, nil.

NEW GENERAL TRACTION CO. (LTD.)—In return to July 18 capital is £370,000 in 50,000 preference and 24,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on the preference and £250,000 has been received. £120,000 is considered as paid on the ordinary. Mortgages and charges, £280,000.

MORTGAGES AND CHARGES.

ART FITTINGS (LTD.)—A debenture dated Aug. 14, 1906, to secure not more than £1,000, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holders, Drake & Gorham.

BASTIAN & PARTNERS (LTD.)—Issue on July 31 of £75 10 per cent. debentures, part of series created July 1, 1905, to secure £4,000, charged on company's undertaking and property, present and future. No trustees. Previously issued of same series, £2,700.

CITY NOTES.

MEMORANDA (Aug. 30).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $30\frac{7}{8}$d. per oz. Consols $87\frac{7}{16}$—$87\frac{9}{16}$ for money, $87\frac{7}{16}$—$87\frac{9}{16}$ for account; $2\frac{1}{2}$ per cent. annuities 86—$86\frac{1}{2}$. Consols Pay Day, Sept. 3; Stocks and Shares Continuation Day, Sept. 11; Ticket Day, Sept. 12; Pay Day, Sept. 13; Mining Share Carry-over Day, Sept. 10.

COMPANIA TELEGRAFICO-TELEFONICA DEL PLATA, MONTE VIDEO.—The directors have declared an interim dividend of 6 per cent. for the first half of the current year.

GENERAL ELECTRIC CO. (U.S.A.)—This company has declared a quarterly dividend of 2 per cent.

W. T. GLOVER & CO. (LTD.)—During the week this company invited applications for £80.000 5 per cent. second mortgage debenture stock at 95.

MACKAY COMPANIES.—A regular quarterly dividend of 1 per cent. on both the preferred and common shares of the Mackay Companies will be paid on Oct. 1. The transfer books will be closed from Sept. 17 to Sept. 29 inclusive.

NORTHALLERTON ELECTRIC LIGHT & POWER CO. (LTD.)—At an extraordinary meeting last week the resolution reducing the capital of the company from £10,000 to £6,500 in 12,000 ordinary shares of 6s. each and 2,900 preference shares of £1 each was confirmed.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of 318 $1,000 and 364 $500 5 per cent. consolidated first mortgage bonds of the *Shawinigan Water & Power Co.* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 22	1,673	+ 21	12	18,892	- 293
Airdrie	,, 17	232	+ 5	33	7,216	+ 659
Anglo-Argentine	,, 26	13,991	+ 1,310	34	502,705	+ 54,786
Ashton-under-Lyne Corp.	,, 25	416	+ 27	22	7,950	+ 883
Ayr Corporation	,, 25	405	- 18	15	6,235	- 36
Baker St. & Waterloo Ry.	,, 25	1,155	...	8	10,427	...
Barnsley	,, 17	199	- 9	33	5,341	+ 40
Barrow	,, 17	335	- 10	33	8,426	+ 474
Bath Electric Trams, Ltd	,, 22	1,086	+ 288	34	27,760	+ 4,733
Birkenhead Corporation	,, 28	1,118	+ 54	...	...	...
*Birmingham Corporation	...	...	...	...	...	...
Birmingham & Mid.	,, 17	9,09[illegible]	- 870	33	336 303	+ 17,726
Blackburn Corporation	,, 22	1,076	+ 63	¶21	23,114	+ 1,312
Blackpool Corporation	,, 23	3,233	+ 215	20	31,918	+ 1,703
Blackpool and Fleetwood	,, 25	2,212	+ 201	...	...	...
Blackp'l, St. Anne's & Lytham	...	..	...	...	..	...
Bolton Corporation	,, 26	2 338	+ 64	21	46,414	+ 2,896
Bournemouth Corporation.	,, 22	2,509	+ 427	†21	37,169	+ 7,603
Bradford Corporation	,, 25	4,782	+ 96	21	99,746	+ 3,898
Brighton Corporation	,, 26	1,388	- 34	21	23,327	- 1,078
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 24	5,404	+ 274	2	10,380	+ 126
Buenos Ayres & Belgrano	,, 19	4 077	+ 355	34	121,261	+ 6,487
	,, 26	3,195	- 209			
Buenos Ayres Elec. Trms	July 28	1,310	+ 89	31	41,025	+ 7,347
Burnley Corporation	Aug. 25	1 220	+ 69	21	24 985	+ 1,268
Burton Corporation	,, 26	318	- 10	§21	6,668	- 432
Bury Corporation	..	...	...	...	...	...
Calcutta Tramways Co.	,, 25	R43,441	+ R1,751	8	R350,141	+ R8,461
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 18	2,155	- 32	20	43 1[illegible]2	- 908
Cavehill	,, 17	108	+ 50	33	2,9[illegible]4	+ 1,161
Central London Railway	,, 25	4 979	- 321	8	43 396	- 2,027
Chatham & Dist. Lt. Rys.	,, 23	732	- 17	†34	22,206	- 545
City & South London Rly.	,, 26	2,280	+ 119	8	19,330	+ 1,296
Colchester Corporation	,, 23	267	+ 16	...	...	...
Cork Electric Trams Co.	,, 23	544	+ 19	34	16 345	- 339
Croydon Corporation	,, 24	1,587	+ 141	12	19,865	+ 1,260
Devonport & Dist. Trams	,, 17	514	- 8	33	14 982	- 363
Dover Corporation	,, 25	366	+ 48	21	5,991	+ 821
Dublin & Lucan Railway	,, 24	153	- 6	§8	1 171	- 39
Dublin United	,, 24	5,714	- 441	‡8	44,851	- 71
Dundee Corporation	,, 28	1,102	+ 230	§14	15,804	+ 3,292
East Ham Council	,, 25	981	+ 104	21	20,178	+ 1,751
Exeter Corporation	,, 24	361	+ 43	21	6,441	- 365
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 17	950	- 8	33	31,785	+ 1 722
Glasgow Corporation	,, 25	17,002	+ 1,912	13	206,793	+ 16,064
Glossop	July 28	143	+ 8	32	4,069	+ 359
	Aug. 4	119	+ 11			
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 17	290	+ 10	33	7,941	+ 312
Gt. Northern & City Rly.	,, 25	1,490	+ 109	8	12,378	+ 987
Greenock & Port Glasgow	,, 17	812	+ 28	33	21,904	+ 905
Halifax Corporation	,, 22	1,696	- 15	21	36,648	+ 1,089
Hartlepool Tramways	,, 17	343	+ 19	33	9,860	+ 1,156
Hastings Elec. Trams Co.	,, 23	1,420	...	8	8,888	...
Huddersfield	,, 25	1,517	+ 99	21	32,880	+ 2,964
Hull Corporation	,, 25	2,282	+ 80	21	48,040	+ 951
Ilford Dist. Coun.	,, 25	520	+ 7	21	10,964	+ 9
Ilkeston Dist. Council	,, 22	143	+ 27	21	2,891	+ 249
Ipswich Corporation	,, 18	540	- 21	21	9,973	- 233
	,, 25	559	- 2			
Isle of Thanet Co.	,, 25	1,993	- 131	46	25,983	- 954
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 17	115	- 16	33	4,059	- 36
Kilmarnock Corporation	,, 25	154	- 4	15	2,476	- 85
Kirkcaldy Corporation	,, 22	274	+ 17	8	2 060	+ 100
Lanarkshire Trams Co.	,, 23	939	+ 29	‡34	29,509	+ 5,629
Leamington	,, 17	197	- 47	33	5,895	+ 2,734
Leeds Corporation	,, 25	6,505	+ 533	21	135,331	+ 6,932
Leicester Corporation	,, 25	2 235	+ 89	31	75 057	+ 4,532
Leith Corporation	,, 25	510	+ 118	‡15	8 059	+ 4,085
Lincoln Corporation	,, 25	134	..	21	2,513	...
Liverpool Overhead Rly.	,, 26	1,537	- 47	8	12 826	- 506
Liverpool Corporation	,, 18	10,842	- 169	33	351,145	+ 5,432
*London County Council	,, 18	24,519	+ 8,774	29	531,662	+ 226,086
London United	,, 24	7,445	+ 859	†31	212,711	+ 12,551
Lowestoft	,, 25	463	- 25	48	8 175	- 632
Maidstone Corporation	,, 25	135	- 10	21	2,571	- 289
Manchester Corporation	,, 25	14,783	+ 1,553	21	292,005	+ 14,809
Mersey Railway	,, 25	1,632	+ 134	8	13,137	+ 1,096
Merthyr	,, 17	205	+ 19	33	6,412	+ 121
Metropolitan Dist. Railway	,, 26	6 450	+ 425	8	58,004	+ 6,751
*Metropolitan Elec. Trams	,, 17	3,512	+ 31	33	111,740	+ 26,931
Middleton	,, 17	361	- 69	33	11,652	+ 315
Nelson Corporation	,, 25	149	+ 10	22	3,202	+ 259
Newcastle-on-Tyne Corp.	,, 25	4,0[illegible]0	+ 341	21	86,903	+ 5,465
Newport (Mon.)	,, 25	698	+ 89	21	13,737	+ 641
Northampton Corporation	,, 24	502	+ 42	21	9,882	+ 46
Oldham, Ashton & Hyde	,, 17	[illegible]12	- 58	33	18,625	+ 497
Oldham Corporation	,, 26	2,073	+ 91	22	40,428	+ 3,500
Perth (N.B.) Corporation	,, 22	170	...	14	2,398	...
Perth (W. A.) Elec. Trams	,, 24	1,338	+ 96	34	49,973	+ 3,008
Peterborough	,, 17	170	- 15	33	4,299	- 329
Pontypridd District Coun.	...	...	...	..	...	...
Portsmouth Corporation	,, 25	2,872	+ 245	21	47,114	- 1,842
Potteries	,, 17	1,552	+ 58	33	58,362	+ 2,936
Preston Corporation	,, 22	810	+ 93	8	6,557	+ 794
Reading Corporation	,, 23	690	+ 11	...	...	..
Rochdale Corporation	...	..	...	..	...	...
Rotherham Corporation	,, 23	574	+ 90	21	10 643	+ 1,040
Rothesay	,, 17	754	+ 100	33	7,970	+ 1,083
Salford Corporation	,, 27	4,521	+ 141	21	97,763	+ 1,342
Sheerness	,, 15	89	- 16	33	1,937	- 407
Sheffield Corporation	,, 26	5,639	+ 672	22	117,330	+ 7,047
Singapore Trams	,, 25	$7,342	...	9	$60,362	...
Southampton Corporation.	,, 22	1,133	- 5	20	3,579	...

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southend Corporation	Aug. 22	741	+ 38	21	9,677	+ 269
Southport Tramways	,, 17	487	- 33	33	10,627	+ 233
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	,, 26	1 592	+ 140	21	31,118	+ 1,419
Sunderland & District	,, 22	132	...	34	13,408	...
Swansea Trams	,, 17	993	+ 24	33	27,296	+ 4,716
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 17	76	- 8	33	1,511	- 155
Tynemouth and District	,, 17	393	- 51	33	8,719	- 180
Tyneside Trams Co.	,, 22	486	+ 44	34	15,503	+ 1,084
Wallasey District Council	,, 25	993	+ 81	21	18,271	+ 633
Walsall Corporation	,, 25	561	+ 62	31	17,549	+ 955
Warrington Corporation	...	..	...	...	...	...
West Ham Corporation	,, 23	2 308	- 112	21	48,883	+ 13,294
Weston-super-Mare	,, 15	445	- 22	33	4,813	[illegible] 214
Wolverhampton Corpn.	,, 22	917	...	8	7,248	...
*Worcester	,, 17	318	- 59	33	9,319	- 761
Wrexham	,, 17	116	+ 1	33	3,366	+ 20
Yorkshire W.R. Trams	,, 26	890	+ 31	34	28,292	...
Yorkshire Woollen District	,, 17	948	+ 176	33	29,681	+ 8,534

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Aug. 29.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Aug. 29.	
		ELECTRIC RAILWAYS TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
5	5/0	Anglo-Argentine Ord. Shs.	7⅜—7⅝	5 4 0	Ap, Oct	$7\frac{15}{32}$	$7\frac{5}{16}$
5	2/9	Do. 5½% Cum. Pref.	5¾—6	4 11 8	—	$5\frac{15}{16}$	$5\frac{13}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	13[illegible] —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	102 —104	4 16 3	—	10[illegible]½	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—4⅝	5 0 0	—	4⅝	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	9[illegible] —104	4 6 6	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117 —120	5 0 0	—	..	..
St.	5%	Do. Pref. Ord. Stk	110 —113	4 8 6	—	12½	11¾
10	5%	Do. 5% Cum. Perp. Pref. Stock.	105 —[illegible]	4 13 0	—	107½	07
4[illegible]	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103%—105%	4 5 6	—	..	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	[illegible]⅜ - 3⅝	4 16 6	—	3½	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5¼—5¾	5 4 0	—	..	..
5	8/0	Do. "B"	5 —5½	5 0 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —10[illegible]	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8 —8½	4 15 0	—	8½	..
5	2/6	Do. Nos. 105,001 to 137,610	7⅞—8⅜	4 15 6	..	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —105	4 5 0	—	..	..
1	0/6	Cape Electric Tram Shares	⅝—⅞	5 14 0	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —102	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	86 —91	6 12 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	1⅜—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	100 —102	4 8 0	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 1[illegible] 8	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	14[illegible] —14[illegible]	5 2 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	97%—99%	5 1 0	..	..	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞—5⅜	5 2 0	..	..	..
5	5/[illegible]	Calcutta Elec. (1-50,000)	[illegible]½ —[illegible]	4 9 0	..	..	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	49	48¾
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Dsbs.	88 —92	5 8 6	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	109 —112	5 7 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$—$\frac{27}{32}$	7 8 6	—	..	..
1	1/6	Rand Electric	$1\frac{1}{16}$—$1\frac{3}{16}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	[illegible]—$\frac{11}{16}$	..	..	..	..
1	1/2[illegible]	Do. 6% Non. Cum. Pref	⅞ - 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	100	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Aug. 29.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 29. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5/0	†Bournemouth & Poole Elec. Sup. Ord.	10¼–11¼	6 4 0	..	–	..
10	4/6	† Do. 4½ per Cent. Cum. Pref	9¾–10¾	4 8 0	..	..	..
10	6/0	† Do. 6% Cum. Second Pref.	10¾–11¾	5 2 0	..	–	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	104½	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	5⅛–5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	102½	101½
5	4/6	†Brompton & Kensington Elec. Sup. Ord.	8 – 9	5 11 0	–	..	..
5	3/6	† Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	–	..	..
5	2/6	†Charing Cross (W. End & City) El. Sup. Co.	4½–5	5 0 0	Feb, Aug	4 9/16	..
5	2/3	† Do. 4½ per Cent. Pref.	4⅜–4⅞	4 12 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 0	–	102¼	102
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 – 4½	5 0 0	–	..	..
5	2/3	Do. Do. (1903)	4 – 4½	5 0 0	–	4⅛	..
5	3/9	Chelsea Electric Supply Ord.	5⅜–5⅞	5 5 0	March ..	5 11/16	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	107½	..
10	5/0	City of London Electric Lighting Ord.	10¾–11¼	5 4 0	Feb, Aug	11⅛	11⅛
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	12½	12 3/16
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 6	..	..	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞–3	4 0 0	April, Oct	3	2 15/16
5	5%	Do. Do. 5% non cum. pref.	5 3/16–5 5/16	4 15 3	April, Oct	..	..
10	4/0	†County of London Elec. Supply Ord.	8¾–9¼	5 8 0	–	8 15/16	8 9/16
10	6/0	† Do. 6 per Cent. Cum. Pref.	11⅝–12⅛	4 19 0	Mar, Sept	11⅞	11¾
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	108	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	..	..
5	5/0	Hove Electric Lighting Ord.	7¾–8¼	5 9 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	–	10⅛	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
1	2/4⅘	London Electric Supply Ord.	1⅞–2⅛	4 4 0	–	–	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	–	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	..	..
5	4/0	†Metropolitan Electric Sup. Ord.	8⅜–8⅞	5 9 6	April, Oct	8⅝	8½
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 9	Jan. July	5⅜	5 9/32
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	–	96	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	7½%	†Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10¾–11	5 19 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102½–103½	4 7 5	Jan, July	103	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 5 11	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅝–5¾	4 8 0	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	..
1	8%	Northern Counties Elec. Sup.	1 7/32–1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 3 5	March ..	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	4/6	Oxford Electric Ord.	6¼–6¾	4 19 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 – 8	4 7 0	Feb, Aug	..	..
St	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 – 2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 3 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16–⅞	–	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1⅛–1⅜	5 2 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3½– 4	6 10 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	98 –101	4 9 0	..	..	–
5	5/6	†Westminster Elec. Sup. Ord.	9¾–10¾	6 6 0	Mar, Sept	10⅜	10
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 13/32	..
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	–	87	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	–	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	–	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 – 100	4 10 0	..	99	..
10	9½%	Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	–
10	6/0	British Electric Traction Ord.	5½–6	5 0 0	–	5⅞	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	9½–10	6 0 0	Feb, Aug	9 13/16	9 9/16
St.	5%	Do. 5 per Cent. Perpetual Debs	113 –116	4 6 0	..	114⅝	113½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92 –95	4 15 0	..	94	92½
St.	4%	†Central London Ordinary Stock	85 –87	4 12 0	June, Dec	86½	85½
St.	4%	† Do. 4 per Cent. Pref. Stock	97 – 99	4 1 0	..	98½	..
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	75	74
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	109½	109¼
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 – 5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	.	..
St.	2¼%	†City and South London Rly. Con. Ord.	44 –46	4 7 0	Feb, Aug	45½	44¾
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	118 –121	4 2 9	Feb, Aug	–	..
St.	5%	† Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	† Do. (1901)	113 –116	4 6 0	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	106½	105½
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½– 4	10 0 0	..	..	–
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 11/16–8 15/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾–9¼	5 8 0	–	8¾	–
St.	4%	Do. 4% 1st Mort. Deb. Stock	94 –97	4 2 6	–	..	..
St.	..	Mersey Con. Ord. Stock	5 –7	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 –10	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛–3/16	.	–	..	..
1	0/6	† Do. 5% Cum. Pref.	13/16–15/16	5 9 0	–	⅞	13/16
St.	4½%	Do. 4½% Deb. Stock	99 –101	4 9 0	–	100	99¾
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May ..	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¾	5 5 0	..	..	..
10	5/0	† Do. 5 per Cent. Cum. Pref.	7¼–8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 –92	5 8 8	–	90¼	89⅞
St.	3%	†Waterloo and City Ord.	101 –104	2 17 9	June, Dec	..	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	–	..	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	–	..	–

Shre.	Last Dividend	Name.	Price Wed., Aug. 29.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Aug. 29. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	–	..	..
1	2/4⅘	Babcock & Wilcox Ord	4 –4¼	4 11 0	..	4 7/32	4 1/16
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	1 9/16	–
5	4/0	British Insulated & Helsby Cables Ord.	6¾–7¼	5 10 0	July, Feb	6 29/32	..
5	3/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	–	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	96 –98	4 12 6	..	–	..
5	..	British Westinghouse 6% Pref.	1¼–1¾	..	..	–	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	..	..
2	1/0	Brush Electrical Engineering	⅞–1⅛	..	March ..	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1⅞–2	6 0 0	Mar, Sept	1 15/16	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	97 –99	4 1 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..	–
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5⅞	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	..	..
1	1⅞d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	1 1/16	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	95 –100	4 10 0	–	98¾	–
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	–	1 5/16	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
8	1/6	†Crompton and Co. (Nos. 1 to 54,000)	1 11/16–1 15/16	3 13 0	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–97%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	1⅝–1⅞	5 11 0	Sept ..	1 23/32	..
5	3/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept ..	1 9/32	1 7/32
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	4 5 6	Feb, Aug	1 21/32	1 17/32
5	2/6	Do. (£5 paid)	2½–3	4 3 0	Feb, Aug	–	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3¼–3¾	9 12 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅞–5⅜	5 11 6	..	5 3/32	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	–	–
2	1/7½	Electric Construction Co.	¼–½	14 0 0	July ..	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July ..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	86 –89	4 10 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 – 9½	5 5 3	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 – 97	4 2 6	–	..	–
5	10/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	..	..
5	9/8	Do. 4½ per Cent. Pref.	5⅜–5⅝	4 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107 –109	4 2 6	..	..	..
St.	12/6	Do. Do. Scrip (all paid)	107 –109	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17 3/32	..
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	101½	100½
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	15/16–1	6 0 0	..	1	31/32
1	7½d.	Do. 6% Cum. Pref.	1 –1⅛	5 7 0	..	1 1/32	1
St.	4½%	Do. 4½% Perp. Deb. Stock	98 –101	4 9 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33½–35½	5 12 6	Mar, July	35⅛	34⅛
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	–
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2¼–2⅝	5 16 6	..	2 19/32	2½
1	6d.	Do. 5% Non-Cum. Preference	1 5/32–1 7/32	4 4 6	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	113 – 116	4 6 0	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	105½	104½
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	–	..	..
5	–	Willans and Robinson Ord.	¾–1¼	..	Apr, Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2¾–3¼	..	Apr, Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	–
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½ 4	–	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	87 –92	5 8 8	..	88½	..
St.	15/0	Anglo-American	66 –68	4 15 9	F, My, Ag, N	67⅜	66
St.	30/0	Do. Preferred	113½–114½	5 5 0	F, My, Ag, N	114¾	114
St.	10/0	Do. Deferred	24⅛–24⅜	2 1 0	F, My, Ag, N	24 5/16	24 1/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–99½	4 0 6	Jn, Ap, Jy, O	98¼	97½
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	8½	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	–
100	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	6/8	Direct United States Cable	15½–16	4 18 6	Ja, Ap, Jy, O	15 31/32	15 9/16
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Ju, Dec ..	..	..
St.	65/0	Eastern Ordinary	144 –147	4 15 0	Ja, Ap, Jy, O	145⅞	144½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 17 9	Je, Ap, Jy, O	91⅞	91
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108	..
10	2/6	Eastern Extension	14¼–14¾	4 15 0	Ja, Ap, Jy, O	14 9/16	14 5/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 –107	3 14 9	Feb, Aug	106¼	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100%–102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37½–38½	6 0 0	Jan, July	38⅛	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	32/6	Indo-European	58 – 60	5 8 4	May, Nov	60	..
100	4%	Mackay Companies Common	75½–76 3/16	5 4 0	Jan, July	–	..
100	4%	Do. Preference	74½–75 3/16	5 6 6	Je, Ap, Jy, O	..	–
1	.	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9½–10	5 0 0	..	..	–
5	–	West Coast of America	⅝–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..	..
10	–	West India and Panama	⅜–½	..	May, Nov	13/32	..
10	4/0	Do. 6% 1st Pref.	6½–6¾	8 18 0	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14⅝	14 9/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	–	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	..	..
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	5/0	Chili Telephone (fully paid)	6¼–6¾	5 16 0	August ..	6 5/16	6
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 16 8	–	–	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109½–111½	5 8 6	–	110	108
St.	5%	Do. Def. Stock	108½–110½	4 11 6	–	109¾	108
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 9/16–5 13/16	4 7 3	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	99	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½–104½	3 6 6	–	103¾	103
1	0/2⅗	Oriental	1 1/16–1 3/16	4 3 6	April, Oct	..	..
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	1 1/16–1 3/16	4 11 0	–	..	–
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	–	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 – 104	4 6 6	..	..	..
5	5/0	United River Plate	7 –7½	5 6 8	July ..	7 5/16	7⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½– 5	6 0 0	–	..	..
10	2/0	Globe Telegraph and Trust	10¾–11	5 0 0	Ja, Ap, Jy, O	11	10
10	3/0	Do. 6 per Cent. Pref	14½–14¾	4 1 6	Ja, Ap, Jy, O	..	..
10	6%	Submarine Cables Trust (Cert.)	129 –132	4 11 0	April, Oct	..	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption, † Ex Dividend, ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

THE Report of Col. DRUITT to the Board of Trade on the tramway accident at Halifax shows that this unfortunate accident was due to the driver not appreciating the different effect of the brakes of the car according to the state of the rails. Probably, if the slipper brake had been sufficiently applied at first, the car would have gone down the gradient in safety. Application of the hand brake merely caused the wheels to skid, and, in Col. DRUITT'S opinion, the sand was not used, for no flats were apparent on the wheels. Of course, the application of the electric brake, or reversal of current, with skidding wheels is useless. The moral seems to be that the "foolproof" principle, as far as brakes are concerned, must be extended further, for at times of failure the driver has no time for reflection.

◆

THAT excellent institution, the Union Internationale de Tramways, has been trying, among other things, to clear up our knowledge as to tramway brakes, and has circulated a number of questions on this subject to its members. With characteristic British aloofness, the Union receives but little support in this country, and out of the 95 undertakings which replied to the questions, Glasgow appears to be the only British representative. The usual course is for the Union to appoint one or two engineers to report upon the replies, the report being discussed at the annual meeting. In this instance the two reporters were not sufficiently agreed over the rival claims of air and electric brakes to write a joint report. Although the field of inquiry is not as wide as it might be, the reports which we give elsewhere will be read with interest, and they will be found to contain some useful data as to costs of maintenance.

◆

ONE of the problems which is much in evidence at the present time is that of speed variation when the motive power is supplied by an internal-combustion engine. Much ingenuity has been displayed by the designers of motor cars in obtaining a variable drive of that kind, and in some cases the mechanical connection between the motor and road wheels has been replaced by an electrical connection in the shape of a dynamo and motor, so that all change-speed gearing is avoided. This has been done more particularly in certain petrol-electric omnibuses. The same difficulty occurs in boats driven by petrol motors. When the boats are small there is not much objection to some form of gearing for reversing, but when they are of any considerable size the difficulty becomes greater. The "petrol-electric" principle is therefore finding its way into the problem of ship propulsion, the latest developments being by Mr. DEL PROPOSTO, as outlined in a Paper of which we give an abstract in this issue. The internal combustion motor used is the Diesel, and by employing engines of 1,000 H.P. in tandem, and three propellers, it is proposed to get power up to 6,000 H.P. By using a "direct drive" with a magnetic clutch, the use of the generators and motors is avoided at high speeds, but the control is always electrical. This last feature has the great advantage of giving control direct from the bridge instead of using the engine room as a kind of large relay.

◆

IT is interesting, if not always profitable, to know how others see us. The latest opportunity in this way for municipalities is given by Mayor MCCLELLAN, of Greater New York, who has been looking round Europe at municipal enterprise. As a result he has come to the conclusion that much of "Europe's vaunted municipal superiority" is a delusion and a snare. Germany apparently is the country where it is vaunted most of all, but where Mr. McClellan has failed to find any success. On the contrary, he has found conditions in cities like Frankfort and Dresden, having their own tramways, which no American community of even second-rate importance would tolerate. Not only is the traffic of these places insignificant to an American, but it is badly handled.

The conditions in this country, according to Mr. McClellan, are even worse than on the Continent, with the possible exception of Glasgow. He is of the opinion that the result of the Tramways Act of 1870 has been the "perpetuation of old fogyism and the stunting of private enterprise," and he is more than ever convinced that municipal operation is the last desperate means, which ought to be resorted to only when private enterprise has absolutely failed. This is certainly sweeping. We gather, however, that Mr. McClellan would give us some credit at least in the management of traffic; of this he certainly formed a poor opinion on the Continent, for he remarks that "Berlin's oft-quoted ideal municipal conditions are lacking even in so elementary a thing as the regulation of traffic. Here and there a few helmeted gentlemen mounted on martial steeds look daggers at the frightened truck drivers and pedestrians, but the traffic around them is in a state of chaos. One good idea in Berlin is that of repairing the streets in the night time, thus reducing the interference with traffic to the minimum."

The Preston Town Council appear to have placed themselves in rather an unfortunate position. Having obtained a tender from the National Electric Supply Co. for public lighting, the Council proceeded to alter the terms of the tender by increasing both the number of lamps and the hours of burning. How the price tendered was suitably altered to meet these changed conditions we do not know, but the final price is much higher by some hundreds of pounds than would have been quoted by the Company. Naturally the company objects, and requests that a new tender should be allowed. As we understand it is a question of competition between the Company and the electric tramway station of the Council, we presume that this course will be adopted.

Cable Interruptions.

	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Môle St. Nicholas—Port au Prince	Aug. 16, 1906

Testing Appliance for Indicators.—An improved form of appliance has been brought out by the American Steam Gauge and Valve Manufacturing Co., of Boston, Mass., for testing steam engine indicator springs without the necessity of sending them to the makers, or using a mercury column. A number of weights are supported on a plunger spindle, the weights, which are in 5 lb. units, being selected to give the required pressure. The plunger is in communication with an oil vessel, which is also in communication with the indicator to be tested; and pressure is put on to the oil by screwing in a plunger, until the plunger rod supporting the weights is forced up. When the plunger is floating the weights are varied as required to give the desired pressures.

Industrial Trains.—Our American friends easily see the possible advantages that accrue from better education, quite apart from the advantage to those who are the objects of the process. According to the *Railway and Engineering Review*, the Atchison, Topeka & Santa Fe Railway made arrangements for a farmers' instruction train through the wheat-raising section of Kansas last month. A party of five professors of the Kansas State Agricultural College were to accompany the train and give lectures at points along the line. The industrial department expects that the first year, if the instruction outlined by the lecturers is followed, the yield of the wheat belt will be increased 1 bushel to the acre. It is estimated that at this rate, through the whole belt, the increase will be more than 2,000,000 bushels. The Union Pacific, also, is to conduct a similar campaign over its line.

An Electrical Museum in Brussels.—Mr. R. Goldschmidt, of Brussels, has presented to that city what is termed, in the report of a United States Consul, a laboratory museum of electricity, to be formally opened in October. The object which the donor has in view is to develop and extend the uses and applications of electricity in Belgium by giving free access to electrical models and apparatus for experimental purposes, any necessary electrical supply being also available. Thus there are separate laboratories, in which there will be apparatus devoted to magnetism, electricity and chemistry, the laws of electricity, lamps, bells, &c., the application of electricity to special purposes, such as agriculture and dairy farming, telegraphy, wireless telegraphy and telephony. The building is divided into four rooms, in one of which will be found the latest scientific literature, and the public will be permitted to study and experiment without charge.

Obituary.—We regret to announce the death, on Thursday evening, the 30th ult., of Mr. C. W. Phipps, who has been works manager to the British Thomson-Houston Co. since the B.T.-H. works were started at Rugby five years ago. Although it was known that Mr. Phipps was seriously ill, his sudden death came as quite a shock to his friends and to the employés at the works, for he was extremely popular with everyone there. Mr. Phipps, who was only 47 years of age, was born in Worcester, but early migrated to America, where he did a great deal of pioneer work in connection with the electrical industry. Later on he was for some time manager of the Brush Electrical Works in Ohio, in whose interests he subsequently travelled all over the world, installing some of the first arc lighting equipments in the United Kingdom, and being the first to introduce and instal a searchlight in Japan. He then took up the position of works manager to the Adams Bagnall Co. of America, but after the absorption of the American Brush Co. by the General Electric Co. of America, Mr. Phipps entered the service of the latter firm and remained attached to their New York office until his appointment to the post of works manager at Rugby, which he filled with great credit to himself and satisfaction to the British Thomson-Houston Co. He leaves a widow and one son.

The Electrical Working of the Trains in the Simplon Tunnel.—In view of certain misleading reports which have been circulated on the subject, it may be of interest to our readers to know that the electrification of the lines through the Simplon Tunnel is now complete. Since August 1st the Brown-Boveri electric locomotives have drawn 15 trains daily through the tunnel. The only steam-operated trains are the through trains de luxe (which run three times a week), and, in addition to these, one other engine passes daily through the tunnel from the locomotive sheds at Brigue for service between Iselle and Domo Dossola. As was only to be expected, some technical difficulties were met with at first. Considerable deposits of soot had accumulated on the insulators of the overhead conductors, and these had to be very thoroughly cleaned during the intervals between working. Further, owing to the unusually damp condition of the atmosphere in which the motors have to work, it has been found advisable to completely enclose them and to depend entirely on internal ventilation, no air whatever being allowed to enter from the outside. The electric locomotives have now been running regularly since August 1st, and the whole system is working most satisfactorily. In addition to the 1,000 H.P. locomotives already supplied, Messrs. Brown, Boveri & Co. have two similar locomotives in hand for the further requirements of this service.

Extraction of Gold from the Sea.—Recently nothing seems to have been heard of the Electrolytic Marine Salts Co., U.S.A., which was floated for the purpose of extracting wealth in the form of gold from the sea. But in a recent issue of

L'Electricien Mr. A. Nodon returns to the subject, and gives his views as to how this desirable object might be attained. He proposes to use copper or lead kathodes, preferably lead on account of the expense, sheets 1 mm. in thickness being suitable. These electrodes would be surrounded by canvas or other suitable material, forming porous bags, in which any deposit not adhering to the electrodes would be collected. The anodes could be made of graphite, lead or cast iron. Of these, however, graphite would be expensive and lead would be attacked, so that grey cast iron would be the most suitable from the chemical point of view, as well as that of cost. The electrolytic baths would be in the seashore, within reach of the tide, and would have a depth of 2 metres and a breadth of 10 metres. By having cement partitions every 40 metres, a battery of 100 such baths could be run together and would furnish 150 grammes of gold per day of 12 hours. During this time 3,000 cubic metres of water would be treated, and a current of 5,000 amperes at 2·5 volts would be required. Mr. Nodon puts the annual cost at 60,000fr. and the profit at 100,000fr., with a capital of 200,000fr., the value of the gold recovered being taken at 3fr. per gramme so as to allow of subsequent treatment.

Electric Cabs.—According to *L'Industrie Electrique*, the electric cabs in Berlin, which were provided with Hagen accumulators, made on the average a daily run of 60 km., the battery being charged twice, and worked at the following cost: Electric energy, 4·25fr. per day; maintenance of accumulators, 3fr.; sundry repairs, 1·25fr.; maintenance of tyres, 4·38fr.; total, 12·88fr. per day. To this must be added wages of driver, costs of administration and depreciation. The most expensive item was the maintenance of tyres. The tyres first used ran about 6,000 km. At present the cost is higher, but the tyres run 13,000 km., and the tyres on the back wheels of Kriéger cars will run 25,000 km. The cost of maintenance at present is 4·38 to 5·62 centimes per car-kilometre. Lengthy trials were carried out later by two cab companies in Berlin over a period of 552 days. On account of repairs each carriage ran out on only 517 days. The cars on trial consisted of four victorias and two landaulettes. The mean speed of the victorias was 15 km. (being destined for Cologne) and that of the landaulettes 24 km. per hour. The results of these trials have been satisfactory, the average cost over 31,000 km. being as follows: Maintenance of accumulators, 3·125 centimes per car-kilometre; electric energy, at 20 centimes per unit, 4·375 centimes per car-kilometre; tyres, 4·500 centimes per car-kilometre; repairs, 1·562 centimes per car-kilometre; wages of driver, 11·250 centimes per car-kilometre; oil, &c., 0·125 centime per car-kilometre. Indirect expenses amounted to: Depreciation, 3·875 centimes per car-kilometre; rent, 1·875 centimes per car-kilometre; taxameter, 0·300 centime per car-kilometre; office expenses, &c., 6·50 centimes per car-kilometre. It follows, therefore, that the total costs per car-kilometre amounted to 37·48 centimes. The mean distance run per day was 60 km., and the greatest distance run on a single charge was 117 km. With the Berlin tariff, the profit is small. The mean receipts were 2·125fr. per fare, the mean distance being 4 km., to which must be added 1·7 km. for returning to the depot. Motor cabs are taken for longer distances than ordinary cabs, the average distance for the latter per fare being 3 km.

Engineering Standards Committee.—Three further reports have been issued by the Engineering Standards Committee as follows: "Steel Conduits for Electrical Wiring" (No. 31); "Nuts, Bolt Heads and Spanners" (No. 28); and "Material used in the Construction of Railway Rolling Stock" (No. 24). The preface to report No. 31 states that the desirability of standardising steel conduits for electric wiring was brought to the notice of the Electrical Plant Accessories Sub-Committee of the Engineering Standards Committee in February, 1906. As a consequence, manufacturers of steel conduits for electric wiring were invited to give evidence on the subject, which was heard on March 6, 1906. Most careful consideration has been given to the evidence submitted by the several witnesses, and measurements have been carried out on conduits at the National Physical Laboratory. The Sectional Committee on Screw Threads and Limit Gauges has been consulted with regard to the question of threads, and the clauses in the present report dealing with gauging have been based on the recommendations of that Committee. It is laid down in the report that plain and screwed steel conduit for electrical wiring are recognised as standards, and tables are given of standard dimensions of both classes, before enamelling or galvanising. The standard lengths are given as 10 ft., 12 ft. or 14 ft., and the necessary tests, prior to the rejection or acceptance of any batch of conduits, sockets, couplers, &c., are explained. The recommendations with regard to gauging laid down by the Sectional Committee on Screw Threads and Limit Gauges have been adopted, as mentioned above. The report on nuts, bolt heads and spanners has been drawn up so that the standard sizes recommended by the Committee shall depart as little as possible from the sizes at present in general use in this country, and consequently schedules of standard nuts, bolt heads and spanners, representing a system practically interchangeable with the existing Whitworth standards, have been drawn up, which it is thought will prove more satisfactory, owing to its greater simplicity. The items dealt with are classified as nuts, lock nuts, bolt heads, spanners and castle nuts. Report No. 24 contains 19 specifications for the material used in the construction of railway rolling stock. In many cases, where a chemical analysis is included, a duplicate specification, containing no analysis clause and distinguished by the letter A following the number of the specification, has also been provided for the purpose of enabling the standard specification to be used by those engineers whose practice it is not to specify any chemical requirements.

The Forthcoming Engineering and Machinery Exhibition.—On Friday last week a luncheon was given at the Trocadero by the organisers of the Engineering and Machinery Exhibition, which is to be held at Olympia from September 15th to October 17th inclusive. The guests were mainly Press representatives, and the opportunity was taken of giving an indication of the scope of the exhibition. From the preliminary prospectus it is clear that it will be of the most comprehensive character, the proposed sections numbering 30, and including electrical appliances, power and light, telegraphs and telephones, chemical machinery, metallugical processes, power transmission, railway and tramway work, printing machinery, gas, steam and oil engines, and machine stoking and labour-saving appliances. Sir William H. White, K.C.B., F.R.S., is president of the exhibition, but in his absence from the luncheon on Friday Mr. J. H. R. Whinfield, of Sir W. G. Armstrong, Whitworth & Co., presided. He stated, in the course of a short speech, that it was exactly 21 years since an exhibition devoted exclusively to the engineering industry was held in this country, a remarkable circumstance when the tremendous improvement in mechanical appliances and the science of engineering was borne in mind. From the preliminary list of exhibitors it was evident, he said, that practically every branch of the industry would be represented, the branches would be as widely diversified as pin points and battleships, and the exhibits would come from all parts of the world, America being largely represented. A feature of the exhibition which he thought would be a great attraction was what might be termed a huge electric fountain and air circulator, which would occupy a central position in the building. This fountain, which would be 33 ft. high, not only produced a beautiful succession of brilliant light effects on the innumerable water jets, which played at the rate of 1,500 gallons per minute, but the air of the building would at the same time be drawn into the base by a system of electric fans and afterwards thrown out completely cleansed, cooled and reinvigorated to the extent of 10,000 to 12,000 cubic ft. per minute. Messrs. James Keith & Blackman (Ltd.) were responsible for this, and he believed that a replica of the fountain was eventually to grace the lawn of an American magnate. There will also be a series of lectures on the various engineering subjects, and possibly conferences, whilst the various engineering societies are, Mr. Whinfield stated, arranging visits to the exhibition. The toast proposed by the chairman of "Success to the Exhibition" was responded to by Mr. F. W. Bridges, on behalf of the organising managers, Messrs. Bridges and Smith.

SOME NOTES ON THE MECHANICAL DESIGN OF ELECTRICAL GENERATORS.*

BY R. LIVINGSTONE.

(Concluded from page 768.)

The design of the spider hub is principally confined to the form of its section. It is customary, in order to give a sufficient length of support on the shaft, to make the length of the hub equal to $1\frac{1}{2}$ times the diameter of the shaft, and in order to give sufficient rigidity to make its section equal in strength to the strength of the shaft. The outside diameter (E) of the hub then will be approximately $1{\cdot}77d + 2c$ (Fig. 13). $2c$ might be made $\frac{1}{8}d$ when E would be equal to $1{\cdot}895d$.

The other dimensions should be approximately the same as in the figure. The principal stress in the hub is that due to the pressure put on the shaft when forcing it into place, and this pressure should be limited to some value.

If the hub is designed as above, then the area of the half-section will be $0{\cdot}64d^2$; and if we allow a stress of 3,000 lb. per square inch, then the total pressure on the shaft will be $0{\cdot}64d^2 \times 3{,}000 \times 2\pi = 12{,}000d^2$.

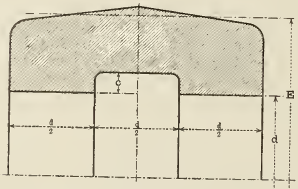

FIG. 13.

Then with a coefficient of friction between hub and shaft of 0·12 the maximum allowable forcing pressure will be

$$1{,}440d^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

when d = diameter of shaft in inches.

Of course, the above rule only applies to hubs designed in accordance with the rules already given, and any other proportions might involve a serious increase in the stress in the hub. For instance, if we applied the pressure given by the above rule to a hub of the proportions of Fig. 14 we would run grave risk of breaking it, as shown in that figure.

The stresses in the spider arms are due to—

1. Flexure due to torsion.
2. Tension due to expansion of rim.
3. Flexure due to fluctuations in the speed of the prime mover, and
4. Handling which the spider receives during manufacture.

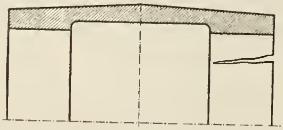

FIG. 14.

It is impossible in this short Paper to attempt any complete investigation of the above, so I will merely try to indicate their relative values.

Every machine is liable to be short-circuited, so the first cause is of importance. The torsion when a machine is short-circuited may be very high, even as much as 10 times normal torsion for a fraction of a second, and although the maximum stress is only enforced for a very short time it might be just long enough to cause fracture if the arms were made too light.

The maximum load during short-circuit depends entirely on the electrical design of the machine and on the inertia of the total revolving mass, but the torsion transmitted through the spider arms depends also on the proportion of amature inertia to the total inertia of the revolving mass.

Thus, if Fig. 15 represents the load and speed from the instant of a dead short, the rotor is losing speed when the load has its maximum value, and so a portion of the energy necessary to balance this load will be given out by the armature; the remainder being supplied by the torsion from the prime mover and loss of energy from the flywheel and other moving portions of the engine. Although in some machines the maximum short-circuit load may be as much as 10 times normal load, in most machines it will not exceed $1\frac{1}{2}$ times normal load, and comparatively lower factors of safety can be used.

The tension in the spider arms due to the expansion of the armature by heating and centrifugal tension in most machines will be low, but in machines running above 6,000 F.P.M. might be as much as 1,000 lb. per square inch, and this stress should be combined with the stresses due to torsion.

The increase of torsional stresses due to fluctuations in the speed of the prime mover is not of much importance when the variation of speed are the slow variations due to change of load. The greatest increase is more often due to the small rapid variations, due to the irregularities in the turning moment of the engine. The armature follows these to some extent, but in a machine where the inertia of the generator rotor is a large proportion of the total inertia, very large stresses could be set up if the angular variation of engine speed is great. It must be remembered too that the stresses set up in this way are alternating—that is, they range from a maximum + value to a maximum − value several times during a revolution, and so, even if only the same numerical value as the torsional stresses, are of considerably more importance. As the engine builder does not care to supply full data of his engine to the generator builder it is usually impossible even to get an approximate value of these stresses so they have to be allowed for in the factor of safety.

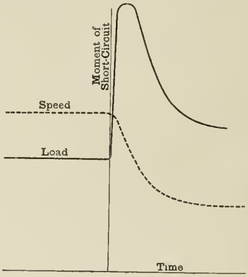

FIG. 15.

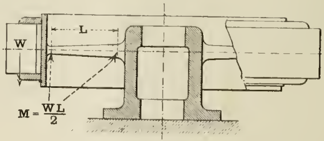

FIG. 16.

The handling which the rotor receives in the shop usually only affects the thickness of the spider arms measured parallel to the shaft. It is evident that it is quite possible to make the arms of deep enough section, so far as torsional stresses are concerned, and yet be so thin that some difficulty would be experienced in handling the spider in the shops. It is always advisable to make the arms thick enough to stand the whole weight of rim, with punchings, &c., when supported only on the boss, as in Fig. 16. It is evident from the preceding that it is very difficult to obtain the actual stresses in the spider arms, and that the torsional stresses at normal load are only a small proportion of the actual stresses. It must also be borne in mind that the same spider may be used on a machine with a much greater output than the one for which it was originally designed, and so the arms should be made as liberal as possible;

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* Based on a Paper read before the Dick Kerr Engineering Society.

a factor of safety of 12–18 may be used when designing the arms for torsion at normal load.

Some attention should also be paid to the appearance of the spider arms as well as to their strength. An "⊢⊣" section is certainly the most economical one to use so far as weight is concerned, but it has not a favourable appearance. The oval arm has a nice appearance and is easy to cast, but it is not so economical in weight as the "⊢⊣" section.

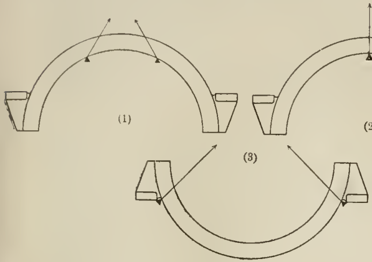

Fig. 17.

The rim of the spider is usually built up of laminations, and in D.C. machines is not called on to withstand any severe stresses. In A.C. revolving-field machines, though, it is always advisable to look into the stress due to centrifugal force and unbalanced magnetic pull. The centrifugal stresses are not only proportional to V^2, but also to the ratio of the weight of rim, poles and coils to the minimum section of rim.

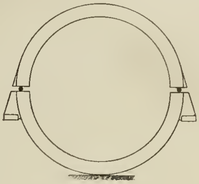

Fig. 18.

Alternator Frames.—A good deal has been written recently on the calculation of stresses in alternator frames, but all of these mathematical investigations deal with the stresses after the machines are assembled and in running order. While work of this description is extremely valuable, it will usually be found that the stresses to which such frames are subjected have their maximum value while the machine is under course of construction. A horizontally divided alternator frame is liable to be picked up, as shown in Fig. 17, and when the two halves are being fitted together it sometimes happens that the condition represented by Fig. 18 is realised. Such a condition ought never to be realised; but it is a possibility which it is well to provide for. Frames which are designed to withstand such rough treatment can be relied on to withstand the comparatively mild stress to which they are subjected under working conditions. Another point which must be considered when "getting out" a new design for an alternator frame is that the same frame should be made suitable for being increased to the maximum width of machine of that particular diameter, and that it should also be made strong enough to take the maximum depth of punchings for that particular bore of frame.

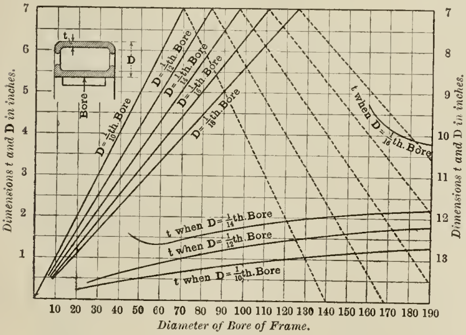

Fig. 19.

Of course, as the frames are seldom subjected to the severe stresses they receive whilst under process of erection, we can run the stresses very high—even as high as 50 per cent. of the elastic limit of the material.

The curve shown in Fig. 19 gives the thickness of metal corresponding to different ratios of depth of section to bore of frame, necessary to stand the treatment indicated. Although such a curve can only give the approximate dimensions, it will be found to give such trial dimensions very accurately, and so result in some saving of time and labour.

WEST HAM CORPORATION ELECTRICITY ACCOUNTS.

The accounts of the West Ham Corporation Electricity Department for the year ended March 31, 1906, may be said to indicate that the undertaking is emerging from the dark days of high costs and deficits. The removal of the power station from Abbey Mills to Canning Town in reducing costs has fully justified the change, albeit in view of recent events concerning power supply in London, and the obvious opportunities in West Ham in this connection, it is a question whether the Council would not have been better advised to have built their new station directly on the Thames. Nevertheless, Mr. A. H. Seabrook, the borough electrical engineer, informs us that the prospects for the future are very good.

The financial result of the year ended March 31, 1906, shows a net profit of £2,523. 2s. 11d. as against a deficit in 1904-5, whilst working expenses have been reduced. The total working expenses were £27,471. 2s. 5d., and the net income £51,371. 7s. leaving a gross profit of £23,900. 4s. 7d. To this is added a sum of £44. 11s. 6d. from the General District Fund, which is the annual charge for the cost of arc lamp columns, making a gross profit of £23,944. 16s. 1d. The capital charges absorbed £21,421. 13s. 2d., and a net profit for the year of £2,523. 2s. 11d. is placed to the Reserve Fund, which now stands at £4,352. 6s. 6d.

The details of the costs are as follows :—

COSTS PER UNIT SOLD.

Generating Costs.	Year ending March 31, 1906.
Coal, &c.	0·414d.
Oil, waste, water and engine room stores	0·033d.
Wages at generating stations	0·090d.
Repairs and maintenance	0·139d.
Miscellaneous	—
	0·676d.
Distributing Costs.	
Wages, repairs and maintenance (including mains, transformers, meters, public lamps, free wiring installations, &c.)	0·175d.
TOTAL WORKS COSTS	**0·851d.**
Management Charges.	
Rents, rates and taxes	0·038d.
Salaries, stationery and establishment charges	0·124d.
Special charges (including insurance, compensation, &c.)	0·085d.
	0·247d.
TOTAL COSTS (excluding capital charges)	**1·098d.**
Capital Charges, &c.	
Interest	0·403d.
Sinking fund	0·411d.
Interest on bank overdraft	0·043d.
	0·857d
TOTAL COSTS (including capital charges)	**1·955d.**

The capital expenditure during the year was £19,082. 17s. 1d., and an analysis of the total is given below :—

Account.	Total March 31, 1906.	£ per kw.	Per cent. of total.
Land	£119	0·02	—
Buildings	78,356	13·74	23·2
Machinery and plant	147,098	25·80	43·8
Mains and services	74,621	13·10	22·1
Transformers	16,473	2·89	4·8
Meters and demand indicators	11,526	2·02	3·4
Electrical instruments	1,224	0·21	0·3
Lamps, columns and fittings	7,335	1·30	2·3
Office furniture	583	0·10	0·1
Total	£337,355	£59·18	100·0

The normal full-load capacity of the station is 5,700 kw., but the following extensions are in hand, viz., one two-phase 1,500-2,000 kw. turbo-generator, two 500 kw. motor-generators direct-current to two-phase alternating current, and one 600 kw. alternator in course of conversion to two-phase. The total number of consumers is 1,088, and the number of units sold was 6,000,616, made up as follows : Private supply 2,471,315, public lighting 750,000, traction 2,779,301. The total maximum demand during the year was 3,296 kw. and the load factor works out to 20·7 per cent. During the year a sub-committee was appointed by the Electric Lighting and Tramways committee to consider the price to be paid for current and other questions affecting the two departments jointly. As a result, the price of current for tramway purposes was reduced from 1·6d. per unit to 1·5d. per unit for the half-year ended September, 1905, and to 1d. per unit from October 1, 1905. It was also decided that the electricity department should pay the tramways department the 15 per cent. transmission losses and an acknowledgment for use of feeders for current supplied to private consumers through tramway feeders.

The horse-power of the motors connected to the mains is 2,300. The total maximum load on the station was 3,296 kw. The number of public lamps on March 31, 1906, were 332 arcs and 132 incandescents.

THE ELECTRIC CAR EQUIPMENT OF THE LONG ISLAND RAILROAD.*

BY W. N. SMITH.

The tendency of a change from steam to electric motive power on suburban lines such as those of the Long Island Railroad is to convert them into a rapid transit system of the same general type as the subway and elevated systems now operating in the largest cities. The building up of any suburban territory is dependent upon the transportation facilities provided for it, and the inevitable result of improvement in transportation is to increase the traffic to a degree gradually approaching the density prevailing on metropolitan rapid transit lines. It was with these ideas in mind that the management of the Long Island Railroad decided to adopt the multiple unit system on its electrified sections.

The design of the car equipment of the Long Island Railroad was based upon a careful study of the traffic conditions as they were outlined by the railroad officials at the commencement of the undertaking, and called for trains with the number of cars varying from two to six per train at different hours of the day, in regular operation, while heavy excursion travel to the beaches and race tracks would occasionally require trains of 10 or 12 cars. Some of the service is express and some local. It was deemed of the greatest importance to provide a single type of equipment that should be uniformly available for all the varying conditions of train service.

The proposed local service on the Atlantic Division involved making stops at an average of about 1·6 miles apart. The express service originally contemplated between Flatbush Avenue Station and Jamaica provided for only one intermediate stop in the 9·63 miles between them. On the Rockaway Beach Division, a local train making all stops between Flatbush Avenue and Rockaway Park would average one stop every 0·99 mile, while an express run to Rockaway Park involved a run of 7 miles in length at the highest practicable speed.

These runs called for a schedule speed, including stops, of about 25 miles per hour for local trains on the Atlantic Division, and about 30½ miles per hour for the express trains. Upon the Rockaway Beach Division, with relatively more frequent stops, the local run called for a schedule speed of about 20 miles per hour, while the express run with seven stops in the 15·88 miles called for about 25 miles per hour. The average length of stop was usually assumed to be 30 seconds.

The headway of trains on the proposed schedule was, between Flatbush Avenue and Jamaica, about 20 minutes during the greater part of the day, with 10 minutes during the morning and evening rush hours, and 30 to 60 minutes during the early morning hours. During the rush hours express trains were also to be interspersed with locals. Between Flatbush Avenue and Rockaway Park the local trains were to run on about half-hourly headway during most of the day, this being decreased to 20 minutes during the rush hours and 60 minutes during early morning hours. Express trains were also to be interspersed between locals during the rush hours. The Brooklyn Rapid Transit trains operating over parts of the Long Island lines were to be mostly express, running on about half-hourly intervals during the early part of the day, but from noon until late at night on a 15-minute headway. Upon days when there would be both a race-track movement on the Atlantic Division and heavy travel to the beaches, the headway of the combined traffic on Atlantic Avenue was to be reduced to about 3⅓ minutes.

The Long Island Railroad local trains as originally proposed were to consist of two and three cars, except during the rush hours, when they were to be of six cars. The express trains were to consist of three cars each. The Brooklyn Rapid Transit trains on ordinary days were to be of four cars each, increased to six on holidays.

The maximum possible speed for express runs can be made when all the cars of a multiple-unit train are motor cars. Ordinary schedule conditions, however, usually permit a portion of each train to consist of trailers, and the most severe condition of frequent stops can be met if the proportion of trailers is not more than one trailer to two motor cars. A considerable saving in the weight of the entire train is thus possible without exceeding either the tractive power of the motors or their ability to radiate the heat developed by the frequent accelerations which are the severest tax upon their capacity. In fact, the proportion of motor cars to trailers is based upon the speed and time characteristics of the schedule and the frequency of stops.

The fact that the Atlantic Division is partly in a subway, and the need of interchangeability with the rolling stock of the Interborough Rapid Transit Subway, had much to do with the design of the cars. The complete success of the first all-steel passenger cars ever built, and which were designed by George Gibbs for the New York Subway, led him, in his capacity as chief engineer of the Long Island Railroad electric conversion, to advocate their use on this road as well. To the Interborough Rapid Transit Co. and the Long Island Railroad Co. belong, therefore, the distinction of being the first railroads in the world to adopt this radical departure in car construction, thus ensuring to the public complete immunity from the danger of fire in cars equipped with apparatus carrying powerful electric currents. The incidental advantages of these steel over wooden cars in superior strength and durability are, of course, likewise of importance in ensuring their adoption. As the Long Island Railroad cars were obliged to meet very similar conditions, both as to the physical nature of the route to be traversed and the class of travel to be handled, they were built along practically the same lines as the above-mentioned steel cars for the New York Subway. In fact, except for the steps, which are made necessary by the low platforms at stations in the suburban districts, the steel car bodies are practically identical with those designed for the New York Subway.

It has been common practice in the past to build passenger coaches for rapid transit service of rather lighter construction than the standard steam railway coaches, chiefly because the steam locomotive was universally used and it was desired to keep down to a minimum the weight behind the locomotive. The multiple-unit system of control, however, which allows the distribution of the motive power under all the cars, removes this restriction upon the weight and makes it possible to construct the parts of a suburban passenger car with more regard for rigidity and greater ability to resist shocks. Multiple-unit cars for this kind of service can therefore be made as substantial as the requirements of safety and durability demand, but it should also be noted that the steel construction adopted does not materially increase the weight over what would be called durable construction in a wooden car, the increased strength and durability being secured without sacrificing operating economy.

STEEL CAR CONSTRUCTION.

The principal dimensions of the steel car bodies are as follows :—

	Ft.	In.
Length over body corner posts	41	0½
Length over buffers	51	2
Length over draw bars	51	4
Width over side sills	8	6¾
Width over sheathing	8	7
Width over eaves	8	8
Width over window sills	9	0½
Width over platform floor	8	10
Height from underside of sill to top of plate	7	1
Height from underside of centre sill to top of roof	8	9¼
Height from top of rail to underside of sill at truck centre (car light)	3	3⅝
Height from top of rail to top of roof with car light	12	0¾

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* Abstracted from the *Street Railway Journal.*

The principal dimensions of the steel trailer cars are the same as those for motor cars, and they may, if desired, be readily converted into motor cars.

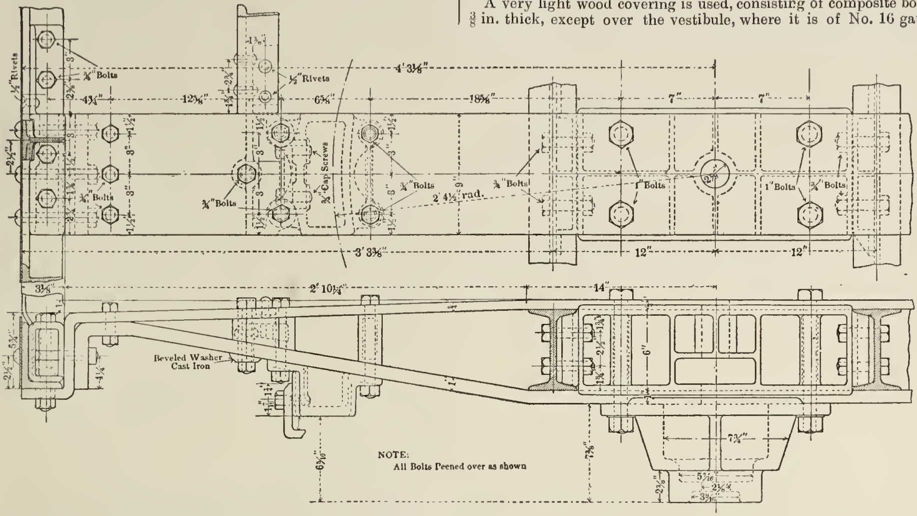

Fig. 1.—Steel Bolsters.

While the formation of the car body is practically identical with the conventional type of steam railroad coach, the adoption of steel as the constructive material is responsible for some differences in the general designs of car framing that have been hitherto followed in wooden car construction. The centre sills consist of two heavy **I**-beams which are continuous between the platform end sills. The side sills are of heavy angles. Two extra sills, extending back to the body bolster, and composed of 4 in. by 3 in. angles, support the vestibule platforms.

The bolsters are of the built-up type, the top and bottom members being made of two rolled-steel plates, as shown in Fig. 1. They are machined on their outer ends to fit together perfectly, the top member being bent down over the bottom member and securely bolted to it. In the space between the top and bottom members and between the centre sills is placed a malleable iron draw casting, machined so as to be a perfect fit between the bolster plates and the longitudinal sills to which it is bolted. Between the centre and the side sills malleable iron struts are inserted. The top member of the body is ¾ in. by 10 in. steel plate, and the bottom member of 1 in. by 10 in. The body centre plates are of cast steel, machined to fit the truck centre plates and the bottom member of the body bolster, and have their edges lipped over the bolster, to which they are secured by heavy turned bolts in reamed holes.

The draft gear comprises a spring draw bar of the Van Dorn automatic type, supported on a sector bar under the car platform, the radius bar being centred upon a pin set in a cast steel auxiliary bolster bolted to the centre sills about 2 ft. 7 in. in advance of the body bolster. Reaching back from this pin to the body bolster, where it is fastened in a similar way, is a continuation of the radius bar, the above-mentioned pin construction being designed to form a sort of knuckle in the radius bar, which cannot be made long enough to reach all the way back to the body bolster because of the 90 ft. radius curve around which the cars are designed to run. At either side of the draw bar safety coupling chains have been provided, fitted with springs and anchor forgings fastened to the anti-telescoping plate under the platform end sill. To carry the weight of the radius bar its outer end is carried in a sector guide directly over the draw bar proper, just back of the draw head. The buffer beams are of oak, faced with ½ in. by 6 in. steel plates. Details of the draft gear are given in Fig. 2.

The roof framing of the car consists essentially of the carlines, arching across the side plates. The roof carlines are connected by purlines of light steel angles. The carlines are secured to malleable iron castings, which are riveted to the side plates, and the purlines, which are of about the same weight angle as the carlines, are riveted to the former with small angle braces. The carlines and purlines are faced with a furring of maple, secured by bolts, to which the roofing and head lining are fastened by wood screws. Maple blocks are also secured to the side plates and hood bows for the support of the roof covering and the head linings. The deck sills and deck plates are of maple, so that the roof and its lining can be readily put up with wood screws.

A very light wood covering is used, consisting of composite board ⅜ in. thick, except over the vestibule, where it is of No. 16 gauge sheet steel, the whole being covered with heavy canvas laid on with white lead.

The eaves of the car are made waterproof by running the canvas cover down over a strip of No. 22 sheet copper 3 in. wide. This laps over and is soldered to the eaves moulding, which is composed of extruded metal riveted over the side plate and end bows, and joined together at the corners of the car by special castings. The eaves moulding, in turn, extends down over the letterboard.

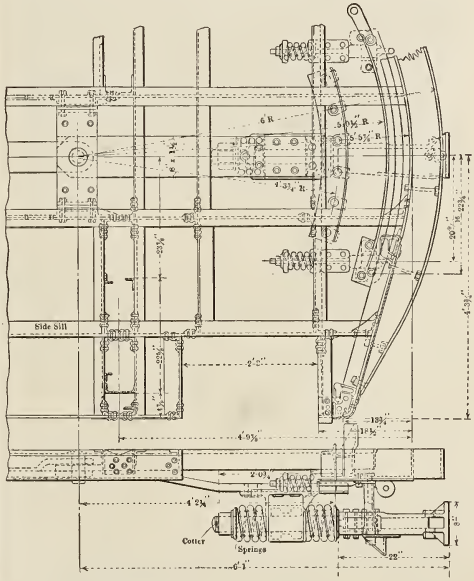

Fig. 2.—Plan and Longitudinal Section of Draft Rigging.

The vestibules are of the Gibbs patent type with floors of steel plates. The vestibule side doors are arranged to slide in pockets in the sides of the car, leaving the entire platform to the passengers. These doors close against pneumatic cushions so as readily to release the clothing of passengers if caught by the closing of the door. The device for operating the side doors consists of a series of bell cranks and levers so arranged that the movable parts are either overhead in the vestibule or entirely outside, leaving the entire interior of the vestibule clear. The side doors are operated by brakemen standing outside the doors at the extreme end of the vestibule. Side steps are provided with plain wooden treads, the gangway being fitted with drop doors of $\frac{3}{16}$ in. sheet steel, to enable the use of the entire width of the vestibule when the side doors are closed. The vestibule floor and drop doors are covered with the Mason patent floor covering. The vestibule end door, when in the extreme open position, is folded over the master controller, the brake valve and all other apparatus in the motorman's compartment. The upper half of this door is glazed, like the others. When this door is shut, and the side doors closed, the entire vestibule is available as a motorman's compartment, and the above-mentioned control apparatus is then entirely exposed.

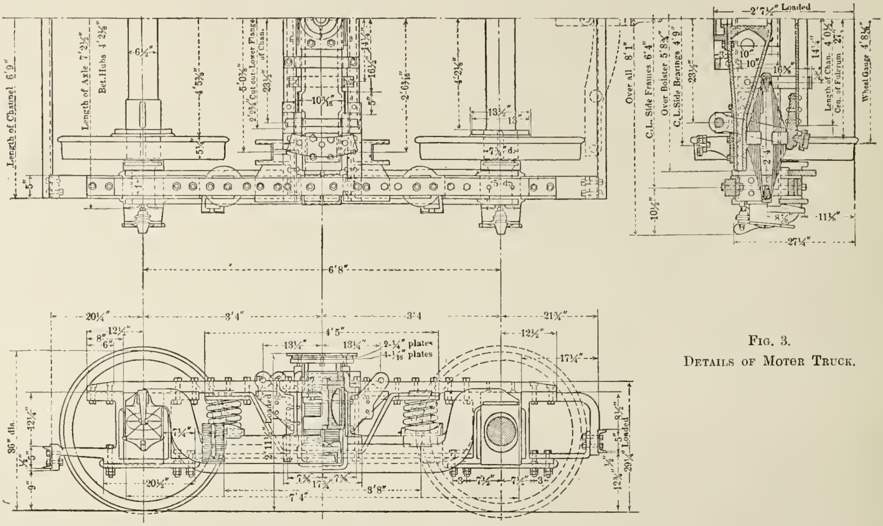

Fig. 3.
Details of Motor Truck.

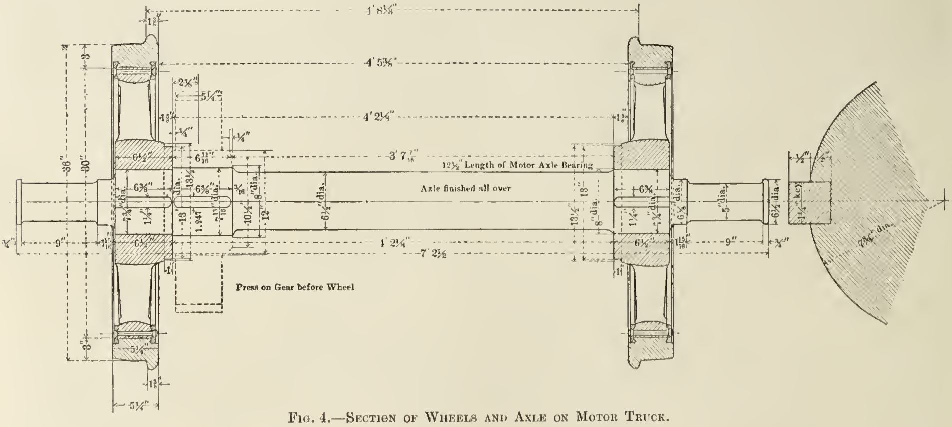

Fig. 4.—Section of Wheels and Axle on Motor Truck.

The body end doors are of the double sliding type and are fitted with a door coupling device that will hold them in any desired position to prevent them from closing when trains are rounding curves. The marker lamps which are mounted on the hood over the vestibule platforms are operated from inside the vestibule by handles extending through the canopy sheathing. The handles are fitted at the lower end with discs carrying coloured crystals that correspond to the colour of the lenses on the four sides of the marker lamps.

In the vestibule at the motor end of the car, just forward of the end-door pocket on the left-hand side facing forward, is placed a swinging door, made convex, of pressed steel so as to form a pocket to contain the auxiliary control switchboard panel.

All motor cars are equipped with pilots suspended from the platform buffers, and the vestibules are fitted with pantagraph safety gates and guard chains to prevent trainmen and passengers from falling between the cars. The usual grab handles are also fitted to the sides and ends of the vestibules. An air whistle is provided over each vestibule, with its operating valve situated conveniently to the control apparatus. Wooden paddles are carried in the vestibules of all cars for raising the contact shoes from the conductor rail when necessary.

The side sheathing of the car consists of steel plates ⅛ in. thick, their lower edges being flush with the bottom of the sill. The bulb angles which form the belt rail and the window sills overlap this sheathing. The post covers between the windows are of special pressed steel, flanged out at their lower ends to fit over the belt rail which runs along the entire length of the car body outside of the posts. The top ends of the post covers extend under the letterboard, which is a steel plate $7\frac{1}{16}$ in wide, running the entire length of the car, riveted to the side plates. The letterboard in turn is overlapped by the eaves moulding. In this manner the entire outside covering of the car is waterproofed by simply overlapping its component parts, avoiding all cracks into which the water can run by gravity. All joints between the side sheathing plates are covered with sheet-metal battens, laid on with thick red lead and secured by rivets.

The flooring of the car body is of corrugated sheet iron, and is supported by the longitudinal sills and the steel plate bridging that is riveted across the space between the sills. The corrugated sheets are provided with metal clips which are riveted to the sheets at about 10 in. centres to secure the "Monolith" plastic floor upon which, after being finished, the maple floor strips are laid with brass screws. This monolithic floor is absolutely fireproof and is laid on in the form of a cement, which, when set, has a smooth, hard finish. The arrangement of the seats is similar to that used in subway and elevated railway cars generally. The seat frames are of steel construction carried upon brackets riveted to the side posts. The cushion and seat backs are of rattan. The seating capacity of each car is 52 persons.

The wainscoting is of steel, backed by asbestos "Ceilinite," so as to make it conduct heat less readily.

All the metal work used in the body framing is given one coat of protective paint before assembling and two coats after assembling. After completion, the outside of the car was cleaned perfectly smooth by the sand blast process, painted with two priming coats, two surfacing coats and with two coats of Indian red, the Railway Company's standard form of lettering and striping in gold leaf, and finally varnished three coats.

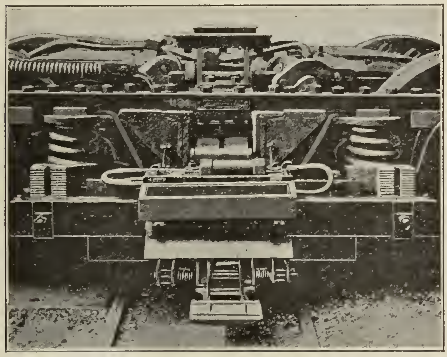

Fig. 5.—Third-Rail Shoe, with Fuse and Connections.

There are 130 motor cars and four trailers, all of which were built at the Berwick, Pa., shops of the American Car & Foundry Co. They were personally designed by George Gibbs, chief electrical engineer of the Long Island Railroad, and a number of United States and foreign patents have been issued to him covering the various features of the construction.

Trucks.

The motor and trailer trucks are of the M.C.B. type, the wheel base of the motor trucks being 6 ft. 8 in. for 36 in. wheels, the trailer trucks being 5 ft. 6 in. wheel base for 30 in. wheels. The distance between truck centres is 34 ft. A drawing of the motor truck is given in Fig. 3, and its general dimensions are as follows:—

Gauge of track, 4 ft. 8½ in.

Distance between backs of wheel flanges, 4 ft. 5⅜ in.

Height of truck centre plate above rail, car body loaded with 15,000 lb., 31½ in.

Height of truck side bearings above rail, car body loaded with 15,000 lb, 35½ in.

Wheel base, 6 ft. 8 in.

Weight of truck complete with two gears, but without motors, 12,800 lb.

Weight on centre plate with car body loaded, 30,885 lb.

Weight of one motor on truck transom, 3,500 lb.

Torque of one motor on truck transom, 3,000 lb.

The truck bolster and track centre plates are steel castings machined to the proper dimensions. The side frames are of wrought iron, machined on four sides. All bolt holes in the side frames are accurately drilled to templates. The end frames are of steel channels. The pedestals are forgings lipped over the sides of the car frames and are machined on all surfaces where they have a bearing, either on the side frames, pedestal caps, or the journal boxes. The transom consists of rolled-steel channels resting in the side-frame castings, and provided with chafing plates of wrought iron. The equaliser bars are of wrought iron in one piece, without welds, machined on top edges for spring seats, and on the bearing surfaces over the journal boxes.

The pedestal caps are of wrought iron, of the individual type, machined and carefully fitted to the pedestals, being secured with hammer-driven turned bolts in reamed holes. The transom top braces are of wrought iron secured by turned bolts in reamed holes. Safety hangers and swing hangers are of wrought iron. The spring plank is of steel channel. The brake hangers, rods, levers and equalising beams in the brake rigging are of forged iron, and the pins throughout the brake rigging are accurately turned to dimensions, all wearing parts being case hardened to prevent rattle. The motor suspension consists of a steel wearing plate on the transom on which the motor nose rests with a wrought-iron strap reaching over the nose and bolted to the transom.

The wheels are steel tyred, with separate cast-steel spoke centres. The dimensions are as follows:—

	In.
Outside diameter of tyre	36
Total width of tyre	5¼
Width of flange	1¼
Height of flange	1⅛
Width of hub	6½
Bore of hub (finished)	7¾

The tyres are of Latrobe steel with standard M.C.B. tread, 3 in. thick, fastened by shrinkage and with double-lipped retaining rings. Tests of the tyre steel showed about 125,000 lb. tensile strength per square inch. The axles are of open-hearth steel and conform to the test requirements of the Pennsylvania Railroad Co.'s standard specifications. Key seats are milled in the wheel seats and gear seats. The gears are forced on at about 50 tons pressure and the wheels at about 75 tons. Fig. 4 shows the details of the motor truck wheels and axles.

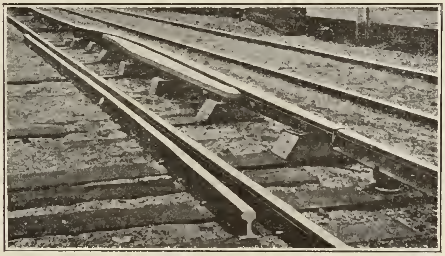

Fig. 6.—Cam in Third Rail for Changing Adjustable Shoe.

The double elliptic bolster springs are of crucible steel. The equaliser springs are of double-coil pattern of open-hearth steel. Brake release springs are of the single-coil type. The track bolster is of cast steel, with seats for the centre plate, side bearings, spring cap and the chafing surface, cast on and machined. The bolster spring seats and their bearings are also of cast steel, as are also the side bearings, which are bolted to the bolster with turned bolts. The centre plate is of cast steel machined and secured to the bolster by turned bolts. Combination bracket and guide castings supporting the brake release springs are also of cast steel, securely bolted to the side frames.

The journal boxes are of the cast-steel "Symington" type, machined on the inside for the M.C.B. standard journal bearing and wedge and on the outer faces for the box cover, and are provided with "Soule" dust guards. The brake head is of standard M.C.B. pattern of cast steel. The brake shoes are of the "Diamond S" type, composed of soft grey iron with chilled inserts and provided with wrought-steel backs.

The trailer trucks are of generally similar type, but of 5 ft. 6 in. wheel base and somewhat lighter construction. The bolsters are of white oak, in three pieces, with iron plates placed between the timbers, securely bolted together with rough machine bolts, which also carry the bolster chafing plates. The centre and side bearing plates are of the same height above the rails as in the motor trucks. The bolster is gained on the top for the centre plate, on the bottom for the spring seats, and on the sides for the chafing plates. The spring plank is also of white oak, in one piece. The centre plate, side bearings, bolster spring caps, seats, equalising spring caps and seats, chafing plates and journal boxes are of cast steel. The frames, pedestals, pedestal caps, tie bars, transom, equalising bars, frame braces swing and safety hangers, spring plank axles, and brake rigging are of forged iron. The brake head and shoe are similar to those in the motor trucks. The weight of a trailer truck is 9,400 lb.

The wheels are steel tyred, with separate cast-iron spoke centres. The following are the dimensions :—

	In.
Outside diameter of tyre	30
Total width of tyre	5¼
Width of flange	1¼
Height of flange	1⅛
Diameter of axle at centre	4½

The tyres are of the same type and are secured in the same manner as those on the motor trucks, and the wheels and axles also conform to the same specifications respectively. The journals are 4¼ in. by 8 in. Both motor and trailer trucks were manufactured by the Baldwin Locomotive Works.

Third-rail Shoes.

The standard third-rail shoes on the Long Island cars are of the hinged-slipper type, supported on the usual wooden beam, which is clamped against the notched face of the equaliser spring seat castings, providing means for vertical adjustment. Upon the centre of the beam is placed a 600 ampere enclosed-type fuse in a wooden box, with a hinged cover and lined with asbestos. The arrrangement is shown in detail in Fig. 5.

Trains from the Brooklyn Rapid Transit Co.'s elevated lines operate over the Atlantic Avenue and Rockaway Beach Divisions by way of Chestnut-street Junction to Rockaway Park. The Brooklyn elevated lines have been for some years operated by the third rail, but the location of their rail is 22¼ in. outside and 6 in. above the track rail, while the Long Island Railroad third rail is 26 in. out and 3½ in. up. This made it necessary to devise some form of adjustable third-rail shoe which would operate with equal facility over both third rails and be able to change from one to the other at reduced speed without requiring attention on the part of the motorman or train crew. Such an arrangement has been worked out, and patents on it have been applied for by James C. Boyd. It consists essentially of a hinged slipper-type of shoe mounted upon a movable lug which is held in either position by means of coil springs and is actuated by an arm that engages with a stationary cam mounted alongside of the track, in line with the third rail. The movement of the car past this cam in one direction changes the shoe from the inner to the outer low position, while a reverse movement of the car past the cam changes it from the outer to the inner raised position. The cam as it appears in the third rail is shown in Fig. 6. These adjustable shoe equipments have been fitted to such cars of the Brooklyn Rapid Transit Co. as are to operate over the lines of the Long Island Railroad.

Air Brakes.

The cars are equipped with hand brakes and with the Westinghouse quick-service automatic air brake. This brake is of the new design developed from the quick-action brake. Compressed air is supplied to the system by a Westinghouse D2 electrically-driven air compressor on each motor car, controlled by a standard Form "J" governor. This pump has a rated capacity of 24 cubic feet of free air per minute, and supplies both the air brake and the pneumatic control system, but the brake and the control systems are operated from separate reservoirs.

All the motor and trailer cars are provided with automatic adjusters which automatically take up the slack in the brake rigging and keep the piston travel uniform throughout the train.

(To be concluded.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Electrician" Primers. Edited by W. R. Cooper. Vol. I.—Theory. Vol. II.—Electric Traction, Electric Lighting and Electric Power. Vol. III.—Telegraphy, Telephony, Electrolysis and some Miscellaneous Applications of Electricity. (London: "The Electrician" Printing & Publishing Co. In one volume, 10s. 6d.; in three volumes, 12s. 6d.; or in separate booklet form.

"Electric Bells, Indicators and Aerial Lines." By Umberto Zeda. Translated from the Italian and revised by S. R. Bottone. (London: G. Pitman.) 2s.

"Journal of the Institution of Electrical Engineers." August, 1906. No. 179. Vol. XXXVII. With index. Edited by G. C. Lloyd. (London: E. & F. N. Spon.) 5s.

THE ELECTROTHERMAL METALLURGY OF IRON.*

BY MAJOR E. STASSANO.

It is well known that in ordinary furnaces only a small part of the calorific power of the combustible materials used for heating is utilised. Moreover, the quantity of heat really used varies with the construction of the furnace and the mode of heating. On the average, the thermal efficiency of industrial fuel is only 2 to 3 per cent. for a forge fire; 5 to 10 per cent. for apparatus in which the heating is produced through walls of refractory material, as in crucibles; from 10 to 20 per cent. in furnaces with hearths and in small blast furnaces; finally, an efficiency of 30 to 50 per cent., and even 70 per cent., is obtained in cupolas and large blast furnaces.

The very small thermal efficiency obtained in industrial furnaces is due in a great part to the fact that the necessary element for combustion—viz., the oxygen of the air, being so much diluted by the inert gas, nitrogen, which, during the combustion, absorbs a great deal of heat, lowering the temperature, and necessitating large dimensions for the combustion chamber. Apart from this, a great deal of heat is lost by radiation from the walls, and also by convection. It is, then, readily understood why a high efficiency can be obtained by the use of electric energy for the production of the heat, for the reason that this source of heat is not due to combustion and that the most important causes of loss inherent in the use of a combustible can be avoided.

In taking 20 per cent. as the mean thermal efficiency of industrial fuels used for heating metallurgical furnaces, and in putting the thermal efficiency of electric heating at only 50 per cent., it is easy to determine the limits within which the substitution of electric heating for heating by combustion may be realised industrially, and with what resulting economy. The mean calorific power of industrial fuels is 6,500 calories,† while the transformation of 1 E.H.P.-hour into thermal energy produces 635 large calories. Taking into account the efficiencies already mentioned it follows that $\frac{6{,}500 \cdot 20}{100} \div \frac{635 \cdot 50}{100} = 4{\cdot}22$ E.H.P. hours, transformed into thermal energy, produce the same thermal work as that obtainable by burning 1 kg. of combustible in an industrial furnace.

The greater number of hydro-electric generating stations produce an electrical horse-power-year at a price not exceeding 40fr.‡ Under these conditions, if one can utilise 50 per cent. of the heat produced in the transformation of electric energy into thermal energy, an electric furnace worked from a generating station which makes use of large water power can work under the same economical conditions as are possible by the use of coal costing 21fr. per ton.

It may be remembered that in the preceding calculations the thermal efficiency of combustibles in an industrial furnace has been given a higher value than is obtainable in practice. The supposition has also been made that in new electric furnaces only 50 per cent. of the heat produced would be utilised, and the cost per electrical horse-power-hour has been arrived at by considering only 8,000 hours' running per annum, whereas in reality a hydro-electric installation is used during 8,760 hours per annum—*i.e.*, without interruption.§ Further, it must be remembered that in many metallurgical operations it is indispensable that certain special combustibles should be employed, such as coke, which, on account of its manufacture, costs more than natural coal. It must also not be forgotten that the price of coal tends rather to rise than to fall. Under these conditions it will be readily understood that the employment of electric furnaces is a matter of importance in localities where hydro-electric power can be utilised to carry out some of the reactions under economical conditions identical with those which would allow of the use of coal costing not more than 21fr. per ton.

The preceding very approximate calculations do not allow the importance of the problem to be realised exactly, because there is another reason not less important which increases the expense when combustibles are used, and which somewhat militates in favour of electrothermal processes. In metallurgy generally the coal does not serve merely, directly or indirectly, as the reducing agent, but also as the source of heat. It is for this reason, notably in the metallurgy of iron, that when the ore is in contact with the combustile during reduction, it is not possible to determine exactly the quantity of coal absolutely necessary to effect the reduction of the ore and that which is necessary for the production of the required temperature. It follows, therefore, that it is necessary to employ an excess of combustible, an excess which is partly absorbed by the metal, according as the ore is reduced. Under these circumstances, the product obtained after the first operation of reduction of the ore is far from containing the only metal which one wishes to extract. The product is a carbide of the metal, more or less rich in carbon, containing in addition numerous impurities and other metals and metalloids arising from the total or partial reduction of the different compounds found in the ore that is used. This result, which cannot be avoided in the different processes at present used in the reduction of ores by coal, necessitates the first product being submitted to a number of successive refining operations, so as to obtain the metal finally in the required degree of purity. Further, during the operation of reduction, certain impurities contained in the industrial combustibles, and even in the air which is necessary to maintain the combustion, mix with the metal, modifying its composition and giving rise to parasitic actions which are generally harmful from the point of view of the success and economy of the succeeding operations.

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* Paper read at the Sixth Congress of Applied Chemistry at Rome, May 1, 1906 (translated). Fig. 3, of the fixed furnace, has been omitted as it is practically the same as that shown in *The Electrician*, Vol. LIV., p. 1003.

† Theoretically, the calorific power of fuels has a greater value than 6,500 calories, but if humidity, which is always rather considerable, is taken into account, as well as ash and other impurities, we find in practice that the calorific power is not above the value indicated.

‡ At Terni, the retail price per electrical horse-power-year is only 27fr.

§ The Commission sent to Europe by the Canadian Government to study electrometallurgical installations admits in its report the utilisation of 8,760 hours per annum.

The electrothermal process depends on a source of heat necessitating neither combustible nor atmosphere to maintain combustion, and its use does not bring with it any of the inconveniences which have just been mentioned. Nor is this all. It is known that the thermal efficiency of a given metallurgical operation is the higher the greater the difference of temperature between the source of heat and the material to be heated. Similarly, the more the surrounding atmosphere is at a high temperature the more active are the chemical reactions which are produced.

Finally, it may be added that the electric energy used for working electric furnaces being generally produced by hydro-electric power, in order that the apparatus should work under the best conditions, it should be installed for continuous working and always fully charged. It is evident that in realising these conditions fairly completely, the advantages presented by electrothermal methods will be considerably increased. The new processes will permit the metallurgical industry to be installed not only in localities deprived of natural fuels and possessing important water power, but will also admit of certain special applications, even where the fuel can be obtained at low prices, and where it would seem at first sight that practical application cannot be realised.

To sum up, it can be shown that, in order to utilise the heat produced by the transformation of electric energy into thermal energy under industrial conditions, chiefly in metallurgy and particularly in the metallurgy of iron, it is sufficient that the apparatus employed should fulfil the following principal conditions:—

1. That the enclosure in which the transformation of electric energy into heat is carried out, and also the metallurgical operations necessitating this heat, should be protected from the direct action of the atmospheric air and constructed of materials absolutely inert from the chemical point of view.

2. That the heat developed by the transformation should be produced at as high a temperature as possible.

3. That the materials under treatment should not come in direct contact with bodies susceptible of modifying their composition in a harmful manner.

4. Finally, that the apparatus in which the different metallurgical operations are carried out under the action of the heat produced by electrical energy, as well as the processes for obtaining the desired products, should be constructed and worked in such a manner as to obtain continuous working with a full charge.

It is upon these principles that I relied in studying the problem before me. In a memoir published in the *Rivista di Artiglieria e Genio* in 1902 I gave a detailed account of the researches and experiments made to determine the definite type of furnace which it was desirable to employ. Referring those who wish for greater details to this memoir, I will confine myself to giving a short description of two types of furnace which enabled me to solve the different problems presented by electrometallurgy in general and more particularly by the electrothermal metallurgy of iron.

As seen in Figs. 1 and 2, the rotating furnace consists of a metallic casing in the form of a cylinder, the upper part of which terminates in a cone. This casing is lined internally with refractory material. The fusion chamber, situated within this lining, is cylindrical in form and is closed by a spherical top. Openings of suitable dimensions are provided in the walls of the furnace to allow of the introduction of the electrodes, which have to penetrate into the interior of the fusion chamber in such a way that their extremities are capable of coming into contact at the centre of the chamber, thus permitting the current to pass from one electrode to another with the production of a voltaic arc above the hearth of the furnace and at a suitable distance from it. At each of the openings provided in the walls for the electrodes is a double metallic cylinder furnished on the outside with rods for supporting and guiding the carbon electrode. By means of a suitable sleeve, each electrode is connected to a metallic rod, which, through a flexible cable, makes connection between the electrode and the terminal for current, which is fixed to the lower part of the metallic casing.

The metal cylinder serving as the electrode carrier is made double so that water can circulate through it for the purpose of cooling the interior, thus keeping the metal part of the electrode carrier at a relatively low temperature. At the upper part of the cylinders enclosing the electrodes is a hydraulic cylinder containing a piston and rod, the latter being in a plane containing the axis of the cylinder and connected to the rod of the carbon carrier. It will be seen that by forcing water under pressure to one side or other of the piston this can be moved, and will carry the electrode with it.

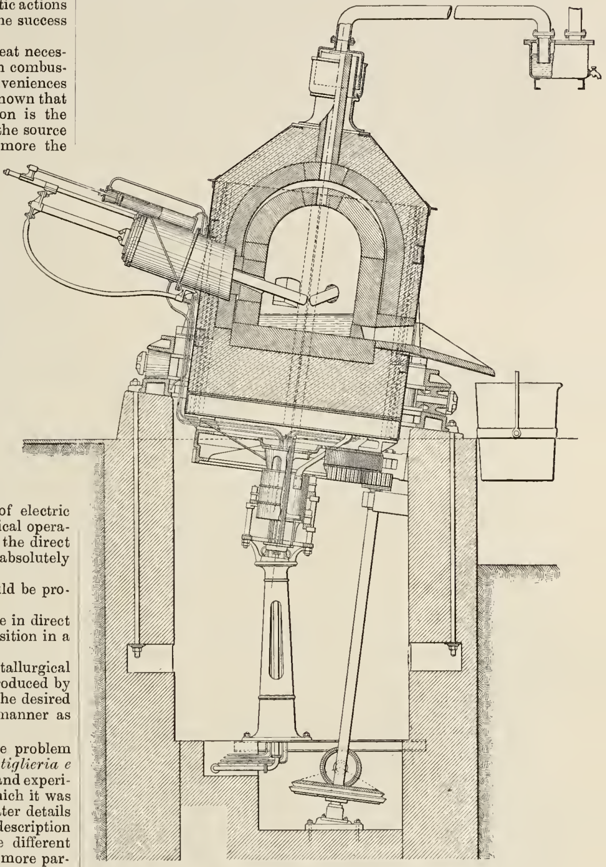

Fig. 1.—Vertical Section of the Stassano Rotating Furnace.

The whole furnace, which has just been described, rests on a metallic seat by means of a sort of collar solidly fixed to the metal casing, and this is provided with truncated rollers which rest upon, and can travel freely on, a circular path of cast iron whose surface is in the form of a truncated cone having a very large angle. This circular path is not placed horizontally; it is fixed on a block of masonry in an inclined position so that the axis of the furnace is inclined with respect to the vertical. To the lower part of the metallic casing of the furnace is fixed a solid toothed wheel which engages with a pinion on a shaft that is actuated by means of bevel gear. In this way a rotatory movement can be given to the furnace as a whole about its axis. In the centre of the toothed wheel, placed below the body of the furnace, are fixed rings of insulated copper, to which are attached, by means of bars of copper, flexible cables running to the electrode carriers. A series of brushes mounted on a metallic support, which is placed in the centre of the cavity below the furnace, bear on the copper rings and are connected to conductors from the generator. In this way a permanent connection is effected between the generator and the electrodes, whether the furnace is at rest or is being rotated. On the upper part of the support for the brushes is fixed a water connection, from which water under pressure is obtained for working the hydraulic cylinders that regulate the electrodes, and also for giving supply to the cooling cylinders, and this water supply is established in such a way as to ensure the circulation being equally good when the furnace is in motion or at rest.

In addition to the openings provided in the walls of the furnace for the electrodes, there is one in prolongation of the hearth for removing the products of the operation, one for charging the furnace, and one on top of the furnace in the centre of the crown to allow the volatile products, which are given off as there actions take place in the fusion chamber, to escape. This last opening is continued in the form of a pipe arranged in the axis of the furnace. The upper end of this pipe leads by means of a sand purifier and a metallic tube into a washer where the volatile products, after passing through the water, find their way to the atmosphere, or are collected, if they are of such a nature that they can be used. Owing to this arrangement the atmospheric air cannot circulate freely into the fusion chamber, for as soon as the charging door of the furnace is shut the gases are under a pressure greater than that of the atmosphere, and consequently no air can enter. Apart from that, when the door is open for charging, no current of air can pass, because the upper opening is closed by the water contained in the washer.

It is evident that a furnace constructed in this way completely fulfils within practical limitations all the conditions which have been indicated for obtaining the best working as far as metallurgical operations are concerned, because:—

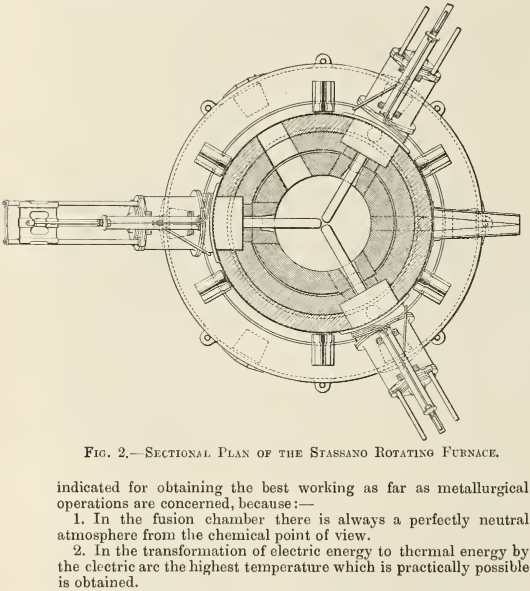

FIG. 2.—SECTIONAL PLAN OF THE STASSANO ROTATING FURNACE.

1. In the fusion chamber there is always a perfectly neutral atmosphere from the chemical point of view.
2. In the transformation of electric energy to thermal energy by the electric arc the highest temperature which is practically possible is obtained.
3. The materials to be treated do not come in contact with the electrodes, and consequently their composition cannot be modified by the absorption of foreign bodies.
4. Lastly, a continual stirring up of the fused material is obtained in this furnace in a certain and practical manner by the rotary movement which is given to it, by which regular chemical reactions are much facilitated, such reactions being rendered more active and more rapid by the very high temperature which is maintained in the fusion chamber, thus allowing a full charge to be maintained, and a maximum output.

It should be mentioned that the electric furnace, fitted up under the special conditions which have been described, has also the advantage of utilising the high temperature which is obtained therein without it being necessary to re-heat the materials under treatment. In fact, considering this furnace in its most simple form, we see that it consists of an enclosure in the centre of which is a source of heat which is not due to combustion, and which gives rise to a very high temperature. Under these conditions it can be understood that the temperature of the furnace tends to become gradually higher and higher until it approximates that of the source of heat by which the maximum is limited. On account of the radiation of the walls, the temperature obtained in the fusion chamber is in the neighbourhood of the maximum, but it never becomes equal to it. Consequently, by proportioning the capacity of the fusion chamber in accordance with the quantity of heat which one desires to utilise, and by suitably regulating the charge so as to obtain the necessary heat in the furnace, it is possible to maintain a suitable temperature for good working without it being necessary to re-heat the charge.

In the practical operations of metallurgy it is not always necessary to have recourse to the stirring of the mass to render the reactions more active. In that case the furnace, though constructed on the principles already given, can be very greatly simplified by being fixed.

In this model of furnace the hearth is rectangular in form; the doors for the introduction of a charge are placed on the two smaller sides of the rectangle, whilst on the longer sides are the tap hole on one side and the opening for the removal of slag on the other. The distribution of heat is rendered uniform throughout the fusion chamber by increasing the points of radiation.

This fixed type of furnace is convenient more particularly for carrying out a reduction previous to refining. The use of this furnace has the advantage of rendering this operation more easy and more economical. This can be verified practically, for example, in the treatment of copper minerals, where it is necessary to maintain the mass in fusion for a long time so as to allow the metallic particles in the mass to separate themselves from the slag through difference of density. In this case the fixed form of furnace allows the required object to be attained, since the molten matter, being in the upper part of the chamber where the temperature is the highest, can remain as a top layer for a considerable time and thus render it possible to have a complete separation between the slag and the useful material, which in this case is the unrefined metal.

It is evident that with furnaces of this kind, suitably modified according to the special requirements of the different metallurgical operations, it is possible to carry them out under much more advantageous conditions than with furnaces in which heating is produced by the combustion of coal.

At the beginning of the present communication I stated that the thermal efficiency of fuels is very variable and very low in industrial furnaces, except in the case of large blast furnaces where the efficiency rises to about 70 per cent. But upon going into the question more closely it is easily seen that this maximum efficiency is only apparent. In reality account must be taken of the fact that in the blast furnace not only is the reduction of the iron ore carried out, but also that of silicon, oxide of manganese, and other substances contained in the mineral. In addition, the different substances become alloyed with the iron, and, far from improving its quality, cause it to lose the malleability and ductility which are characteristic of this metal, thus rendering it necessary to submit the cast iron obtained to long and costly operations of refining in order that iron of a suitable quality of malleability may be obtained. This fact explains why the thermal efficiency of the blast furnace is more apparent than real, since one part of the heat thus utilised serves only to accomplish a veritable task of Sisyphus.

It is well known that the pig, such as is obtained from blast furnaces, is capable of many useful applications, as is shown by the large extent to which it is used in castings in the industry, but if the blast furnace could produce malleable iron directly the numerous articles which are now made of cast iron on account of economy would certainly be made of malleable iron or of cast steel.

Since all the other types of furnace used in the metallurgical industry in general, and more particularly the metallurgy of iron, have an efficiency much inferior to that of the blast furnace, for generally it is not much greater than 20 per cent., we may, for the reasons already given, and without fear of contradiction, attribute to the electrothermal furnace an efficiency equal or superior to 50 per cent. of the heat supplied to it by the transformation of electric energy into thermal energy. The new processes founded on the use of this furnace could lead to the establishment of the great metallurgical industry in places where natural fuels are not found, but where there is abundant water power, subject to the condition that the retail price per electrical horse-power-year should not be greater than 40 frs. Electrothermal furnaces can, in addition, be used to advantage for certain special operations where such water power is not available, but where natural fuel is abundant, or in places where other cheap fuel, such as blast furnace gases, is available.

Having made these observations I will now examine the results obtained, so as to see to what extent the theoretical deductions on which I base my experiments have been confirmed in practice. If we knew exactly the quantity of heat necessary to produce the fusion of unit weight of the metals in question to raise them to a certain temperature, as well as the amount of heat required by the different kinds of slag obtained in the course of the operations, and if, in addition, we could take into account the heat of formation of the different solid and gaseous compounds formed, it would be easy to determine exactly the thermal efficiency of the new furnaces in which the quantity of energy consumed can be measured very approximately and at any moment. Unfortunately, the information which we possess at the present time as to specific heats of different bodies at high temperatures, and as to latent heats of fusion of metals, and of the slags which are formed during the metallurgical operations, is very imperfect or entirely wanting. It is to be hoped that those who cultivate pure science, and who are interested in the needs of practice, will increase the delicate methods of research which every day reveal to us new secrets of Nature, so that we may arrive at the precise data which industrial processes require for progress. At the present time we must be content with determining the efficiency of the furnaces in accordance with the insufficient data available.

In making use of the results of the calorimetric measurements found in the tables of Lunge, supplemented by Jüptner v. Jörnstorff (*Die Untersuchung von Feureungs Anlagen*), and which give the quantity of heat necessary to raise the temperature of 1 kg. of iron to 1,200 deg., it is possible to determine approximately, by continuing the curve that can be easily constructed, according to the data in the table, the quantity of heat necessary to raise the iron to the temperature of fusion and even beyond. Further, according to information furnished by Gruner, Ledebour and other metallurgists, the heat necessary for the fusion of slags can be determined.

According to data thus obtained, we may admit that 510 calories are necessary to fuse 1 kg. of iron and to raise it to a temperature of 1,900 deg., this temperature being that at which, in general, the cast is made, so that the metal may be very fluid. As to the slags, we must allow 600 calories for the fusion and for raising them to the same temperature when basic.

At the preceding Congress of Applied Chemistry, held in Berlin in 1903, Dr. Hans Goldschmidt presented a report in which he gave an account of experiments at which he was present in 1901 at Darfo, in the rôle of a delegate of the Imperial German Patent Office, so as to determine if my type of furnace would permit of malleable iron being obtained directly from the mineral in one operation. In treating a mineral having the following composition—

	Per cent.		Per cent.
Fe_2O_3	93·020	P	0·056
MnO	0·169	CaO. MgO	0·500
SiO_2	3·790	H_2O	1·720
S	0·058		

he found that iron having the following composition was obtainable by a single operation :—

	Per cent.		Per cent.
Fe	99·764	S	0·059
Mn	0·092	P	0·009
Si	traces	C	0·090

And that in order to carry out this reduction the electric energy required amounted to about 5 H.P.-hours per kilogramme of metal produced, which is equivalent to an efficiency of about 60 per cent. of the electric energy used.

After these trials at Darfo I installed a rotating furnace on my system in the artillery works at Turin for the Minister of War, suitable for the preparation of steel to be used in the manufacture of artillery projectiles, the material employed being iron and steel turnings and scrap from the different factories of the Minister of War. From the certificates given by the War Office, referring to 38 successive operations of refining cast iron and scrap carried out in ordinary working with my furnace between May 15 and 27, 1905, and the results of which were given in the *Giornale del Forno*, published by the Administration, it follows :—

1. That the furnace produced in ordinary working 2,500 kg. of steel per day in refining pig iron and smelting scrap, with a loss not exceeding 20 per cent., although the charge included 75 per cent. of turnings
2. That a charge of 600 kg. included at least 150 kg. of pig iron, for the refining of which 29 kg. of iron ore and 6 kg. of lime are required.
3. That each operation requires the expenditure of 850 kw.-hours of electric energy.

Since the amount of electric energy required was measured on the primary circuit of the transformer supplying the furnace, the amount really required is only equal to about 92 per cent. of the 850 kw.-hours mentioned—*i.e.*, 752 kw.-hours if account is taken of the losses in the transformer and in the secondary connections.

From the results obtained in the trials just mentioned, and according to data already given for the calculation of the heat necessary to produce fusion, and for raising a kilogramme of pig and a kilogramme of slag to a temperature of about 1,900 deg., it is possible to arrive at the thermal efficiency of the new type of furnace.

We have, for melting 600 kg. of iron and raising it to a temperature of 1,900 deg., 600 × 510 calories	306,000
For melting about 10 kg. of basic slag, 10 × 600 calories	6,000
For reducing the oxide of iron contained in the 29 kg. of ore added to the charge, the composition being given,* $\frac{29 \times 312}{160} \times 192 + \frac{29 \times 603}{232} \times 279$ calories	30,885
	342,885

Since the amount of energy required by the furnace for each operation was 772 kw.-hours, we have

$$\frac{772{,}000}{735} 635{\cdot}3 = 667{,}256 \text{ calories,}$$

and the thermal efficiency of the furnace is consequently

$$\frac{342{,}885 \times 100}{667{,}256} = 51{\cdot}42 \text{ per cent.}$$

This result, which is in apparent contradiction to that given by Dr. Goldschmidt, according to experiments carried out at Darfo, is, nevertheless, identical, as we shall see. The furnace installed at Darfo, which required about 100 kw , was operated by means of single-phase alternating currents, and consequently was provided with only two electrodes. In the artillery works at Turin the furnace is supplied from a three-phase network, and therefore requires the use of three electrodes, and consequently of one additional cooling cylinder, which naturally causes the loss of a considerable amount of heat, thus reducing the efficiency of the furnace.

Some figures will enable me to prove the exactness of this fact. According to numerous daily measurements carried out during the running of the furnace, it has been found that three cooling cylinders require the supply of 40 cubic metres of water per 24 hours. In leaving the cylinders the water is found to have a rise of temperature of about 15 deg. Under these conditions the thermal losses due to the working of the cooling cylinders represent energy equivalent to

$$\frac{40{,}000 \times 15}{635{\cdot}3} = 904 \text{ H.P. hours}$$

in 24 hours. Since the furnace during this period requires about 200 H.P. during 22 hours, and since during the operations of charging and casting the current is interrupted, the thermal losses due to the cooling cylinders are equal to

$$\frac{904 \times 100}{200 \times 22} = 20{\cdot}5 \text{ per cent., about.}$$

If, on the contrary, the furnace were fed with single-phase current, this loss would be reduced by about 7 per cent., and consequently the same efficiency would be obtained as that given for the furnace at Darfo.

It is evident that in increasing the capacity of furnaces, this cause of loss would rapidly diminish because the quantity of water circulating in the cooling cylinders would be constant, the quantity of energy passing by each electrode would increase, and consequently the losses would be less.

In fact, in furnaces having a capacity of 1,000 H.P., provided with six electrodes, the thermal losses due to cooling would be, according to figures already found, 904 × 2, since there are six electrodes instead of three. On the other hand, the furnace would require, during 24 hours, 22 × 1,000 H.P.-hours, whence the percentage of loss would be $\frac{904 \times 2 \times 100}{22 \times 1{,}000} = 8{\cdot}2$ per cent.

It is permissible to conclude from the experiments at which Dr. Goldschmidt was present, and from those carried out in the artillery works, that it is possible in the case of my system, which is worked under the best possible conditions for utilising electrical energy in metallurgy—

1. To obtain a thermal efficiency above 50 per cent. as regards the electric energy supplied, even in the case of small furnaces, where naturally the losses are great.
2. To obtain direct from the ore by a single operation malleable iron, as well as steel, of a definite composition by employing a suitable mixture of the pig to be refined and of scrap.
3. By carrying out the operations out of contact with the air, the maximum efficiency is obtained as regards the materials that are used.

It is therefore evident that analogous results will be obtained in the treatment of other minerals and in the refining of metals other than iron.

In order to complete the account which I have given it would be necessary to mention the processes which, after my experiments, were brought out by other inventors. For reasons which are easily understood I will leave this part of the subject on one side, and I do so the more willingly since the detailed report issued by the Commission sent by the Canadian Government to study the electro-thermal installations in applied metallurgy existing at the present time in Europe is just completed.

On the other hand, the information which I have just given and the certificates which have been given to me by the War Office as a consequence of the satisfactory working of the furnace which I installed, are sufficient for the value of the process to be determined. At the time when the Canadian Commission passed through Turin, the members were not able to see the furnace at work owing to its incomplete state through the refractory material not having been supplied.

Although I have no intention of discussing either the details or the numerous data or deductions found in the report of the Commission, I must nevertheless refer to two points in the conclusions arrived

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* The mineral used had the following composition :—

	Per cent.		Per cent.
F_2O_3	31·200	CaO. MgO	traces
Fe_3O_4	60·264	S	0·020
MnO	0·125	P	0·005
SiO_2	6·200	H_2O combined	0·320
AL_2O_3	1·800	Losses	0·066

at by the Commission after they had carefully looked into and commented on the results of trials carried out for the Commission at the different works visited.

I am compelled the more to raise these two points because they are in complete disagreement with the logical and natural conclusions drawn from the precise facts which I have just put forward in the present memoir, and which were admitted by Dr. Goldschmidt and by the War Office during the trials at Darfo with the ordinary furnace which I installed for the purpose.

In the second paragraph of the conclusions drawn up by the Canadian Commission, it is stated:—

"Under present conditions the electric furnace cannot compete from the economical point of view with the Siemens and Bessemer processes as regards the manufacture of industrial steel. Its industrial application is limited to the manufacture of steels of superior quality required in certain special applications."

This assertion does not appear to me to be exact, and the figures which I have given, deduced from perfectly ascertained facts, enable me to prove it.

Mr. Harbord, the metallurgist, who was one of the members of the Canadian Commission, recognises himself, in a special report, that, as regards handling and the manipulation of the furnace, the expense in the production of iron and steel by means of the electric furnace for refining and smelting up scrap are the same as those occurring in the use of the Martin furnace. Consequently, if there is a difference between the expenses of manufacture with the electric furnace as compared with the expenses entailed by the use of the Martin furnace, this difference can only come about in the electric energy required as compared with the comsumption of fuel, and by the extent of utilising initial materials, in which there can be a difference in the two systems of furnace.

It is easy to determine this by making a comparison between a Martin furnace of an average capacity, capable of producing 10 to 12 tons per operation, and an electric furnace of 1,000 h.p., which is an average power for this kind of furnace.

It will be admitted that in the case of the Martin furnace the losses of initial material are only about 10 per cent., which is certainly not large, and that in the case of the electric furnace these losses are not more than 2 per cent., as determined in the furnace used at Turin. Let us suppose in addition that, in an electric furnace of 1,000 h.p., the consumption of electric energy is proportional to the figure found at Turin, where the furnace was only of 200 h.p. By so doing it will be noticed that I place the electric furnace at a disadvantage.

Under these conditions the operating expenses, for fusing a ton of material in the electric furnace, may be estimated at 10·35fr. as follows:—

1,300 kw.-hours at 0·005fr. =	8·85fr.
5 kg. of electrodes at 0·30fr. =	1·50fr.
	10·35fr.

In the case of the Martin furnace, account must be taken of the cost of the coal necessary to produce a ton of the product, and that of 80 kg. of initial materials, which, as has already been said, are lost. Consequently, if from the 10·35fr. representing the cost of fusion in the electric furnace is deducted the value of 80 kg. of initial materials at 7fr. per 100 kg., one has to take account of the price of the fuel necessary to carry out the fusion of 1 ton of steel in the Martin furnace when comparing the cost of manufacture by the two processes.

In the electric furnace, on account of the loss of initial materials in the Martin furnace, the cost is reduced to 10·35fr. − 5·60 = 4·75fr.

In the case of the Martin furnace of the capacity mentioned, we must allow a consumption of fuel not less than 400 kg. per ton of steel, and in order to obtain a good result it is necessary to employ coal costing at least 11·60fr. per ton, a price which certainly is not high, even in localities where coal is abundant. It therefore follows that the cost of fuel is 4·64fr. In the Bessemer process results are obtained analogous to those of the Martin process, more particularly if account is taken of the fact that with the electric furnace cheap materials may initially be employed, notwithstanding which a good result is obtained, whereas in the Bessemer process it is absolutely necessary to employ cast iron of the best quality, and on which there is a loss of 10 to 25 per cent.

The second conclusion of the commission with which I do not agree is that referring to the manufacture of pig in the electric furnace. In fact, admitting that the essential advantage presented by electrothermal processes—viz., that of allowing malleable iron to be obtained directly by a single operation, as has been proved by experiments carried out and carefully controlled, all the conclusions of the commission on that point are invalid We must not lose sight of the fact that the production of pig is a necessity imposed by the means of manufacture, and that the necessity for this intermediate product would disappear with the employment of the electric furnace.

In conclusion, it seems possible to assert that if the electrothermal processes have not yet received the great development which might be expected, this is not on account of imperfections or difficulties, but merely on account of opposition, such as is always met by new inventions, precisely on account of their novelty, which raises opposition, or even on account of the natural hostility of industries which, using old methods, consider, rightly or wrongly, that a new discovery would be harmful to them.

The history of progress is full of examples of this kind, but the experience of life shows us that with tenacity and courage, to which must be added sacrifices, the new ideas, if they are good, finish by triumphing over all obstacles which are placed in their way. But in order to realise the progress and to arrive at the desired aim, it is necessary and even indispensable that the ideas which one wishes to put forward should be clearly stated to avoid all misunderstanding and false interpretation.

For this reason, in bringing my communication to a close, in which I have attempted to give an exact résumé of the present position of the important problem of electrothermal metallurgy, I wish to state that this new industry has left the period of experiment behind, and that it can now enter tranquilly and with profit into that of practical application, because

1. The atmosphere in which the transformation of electric energy into thermal energy takes place is protected from the direct action of the air, and is, consequently, absolutely neutral from the chemical point of view.
2. The heat developed by this transformation allows the highest temperatures to be obtained.
3. The materials treated are not in contact with foreign bodies that are capable of modifying their composition in a disadvantageous way.
4. Finally, the apparatus in which the different metallurgical operations are carried out by means of heat produced by electrical energy, and the processes which take place in obtaining the required products, are constructed and designed to allow of continuous working with a full charge.

ON THE ELECTRIC INDUCTIVE CAPACITIES OF DRY PAPER AND OF SOLID CELLULOSE.*

BY ALBERT CAMPBELL, B.A.
(From the National Physical Laboratory.)

(Concluded from page 787.)

Part III.—Solid Cellulose.

A series of tests were made on a number of samples of nearly pure cellulose kindy supplied to the laboratory by Mr. C. F. Cross.

The material was prepared by the following process: Crude viscose 10 per cent. solution of cellulose xanthogenic acid (sodium salt), with alkaline by-products, was spread on a glass plate, dried at 60°C., salted out with pure brine to remove soluble by-products, and the cellulose finally "fixed" and purified by treatment with acid and thorough washing.

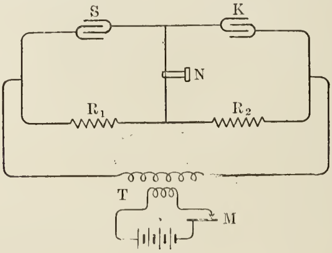

Fig. 7.

The samples were in the form of fairly uniform translucent sheets from 0·06 mm. to 0·3 mm. in thickness. For most of the experiments the sheets were dried for several days in an oven at 80°C. to 110°C. As the air-dry material is of the nature of a colloidal solution, the thorough drying is a long process, and the reabsorption of moisture from the atmosphere is very much slower than in the case of fibrous cellulose like paper. In the first experiments clamps of indiarubber and tinfoil were used, but it was found that these did not make satisfactory contact with the very smooth surface of the cellulose; they were therefore discarded and were replaced by mercury clamps† consisting of troughs with indiarubber edges pressed against opposite sides of the sheet and filled with mercury. The clamps and the mercury were usually dried in the oven and applied while still hot, a set of tests being taken as the whole apparatus cooled down to the temperature of the room. Capacity tests made on mica sheets of two different thicknesses gave concordant results and so proved that the mercury contacts were satisfactory. The drying made the cellulose very brittle, but immersion in water restored it to the flexible condition. Some of the capacity measurements were made by Maxwell's method (as already described), but in order to avoid polarisation and minimise the effect of conduction the method[*] shown in Fig. 7 was usually employed.

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* Paper read before the Royal Society.

† See R. Appleyard, *Proc.* Phys. Soc., p. 721, Vol. XIX., December, 1905.

S is a small standard condenser, K the condenser to be tested, R_1 and R_2 variable resistances, while M is a telephone plate sounder[†] (giving 800 ∽ per second), such as is sometimes used in place of an electric bell. The intermittent current from M gives, by means of the transformer T, an alternating-current in the bridge SKR_2R_1.

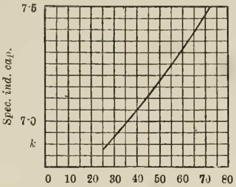

Fig. 8.—Oven-dried Cellulose. Specific Inductive Capacity.

The ratio R_1/R_2 is altered until there is silence in the telephone N; then $K/S=R_1/R_2$. When the cellulose was thoroughly dry the point of balance was quite definite, but when it was only air dry a point of minimum sound was all that could be obtained (but see below). The results obtained from sheets of different thicknesses (0·06 mm. to 0·3 mm.) were in very fair agreement both for capacity and resistivity throughout a considerable range of temperature. The resistivities were measured by the method of direct deflection at 200 volts with 1 minute's electrification. Table IV. gives mean results for a range of temperature from 70°C. down to 20°C., and Figs. 8 and 9 give the corresponding curves. (The resistivities with two minutes' electrification were 20 to 30 per cent. higher.)

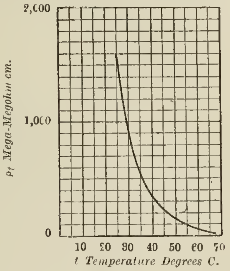

Fig. 9.—Oven-dried Cellulose. Apparent Resistivity by Direct Deflection Method.

Table IV.

Temperature.	Sp. ind. capacity.	Resistivity.	Temperature.	Sp. ind. capacity.	Resistivity.
°C.		megohm-cm.	°C.		megohm-cm.
20	6 7	..	50	7·2	125×10^6
25	..	$1{,}600 \times 10^6$	60	7·3	40×10^6
30	6·8	900×10^6	65	..	20×10^6
40	7·0	330×10^6	70	7·5	..

Tests on Damp Cellulose.

The influence of moisture upon the electrical properties of paper (illustrated by the curve of Fig. 6) is striking. Some years ago I observed that, when even a trace of moisture was present, a sudden lowering of the temperature always caused a considerable increase in insulation resistance.[‡]

At that time I advanced the theory that the effect was largely a mechanical one, the lowering of the temperature causing the moisture to be drawn into the hollow tubular interiors of the fibres. Since the solid cellulose is not of fibrous structure, it was of interest to try its behaviour when in the "air-dry" condition—*i.e.*, after exposure to the atmosphere for a considerable time. Of course, the amount of moisture present depends on the humidity of the air, the temperature, &c., and therefore the conditions vary from day to day; thus the results refer only to the actual conditions holding at the time of the particular experiment. In each case the cellulose was placed between the clamps, hot mercury was poured in, and observations were made during the cooling. Tests of apparent resistivity were made by observing the current due to a constant P.D. kept continuously applied. Fig. 10 gives an example of a curve thus obtained. As might be expected, strong polarisation effects made their appearance. When attempts were made to measure the capacity by Maxwell's method the polarisation caused a large displacement of zero, and made it impossible to obtain any true result. With the telephone method of Fig. 7 the relatively good conductance of the specimen made it impossible to obtain a balance. However, by shunting the standard condenser S (as shown in Fig. 11) by a variable resistance X, it was always possible to get a good balance.

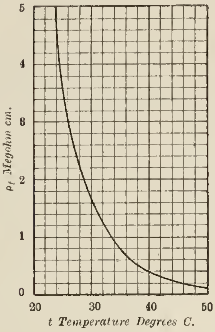

Fig. 10.—Air-dry Cellulose. Apparent Resistivity by Direct Deflection Method.

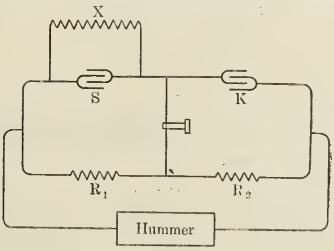

Fig. 11.

As high frequency is desirable, the source of current was a microphone hummer[*] of special construction giving 2,000 ∽ per second. The arrangement of this is shown in Fig. 12. A is a rod of mild steel (or tool steel) supported horizontally at nodal points, and carrying at one end a very light microphone, B, shunted by a condenser, C. T is a transformer whose secondary is connected to the coil of a polarised telephone magnet, M. If A is set vibrating by a blow the pulsating current in the microphone circuit gives an alternating current round M, and so maintains the vibration. The

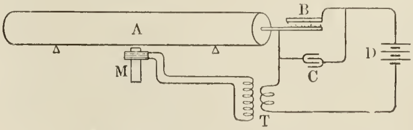

Fig. 12.—Microphone Hummer for 2,000 ∽ per second.

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[*] Used by Nernst and others.

[†] An "Electric Trumpet" supplied by the General Electric Co.

[‡] See E. H. Rayner, *Proc.* Inst. Elec. Eng. p. 625., Vol. XXXIV., 1905.

[*] For earlier microphone hummers see the following: R. Appleyard, *Elec. Review*, pp. 57 and 656, Vol. XXVI., 1890; J. E. Taylor, Inst. of Elec. Eng., p. 396, Vol. XXXI., 1901; and F. Dolezalek, *Zeitschr. für Instrumentenkunde*, p. 240, August, 1903.

testing current is taken from another secondary winding of T. A mild-steel rod 2·5 cm. in diameter and 23·7 cm. long gives 2,000 ∽ per second. By using a shorter rod a frequency of 3,000 to 4,000 can be attained.

When the telephone is silent $K/S = R_1/R_2 = X$ divided by insulation resistance of K.

In Fig. 13 is shown the variation of capacity with temperature for a sample of air dry cellulose, suddenly heated and allowed to cool slowly.

From the values of the shunt X required to give a balance, the values of the insulation resistivity of K at the various temperatures can be obtained. Measurements made with the high frequency ($n = 2{,}000$ ∽ per second) at room temperatures gave values of the resistivity about 10 times smaller than the apparent resistivity shown by the steady deflection method (as in Fig. 10); the variation with temperature was also much less with the high frequency alternating current. It may be mentioned that in the direct deflection test the immediate deflection fell off 10 to 15 per cent. after one minute's electrification. In telephone work the frequencies are high, and therefore it is the lower values of the resistivity that would occur when leakage due to moisture happens.

The matter, however, seems to want further investigation.

It will be seen from Fig. 13 that when air-dry cellulose is quickly heated the specific inductive capacity increases very considerably. If the raised temperature is maintained and the moisture allowed to escape, the capacity gradually falls to a value dependent on the temperature. Since the material is not porous in the same sense that paper is, the mechanical theory based on the tubular nature of the fibres is thus excluded. The observed facts seem to indicate that a part of the moisture is chemically combined with the cellulose, the whole forming an electrolytic solution (possibly of water in cellulose hydrate). When the temperature is raised, partial *dissociation* appears to occur and, with continued steady temperature, dissociation equilibrium is attained. High specific inductive capacity and low resistivity would thus correspond to the presence of a relatively large amount of dissociated moisture present throughout the material.

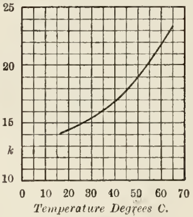

FIG. 13.—AIR-DRY CELLULOSE. SP. INDUCTIVE CAPACITY.

Dielectric Strength of Solid Cellulose.—A number of sheets of cellulose from 0·06 mm. to 0·3 mm. thick, were tested for breakdown voltage, both air-dry and oven-dried specimens being tried. The apparent dielectric strength (*i.e.*, $V_{\text{max.}}$ divided by thickness in centimetres) varied with the thickness of the sheet; for air-dry cellulose it was of the order of 250,000 volts per centimetre, and for oven-dried material 500,000 volts per centimetre.

Cellulose Acetate.—As cellulose acetate is coming into common use as an insulating material for covering thin wires, its electrical properties are of practical interest. It was therefore thought desirable to make a few tests upon it with a view to comparing its properties with those of cellulose. The acetate is soluble in chloroform, and by pouring the solution on to a glass plate a smooth and tough film may be obtained. Two specimens were tested, namely :—

(*a*) Normal tri-acetate (kindly supplied by Mr. C. F. Cross).

(*b*) A sample from a German source, said to contain both tri- and tetra-acetate; it was found to contain also a small amount of sulphur in combination, probably SO_4H residue. By more recent methods of acetylation these products are more economically obtained; the acetylising mixtures contain sulphuric acid, and a proportion of SO_4H residues is fixed together with the acetyl.

Sample (*a*) when air dry gave a specific inductive capacity of about 4·7; when oven dried the value was about 3·9. The variation with temperature was scarcely perceptible, being of the order of 1 per cent. for 40°C. Sample (*b*) gave less consistent and somewhat higher values.

The resistivities were also determined approximately, the result at 200 volts with one minute's electrification being given in Table V.

General Remarks.—On comparing the temperature capacity curves for the cable and the dry cellulose sheet, it will be found that the rate of variation of capacity with temperature is about 50 per cent. greater in the cable than in the sheet; this indicates, probably, that the paper of the cable was not dried to such an extreme extent as the cellulose sheet. The air-dry cellulose, on the other hand, has a very much larger k to start with and this increases very rapidly with temperature (if the moisture be kept from escaping).

Table V.

Material.	Condition.	Temp.	Resistivity.
		°C.	Mega-megohm-cm.
Cellulose acetate (*a*)....	Air dry	16·5	200
,, ,, ...	Oven dried	26 0	Over 9,000
Cellulose acetate (*b*)....	Air dry	26·0	13
,, ,, ...	Oven dried	26·0	121

With regard to the resistivities, the curves of Figs. 4, 9 and 10 have been brought together in Fig. 14 (by altering the scales) so as nearly to coincide at 40°C. It will be noticed that between 30°C. and 40°C. the cable shows the least, and the air-dry cellulose the greatest variation with temperature. This is probably due to the fact that in the cable the moisture can partially escape into the air spaces. It is curious to find, for the dried cellulose, that while the capacity does not alter much with temperature, the insulation alters enormously. This leads to the inference that in spite of the extreme drying (to brittleness) the alterations with temperature are still due to dissociation of combined moisture. The amount of this moisture may be very infinitesimal when we remember that the drying raises the resistivity 300 million times. With regard to the cellulose acetate, even in its air-dry condition it is a good insulator. Its specific inductive capacity also is lower than that of cellulose. It is evident, therefore, that it is far less susceptible to the effects of moisture than either paper or solid cellulose.

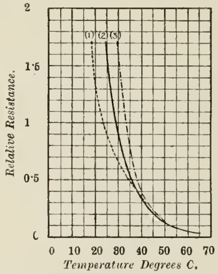

FIG. 14.—(1) CABLE, (2) OVEN-DRIED CELLULOSE, (3) AIR-DRY CELLULOSE.

In conclusion, I must express my hearty thanks to all who have aided me in the above investigation; to Dr. Glazebrook for constant and valued advice and help; to Mr. Gavey and his colleagues, Mr. H. Hartnell and Mr. A. G. Lee, for all the data in Part II., some of which were obtained expressly for this Paper; to Mr. C. F. Cross for all the material used in the cellulose tests and for kind advice; to Signor E. Jona for valuable information; and to Dr. W. A. Caspari and Mr. W. Gemmell for help in connection with the chemical part of the subject.

THE VALUE AND EFFECT OF HIGH-EFFICIENCY INCANDESCENT LAMPS.*

BY F. W. WILLCOX.

(*Concluded from page 789.*)

Advantages of a Lamp-hour and Candle-hour Rate.—There is clearly an advantage in supplementing the pure kilowatt-hour meter rate by a charge per lamp in some form or other. The merits and demerits of this as a general proposition I will leave to be decided by experts on rate questions, but it is patent that a central station cannot reap the full benefits of any improvement in lamp efficiency unless charges in some way are made to include the lamp or candle-hour value. The new high-efficiency lamp enables us to produce a given amount of light more cheaply, as already indicated, but it theoretically increases the cost for a given amount of kilowatt-hours. As a result, the benefit apparently all goes to the consumer, with little or no return to the lighting company, if we exclude the stimulating effect upon business.

It is clear that the kilowatt-hour cost basis is not a fair one for lamp renewal costs. This is true because it is inevitable that with the decrease in total wattage of lamps the renewal costs per kilowatt-hour should increase in the same proportion. For example, a 16 c.p. lamp of 1 w.p.c. or 16 watts total would, at the same price per lamp, cost three times as much per kilowatt-hour as the present lamp.

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* Abstract of a Paper read before the National Electric Light Association at New Jersey in June.

To keep renewal costs per kilowatt-hour unchanged would require the costs of higher efficiency lamps to be diminished in the same ratio as the efficiency is increased. This cannot logically be expected, as improved lamps will tend to cost more rather than less. It would be correct practice, therefore, to drop the kilowatt-hour as a basis for lamp renewal costs and take the cost per candle or equivalent light.

The Standard for the New Lamp.—A careful study of the question shows that the minimum disturbance to central-station operating results, renewal costs, and particularly to the company's income, is given by a lamp of 25 per cent. increased candle-power —*i.e.*, the new 20 c.p. 50 watt lamp. It has been decided, therefore, to standardise on this lamp, and to make the new standard lamp (to replace the present 16 c.p. 3·1 w.p.c lamp) a 20 c.p. 2·5 w.p.c. lamp with the same total wattage of 50 watts, and not a 16 c.p. 40 watt lamp.

The same reasoning would indicate that in the case of the tantalum lamp a 25 c.p. 50 watt lamp would be advisable.

There are, moreover, other good reasons for this course. A higher candle-power incandescent lamp is needed to cope with competition of the Welsbach gas light, whose candle-power value is high. Many consumers, particularly the desirable consumers, will spend a given amount of money for light in any event, and it is rational to anticipate this fact by giving them the increase in the candle-power of the lamp, instead of necessitating an increase of installation to accommodate more lamps of the present candle-power.

This plan follows the practice adopted by gas companies at the time of the introduction of the Welsbach lamps, where the improvement in efficiency is given in a very large measure in increased candle-power, which practice has proved so satisfactory to the gas business. Moreover, it gives the central-station company the same output per consumer as at present given, thus avoiding the necessity of having to increase the number of consumers or the number of lamps connected per consumer, which would necessitate a possible increase in distributing expense. The lamp-renewal cost per kilowatt-hour is kept down. The new 20 c.p. 50 watt lamp, comparable in life with the present 16 c.p. 3 1 w.p.c. gives a derived unit (by lowering the voltage 4 per cent.) of 16 c.p. 45 watts total with 1,000 hours' life—a comparable lamp to the present 16 c.p. 3·5 w.p.c. lamp—thus providing the new lamp for conditions requiring such lamp life.

The proposed plan does not contemplate dispensing with lower candle powers and wattages. There will be smaller units—30 watts, 20 watts—and other sizes made with the new "G.E.M." filament. The tendency will be, however, to go above and below the present 16 c.p. standard.

The Policy for Lamp Renewals with Higher-efficiency Lamps.—The control of lamp renewals by central-station companies is shown by both practice and theory to be a necessary condition for securing and insuring the best lighting results. The cost of lighting, of which the lamp renewal is a part, can unquestionably be made less to consumers when the central station purchases and supplies the lamp. This is so because the central-station company purchases intelligently where the average consumer purchases unintelligently, generally choosing a poor-quality long-life low-efficiency lamp and paying therefor the highest retail price.

Experience shows that central stations must supply the lamps to insure the use of lamps of the maximum efficiency and provide lighting service at the minimum cost to consumers. In practice we find that where the consumer is left to purchase his lamp, the first cost and life of the lamp becomes of greater importance than the efficiency of lamp and consequent cost of light. In proof of this we note that there are to-day no 3·1 w.p.c. lamps used on central-station circuits in this country except where the companies furnish renewals. It is well known that where the practice prevails of making the consumer buy his own lamp, as in Europe, lamps of only the lowest efficiencies are used—namely, 4 and 5 watts per candle, and that there is little demand for any higher efficiencies or inducements held out to the lamp manufacturers to supply such. We may conclude, therefore, that the new 2·5 w.p.c. lamp at full efficiency would not be adopted by the average consumer were he left to purchase his own lamp renewals.

To secure the introduction and use of higher efficiency lamps it is necessary for central-station companies to furnish renewals. If central-station companies agree that it is very desirable to have the new lamp of the same total wattage as the present lamp in order that income may not be impared, then it becomes necessary for the lighting company to furnish renewals of this lamp to their consumers to secure its adoption. Otherwise, consumers will purchase the lamp in higher voltages with reduced wattages per lamp and longer life, resulting in impairment of income by the differences in the wattage of the lamps.

This seems to me a strong argument for as full control of the new lamps as is now the case with the present lamps; that is a free renewal supply. In any event, central stations should supply the new lamps to their customers at as low a cost as possible to replace the present carbon-filament lamp on some one of the following plans:

First.—Where the rates are fair or well maintained with some available margin, the additional costs of renewals, which, as shown herein, are very slight, can be absorbed in the present rates and the new lamps supplied free on the same basis as the present lamps.

Second.—Where rates are very low with no margin available, the rates can be increased by the small margin necessary to cover the slightly increased cost of lamp renewals. On rate systems which charge by lamp-hour, lamp-month or lamp-year, this increase can be readily made. On regular watt-meter systems it can be effected by a slight increase in the kilowatt-hour rate. With the introduction of a higher-efficiency lamp, such an increase in rates is logical and justifiable, as the customer is returned many times the value of the small increase in charge.

Third.—Where rates cannot be increased by reason of laws in force and otherwise, or where rates are low, with no margin available for this additional renewal expense, it would appear to be necessary to charge customers an additional sum per lamp, represented by the difference between the cost of the new lamp and the present lamp.

Renewals with the Tantalum Lamp.—For lamps like the tantalum, costing materially more than the present lamp, the second or third plans may be adopted instead of the first, thus providing consumers with the lamps at the minimum cost by charging only the additional cost therefor. Assuming a price for the tantalum lamp of 75 cents retail, 60 cents to central stations now buying at 16 cents, and with a lamp life of 800 hours on direct current, the renewal cost will be 1·5 cents per kilowatt-hour, which is 0 86 cent more than present 3·1 w.p.c. lamp-renewal costs. An increase of 1 cent per kilowatt-hour in rates would, therefore, fully cover the increased cost to the central station and give consumer 60 per cent. more light for only a 10 per cent. increase in cost at a rate of 10 cents per kilowatt-hour.

Or consumers can be supplied with renewals of tantalum lamps at the increased cost over present lamps. As compared to present 3 1 w.p.c. lamps at 16 cents—the life of which (500 hours) is five-eighths that of the tantalum (cost 60 cents)—we find the relative cost of the tantalum lamp to be 60 times five-eighths, or 37·5 cents. Deducting cost of present lamp (16 cents), gives 21·5 cents, or, in round figures, 25 cents more for the tantalum lamp. This is about the price of a Welsbach mantle. Electric companies could therefore meet Welsbach competition with the tantalum lamp by supplying renewals at the same price as Welsbach mantles—without increasing renewal costs over free renewals with present 3·1 w.p.c. lamps.

The Effects in the Analagous Case of the Welsbach Lamp.—The general effects of the introduction of high efficiency lamps can perhaps best be determined by referring to the results of an analagous case in the gas business. We all well remember what consternation was caused among gas companies by the advent of the Welsbach mantle gas lamp several years ago. The improvement produced by this lamp was a much greater one relative to the old gas burner than that of the new lamps in comparison with the present lamps. It was feared generally among gas companies that the Welsbach lamp would bankrupt them, and the majority of gas companies looked upon this lamp with such great disfavour that for a long time they would not undertake to supply them to their customers How different the actual results were from those expected we all well know, as the present development of gas lighting attests. Far from being detrimental to the gas business it was its salvation and gave it a new lease of life in the lighting field, proving substantially the benefit to a lighting company of benefiting the consumer.

General Conclusion.—Why should not electric lighting companies derive similar benefits from the introduction of higher-efficiency incandescent lamps? It would appear illogical to expect otherwise, or that any improvement in efficiency of the electric lamp would not yield central stations as desirable and proportionately as full returns as those obtained in the gas business.

The demand for more light is insistent, and its use appears to increase with every improvement in lighting devices. The electric lighting industry has suffered from the want of higher-efficiency lamps, its growth has been retarded, its possibilities curtailed.

Now with the advent of incandescent lamps giving improvements of 20 and 30 per cent. and the promise of still greater gains, the restrictions of the past will be gradually removed and the industry is sure to expand and develop to the full measure of the opportunity the improvements afford.

There should be no question on this point, or of the wisdom of supplying consumers electric light at the lowest possible cost, by the employment of high-efficiency lamps and the adoption of a profitable low-rate system of charges—thus giving electric lighting a free rein, and enabling it to distance its competitors and maintain that supremacy which it rightly should hold in the lighting field.

These considerations should prompt each and every central-station manager to enthusiastically welcome and promptly utilise the new improved lamp, and give the benefit to his consuming public from whom his company's business is derived and upon whom its stability and success depends.

The Paper concludes with an appendix giving the cost of producing a kilowatt-hour with different lamp efficiencies for the same number of lamps supplied, the figures being similar in form to those in the table which is reproduced.

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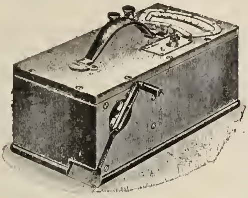

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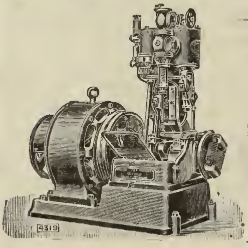

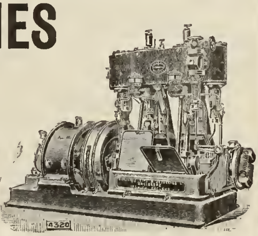

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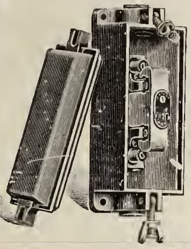

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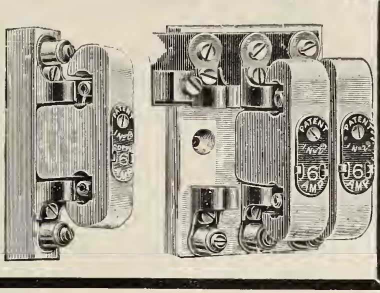

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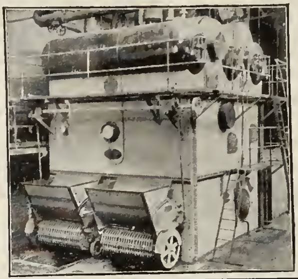

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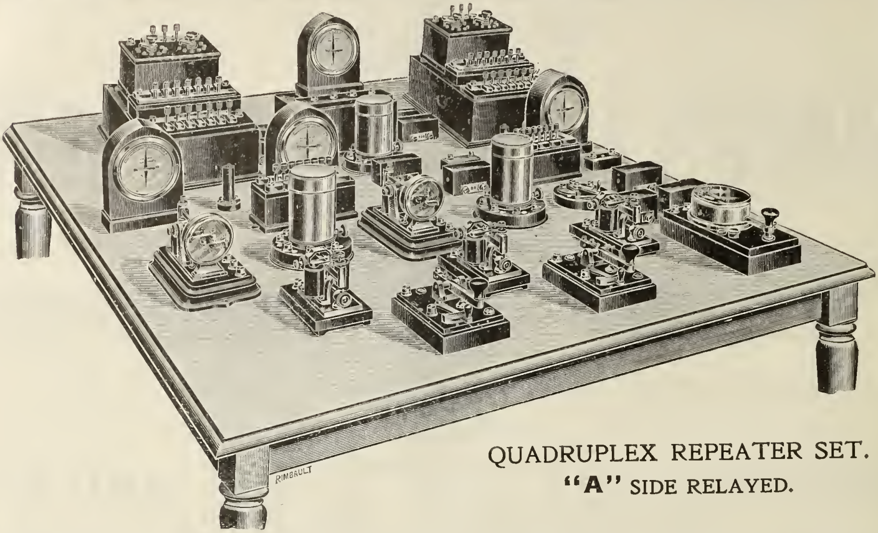

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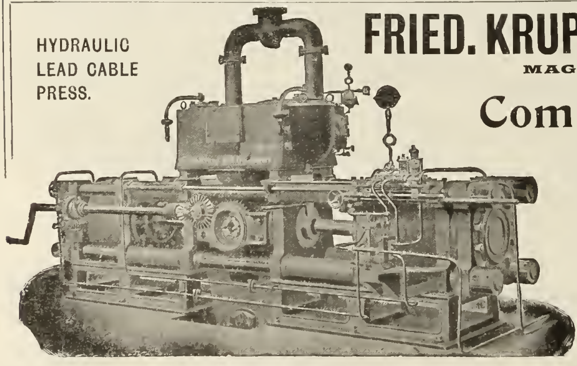

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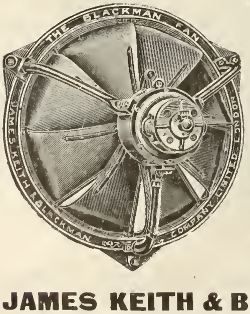
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It is unlikely, for instance, that the domestic cook ever thought the process of beating an egg with a fork was unnecessarily laborious until the egg beater made its appearance. We are accustomed to a thing being done in a particular way, and it does not occur to us why it should be done otherwise; or in fact that there is any particular inconvenience in the method used, until someone of an inventive turn of mind points it out. The inventor must therefore divest himself of the habit of taking things for granted, which is often difficult in a subject with which one is familiar, and it is no doubt for this reason that many important inventions have been made by persons who are not engaged in the particular industries to which the inventions relate.

Having discovered a true want, the inventive idea may follow more or less easily, and then, according to the popular idea, the invention is complete. Not a few inventors share this opinion, and having evolved an idea they rush off to the Patent Office and file a provisional specification. But the idea is by no means all that is necessary, and if only this fact were recognised there would be fewer inventors, and fewer of those patent specifications which are the delight of the infringer and a source of annoyance to the holder of a successful invention.

After the evolution of the idea there are three stages, which may be termed the laboratory stage, the stage of commercial proof, and the stage of finance. The first should be necessary to assure the inventor that the invention is what he believes it to be, but unfortunately many inventors consider this stage as quite superfluous. The second is necessary to convince others—a much more difficult matter—and along with this, or following after it, is the stage of obtaining the necessary financial support for the working of the invention. It is this third stage that very few inventions survive. In America it may be comparatively easy to get new ideas taken up; but in this country it is difficult to convince people so far that they are willing to give financial support to a new invention. And in addition to this difficulty there may be strong opposition from interests with which there would be competition. The financial stage is therefore one that should be avoided at all costs as far as possible. The inventor of mechanical appliances may be happy in his lot because such appliances may be manufactured under royalty by some firm that is already well established. But the inventor of such a thing as a process generally remains a poor man, because most of the time during which the patent is valid is occupied in inducing the financier to believe that the invention is of value.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Practical Telephone Handbook and Guide to the Telephonic Exchange. By JOSEPH POOLE. Third edition: Entirely Re-written and Greatly Enlarged. (London: Whittaker & Co.) 1906. 6s.

Mr. Poole's handbook has developed into a text book and technical work on telephony, and it is undoubtedly the most complete work on the subject published in this country. In order that the reader may not be prejudiced against the book from the outset, however, we warn him to begin at p. 48, or better still at p. 63, for the knowledge of electricity and magnetism which the author attempts to give the student in the first part of the book will be acquired far better from any one of the recognised text books on the subject. There is no need to commence a technical book on telephony with an explanation of the "two kinds of electricity" and a definition of potential as the amount of work which a charge of electricity is capable of doing in combining with its opposite kind and so becoming neutralised. If some elementary theory is necessary at the outset, the author should rather have explained in the proper place why in the Bell magneto-transmitter a sheet of iron, vibrating in front of a magnet with a coil in it, induces currents in the coil, and why a permanent magnet instead of a core of soft iron is used in a telephone receiver. Both these points are dealt with, it is true, but the former is hidden away in the chapter on "History," and the latter has been added as an afterthought after all the receivers in general use have been fully described. Such errors in arrangement, and the careless statement on the last page of the Appendix that 1 H.P. = 746 watts per minute, prove that the author's *métier* is not that of a text-book writer, although he is an engineer possessing a really sound knowledge of his subject. We will pass on to those parts of the book which possess merit, and commence, as we have recommended the reader to do, at p. 63.

In the two chapters (IV. and V.) on "Receivers in General Use" and "Transmitters in Practical Use" the most useful patterns of receivers and transmitters are clearly described, but the Gower, Collier and Mercadier receivers, and "button" and "pencil" transmitters hardly come under these headings, although they are certainly worthy of mention in a book on telephony. This portion of the book, however, is not a mere catalogue of instruments; the descriptions are really descriptive and of technical interest. For instance, in the case of receivers, the methods of preventing differences of temperature from affecting the size of the air-gap are compared, and the arrangement of a cap at the end of the receiver case to protect the cord near the terminals is shown and recommended; while, in the chapter on transmitters, dimensions and detailed data concerning the "solid back" and "Ericsson" are given, and there are some useful pages on transmitter testing. Bells, magnetos, switch hooks and lightning arresters are adequately described in chapter VI., and then follow the principal connections used in subscribers' sets. The diagrams and illustrations of instruments are well chosen, both in this chapter and others, but here and there in the book a proper sense of proportion has not been shown in selecting the size of the illustrations, and the diagrams do not all show the finish and sharp lines which we like to see in the figures of a technical book of this character. Needless to say, we except from this criticism the dozen blocks which have been reproduced (with permission and acknowledgment) from articles which have appeared in *The Electrician* during the last few years.

Readers will welcome the chapter on extension instruments, for the improper use of these is one of the chief sources of trouble between the telephone subscriber and his correspondents; we trust that in succeeding editions the author will treat this subject more fully, and will amplify it also in connection with the following chapter on intercommunication telephones, which is far too short.

Chapters X. to XXII. are on exchange equipment. They start with good descriptions of indicators, jacks, plugs, cords and keys. In some cases, it is true, as for instance with the jack, the reader is left in ignorance of the precise function of the particular appliance until he comes to the diagrams of the circuits several pages later, but such lapses are almost inseparable in a book of this nature if it lays any claim to completeness. The switchboard practice and general exchange equipment described in these chapters are those adopted by the National Telephone Co., and the writer comes straight to the point without too much history. In addition to the circuits and the apparatus itself, the mechanical construction of the switchboards is also dealt with, but the latest models are not treated exhaustively. When writing on junction and trunk-line working, Mr. Poole, we are glad to see, retains the English nomenclature, and he is liberal with diagrams to make clear the somewhat complicated connections of the common battery junction circuits. The chapter on party lines is not long, but is probably adequate, in view of the limited use of this method of working in Great Britain. Distributing frames, meters, relay, repeater and condenser racks all receive attention, and a comparatively long chapter is devoted to power plant. In this the author makes a similar mistake to that made in the commencement of the book. He endeavours to include in a few pages a small elementary treatise on the dynamo and motor, instead of assuming that the reader already possesses sufficient knowledge from ordinary text books to enable him to proceed at once to the particular methods of applying these machines in telephone exchanges. The chapter would be made much more useful by omitting the more general information and letting detailed particulars occupy its place.

The chapter on traffic statistics, which follows those on exchanges, not only tells how to obtain statistics relating to the working of exchanges, but also gives some typical figures of considerable interest and value. Forty-four pages are devoted to "Aerial Line Construction," in which we are glad to see that roof work is dealt with as thoroughly as pole-line construction. The succeeding chapter on underground work contains a section on submarine cables which would have been more complete if descriptions of the recent German telephone cables had been included. The remaining chapters are on "loaded" telephone lines, testing, and miscellaneous applications of the telephone.

Mr. Poole has, on the whole, done his work of revision well, and his Practical Telephone Handbook may be recommended without hesitation, both to those who are studying telephony, and as a book of reference to engineers already engaged in the telephone industry.

Analyse des Métaux par Electrolyse. By A. Hollard and L. Bertiaux. 1906. (Paris: H. Dunod and E. Pinat.) 5fr.

This book commences with a description of the electrodes used in electrochemical analysis. Basin electrodes are first described and then the cylindrical electrodes of Riche and Luchow, which we beg leave to believe are now very rarely employed. Naturally, Hollard's own electrode, which is a cylindrical one of platinum gauze, is the one most recommended. Some reference to rotating electrodes might, we think, have been included, seeing that within the last three years they have been very much used and written about.

Chapter II. deals with the current density which may be employed in electrolytical analysis. In Chapter III. the tension of polarisation is discussed, and methods are given for raising the decomposition value of hydrogen and the repression of the oxidising action at the anode by the introduction of reducing agents such as sulphur dioxide. There is also a description of Hollard's method for electrolysing with two liquids, the kathode being placed in the solution of the metal to be deposited and the anode in an indifferent solution, such as magnesium sulphate. Chapter VI. treats of the distribution and generation of the current; we think the authors might have got a draughtsman to draw the diagram here given.

In Chapter II. of the second part the actual analytical part of the book commences. Metals which cannot be deposited from acid solutions are first treated of, commencing with manganese, zinc, iron, nickel, &c. The directions given are lucid and adequate. We do not, however, invariably agree with the methods which are recommended; but it will always be found that different authors prefer different methods, so we can hardly carp at the authors giving the methods which they themselves prefer. The rest of the book is devoted to the separations and analysis of commercial metals, such as brass, lead sheet, &c. This last part of the book contains much which is interesting and suggestive, and we welcome this the latest book on electrochemical analysis.

Les Enroulements Modernes des Dynamos à Courant Continu. By A. Meynier and H. Nobiron. (Paris: Ch. Béranger.)

It is, of course, impossible to deal at all exhaustively with the comprehensive subject of continuous-current windings in a book of only 50 pages, but by concise writing MM. Meynier and Nobiron have been able to compress a good deal of matter into this space.

After enumerating and explaining the various kinds of continuous-current windings and armatures, the authors quote the winding formulæ elaborated by Prof. Arnold, illustrating the application of this winding theory by a number of simple examples. The first and theoretical part of the book concludes with a brief exposition of equalising connections. In the second part of the book the mechanical construction and design of the armature core, teeth and formers are dealt with at some length. In view of the total absence of novel matter or useful figures or data culled from practice, the book is not likely to appeal to experienced dynamo designers, but it may be recommended to students as a clearly written and well illustrated first guide to the art of dynamo design.

ADVANTAGES AND DISADVANTAGES OF DIFFERENT SYSTEMS OF TRAMWAY BRAKES.*

REPORT BY M. SCHOLTES.

The question of brakes has not been considered at our general meetings since the year 1900, but in accordance with a resolution adopted at Vienna in 1904 at the time of the Congress of the Union Internationale de Tramways et de Chemins de Fer d'Intérêt Local this question was put on the programme for the present general meeting. This Association had, in fact, decided at the time of the congress at Vienna to defer the adoption of the resolutions which had been presented, so as to allow of a more thorough study of the subject to be made with the German Association.

The reports presented to the general meetings of the German Association (Wiesbaden, 1900, and Stuttgart, 1901), as well as the reports presented to the Union Internationale (London, 1900, and Vienna, 1904), considered in a thorough manner the advantages and disadvantages of the different systems of brakes. An important gap, however, was evident through the almost complete neglect of one of the most important factors of the question—viz., the expenses of first cost and of maintenance. It was impossible to deal with this factor on account of the short experience so far obtained by the undertakings which had replied to the questions. In the present report I will endeavour more particularly to clear up the question of costs.

There is no doubt that all undertakings, when they have decided to have one or another of a system of brakes, consider as the most important factor their certainty of action. The factor of expense only takes second place; nevertheless, this should not be neglected.

The reports which have been presented hitherto are unanimous in recognising that the use of a simple hand brake is not always enough, and that it was necessary to equip the cars also with a mechanical brake. The opinions put forward on this point differ only as to the system of mechanical brake to be used, whether preference should be given to an electric brake or to an air brake. This question was difficult to decide so long as the factor of expense was neglected, but experience running over a number of years now allows this point to be cleared up.

The report which I present to-day relies upon the replies furnished by 95 undertakings. At the time of the meeting of 1900, 63 undertakings only had replied to the questions.

First of all it should be remarked that all the replies have not been taken into account. Certain undertakings, for example, include a hand brake in the category of mechanical brakes; others mention the use of the electric brake as a brake for service use, but at the same time remarking that the electric brake was reserved for emergencies! Confusions and contradictions of this kind make the report more difficult and do not permit a separate study to be made of the different systems of brakes.

Along with undertakings using the air brake, we can only compare, in my opinion, those undertakings which employ electric brakes on the whole or a portion of their cars, for service use, and not merely as an emergency brake, whether it be a short-circuiting brake or an electromagnetic one.

In the great majority of cases the mechanical brakes form part of the first equipment of the cars. In 14 cases, however, mechanical brakes were required by the authorities, usually in accordance with the opinion of the undertaking concerned.

The replies given by the overhead railway, between Barmen and Elberfeld, and the light railways of Mansfeld and Dusseldorf-Crefeld and of the Metropolitan of Berlin have not been taken into consideration, as these undertakings cannot be considered as tramways.

In a general way it appears from the replies which have been given that no undertaking mentions any system of brakes as not having given satisfaction. With few exceptions all the undertakings state that they wish to retain the system of brake in use in the event of extension.

In proceeding to a critical study of the different systems of brakes, it seems to me useful to mention the number of undertakings using one or other of these. This classification is indicated in the following table :—

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* M. Scholtes, Director of the Nüremberg-Fürth Tramways, and M. Bjorkegren, chief engineer of the Grande Compagnie des Tramways of Berlin, were appointed by the Union Internationale de Tramways et de Chemins de Fer d'Intérêt Local to draw up a report on a series of questions submitted to a number of different tramway undertakings, chiefly on the Continent. M. Scholtes and M. Bjorkegren were not able to agree sufficiently well to present a joint report, and therefore separate reports were presented at a meeting in September last at Frankfort. These reports have now been published in the "Réponses aux Questionnaires," which has recently been issued by the Society preparatory to the meeting to be held this month at Milan. We reproduce translations of them here in full.

System of brakes.	Number of cars classified according to their tare in French tons.									No. of cars.		No. of under-takings.	
	5–6	6–7	7–8	8–9	9–10	10-11	11-12	12-13	13-16	Total	%	Total	%
Hand ...	201	431	812	296	520	4	3	47	7	2,316	31	46	49
Electric	7	360	773	1,510	626	103	103	181	10	3,673	49	45	47
Air ..	21	286	270	175	313	24	422	1	..	1,512	20	4	4
										7,501	100	95	100

It follows from this table that the electric brake is that most used; then comes the hand brake, and lastly the air brake. The hand brake is more particularly used for cars of light weight and in the less important undertakings, which appears to be a natural result. These undertakings mention that the hand brake is sufficient for their purpose, and that consequently they do not see any necessity for using a mechanical brake. In cases of emergency they use the electric brake. This method appears to be rational if it is well understood that the undertaking runs cars of only light weight, that the route is not too undulating, and that the cars do not run at too high speeds. It is necessary, however, in this case that the electrical equipment should be sufficiently overhauled so as to be certain of good working of the brake in case of danger. This inspection is naturally of great importance, for generally the emergency brake is only used occasionally.

When, as shown by the above table, the rolling stock includes cars of a tare greater than 12 tons, and when the route includes gradients up to 10 per cent., it is not so easy to understand the use of the hand brake. It is evident that in such a case the muscular effort on the part of the driver is too great, and that under certain circumstances the safety of working may depend upon the fatigue experienced by the driver.

Twenty undertakings assert in their replies that the electric braking throws too much work upon the motors, bringing about a rapid wear of the gearing, and that the resistances are subjected to great heating and are damaged, and that damage is also apparent in the controllers. These statements simply show, in my opinion, that the electric equipment of these undertakings is not suitable for electric braking. As against these cases might be mentioned undertakings which through judicious choice of the size of the different items of their equipment have not met the inconveniences just mentioned.

Some people state that the electric brake gives rise to shocks in braking. It is very probable, however, that this inconvenience is the result of bad graduation of the braking resistances, or even of bad handling of the brake, which latter will give rise to shocks in braking, whatever the system employed.

Eleven undertakings only have made trials of brakes. This small number is easily understood when it is remembered that experiments on brakes, if they are to give exact results, necessitate numerous precise measurements. In the trials carried out by these 11 undertakings the cars were braked electrically, and the results obtained approximate closely to those indicated in the report presented by M. Poetz to the meeting at Wiesbaden in 1900, and which were the result of a long series of exact trials. As a result of these trials it follows that the electric brake is the most powerful of all systems.

Apart from the higher first cost and the higher cost of maintenance, the air brake has several other disadvantages, such as failure to work in time of frost, a more frequent adjustment of the brake shoes and leakage of pipes. It appears that these disadvantages are felt more particularly when the air brake is first put in use. There is no doubt that the numerous mechanical parts of the air brake undergo rapid wear and necessitate, on account of their complication, superintendence by skilled men. The air pressure applies the shoes suddenly and forcibly to the tyres, and this produces rapid wear. It therefore follows that of all the systems the air brake is the most irksome.

Another important factor, which is not favourable to the air brake, and which must be taken into consideration, is the cost of compressing the air. The compression is effected exclusively by means of an eccentric, or by toothed gearing put in action by the motion of the car. This method, compared with that in which compressed air is supplied by a special motor, has the advantage that the energy of the car can be used in running on down grades, but it has the disadvantage that the source of energy cannot be controlled.

Although in the questions addressed to the members of the Association great importance was attached to the expenditure of energy required by the use of the air brake, this point has not been cleared up by means of tests of any value, except by the Grande Compagnie des Tramways de Berlin, the Grande Compagnie des Tramways de Leipzig and by the Tramways de Nüremberg-Fürth.

The additional energy required for the compression of the air is estimated in Berlin to amount to 40 watt-hours* for two-axle motor cars of a tare of 8 to 9 tons; 67·5 watt-hours for four-axle motor cars of a tare of 12 to 13 tons; in Leipzig 40 watt-hours for two-axle cars, tare 7 to 8 tons; and lastly, in Nuremberg, 31·5 watt-hours for four-axle cars, tare 11 to 12 tons. The lower value given by Nüremberg is due not only to the fact that the cars are less heavy but also because the route is less undulating than that of Berlin.

The additional energy required for the compression of the air in the case of those undertakings using air brakes is as follows :—

Undertakings.	Motor car kilometres (miles) run in 1904.		Annual cost of compressed air.		
			Kw.-hrs.	Marks	(Pounds).
Grande Société des Tramways de Berlin..	55,110,000	(34,168,200)	2,204,400	220,440	(£11,022)
Grande Société des Tramways de Leipzig	12,622,000	(7,825,640)	504,880	50,488	(£2,524)
Tramways de Hanovre	9,004,000	(5,582,480)	361,800	36,180	(£1,809)
Tramways de Munich	8,004,000	(4,962,480)	320,160	32,016	(£1,601)
Tramways de Nüremberg-Fürth	5,094,000	(3,159,280)	203,760	20,376	(£1,019)
Tramways de Crefeld..	2,265,000	(1,404,300)	90,600	9,060	(£453)

This table presupposes that in the undertakings mentioned the whole of the motor cars are equipped with air brakes, that the additional energy is the mean of the figures mentioned above—*i.e.*, 40 watt-hours, and lastly that the price per kilowatt-hour is 10pf. (1·2d.). This table takes no account of the use of trailers.

The following table gives some indication as to the first cost and the costs of maintenance of the different systems of brakes. The figures in this table are the mean of figures given by the different undertakings in reply to the questions :—

Systems of brake.	First cost.		Annual cost of maintenance.		
	Per motor car.	Per trailer.	Per car.	Pf. per c. km.	P'nce per c. mile.
	M. £ s.	M. £ s.	M. £ s.		
Hand brake ..	inc. in total	cost of car	87·80 (4 8)	0·21	0·04d.
Electric brake.	290 (14 10)	375 (18 15)	52·00 (2 12)	0·14	0·027d.
Air brake	120 (6 0)	190 (9 10)	206* (10 6)	0·33*	0·064d.

* To this figure must be added the cost of compressing the air—namely, 0·4pf. per motor car-kilometre = 0·077d. per motor car-mile.

As shown by this table, not only are the first costs of the electric brake much less than that of the air brake, but the costs of maintenance are much lower than those for the air brake or hand brake. This considerable difference in the cost of maintenance in favour of the electric brake is due to the fact that the wear of the brake shoes is reduced to a minimum, for, in electric braking, the hand brake is only used just for stopping when the car has already practically come to a standstill through electric braking

When general use is made of the electric brake, and not merely for emergencies, the equipment of the motor cars only requires, as an addition, the installation of a more elaborate controller, carrying with it more resistances. According to the replies received to the questions, this additional cost, on the average, is 290 M. (£14. 10s.) per motor car. On the other hand, the cost of installing electric brakes to trailers is heavier; it varies according to the system, but on the average it amounts to 375 M (£18 15s.) per trailer.

The replies to the question show that in the early years of electric traction the trailers were, in most cases, equipped with disc brakes, but in later years preference was given to the solenoid brake.

The figure of 1,200 M. (£60) given for the cost of installing the air brake is a mean of the cost of old and recent types for the different systems. In the case of old types the price was as high as 1,570 M. (£78. 10s.); for new types it is only 950 M. (£47. 10s.).

The first cost of the air brake on trailers is mentioned as 190m. (£9. 10s.). The information which has been given to us does not indicate whether, for this price, the brake acts automatically in the case of the coupling being severed.

The systems of air brakes mostly used are those of Böcker and the Standard Air Brake Co. These systems are used more particularly on all the carriages of the municipal tramways of Breslau, of the Grande Compagnie des Tramways de Leipzig and of the Munich tramways. The Grande Compagnie des Tramways de Berlin, the tramways of Crefeld and the tramways of Nuremberg only have a certain portion of their cars equipped with air brakes. The remainder of the cars are provided with electric brakes or hand brakes. The tramways at Hanover make use of the Carpenter-Schulz air brake.

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* From the form of the question and of the replies sent in it appears that these figures are per car-kilometre.—Ed. *E.*

The Grande Compagnie des Tramways de Leipzig mentions in its reply, when dealing with the comparative cost of maintenance of electric and air brakes, that account should be taken of the cost of the increased maintenance of armatures, bearings, brushes and gearing. This observation is well justified, but unfortunately the data do not allow this point to be cleared up. At Leipzig these expenses rose to 63 M. (£3. 3s.) per car per annum; at Nüremberg they are less.

The experience acquired during the last few years on the subject of different systems of brakes points to the same result, and appears to-day to be sufficient to enable one to reach a rational conclusion. The data which have been obtained by the questions confirm in addition my own view as to the matter, and I think, consequently, that the conclusions proposed at the meeting at Vienna can be maintained, viz.:—

(1) In the choice of a brake system all the particular circumstances of the service should be taken into account. The application of each of the three systems, hand brake, electric brake and air brake, should be carefully studied. Braking should take place without shocks. The equipment of the car should include two systems of brakes, completely independent of one another. The brake in general use should be such as not to cause fatigue to the driver.

(2) When, on account of the weight of the cars, on account of trailers, or on account of difficulties of the route, the hand brake cannot rationally be employed, a mechanical brake should be used, preferably an electric brake.

(3) If the use of an electric brake for general purposes necessitates certain inconveniences, such as, for example, the choice of too large a motor, or too much graduation in the starting resistances, in such a case it would be well to employ a compressed air brake. The use of the latter system would be a necessity in the case of the cars being heavy or running at a high speed, or in the event of trains including more than two trailers.

REPORT BY M. BJORKEGREN.

Before passing to the study of this question, I feel constrained to remark that the discussion of a subject of such importance ought, in my opinion, to be considered without previous convictions. No attention should be paid to economical or other considerations which might affect one or other of the undertakings in question. In other words, the question should be treated from the scientific point of view only.

The science of the modern engineer consists to-day not merely in the creation of a mechanism which is well thought out in all its details; the modern engineer must deal equally with the commercial side of the question—*i.e.*, he must be certain that the advantages of the machine which he creates are suitably proportioned to the different costs that follow on the application of his invention. This consideration is in itself to-day predominant in the purchase or refusal of a machine.

It is from this point of view equally that every director of a tramway must look at the question of brakes. He must put into the two pans of the balance, on the one side the safety of the service which requires a good system of brakes, and on the other the cost of installing and the cost of maintenance which follow on the adoption of the brake. Neither of these two points of view can be considered separately. Only a study of the two together can bring us to a rational conclusion. Nevertheless, the safety of the service must always be the predominating factor.

It appears to me that, in his report, M. Scholtes has given too great a prominence to the question of costs, and he has therefore arrived at conclusions with which I cannot altogether agree.

I agree entirely with the opinion of M. Scholtes in his criticism as to the use of the hand brake for general use. On lines not having trailers, where there are but slight gradients, and where the speeds are moderate—*i.e.*, on lines on which the conditions of running do not differ materially from a line worked by animal traction—the use of the hand brake only seems to me to be rational. A short-circuit brake, or even a reverse-current brake, is sufficient in case of emergency.

Equally I agree with what M. Scholtes says as to the use of the hand brake being insufficient in all other cases, and that it is necessary to adopt a mechanical brake, unless the hand brake on trailers is specially operated. The mechanical brake should be used as a service brake, particularly when a trailer is attached, so that the driver is always certain of its good working in emergencies. There is no doubt that in cases of danger a driver will make use of the brake with which he is accustomed to work more quickly and more rationally. Further, the good working of a mechanical brake which is not in general use is always uncertain, because it does not receive sufficient inspection.

When the mechanical brake is used for service work the hand brake should be used as a reserve. In that way it will act as a brake supplementary to an electric brake, and its good working will always be under inspection.

The mechanical brakes generally used fall into two classes—the air brake and the electric brake. To which class should preference be given? It was round this point that all the discussion took place at the Vienna Congress, and this is the most important factor to be elucidated by discussion to-day.

The communications which have reached me in reply to questions addressed by our Association are, unfortunately, very incomplete, more particularly in what concerns the principal points of our inquiry. Thus the mean of the figures given does not allow us to deduce incontrovertible conclusions. Not only so, but the replies to the questions are insufficient to enable me to say which system has the greatest or least value. The greater number of undertakings are only acquainted with one system. Moreover, an undertaking would feel it too great a responsibility to say that the system of brakes which it employs leaves anything to be desired.

I am, therefore, of the opinion that a critical comparison of the different systems has no value when it is based upon the number of brakes in use. It must not be forgotten that the question of brakes has only a relative interest for a number of the electric undertakings as far as first cost goes. It is on this account that I find myself forced to rely considerably upon the experience acquired by the Grande Compagnie des Tramways de Berlin as to different systems of brakes

Above all, a system should be considered from the point of view of the safety which it offers. If there are two systems showing the same safety, the one having the smaller first cost and the lower cost of working should be preferred. As to costs, a distinction should be drawn between first cost, cost of maintenance and cost of energy.

According to recent information, the electric equipment of a two-axle motor car with electric braking by short-circuiting necessitates a supplementary expenditure of about 300M. (£15), as compared with the same car supplied only with hand brakes. This first cost does not take into account the increased size of motor. On all our motor cars we employ two electromagnetic brakes, and also upon our two-axle cars equipped with two motors. The two-brake discs in the system used by us cost about 400M. (£20), which, therefore, brings the complete installation of an electric brake on our motor cars to 700M. (£35). The installing of the brake on trailers comes to about 425M. (£21. 5s.). These costs are the same, even when it is a question of four-axle cars, because it is generally sufficient to fix brake discs on two axles only. If discs were fixed on all four axles, the total additional charge would be 425M. (£21. 5s.).

On the other hand, the installation of an air brake having a compressor worked by an eccentric costs at the present time, for a two-axle motor car, about 1,000M. (£50) and for a trailer 200M. (£10). For a four-axle car the cost would be 1,050M. (£52. 10s.). It follows, therefore, that the mechanical brake equipment for a train made up, as in our service, of a four-axle motor car and a two-axle trailer costs 1,125M. (£56) for the electric brake and 1,200M. (£60) for the air brake.

The first cost of an air brake for a motor car and trailer is therefore, in the case of my company, only slightly greater than that of installing an electric brake. This difference would naturally be much greater if we decided not to put in electromagnetic brakes on our motor cars. To work an undertaking like ours in that way would, however, be undesirable, because we have the electric brake for service use; further, our motors are already worked to their limit. Too much work would, therefore, result for the motors if we proceeded to brake our motor cars by short circuiting.

When the air compressor, as in our undertaking, is worked by means of gearing, the first cost is increased by about 300M. (£15).

Summing up, therefore, it follows from what has been said that the first cost for the air brake is greater than for the electric. It is fair to add, however, that in ordering new cars this additional cost, which is not of great importance, would not be considered.

As regards the cost of maintenance, this should be the subject of most careful investigation. Unfortunately it is just on this point that the replies to the questions are most inadequate It was, in fact, only last year, at the Vienna Congress, that the tramway undertakings were asked to obtain statistics relating to the cost of maintenance of brakes. These statistics are not over a sufficiently long period to make the figures of any value. However that may be, in my opinion it will be absolutely necessary, if the question of brakes should be put in the programme of future meetings, that each undertaking should be particularly asked to commence, without delay, a special account of the expenses entailed by the maintenance of their brakes. In that case the reporter at the time of the next meeting would have figures of value at hand. In all undertakings this account should embrace the electric equipment of the cars It is evident that as soon as the electric motor is no longer used exclusively for the propulsion of the car, but for an opposite purpose, generating a certain amount of electric energy for braking, the cost of maintenance of the motor becomes greater, on account of electric braking, than it would be with air brakes. This difference, which is not in favour of electric braking, will naturally be less the greater the dimensions given to the motors and other parts of the equipment; but since, on the other hand, these dimensions must be restricted within certain limits on account of the increased weight and the lower efficiency which would result from increasing them, it follows that a difference will result to the disadvantage of the electric brake.

The books kept by the Grande Compagnie des Tramways de Berlin up to the present give the cost of maintenance as follows: For the electric brake, which in my undertaking is used at the same time as the hand brake, 70m. (£3. 10s.) per motor car, and 45M. (£2. 5s.) per trailer; air brake, 150M. (£7. 10s.) per motor car, and 25M. (£1. 5s.) per trailer. It should be mentioned, however, that the figures given above for the electric brake do not include any sum for the maintenance of motors, controllers and resistances. I feel certain that this part of the cost is relatively important, without, however, attaining the difference between the figures given above for the cost of maintenance of the electric brake and the air brake. Unfortunately, it is no longer possible for us to determine in our undertaking the proportion of these expenses since we often change the armatures of the motors, which naturally prevents us from keeping a special account for each motor. This would only be possible in the future, supposing that new cars or new equipment were put in service.

In my opinion solenoid brakes entail a less serious maintenance than disc brakes, notwithstanding that the brake blocks wear more rapidly. As to air brakes, the greater part of the cost of maintenance is due to replacement of the brake blocks.

In order to obtain some exact idea of the expense of maintaining air brakes, including the replacement of brake blocks (material and handling) and also lubrication of compressors, since 1904 we have handed over the maintenance of the brakes at one of our depots to the maker of the brakes, not retaining any control on our part. The workmen are paid by us and all necessary material is taken from our stores. We have thus been able to effect, by good organisation and periodical inspection, a considerable economy in renewals. In this way it is possible to remedy wear and tear as required, and often to avoid a car being put out of service.

The cost of maintenance of the air brake per car belonging to the rolling stock of the depot in question was as follows :—

	Marks.		Marks.		Marks.
October	15·60	February ..	17·90	May ..	14·20
November ..	15·50	March	21·40	June ..	12 60
December ..	17·80	April	14·00	July ..	13 50
January	17·20				

As will be seen the costs diminished slightly between October and July; but we do not think that the cost will become still less, for in our undertaking the cars are worked as hard as it is possible, and on several lines almost continuously. The motor cars run daily about 150 km. (94 miles). However that may be, it is certain that the cost of maintenance of air brakes is greater than that of electric brakes.

The third part of the subject under consideration refers to the additional cost of energy required by the air brake. In our reply to the questions we mentioned the numerous comparative tests which we had made on hand brakes, the electromagnetic disc brake and the air brake. The most exact results were obtained with our experimental car, which is provided with all necessary measuring instruments. We were able to determine that, in relation to the hand brake, the energy necessary for an average of two brakings per kilometre was 22 watt-hours for the Sperry brake, and 33·6 watt-hours (see last footnote) for the air brake. The difference between the air brake and the magnetic brake was, therefore, not very important. The additional energy required is naturally nothing if the short-circuit brake alone is used.

The Munich Tramways mention in their replies that under certain conditions their four-axle motor cars take less current when they are braked by the air brake than when the hand brake is used This fact is singular enough, and I do not know how to explain it, even if I concede that our tests, since they were conducted by engineers, gave results differing perhaps from the results which would have been furnished by ordinary running. I might, perhaps, explain the point by suggesting that a driver operating on a busy thoroughfare, such as the Leipzigerstrasse or Potsdamerstrasse, in Berlin, would be inclined, more particularly if the working of the hand brake were a little arduous, to bring his brake blocks prematurely near the tyres so as to be able to brake more rapidly in case of danger. We must admit, however, that in our undertaking we have never observed this to be the case.

Another point should not be omitted in comparing the electric brake with the air brake as a brake for service use—viz., the efficiency of the motors. There is no doubt that when the electric brake is used generally the motors must be more powerful than in the case of an air brake. It is therefore evident that, since every motor has its maximum efficiency for normal service, the motor when propelling the car will be working at a reduced efficiency. Naturally, this point has not been determined by tests, since the electric equipment of the car was the same during all the tests.

The table given by M. Scholtes on the subject of the cost of energy necessary for the operation of the car is certainly exact, but it is not permissible to conclude therefrom that the electric brake is superior, because the latter implies the use of a larger motor.

In conclusion, if we compare among themselves the total costs necessitated by the two systems when used as service brakes, there is no doubt that the use of the air brake is a more serious matter than that of the electric brake, not only from the point of view of first cost, but also from that of running. Also the electric brake is preferable to the air brake when cost is the only matter to be considered. But, as M. Scholtes himself recognises elsewhere, this consideration of cost is not the only one which enters into the question of superiority of either system; it is the greater or less security which should, above all, be considered.

As to the question of safety offered by the two systems of brakes, I would say that if the question is studied purely from the theoretical point of view, I should give preference to the air brake, because it acts instantaneously, and because inexperienced drivers can operate it without too great a shock. But the theoretical point of view alone should not predominate in deciding on the degree of safety. This should be decided in taking into account all the factors which are considered in statistics of collisions between vehicles; now these statistics show that from the point of view of collision the two systems are about equally good. This result arises, in my opinion, from the fact that drivers, knowing that they have at hand a brake which is certain to act, are inclined to pass dangerous points recklessly and too rapidly. Thus, if through some unforeseen circumstance—such, for example, as greasy rails—the brake does not produce its effect, or produces it but slightly, a collision becomes inevitable, whereas it would have been avoided if the driver had travelled more carefully and if he had braked in good time.

The electric brake, besides having the disadvantage of being dependent on the trolley line, has a further disadvantage—viz, that its action is not always immediate. This delay, even if it is but for a second, is enough to give the driver a feeling of want of confidence in his brake. Moreover, this feeling, coupled with other considerations of convenience—for example, the electric brake should always be combined with a hand brake—make the drivers on our undertaking prefer the air brake and request its general application.

The electric brake is, and in my opinion will remain, a brake requiring judgment—*i.e.*, the driver should himself feel how he should handle the brake for different speeds. The rational handling of the electric brake, therefore, requires certain dexterity on the part of the driver.

The length of braking necessary on the two systems is about the same, the air brake giving better results for lower speeds, the electric brake for higher speeds. The air brake is more agreeable in the sense that it is more gradual. It takes place less sharply than electric braking. The inexperienced driver manipulating a hand brake can also produce shocks, but this depends less upon the skill of the driver in the case of the air brake than with the electric brake.

The experience acquired by the Compagnie des Tramways de Berlin allows me to put forward the view that for undertakings working under conditions analogous to those in Berlin the two systems of brake have the same degree of safety. This follows, as mentioned above, from statistics that we obtained last April, and which show that collisions are equally numerous on both systems.

On the contrary, I think that for undertakings having long and severe gradients, and where blocks may be possible, the electric brake should not be recommended, for in those cases the danger of short-circuits in the brake equipment must be taken account of. The use of the air brake presents, in addition, for undertakings working under such conditions, the advantage of being able to make the braking automatic in the case of trailers if the coupling breaks.

When it is a question of undertakings running cars or trains consisting of heavy vehicles running at high speeds on suburban lines, it seems to me that, in this case also, air brakes should be preferred, for the small supplementary cost entailed gives greater safety as compensation. It should be remarked, further, that in such undertakings the other costs increase in such proportion that the cost of braking becomes insignificant.

To sum up, I think I may say, from the point of view of safety, that the air brake may be used in all kinds of undertakings. The electric brake, on the other hand, can only be applied in certain cases. I therefore think that I must slightly amend the conclusions put forward by M. Scholtes. The conclusions should be:—

1. In the choice of a system of brakes all the particular circumstances of the case should be considered. The application of each of the three systems—hand brake, electric brake and air brake—should be carefully studied. The brake for general use should allow of braking without shock and should not cause fatigue to the driver. It should, at the same time, be suitable for use in case of emergency and as such should work sufficiently rapidly and certainly. In addition to this brake for general use, the equipment of the car should include a second brake (an auxiliary brake).

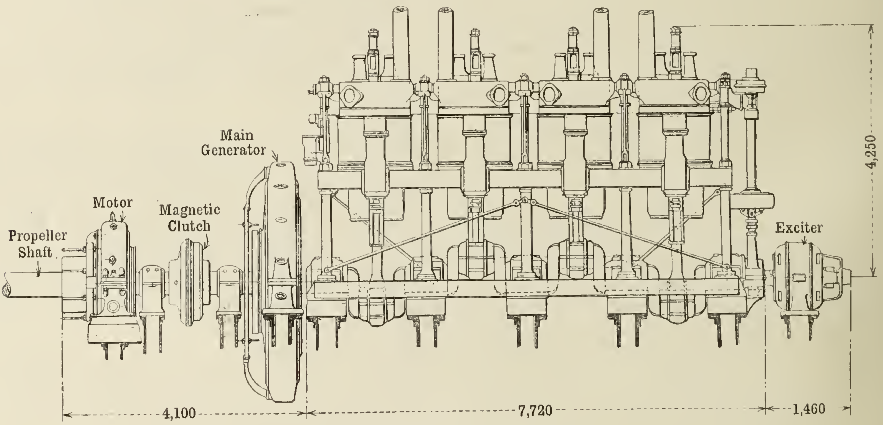
2. When, on account of the weight of the cars, the use of trailers, or on account of the route, the hand brake can no longer be rationally used as a service brake, a mechanical brake should be used, either an electric brake or an air brake,

THE DEL PROPOSTO SYSTEM OF ELECTRICAL TRANSMISSION GEAR FOR THE PROPULSION OF SHIPS BY IRREVERSIBLE ENGINES.

A Paper by M. C. Del Proposto, published in the *Bulletin* of the Société Belge d'Electriciens, describes an electrical method of power transmission which has been developed by the author in connection with the use of irreversible internal combustion engines for the propulsion of ships. The system is more particularly intended for application to Diesel engines, and the earlier part of the Paper enlarges upon the advantages which this type of engine possesses over steam or suction gas plants for marine use, provided that a satisfactory transmission gear can be devised for starting, reversing and running at reduced speed. Not only, for the same radius of action, is the weight of fuel reduced to about two-fifths of the amount required when it takes the form of coke or coal, but it can be stowed away in the more out-of-the-way portions of the ship, making a larger portion of the space that would otherwise be occupied by bunkers available for cargo. The space required by the boilers or gas producers is also saved and the services of the stokers are dispensed with. Again, the expenses in getting liquid fuel on board are nothing approaching those of coaling, and the cost of the crude oil which is used compares favourably in most parts of the world with that of coal required for the same distance run, being, of course, most markedly cheaper near the oil-producing districts.

Applications of electrical transmission for driving boats have been made at various times and in different countries. An example is found in the "Vandale," an oil tank boat of some 1,100 tons displacement, built by Nobel Bros., of St. Petersburg, in 1903, for service on the Volga and the Caspian Sea. The engine room of this boat contains three generating sets, each consisting of a three-cylinder Diesel engine running at 240 revs. per min., direct coupled to a continuous-current dynamo giving 87 kw. at 500 volts. These three dynamos supply current respectively to three motors of about 100 h.p. each, mounted on the three propeller shafts and situated in the after part of the boat. Thus each propeller motor can be controlled independently, and the three controllers are placed on the bridge. All regulation is done on the fields of the generators which are supplied by small exciter machines mounted at the opposite end of each engine shaft, the motors being always connected to the terminals of their respective dynamos. The pilot on the bridge thus directly controls the vessel himself instead of by means of orders conveyed to the staff in the engine room. Changes of speed and direction are promptly and smoothly effected, and in the case of a vessel with more than one propeller, it is easy to steer with accuracy without using the rudder by handling the controllers alone.

In a system such as that employed on the "Vandale," in which the transmission is entirely electrical, there are certain unavoidable losses which diminish the overall efficiency, and therefore increase both the size of engine required and the fuel consumption over that which would be required with a more direct method. It was mainly to obviate this disadvantage that M. Del Proposto's system was designed.



1,000 h.p. Diesel-Del Proposto Equipment.

The principal objections to the use of internal combustion engines for marine work have hitherto been the fact that engines of this type have not up to the present been commercially manufactured in sizes large enough for the propulsion of anything but small vessels, and also difficulties in reversing and speed regulation. The author, however, points out that the Augsburg Company have already constructed Diesel engines of 1,000 b.h.p., so that if three propellor shafts are used, each with its own engine, 3,000 b.h.p. is at once available; or with two such engines to each shaft, 6,000 b.h.p. could be obtained. This, although of course not sufficient for large liners or battleships, would suffice for cargo boats and other vessels of quite considerable size. These engines have four single-acting cylinders, each 700 mm. diameter and 1,770 mm. stroke, and run with a four-stroke cycle at 150 revs. per min. There is, however, every indication that engines of this type can be successfully constructed for considerably larger powers, and that the building of marine Diesel engines of large size will soon be carried on on a considerable scale.

The other objection of irreversibility and limited speed regulation is of more moment. For very small craft mechanical clutches and reversing gears have been used with success, but such methods are not practicable when dealing with the power required for the propulsion of vessels of any size, and recourse must be had to some form of electrical transmission.

The simplest form of this is the mounting of a dynamo on the engine shaft which is governed to run at constant speed, and using the current from this to drive an electromotor connected to the propeller shaft, some simple form of switch gear being all that is required to vary the speed and direction of motion.

In this arrangement a dynamo is mounted as before on the engine shaft, but the propeller shaft with its motor is brought right up to the engine room and can be coupled directly to the engine, when required, by a magnetic clutch. Thus at starting, and when running at reduced speed, or in the reverse direction, the clutch is free and the electrical transmission is used in an exactly similar way as in the system previously described. When, however, the vessel is travelling forward at its normal speed the clutch is put into engagement and the motor and dynamo simply run round unexcited and with their brushes raised. A separate exciter, mounted at the other end of the engine shaft, is used as before for supplying the current for the magnetic clutch. A mechanical clutch can, of course, be substituted for the magnetic clutch, but the amount of energy required for its working is so small compared to the whole output of the engine as to be negligible, and, in the author's opinion, magnetic clutches are preferable on account of their simplicity.

It is unnecessary to have either the dynamo or the motor of as large a size as in the system in which the transmission is permanently electrical, as they only work for short periods during starting and manœuvring, nor is the full power required when running at reduced speed for extended periods, as might be necessary in fogs when the electrical gear would be in action.

All control, as before, is effected from the bridge by means of a controller which closes the circuits in the proper order and cuts resistances in and out of the dynamo field circuit. A lamp connected across the terminals of the exciter indicates to the officer on the bridge whether the engine is running, and a centre zero voltmeter connected to the propeller motor terminals serves to indicate the speed and direction of motion of the propeller shaft while the electrical gear is in action. An electromagnetic device actuated by the controller lifts the brushes of both dynamo and motor after the clutch is engaged and the excitation is switched off.

Arrangements can be made in vessels with two engines and propeller shafts for one dynamo to supply both motors, so that in event of one engine breaking down the vessel can still proceed at reduced speed, using both propellers. An example of the Del Proposto system on a small scale is found in the equipment of a boat named the "Venoge," in use on the lake of Geneva. In this vessel a two-cylinder Diesel engine is used which can develop from 45 H.P. to 50 H.P. at 260 revs. per min. The generator to which it is coupled has a continuous rating of 20 E.H.P. with a considerable overload capacity. The engine was built by Messrs. Sulzer Bros., of Winterthur, and the electrical equipment was from the Compagnie de l'Industrie Électrique et Mécanique, who manufacture under the patents of M. Thury. The boat has been running regularly since May, 1905.

As to ease of manœuvring, a vessel equipped on this system has all the advantages possessed by the permanently electrical system like that of the "Vandale," combined with the better efficiency at full speed, and the equipment, as has already been pointed out, is much lighter and cheaper.

Another vessel equipped on the same system is the "Sarmat," an oil tank ship about 220 ft. long and 1,150 tons displacement, belonging to Messrs. Nobel Bros., of St. Petersburg, and put into service last year. Two separate four-cylinder Diesel engines are employed, each with its own generator, exciter, clutch and motor on its own propeller shaft. The aggregate horse-power is 360 and the total weight of the machinery is 65 tons. This vessel, which is of slightly greater displacement than the "Vandale," and of about the same engine power, is capable, under similar conditions, of attaining a speed of 8·1 knots, as against 7·4 knots of the "Vandale," whose machines weigh in all 81 tons.

The author next proceeds to give details of weights and dimensions for equipment of sizes varying from 200 H.P. to 1,000 H.P., and photographs are given of some marine type Diesel engines which have already been built, followed by a résumé of the advantages claimed for the system. The figure shows the general arrangement of a 1,000 H.P. equipment. Figures are also given of the much greater distances which can be accomplished than with steam engines and coal-fired boilers without taking fuel on board, and the possible application of the system to ships of war, which has been proposed by M. Philippoff, is discussed.

The Paper concludes with details of two designs, by Prof. Boskiewski, of St. Petersburg, of vessels in which the system is employed. The first of these is a boat of 10,750 tons displacement, carrying 5,250 tons of cargo and 1,120 passengers, with an equipment of 3,500 I.H.P. and storage room for 600 tons of fuel, which would enable it to perform a voyage of 20,000 nautical miles at a speed of 10 knots. The three engines would each have four cylinders, 700 mm. diameter and 770 mm. stroke, running at 150 revs. per min., and the total weight of the machinery would be 564 tons. The other design is of a gunboat of 1,316 tons with a 1,400 I.H.P. equipment and storage space for 155 tons of fuel, which would be sufficient to make a journey from Cronstadt to Vladivostock, via the Cape of Good Hope, without taking in fuel.

EXPERIMENTS ON WATER RESISTANCES.*

BY KARL WALLIN.

Objections have been raised to the use of water resistances for the testing of alternate-current machinery. It has been supposed that condenser effects might arise, and be of such a magnitude as to cause appreciable errors in the results. Among other things it has been pointed out that the determination of the fall of voltage in alternators and transformers by means of a load obtained by water resistances gives too favourable results and that it is indeed possible to have a rise in voltage with increased current under these conditions (see Kapp on Transformers, p. 141 and the following pages of the second German edition). Consequently it would not be possible with voltmeter and ammeter to test the performance of alternate-current machinery by this method. The following experiments, however, tend to show that the objection is of a purely theoretical and not of a practical nature.

The author has carried out tests in the Technical High School at Stockholm in order to investigate the problem, using low voltages The electrodes consisted of two rectangular iron plates, kept at a small distance apart by a wooden framework, and separated by a U-shaped copper wire covered with guttapercha, which was placed between the edges of the plates. The containing vessel was filled with distilled or tap water, as desired. The exposed surface of each plate was 4,300 sq. cm., and the average distance of the plates apart was 0·6 cm. During the tests the voltage and current were determined by very accurate instruments, and oscillograms were taken by Duddell's methods. A few of the results are given below, as obtained with different kinds of wator :—

No.	e.	i.	s.	d.	
1	7·92	0·1	567,000	0·23	Fig. 1
2	113·00	2·0	404 000	4·65	Fig. 2
3	55·00	50·0	7,880	116·00	Fig. 3

where e = volts, i = amperes, s = calculated specific resistance in ohms per cubic centimetre, and d = current density in amperes per square metre. For larger currents a solution of soda was used. Currents were passed up to 1,000 amperes, but the oscillograms were exactly as in Fig. 3, and the voltage and current curves were exactly superimposed.

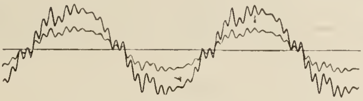


FIG. 1.

From this it appears that no phase displacement arises in consequence of the dielectric properties of water, although the distance of the plates apart was very small as compared with the areas exposed. Moreover, the watt components of the current were undoubtedly much smaller than is likely to be the case in practice, more especially in the case of distilled water. Seeing that no displacement could be noticed, it is fair to suppose that no capacity effect is likely to complicate results if water resistances are used for the purpose of alternate-current tests.

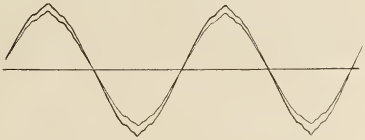


FIG. 2.

Supposing a soda solution to be used, it is possible for a phase displacement to arise under certain conditions. In order to investigate this, several experiments were carried out with soda solutions of different strengths, and both with fixed and adjustable electrodes. The fixed electrodes consisted of three parallel iron plates, at distances apart of 0·14 cm., the middle one serving as the one electrode, and exposing a surface of 220 sq. cm. to the fluid. The movable electrodes consisted of plates 15 cm. by 15 cm., and arrangements were made so that the distance between them could be reduced to 0·15 cm. if desired. The results showed, as might have been expected, that the greatest phase displacement arises with a highly saturated solution, and with the plates close to one another. Curiously enough when using an absolutely saturated solution, containing 3 kg. of anhydrous soda and 12 litres of water at the boiling point, no phase displacement or alteration of curve could be noticed. With this solution a test was made to notice the effect of heavy currents. For this purpose an iron rod, 0·5 cm. in diameter, was used as one electrode; a length of 5 cm. was immersed, giving a total surface of 7·8 sq cm., and a current of 40 amperes was passed at 20 to 30 volts. The water boiled violently round the rod, and there was a strong humming noise. On lifting the rod slightly, flashes of light were caused, accompanied by rather violent explosions and an unsteady current. The volt and current curves were steadily superimposed, and jags and unevennesses were only caused when the rod was moved. A comparison of the results with solutions of different strengths shows that with an 0·5 per cent. solution there is no noticeable capacity effect; on the other hand, it is well marked

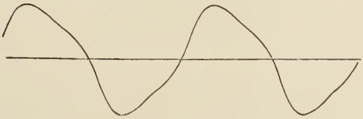


FIG. 3.

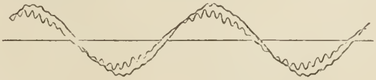


FIG. 4.

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* Abstracted from the *Elektrotechnische Zeitschrift*, August 9, 1906.

when using a 5, 10, or 15 per cent. solution, and passing 20 amperes at from 0·9 to 1·5 volts.

Although the result produced is very similar to that of a condenser, the current curve with a water resistance has no well-marked harmonics. Fig. 4 shows a voltage and a current curve for a condenser in parallel with an ohmic resistance. The condenser took 0·661 ampere, and the resistance 0·22 ampere. Although the phase displacement is small, it will be noticed that the harmonics in the current curve are more marked than in the voltage curve.

On the whole these experiments show that resistances consisting of iron plates immersed in soda solution may cause the power factor to be distinctly less than unity, but only in the case of very low voltages. This effect disappears almost entirely at higher voltages, and is practically negligible at 100 volts. For the purpose of testing transformers and alternators the power factor may safely be taken as being unity.

DIAGRAM OF ELECTRIC WAVE-LENGTHS.*

BY W. W. MASSIE.

Wireless telegraph engineers and operators are frequently confronted by the problem of determining electric wave-lengths with certain known capacity and inductance in circuit or of ascertaining the capacity and inductance required to produce a certain wave-length. To eliminate the necessity of repeated calculations the accompanying diagram, shown in Fig. 1, has been made.

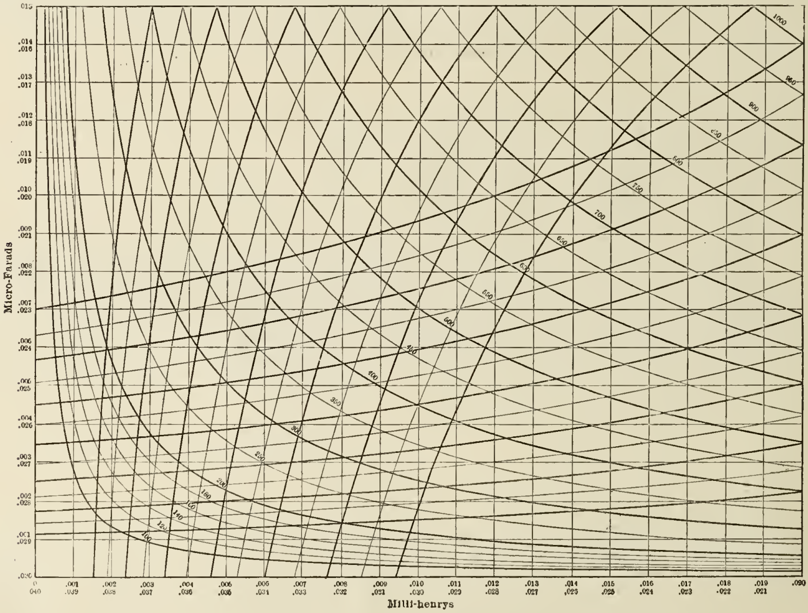

Fig. 1.—Diagram showing Wave Lengths in Metres for Various Capacities and Inductances.

The curves of the diagram are based on the following well-known formula :—

where

$$C = \frac{\lambda^2}{4\pi^2V^2L}.$$

C = capacity,
λ = wave length,
L = inductance,
V = velocity of light = 300,547 per second,

which can be written:

$$\lambda^2 = 4\pi^2V^2LC,$$

or

$$\lambda^2 = KLC,$$

in which K is a constant having the value indicated. From the last formula it is seen that a curve plotted to rectangular co-ordinates showing the relation between L and C for a constant value of λ will be an equilateral hyperbola

To obtain accurate readings, and at the same time to minimise the size of the paper, the curves were plotted as illustrated in Figs. 2, 3, and 4. Fig. 2 shows the curve in its natural form. Fig. 3 shows the curve with section C folded over B. Fig 4 indicates both A and C folded over B. At first sight the curves, laid out in this way, appear somewhat complicated, but with a little practice values can be easily and accurately read to five significant figures.

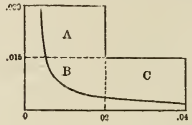

Fig. 2.

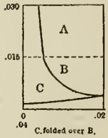

Fig. 3.

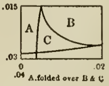

Fig. 4.

Method used in Plotting the Curves.

Since, for example, a wave-length of 500 metres requires 0·010 m.h., with 0 007 mfd., or 0·100 m.h. with 0·0007 mfd. or 0·001 m.h. with 0 07 mfd., while a 5,000 metre wave requires 0·10 m.h. with 0·07 mfd., or 1·0 m.h. with 0·007 mfd., or 0·01 m.h. with 0·7 mfd., it can readily be seen that the range and values are not confined to these given in the diagram, but can be varied to an unlimited extent as the value of C or L can be increased or decreased any number of decimal places if in doing so the opposite factor is decreased or increased a corresponding number of decimal places. The wave-length can also be varied any number of decimal points if the decimal point in C or L is correspondingly changed two places for each one in the wave-length, as shown by the formula above.

Floating Exhibition.—A novel form of exhibition is being arranged by the Floating Exhibition Synd. (Ltd.), in the form of a steamer fitted up for exhibition purposes. This steamer will leave for Montreal towards the end of September, and will then make a tour of the world, showing British machinery and manufactured goods at various ports. We understand that it will be on view in London before starting on this tour.

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* From the *Electrical World*.

ON THE EXPERIMENTAL DETERMINATION OF THE RATIO OF THE ELECTRICAL UNITS.[*]

BY LORD RAYLEIGH, O.M., PRES.R.S.

An able discussion of the principal determinations of the above quantity, usually denoted by v, has been given in the Reports of the Paris Physical Congress (1900) by H. Abraham—himself a contributor to the series. This ground it is unnecessary to retraverse, but I desire to place on record one or two suggestions which have occurred to me but which I may probably have no opportunity of myself putting into practice.

The most approved methods involve the construction either of a condenser or of an electrometer, of which in the first case the capacity, and in the second the potential, can be calculated in electrostatic measure. The first method, on the whole, offers the greatest advantages, and I preferred it when (about 1882, and with the advice of Prof. Stuart) the Cambridge condenser was designed.[†] In this method two currents are compared by a galvanometer. The first is that due to a given E.M.F. in a resistance whose value is known in electromagnetic measure. The second is the intermittent current due to the same E.M.F. charging n times per second a condenser whose capacity is known from the data of construction in electrostatic measure. The comparison may be conducted by the aid of Wheatstone's bridge.

There are, however, one or two matters as to which doubts may arise. Thus it is essential that the commutator by whose action the condenser is periodically charged and discharged, should introduce no E.M.F. on its own account. A more serious doubt hangs over the behaviour of the galvanometer. It is assumed that this instrument indicates exactly the *mean* current, whether the current be steady or intermittent. The principal error to be feared, arising from a somewhat oblique position of the needle and its temporary magnetisation under the condensed charging currents, would be eliminated by reversing the battery. But is it certain that the axial magnetisation remains constant, even when this axis is strictly perpendicular to the magnetic forces due to the currents ?[‡]

Another question relates to the leads connecting the condenser with the remainder of the apparatus. These must themselves have capacity, and the effect is easily allowed for[§] if the capacity is definite. It is here that a doubt arises. Consider, for example, the coaxial cylinders of the Cambridge condenser. When the condenser is to be in action, a leading wire is brought into contact with the inner surface of the inner cylinder. A rupture of this contact throws the condenser out of action; but whatever be done with the end of the lead, its electrical situation is not the same as before. It is only in very special cases, if at all, that capacities can be *added* by simply making contacts.

Passing on to the condenser itself, we may notice that in almost all cases it has been necessary to provide a guard-ring, on the principle first introduced by Lord Kelvin. This leads to complications, though, perhaps, not very serious ones. Thomson and Searle have shown how to allow for the guard-ring in the calculation of electrostatic capacity, and how to connect it with the bridge in the electromagnetic measurement. It is a further slight complication that the potential is not quite the same for the guard-ring and for the main part of the condenser.

It has occurred to me that a condenser, not very different from the Cambridge one, may be so arranged as not only to dispense with the guard-ring, but also to eliminate all questions connected with the capacity of the leads. The principle is that of the variable condenser described in Maxwell's "Electricity," § 127, and further considered below. There are three outer (A, G, D) and two inner cylinders (B, F), the components of two pairs being of the same length; and the outer surfaces of the inner cylinders and the inner surfaces of the outer cylinders being accurately worked to the same diameters. One pair, A and B, are mounted coaxially upon an insulating base and remain undisturbed. The other parts are movable and allow of the formation of two condensers. In the first of these the third outer cylinder D is mounted upon A, so that the inner surfaces correspond. Upon the accurately worked top of B is placed a disc, C, of the same diameter, and D is also closed above by a plate, E The leads make contact with the cylinders A, B, at their bases. Of this condenser and its leads the capacity is unknown.

In the second arrangement the long pair of cylinders F, G are interpolated, G resting directly upon A, and F upon B, while C is removed so as to close F in place of B. The third outer cylinder D with its cover E now rests upon G instead of A. In this way we obtain a second condenser. Although its capacity is unknown, the *increase* of capacity is accurately that of the intermediate cylinders F, G considered as forming parts of infinitely prolonged wholes. That is, if l be the length, b the larger and a the smaller radius, the increase of capacity is $\frac{1}{2}l \div \log(b/a)$.

The circumstance that in this method the smaller capacity is much greater than that of the leads alone is scarcely an objection. In the approximate formula the electromagnetic capacity is proportional to the resistance of the opposite member of the Wheatstone quadrilateral, so that it is merely with the *difference* of resistances needed in this branch that we are mainly concerned. The resistance that must be *added* as we pass from one condenser to the other can be determined with full accuracy.

The length l and the smaller diameter $2a$ are readily measured. The inner diameter $2b$ of the outer cylinder is less easily dealt with; and even if the error were no greater than for $2a$, it would be seriously multiplied in $\log(b/a)$, which is approximately proportional to $(b-a)$. In the Cambridge apparatus the interval between the cylinders was intended to be found by gauging the space with water, and the process is described by Thomson and Searle (p. 600). If this plan be adopted, there is no need to measure b otherwise. If v be the included volume,

$$v=\pi l(b^2-a^2),$$

and

$$C=\frac{\frac{1}{2}l}{\log(b/a)}=\frac{l}{\log\left(1+\frac{v}{\pi la^2}\right)},$$

or approximately

$$C=\frac{\pi l^2a^2}{v}.$$[*]

It is to be remarked that by this method we determine what we really require—*i.e.*, the *mean* value of $b-a$.

In carrying out the necessary measurements there should be no difficulty over l or a. The evaluation of v is more troublesome, and the principal uncertainty would seem to arise out of the possible presence of air-bubbles. Thomson and Searle used a vacuum towards the later stages of the filling. Perhaps it would be an improvement to have a vacuum (? from carbonic acid) from the first, and to introduce the previously boiled water from *below*. It would be possible, though probably more elaborate, to determine v without water by the behaviour of included air.

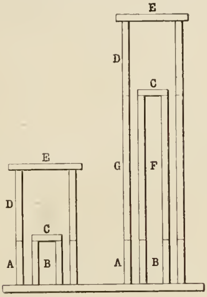

Fig. 1.

The investigation of the formula for the electromagnetic measure of the capacity as derived from observations with Wheatstone's bridge is given in Maxwell's "Electricity," §§ 775, 776, but so succinctly that the full bearing of it may easily be misunderstood. Thus Thomson[†] speaks of it as "only an approximation," and substitutes a fuller treatment. After pointing out that in simple circuit the combination of commutator (period T) and condenser (capacity C) is equivalent to a resistance R, where $R=T/C$[‡], Maxwell proceeds to consider the bridge arrangement. "Let us suppose that . . . . a zero deflection of the galvanometer has been obtained, first with the condenser and commutator, and then with a coil of resistance R_1 in its place, then the quantity $T\div[2]C$ will be measured by the resistance of the circuit of which the coil R_1 forms part, and which is completed by the remainder of the conducting system, including the battery. Hence the resistance R, which we have to calculate, is equal to R_1, that of the resistance coil, together with R_2, the resistance of the remainder of the system (including the battery), the extremities of the resistance coil being taken as the electrodes of the system."

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[*] From the *Phil. Mag.*, August, 1906.

[†] For description, see J. J. Thomson, *Phil. Trans.*, 1883, p. 711; Thomson and Searle, *Phil. Trans.*, 1890, p. 586.

[‡] It is possible that the difficulty arising from the uncertain behaviour of steel magnets might be obviated by the use of a galvanometer of the so-called d'Arsonval type. The string galvanometer of Einthoven (Drude, *Ann.*, XII., p. 1,059, 1903) would appear to be specially suitable.

[§] Thomson and Searle, *loc. cit.*

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[*] In the Cambridge condenser $l=61$ cm., $2a=23\frac{1}{2}$ cm., and $2b-2a=1{\cdot}1$ cm. I do not know that these dimensions are susceptible of much improvement.

[†] *Phil. Trans.*, 1883, p. 708.

[‡] Maxwell has 2 C in place of C, inasmuch as he supposes the charge of the condenser to be *reversed* instead of merely annulled.

"Using the notation of Art. 347 [see figure], and supposing the condenser and commutator substituted for the conductor AC in Wheatstone's Bridge, and the galvanometer inserted in OA, and that the deflection of the galvanometer is zero, then we know that the resistance of a coil, which placed in AC would give a zero deflection, is

$$b=\frac{c\gamma}{\beta}=\mathrm{R}_1. \quad . \quad . \quad . \quad (3)$$

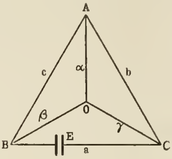

Fig. 2.

The other part of the resistance, R_2, is that of the system of conductors AO, OC, AB, BC and OB, the points A and C being considered as the electrodes. Hence

$$\mathrm{R}_2=\frac{\beta(c+\alpha)(\gamma+a)+c\alpha(\gamma+a)+\gamma\alpha(c+a)}{(c+a)(\gamma+\alpha)+\beta(c+\alpha+\gamma+a)}. \quad . \quad . \quad (4)^*$$

"In this expression a denotes the internal resistance of the battery and its connections, the value of which cannot be determined with certainty; but by making it small compared with the other resistances this uncertainty will only slightly affect the value of R_2.

"The value of the capacity of the condenser in electromagnetic measure is

$$\mathrm{C}=\frac{\mathrm{T}}{[2](\mathrm{R}_1+\mathrm{R}_2)}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)\text{''}$$

Apart from the difference of notation, (5) is the same as the formula arrived at by Prof. Thomson. Maxwell's idea would appear to have been that it makes no difference to the galvanometer in OA whether in AC we have the resistance R_1, which gives the ordinary balance, or the commutator and condenser, provided that the condition be satisfied that the same integral current passes from A to C in both cases.† In considering the fulfilment of this condition we must remember that the difference of potential (A – C) at A and C under the steady current is not the same as that (A′ – C′) to which the condenser is charged. The latter corresponds to the rupture of AC, so that no current there passes. The condition may be expressed:

$$\frac{\text{Capacity}}{\mathrm{T}}(\mathrm{A}'-\mathrm{C}')=\frac{\mathrm{A}-\mathrm{C}}{\mathrm{R}_1};$$

and what we have further to consider is the relation between A′ – C′ and A – C.

Let E′ be the E.M.F. which must act in R_1 in order to stop the current in it. Then E′ = A′ – C′. From another point of view the zero current in AC may be regarded as the resultant effect of two independent E.M.F.s E, E′ acting in the system composed of R_1 and the other resistances. Thus

$$\frac{\mathrm{E}'}{\mathrm{R}_1+\mathrm{R}_2}=\frac{\mathrm{A}-\mathrm{C}}{\mathrm{R}_1},$$

so that

$$\frac{\mathrm{A}'-\mathrm{C}'}{\mathrm{R}_1+\mathrm{R}_2}=\frac{\mathrm{A}-\mathrm{C}}{\mathrm{R}_1}.$$

And

$$\frac{\text{Capacity}}{\mathrm{T}}=\frac{1}{\mathrm{R}_1+\mathrm{R}_2},\ \text{simply.}$$

(*To be concluded.*)

Proposed Single-phase Road at Des Moines, U.S.A.—Engineering and financial details are being worked out for the early construction of an electric railway from Des Moines to Winterset and Creston, Iowa. According to the *Western Electrician*, a terminal contract with the Des Moines City Railway Co. provides for a loop in Des Moines, and the company has a terminal franchise in Creston. Between the two cities the distance is 65 miles, of which distance the company will own a line 60·14 miles long. A power plant of 2,000 kw. capacity will be constructed, which will furnish power for the operation of the cars on the single-phase alternating-current system. Construction of the road will be in accordance with heavy freight practice, and in addition to a passenger business, equipment will be provided for the handling of heavy freight. The grades are light, and the route is through a prosperous country. At the start the company will operate 10 passenger cars, two heavy electric freight locomotives and such additional freight equipment as may be found necessary for handling the business.

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[*] In Maxwell's statement a and α are interchanged in the first term of the denominator.

[†] *E.g.*, in the case of steady currents the introduction of an E.M.F. into AC has no effect, provided the resistance of that branch be so altered as to satisfy the above condition.

CORRESPONDENCE.

PHOTOGRAPHIC ACTION OF IONISED AIR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Since a stream of ionised dust-free gas may be blown through a tube some inches long and yet retain its peculiar state for an appreciable time, there must still remain numerous electrons moving at a high velocity throughout its mass. It seemed reasonable, therefore, to expect that a current of ionised air would be capable of affecting a photographic plate.

In order to test this, however, it was necessary to guard against effects due to the presence of "emanation" or secondary radiation produced by the ionising source, and a number of preliminary experiments were required. When all precautions were taken, an exposure of 15 hours to a stream of ionised air gave a clearly-defined darkening upon a sensitive plate after development. The cone of air issuing from a small orifice could be shown, by an exploring wire connected with an electroscope, to be so well defined that the question naturally occurs to one whether there may not also be a useful physiological action brought about by concentrating a flow of ionised gas upon a diseased area.—Yours, &c.,

Shooters Hill, Kent, Aug. 30. Charles E. S. Phillips.

AUTHORISATION OF LOANS BY THE LOCAL GOVERNMENT BOARD.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of August 17th you describe what you call a "new departure" on the part of the Local Government Board with regard to loans for mains. It might interest you to know that a sanction was received from the Local Government Board as far back as April 8, 1902, allowing the Grimsby Corporation to borrow the sum of £2,350 on services, meters and extension of distributing mains exactly on the terms which Mr. Hooper announced at Exeter. In every loan sanctioned since, a sum has been included in a similar way, and I have found the arrangement to work very satisfactorily, no trouble having ever arisen with the Local Government Board. I do not know if Grimsby was the first town to have a loan sanctioned in this manner, but there was no trouble about it. I asked for the money on account, and the Local Government Board sanctioned it without any demur, and presumably would have done the same for any other town.—Yours, &c.,

W. A. Vignoles.
Grimsby, Sept. 4. Borough Electrical Engineer.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

There are vacancies for station supervisors at the electric generating station at Portsmouth Dockyard. Applications to the Electrical Engineer, H.M. Dockyard, Portsmouth, by Sept. 15. See an advertisement.

Two telegraph inspectors and one telegraph mechanic are required for Southern Nigeria. Inspectors' salaries £240 each per annum, rising by annual increments of £15 to £300 per annum; mechanic's salary £240. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by Sept. 17. Further particulars are given in an advertisement.

An engineer is wanted to take charge of the running of an eight-hour shift at Stepney (London) Council's electricity works. Salary £2 per week. Applications to the engineer and manager, Mr. Wm. C. P. Tapper, 27, Osborn-street, E., by Sept. 11. See also an advertisement.

A shift engineer is required for the winter months at Rathmines (Dublin) electricity works. Applications by 13th inst.

Todmorden Council have appointed Mr. Talbot, of the gas works, as electrical engineer, his salary being increased by £25 a year; Mr. T. H. Holland has been appointed manager at £150 per annum; and Mr. Edward Brunt as engineer at £2. 5s. per week.

Mr. Douglas Farrar, assistant lecturer in electrical engineering at N. Wales University College, has been appointed lecturer in electrical engineering at Hartley University College, Southampton.

Mr. William S. Ibbotson, B.Sc., of Beeston, Notts., has been appointed assistant (to teach electrical engineering and practical mathematics) in the engineering department of the Darlington Technical College.

Mr. H. E. Midgley, M.A., A.M.I.C.E., has been appointed assistant engineer at Erith electricity works.

Capt. A. C. J. Stevens, R.E., and Capt. P. S. Watkins, R.E., have been promoted from assistant instructors to be instructors in the army schools of electric lighting, and Capt. John D. Monro, R.E., has also been appointed instructor.

EDUCATIONAL NOTICES.

University of Glasgow.—The next session begins on Oct. 18 and ends on March 28. Students in the engineering and naval architecture departments usually spend the summer months in practical work. Prospectuses of the courses for the B.Sc. and D.Sc. degrees and syllabus of classes from Prof. Barr, James Watt Engineering Laboratories, The University, Glasgow.

University College, Bristol.—There are courses of instruction in electrical, civil, mechanical and mining engineering and surveying at this college, and special facilities are offered in connection with college and engineering works scholarships. Favourable arrangements have been made with firms in or near Bristol for practical training to be obtained concurrently with the college course. Applications for vacancies should be made as early as possible to the registrar and secretary, Mr. Jas. Rafter.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

City and Guilds of London Institute.—The entrance examinations to the Institute's Colleges are held in September. Particulars of the entrance examinations, scholarships and courses of study in electrical and mechanical engineering, chemistry, &c., may be obtained from the colleges at Exhibition-rd., S.W., and Leonard-st., City-rd., E.C., or from the head offices of the Institute, Gresham College, Basinghall-st., E.C.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Evening technical courses in all branches of electrical and mechanical engineering will commence on Sept. 24. The laboratories are well equipped for both alternate (single and polyphase) and continuous-current work and for all kinds of electrical testing.

Battersea Polytechnic (London, S.W.)—The term commences on Sept. 17. There are technical day courses in electrical, mechanical, motor and chemical engineering, as well as evening courses in preparation for the London University engineering degree and in all mechanical and electrical engineering subjects, including motor car engineering. The evening courses begin on Sept. 24. Prospectuses from the Secretary.

Borough Polytechnic Institute (London, S.E.)—The new session commences on Sept. 24. There are classes in electrical and mechanical engineering, applied mechanics, technical drawing, practical mathematics, chemistry, &c. The laboratories are well equipped for practical work. Prospectuses, &c., may be obtained from the secretary, Mr. W. M Richardson.

Hackney Technical Institute.—The session commences on Sept. 24. There are evening courses in electrical engineering subjects, including alternating currents, dynamo design, wireless telegraphy, &c. Prospectuses from the secretary of the institute, Dalston-lane, London, N.E.

South Western Polytechnic (London, S.W.)—A complete three years' course in electrical engineering is given in the day classes and a four years' course in the evening classes at this polytechnic. Courses of lectures and practical work are also given in electrical engineering (elementary, intermediate and advanced) and electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting and calculus for engineers. These lectures may be taken separately or as part of a course. Particulars from the Secretary, Manresa-road, Chelsea, London, S.W.

Sir John Cass Technical Institute, London.—The new session begins on Sept. 24. There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the electrical, metallurgical and chemical industries and in trades associated therewith. Every facility is afforded for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. Courses of instruction in glass blowing will also be given during the session by Mr. A. C. Cossor. Details of the classes can be obtained at the Institute, Jewry-street, Aldgate, E.C.

Aberdeen.—The Gas and Electric Lighting committee have agreed to reduce the charge for the first hour's maximum demand of electric current for lighting from 6d. to 5½d., and for after consumption from 2d. to 1½d. per unit. The charges for current for power and other purposes have also been reduced.

Argentina.—The "Review of the River Plate" states that, in answer to a recent request of the Law Courts to be supplied with a copy of the contract or concession of the Compañia Alemana Transatlantica de Electricidad to supply electric energy in Buenos Ayres, the municipality has made reply that the company has no concession, but that on Jan. 29, 1897, the Mayor granted permission to Mr. H. Baehcker, on behalf of the Allgemeine Elektricitäts Gesellschaft, of Berlin, to lay mains and erect a power house, and this permit was approved by the Council on June 11 of the same year. Severe comment is made locally upon the attitude taken up by the Council.

Australasia.—A net profit of about £1,300 has been made on Wellington (N.Z.) municipal electric tramways during the past year.

A poll of *Launceston* (*Tasmania*) ratepayers is to be taken this month on a proposal to construct electric tramways and as to whether it is advisable for the Corporation to lay the lines and provide the service or to lease the powers to a company. The city surveyor (Mr. St. John David) has submitted a report on the matter.

In proposing the adoption of the Electric Lighting committee's report at a recent meeting of *Sydney* City Council, Alderman Hughes said the installation was now on a fair business footing and returned 5¾ per cent. on the capital, after providing for interest and sinking fund. The Lord Mayor (Alderman Taylor) said the profit on the past year was £5,600, but if depreciation had been provided for at the rate of 2 per cent., there would have been a deficiency of £2,400. He thought the Corporation had made a mistake when they reduced the charge for current for power to 1½d. per unit when it cost 2⅓d. per unit to generate.

Bath.—An inquiry was held last week into the application of the Council for sanction to borrow £4,000 for extensions of the electricity undertaking.

The town clerk (Mr. R. Moger) gave statistics of population, outstanding loans, ratable value, &c., and said that the £4,000 was needed for mains and house services. In Sept., 1905, sanction was issued for leave to borrow £2,325, but the total expenditure up to the present had been £4,856. 9s. 10d. An application had been received from Messrs. Stothert & Pitt for a supply of energy for power. The firm had guaranteed a minimum consumption of 140,000 units per annum for three years, and would pay 1¼d. per unit, subject to discounts, which had been worked out at 1d. for punctual payment. It was considered that the minimum would be exceeded by the firm, and the Council had reason to think that other consumers would come on when the main was laid. They had already received an application from one probable consumer, and negotiations were on foot with other people. It was proposed to lay a larger cable than would be necessary to supply ordinary consumers. The estimated cost was £2,044, but they had in hand stock of the value of £1,674, so that only £370 would be required for the main. With their previous expenditures, supposing they obtained the further loan asked for, it would leave them with a balance of only £1,099 for further extensions and the requirements of the undertaking, so that probably there would have to be another application at an early date. Mr. Moger asked for as long a period as possible for the loan. They were rather handicapped owing to loans being granted for very short periods. About a year ago there was a loan for meters, and at the present rate of progress they would almost have paid off that loan before they had spent the money, and it pressed hardly on the undertaking to provide such a large sinking fund. They hoped they would get 20 years for the loan.

The inspector (Mr. F. H. Tulloch) said he thought there was power to grant a 25 years' period for a loan for mains.

The city electrical engineer (Mr. F. Teague) explained the nature of the route, &c., and referred to the large power users likely to come on to the supply mains.

Bridlington.—In future, where the Council accede to an owner's application for the lighting of any private yard, the lighting will be supplied at the Corporation's expense, provided the owner pays all capital charges incidental to the laying of the necessary cable from the boundary wall and the fixing of bracket or lamp-post, and provided, also, that the lighting may be discontinued if at any time the houses cease to be occupied.

Carriage of Cycles on Tramcars.—Manchester Tramways department, which has a highly organised and well developed system of parcels collection and delivery, is considering the advisability of adding the conveyance of cycles by special Saturday afternoon cars.

Customs Duties.—It has been recently decided that electric radiators imported into New Zealand are subject, as "hardware," to a duty of 20 per cent. ad val.

Under the new Italian tariff electric accumulators and metallic parts of same are, as before, subject to a duty of 16 lire per 100 kg.; the duty on arc lamps is 60 lire per 100 kg., instead of 30 lire, as hitherto, and on incandescent lamps 5 lire per 100 instead of 30 lire per 100 kg.

Dover.—The Corporation have applied for sanction to a further loan of £3,000 for extensions of the electricity undertaking.

Eastbourne.—On Wednesday the Council rejected a motion to convene a meeting of ratepayers to discuss the question of the construction of tramways.

Eccles.—The Council have decided to apply for sanction to a loan of £15,078 to cover excess expenditure since 1900 on the electricity works, and also for extensions of mains, &c., during the next three years.

From April 1 next a flat rate of 4d. per unit will be charged for electric energy consumed in offices, shops, dwelling houses, public houses and clubs.

Elgin.—The Council, having received notice from the National Electric Construction Co of intention to apply for a provisional electric lighting order, have decided to take a plebiscite of the ratepayers on the general question of electricity supply. It is considered probable the Council will themselves apply for an order and oppose the company's application.

Engineers' Wages.—The claim of the Amalgamated Society of Engineers for an advance of 2s. per week on existing rates of pay for all skilled workers (other than moulders and machine workers whose claims have already been dealt with) was posted to the Manchester Engineering Employers' Association on Monday. It is probable that the employers will arrange a joint meeting with representatives of the men, under the terms of settlement agreed upon in 1898.

Exhibitions.—Efforts are being made to organise a representative exhibition of the Balkan States next year at Earl's Court. The Servian Government has decided to be thoroughly represented.

The Mayor of Chester formally opened on Wednesday the exhibition of electric lighting fittings, motors, domestic appliances, &c., which has been organised by the electricity department. The exhibition remains open for nine days.

Fareham.—An inquiry has been held here into the application of the Council for sanction to borrow £800 for electric lighting extensions.

Evidence was given by the clerk (Mr. L. Warner) and the electrical engineer (Mr. A. Blake). It was stated that the electric light loans amounted to £12,251, of which £4,604. 19s. 7d. had been repaid. The last loan was in 1903.

Fleetwood.—Negotiations are proceeding between the Council and the Fleetwood & District Electric Light & Power Synd. in regard to the street lighting contract.

The syndicate offers to allow the Council a rebate of £50 per annum in lieu of supplying incandescent lamps, the Council to find their own lamps in future and to change same when necessary. The surveyor would keep a proper lamp-renewals book, which the syndicate would be allowed to inspect, and the Council are to take over the stock of lamps (about 250) at 6d. each, the arrangement to take effect from Oct. 1.

The Highways committee is considering this proposal.

Forthcoming Books.—Messrs. Whittaker will publish shortly a new book entitled "Elementary Principles of Continuous-Dynamo Design," by H. M. Hobart, M.I.E.E.

"The Electrician" Company, who have just published the complete series of "Electrician" Primers (82 Primers in all, including Glossary), will shortly issue "A First Year Course in Practical Magnetism and Electricity," being a series of practical elementary experiments prepared by Dr. P. Egerton Shaw, B.A., Lecturer and Demonstrator in Physics at University College, Nottingham. This work will form a useful sequel to "The Electrician" Primers. The same company will have ready shortly the new edition of "'The Electrician' Wireman's and Mains Superintendent's Pocket Book," edited by Mr. F. C. Raphael. The same company have also in the press a valuable practical manual entitled "Electric Blasting Apparatus and Explosives, with Special Reference to Colliery Practice," by W. Maurice, A.M.I.E.E. Other books in "The Electrician" series now in the press include a new edition of "Submarine Cable Laying and Repairing," by H. D. Wilkinson; a new edition of "The Potentiometer and its Adjuncts," by W. Clark Fisher, and "The Mechanical Design and Construction of Commutators," by R. Livingstone.

Gas versus Electricity.—The A.E.G. English Mfg. Co. write:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A large number of corporations and electric supply companies have lately taken up maintenance of Nernst lamps in order to make sure that their consumers get the best value for their money and in order not to let those who grumble at their current bills fall into the hands of the gas companies. Amongst the towns that have adopted our maintenance scheme for Nernst lamps are Tynemouth, Northampton, Nuneaton, Wrexham, Newcastle-on-Tyne, Huddersfield, Norwich, Aston Manor, Loughborough, West Bromwich, Hereford and Ipswich. The latter town is just sending out a circular to all their consumers, which will no doubt interest your readers.

The circular referred to is pamphlet No. 21 prepared by Ipswich Corporation Electric Supply Department, and is entitled "How to Reduce the Cost of Electric Lighting." It deals with the necessity for the use of the most efficient electric lamps where it is desired that the cost of electric light, light for light, should be shown to compare favourably with the cost of gas lighting. The circular proceeds to set out in tabulated form some instructive details as to how this can be easily shown to be the case. The object of the information given is to compare the cost of electric lighting by ordinary electric glow lamps and Nernst lamps. At Ipswich all descriptions of installation works are carried out by the Corporation electricity department.

Gateshead.—At a meeting at Wrekenton, last week, a resolution was passed in favour of the extension of the tramways of the Gateshead & District Tramways Co. to the Wrekenton district. The company already possesses powers but requires an extension of time to construct the line.

Gold Coast.—In 1905 there was a decrease in the imports of machinery into the Gold Coast compared with 1904 to the value of £85,804, due chiefly to the depression in the mining industry.

Telephone exchanges at Accra, Cape Coast, Sekondi and Tarkwa now connect all Government offices, most of the leading business houses and the mines in the Tarkwa district. A subaqueous telegraph cable has been successfully laid across the Volta river to replace the old faulty cable. The extension of the telegraph from Attabubu to Yeji was completed during 1905 and is now being carried on to Salaga, and this line will shortly be finished. There are over 40 telegraph offices in the district comprehended by the Gold Coast, with a total length of line of about 1,100 miles.

Halifax Tramways Dispute.—As announced in our last issue, most of the employés of the tramways department went out on strike on Friday last in sympathy with driver Chadwick, who was dismissed owing to his being driver of the car to which an accident occurred on July 1.

The efforts made to settle the dispute were unsuccessful, the result being that there was practically no tramcar service on the Friday, but the tramways department is gradually increasing its service, and on Wednesday there were only two routes without cars running on them.

An Emergency committee had been appointed to confer with representatives of the men to discuss the points of a proposed basis of settlement, but the men found a fresh grievance in the order to take in their uniforms on Friday morning and to work all day in plain clothes. That condition the Tramways committee insisted upon. The chairman of the committee (Ald. Hey) and the general manager (Mr. F. Spencer) had during the week been making arrangements to keep the cars running, and a number of men had been engaged to take the places of those who had sent in notices. Those engagements have been confirmed by the committee, and, therefore, the whole of the late employés cannot be found work, even if they wish to continue in the service of the Corporation.

Various meetings of the men and their sympathisers have been held, but each succeeding day has seen an increased service of cars as the tramways department has been able to engage practically all the men they require.

The matter came before the full Council on Wednesday, when Ald. HEY moved the minutes of the Tramways committee without comment, and the report was adopted.

Italy.—The Società Ligure Toscana di Electricità is now well at work in the Leghorn district of Italy supplying current for lighting and power, and is doing a considerable business.

At Leghorn also a company has been established, with capital provided by Genoese and Livornese capitalists, for the manufacture of electric cables, wires and general installation appliances. The works are at Torretta, a suburb near the station at Leghorn, where a large number of factories and works are gradually springing up connected with cotton yarn spinning, flour mills and many other branches of industry. The capital of the new electric manufacturing company is 1,200,000 lire, which can be increased to 3,000,000 lire, and it is expected that the works will employ about 300 workpeople. The principal agent in the establishment of this company was the Banca Commerciale Italiana, which is taking up with considerable spirit the exploiting of industrial undertakings.

Knaresborough-Harrogate Tramways.—Knaresborough Council have approved the proposal to construct a tramway or light railway between Knaresborough and Harrogate, and a special meeting has been called to discuss details with the promoters

Leeds.—On Wednesday the Council increased the salary of the assistant electrical engineer (Mr. C. N. Hefford) by £50 per annum.

London County Council Tramways.—The conversion to electric traction of the lines from Vauxhall to Westminster Bridge-road, and from Vauxhall to Southwark Bridge and the Hop Exchange, Southwark, has been completed. The Board of Trade inspection took place on Tuesday.

Londonderry.—The Law committee have asked Messrs. J. G. White & Co. to submit in writing further particulars of their proposals to acquire the municipal electricity undertaking.

At a recent meeting of the committee Mr. G. Balfour attended on behalf of the company and stated that the basis of negotiations would be the repayment by the company to the Corporation of their capital expenditure, which he understood was £53,000. Of that £9,000 had been paid off, and therefore the basis of negotiations would be whatever sum between £44,000 and £53,000 they might agree upon.

Manchester.—The question of the construction of an underground electric railway has been revived, but the Parliamentary committee of Manchester Corporation will oppose the scheme.

At Wednesday's meeting of the Corporation Mr. Hynes asked what steps were being taken to prevent the serious loss arising in the tramways parcels department, and whether there was any probability that the department would soon be dispensed with. Ald. Bowes said the Tramways committee had already prepared a report as to the future policy of the department and recommendations would be presented at the next meeting.

Motor Omnibuses.—At the meeting of the London General Omnibus Co. last week, Sir John Pound said the company were passing through a time of transition.

Owing to motor manufacturers being behind time in delivery of chassis, they had had 17 fewer omnibuses running, but they had carried 108,341,000 passengers, an increase of 507 passengers per running vehicle. On the roads covered by both horse and motor omnibuses, short-distance passengers preferred a horse omnibus and long-distance passengers took a motor. There was an increase of £6,218 in road expenses, mainly for fuel and lubricants (£4,738). They had also written down the value of their motors on the basis that the chassis and mechanical parts would last a little over three years, while charging all renewals and repairs to expenses. At June 30 they possessed 92 motors, but now they had 135 and had besides contracts and options for several hundreds more. There had been agitation with regard to the noise made by motor omnibuses. Some of them were undoubtedly noisy and engineers were devoting their attention to the removal of that objection. The quietness of their omnibuses was partly due to the design and partly to the efficiency of their drivers, for whom they had established, at a considerable cost, special schools of instruction with regard to the engines and working parts and their proper manipulation. The solution of problems took time, and it would be a matter of regret were the motor omnibus industry to be hampered and restrictions placed unnecessarily on what would, he believed, be the most popular, speedy and efficient means of transport in the metropolis.

Municipal Telephony.—The purchase of the Glasgow municipal telephone system by the Post Office is to date from June 1 last, and the undertaking is to be transferred to the Government on the 10th inst., on which date the Corporation will cease to transact telephonic business.

The Post Office authorities have refused to deal with (1) the transfer of the staff to the Post Office and (2) the continuance of the existing telephone rates to present subscribers, and these points must rest upon the statements made in the communications from the secretary to the Post Office. The employés will be taken over, but the question of the incorporation in the established staff of the Post Office of such of them as are employed on work ordinarily performed by established officers of the Post Office will remain for further consideration, and the Postmaster-General notifies that he will be unable to recognise any claim which may hereafter be put forward based on the expectation of such incorporation.

The Postmaster-General (Mr. Buxton) intimated in a letter dated Aug. 31 that it must be clearly understood that it would be necessary to revise the rates at present charged by the Corporation, and to adapt those rates to the altered conditions under which the service will in future be carried on, including intercommunication with the system of the National Company throughout the area. The rates which it might be found necessary to fix would be applicable to new subscribers, and to existing subscribers as their agreements terminated.

The Telephone committee recommend tha tthe agreement be accepted by the Corporation.

The Postmaster-General has also intimated to the Corporation that he proposes to pay the purchase price of the undertaking on 10th inst., and the committee recommend that the money when received should be handed to the city registrar to be applied by him to the reduction of the debt due by the telephone department.

The August supplement of the Glasgow Corporation telephone directory shows an addition to the subscribers' list of over 700 numbers.

New German-Norwegian Cable.—We understand that work is about to be commenced in connection with the laying of a new submarine telegraph cable between Germany and Norway. The cable is to be laid during September.

Ossett.—As announced in our last issue, the L.G. Board have refused to reconsider their decision not to sanction a loan for electricity supply. The Council obtained a provisional order in 1898, and an expenditure of about £700 has been incurred in the preparation of a scheme, &c.

Palace Lighting.—The electric light is gradually being substituted for gas in Hampton Court Palace. Current is being taken from the Twickenham & Teddington Electric Supply Co.

Persia.—Bunder Abbas has at last been connected with the rest of the world by a subaqueous telegraph cable across Kishm Island and a land line to the telegraph station at Henjam. The opening of this line is shortly expected, and is likely to prove a great boon to the trading community.

Personal.—Mr. Francis E. Drake, who has just been appointed general manager of the Société Anonyme Westinghouse, of Paris and Le Havre, acquired early experience in the services of the Flint & Père Marquette Railway as telegraph operator, after which he was for five years sales manager of the Standard Electric Co. of Chicago, and for nearly two years manager of the Walker Electric Co., Cleveland, when the United States Government appointed him director of machinery and electricity at the Paris Exposition (1900). Mr. Drake was responsible not only for the idea of a separate building for the American exhibits, but also for its complete design, construction and lay-out. In 1901 Mr. Drake was appointed to reorganise the works of the Union Elektricitäts Gesellschaft of Berlin, which he carried through and finished in 1903. The following two years he was in America as president of the Lanyon Zinc Co., one of the largest zinc smelting firms in the world. In April, 1905, Mr. Drake returned to Europe to organise the Continental business of the Chicago Pneumatic Tool Co., and founded in Berlin the Internationale Pressluft und Elektricitats Gesellschaft, m.b.H., of which concern he is general director. Mr. Drake is also a director of the Consolidated Pneumatic Tool Co. (Ltd.), London.

Mr. W. M. Madden has resigned the editorship of the "Electrical Times." The new editor will be Mr. Ernest Slater.

Mr. E. H. Cozens-Hardy, of the firm of O'Gorman & Cozens-Hardy, and son of Lord Justice Cozens Hardy, was married at Kendal, on the 29th ult., to Miss Gladys Lily Cozens-Hardy, of Kendal.

At Worksop Prior Church on Tuesday Mr. H. A. Best, assistant electrical engineer at Worksop electricity works, was married to Miss Ethel Marion Palmer.

Presentation.—Mr. C. S. Collison, who has resigned his post as switchboard attendant at Loughborough electricity works to take up an appointment in charge of the plant at the G.P.O., Leicester, was on Saturday presented with a clock, letter wallet and card-case by the members of the Loughborough staff. The borough electrical engineer (Mr. W. H. Allen), who made the presentation, spoke of Mr. Collison's good services during the time he had been at Loughborough and wished him every future success.

Redditch.—In submitting the Electric Supply committee's report on Tuesday the chairman (Mr. F. Dolphin) said that the condition of the electricity undertaking had greatly improved, not only in the financial position, as shown by the balance-sheet for the past year, but also in the more satisfactory working of the generating plant. He thought they could take it that in a short time the undertaking would make no demand on the rates. The total capital expenditure was £36,235, and the gross profit for the year was £1,440 (equal to 4 per cent.). There had been a large increase in the number of consumers, while the cost of generation showed a reduction of ½d. per unit.

Salford.—A resolution was moved by Mr. Burnley, at Wednesday's meeting of the Corporation, that the Tramways committee be instructed to abstain from printing or issuing tramway tickets offering to give or pay money or other valuable consideration dependent upon chance.

The Chairman of the committee (Ald. Linsley) said he could not accept the motion. The difficulty lay in the three years' contract with the Bell-Punch Co , who supplied the punches at a certain price in consideration of printing advertisements which had been approved. That advertisement had been approved by the committee twice over. Only four or five months of the period of the contract had elapsed. Ultimately it was decided to endeavour to obtain a modification of the contract.

The Tramways committee, having considered the application from their workmen for an increase of wages, recommend that in future conductors receive 5½d. an hour on appointment, 6d. after one year's service and 6½d. after three years.

Steam Turbines in Australia.—Sydney Municipal Council have decided to instal steam turbine generating sets in their electricity works, and, after deputing their chief electrical engineer (Mr. T. Rooke) to make a tour of inspection of the different types of turbines installed in different parts of the world, have decided to adopt the Willans Parsons type, as built by Messrs. Willans & Robinson, of Rugby.

Sunderland.—For the position of borough electrical engineer, which has been rendered vacant by the retirement of Mr. John F. C. Snell, the Corporation received 69 applications, but this number has been reduced to the following six, from whom a final selection will be made by the Council on Wednesday next: Mr. A. S. Blackman, Bradford; Mr. A. A. Day, Bolton; Mr. H. Faraday Proctor, Bristol; Mr. C. E. C. Shawfield, Wolverhampton; Mr. C. D. Taite, Salford; and Mr. T. P. Wilmshurst, Derby. The salary is £800, increasing to £1,000 per annum.

Technical Circulating Library.—The subject of establishing a technical circulating library has been discussed in the technical journals from time to time, and we may very well point to the fact that Mr. H. K. Lewis, the well-known publisher and bookseller, of 136, Gower-street, London, W.C., has long ago solved the problem. The question of a good lending library for expensive engineering and technical works has often been raised by both practising engineers and students—a modified "Mudie," in fact. For the medical world H. K. Lewis's Circulating Library has for many years exactly supplied this want. One of the best known medical journals recently referred favourably to Mr. Lewis's institution in Gower-street. Some two or three years ago the library was extended to include all branches of engineering books, as well as the growing class of works which may best be described by the term "technical." This fact does not appear to be so generally known in engineering circles as it deserves to be, and there must be a large number of consultants and managers, not to speak of technical students, who would be glad to avail themselves of this easy and inexpensive means of consulting the latest books on their special subjects.

Topsham (Devon).—The inauguration of the public electric lighting took place on Monday. Current is supplied by the local electric light company at £1. 7s. 6d. per lamp per annum. There are 63 lights, some being of 50 c.p. and the remainder of 30 c.p.

Trade Union Congress.—The thirty-ninth annual Trade Union Congress is being held at St. George's Hall, Liverpool, this week. There are 491 delegates, who were welcomed by the president (Mr. D. C. Cummings) on Monday. The members were also officially welcomed by the Lord Mayor of Liverpool.

The annual report of the Parliamentary committee was mainly devoted to Parliamentary and legal matters. The report stated that the decision in the appeal in the House of Lords in the "Miners' Federation *v.* Denaby Main" made it clear that the funds of a union could not be mulcted for the unauthorised acts of members. The concessions of the Government and the agreement arrived at between them and the committee on the question of contract could not be too highly appreciated. They trusted it would put an end to a long system of friction and prevent the sweating of the workmen of which their members had for so long justly complained.

The report proceeds: We must no longer be content to fight for a living wage, which is measured by the iron-bound law of supply and demand. We want something even beyond. The demand should be for a higher standard of living; something that will enable us to educate our families, to participate in art, literature, music, and half the good things that help to make life bright, happy and comfortable. The highest aim of the congress is to bring the various brotherhoods together so that collective forces may concentrate organisation and effort in support of political and economic principles whenever found to be in common agreement. Your committee believe in conciliatory endeavour, and appeal to the miners of Britain, through their representatives, to get together and find a solution of the eight hours' question. Both sides are entitled to their opinions, and the history of the movement shows how courageously and conscientiously they hold them. Each side believes in short hours, differing only in the method of application. The justification in making so outspoken an appeal is that, so long as the miners fail to obtain a legal eight hours, other trades where the principle would equally apply are prevented from asking for legislation which would be of incalculable benefit to thousands of workers.

Compulsory Arbitration.—Mr. Ben Tillett moved a resolution in favour of compulsory arbitration in trade disputes. Industrial Boards of Conciliation and Arbitration were, he suggested, to be formed in all large industrial centres, and the courts were to be constituted by an equal number of workmen and employers. The proposal was defeated by 938,000 to 541,000 votes.

Parliamentary Procedure.—At the instance of the National Federation of Enginemen the Parliamentary committee were requested to devise a method of Parliamentary procedure which would obviate the abandonment of certain bills at the end of the session and to carry them over from session to session until they were either passed or rejected.

Halifax Tramway Dispute.—The delegates passed a resolution of "sympathy with the tram workers now locked out in Halifax," and urged Halifax Corporation to use every means in their power to meet the reasonable claims of the men.

Engine Drivers, &c.—A resolution was passed to the effect that all persons in charge of steam engines and boilers who are directly under the control of the Home Office or Board of Trade should be compelled to obtain certificates of competency.

The following resolution was also passed: "That it shall be considered a criminal offence for a company to allow any person to drive a locomotive engine upon any railway over any portion of the road he is not thoroughly conversant with, and that railway companies should be compelled always to have two men in charge in the motor house, or on the footplate of all locomotive engines working railway trains."

Factory Inspection.—It was resolved that this Congress instructs the Parliamentary committee to prepare a bill dealing with inspections under the Factory Act and the qualification of inspectors for the post of factory inspector.

Hours of Labour.—It was resolved that, in view of the present rapidity of production and the continuous introduction of labour and wage-saving machinery, and the consequent displacement of manual labour in many industries, this Congress declares in favour of a shortening of the hours of labour to not more than eight hours per day, or 48 hours per week, as a means towards the absorption of many of those workers who are at some seasons of the year thrown out of employment, and calls on all the organised workers of the United Kingdom to make this one of the test questions at all Parliamentary and municipal elections; and that the system of systematic overtime should be abolished in all trades; and that it be an instruction to the Parliamentary committee to formulate these proposals in a bill to be laid before Parliament during the forthcoming session.

Minimum Wages.—At yesterday's sitting a grouped resolution that a minimum wage of 30s. per week be demanded for all workers was discussed at length, and ultimately the matter was referred to the General Purposes committee. A resolution for a minimum wage of 30s. per 48 hour week for Government workers in the London district was, however, carried.

Valparaiso.—The Deutsche Ueberseeische Elektricitäts Gesellschaft, of Berlin, announce that damage to the extent of about 300,000m. (£15,000) has been caused to their Valparaiso tramways by the recent earthquake.

Wemyss and District Tramways.—The formal opening of these lines takes place to-morrow (Saturday).

Workhouse Lighting.—A loan has been sanctioned for the electric lighting of Chepstow workhouse.

Worthing.—The Council have applied for sanction to a further loan of £1,660 for the electricity undertaking, £1,000 for house services and meters, £500 for extensions of the distributing mains, and £160 for water-softening plant.

Ystradgynlais (Brecon).—A company is being formed for the purpose of erecting electricity works and supplying electricity in Ystradgynlais, Cwmtwrch and Abercrave.

Sports.—The first annual sports of the Siemens Institute, established by Siemens Bros. & Co. for the benefit of the employés at their Stafford works, took place on 25th ult. Numerous interesting events were successfully carried through, a temporary grand stand being provided for visitors. The Stafford Volunteer Band, conducted by Mr. J. Herbert, performed a lengthy repertoire of music. Mr. H. T. Poole was hon. secretary.

The events which excited the most interest were the final rounds of a tug-of-war, for which 22 teams entered, and which finally resulted in a victory for the pattern makers and carpenters over the stores department, and a championship tug-of-war, in which "the staff" easily beat "the works." Mr. Frewer (chief sectionist in the drawing department) presented the prizes. About 2,000 spectators paid for admission.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The annual report of the city electrical engineer (Mr. J. A. Bell) for the year ended July 31 states that in December last they disposed of the Cotton-street land and buildings to the gas department.

The first instalment of the Ferryhill station buildings had been completed and the plant at present erected finished. The G.N. of Scotland Railway Co. had become a consumer during the last 12 months, though only to a limited extent. The joint station, Kittybrewster and Waterloo stations would be connected shortly. Rubislaw Quarries, the new post office and the new theatre had also decided to become consumers, and would, it is expected, be connected before the end of this year. Power consumers were continuing to increase in a satisfactory manner. The reduction in price made in July had already brought in business that otherwise they could not have obtained, and Mr. Bell expects this to be more noticeable in the course of time. Extensions of mains equal to 2,187 miles had been laid, and considerable additions to feeders and strengthening up of existing distributors had been necessary. No new plant had been ordered during the year. A 420 kw. generator was installed in November, 1905, and the converted boilers from Cotton-street were now installed. A new flywheel, to replace the cracked one, was installed on the 720 kw. set in June. All station plant had been maintained in an efficient state out of revenue. The output was only some 200,000 units in excess of last year, a result largely attributed to bad trade, and, in a lesser degree, to the use of more efficient lamps. Taxes and capital charges increased. No provision was made in their act for depreciation, though hitherto it had been the practice of the department to depreciate yearly by writing down the capital, in addition to the statutory sinking fund. There was no question that that practice was a prudent one, and so long as they had the old generating station and obsolete plant to dispose of the amount annually set aside under that heading was warranted by the circumstances. It would be apparent that, when an undertaking brought to an up-to-date condition was charged with repayment of capital during a fixed period, to charge it also with an annuity for the purpose of providing another amount largely in excess of the sinking fund under the name of depreciation was practically charging the present consumers with over twice their share of capital expenditure, a course which did not appear to be equitable or altogether necessary, when it was also borne in mind that all maintenance and repairs were charged to revenue. It would be seen that their depreciation and reserve accounts amounted to 23·8 per cent. of capital, and, while it might be no guide to see what other undertakings were doing in this matter, it was perhaps of interest as a comparison. Inquiries were made of 194 municipal electrical departments, and 171 replies were received. Of these 125 had not laid anything aside for depreciation other than their statutory sinking fund. Combining the amounts set aside for depreciation and reserve, Mr. Bell reports that he found there were 114 out of the 171 undertakings that had laid aside portions of their surplus, varying from under 1 per cent. (23 undertakings) to between 16 and 17 per cent. (two undertakings). The other 57 had made no provision for either account.

Many undertakings in the south had not obtained the same favourable terms as to repayments of loans as Aberdeen, and therefore their sinking fund might be slightly higher. Still, he submitted for the Electricity committee's consideration that, while in no way endangering the stability of the undertaking, it was not necessary to lay aside such large sums annually for depreciation, in view of their having now wiped out any losses on their old generating station. He further submitted that the depreciation fund, which now amounted to £39,454, should be available for the replacement of obsolete plant, should such a contingency arise.

Mr. Bell recommended that the charges for the current year be reduced as follows: Ordinary consumers for lighting 5½d. per unit for the first hour of maximum demand and 1½d. after (in place of 6d. and 2d.); public lighting 5½d. per unit for first hour and 1½d. after (in place of 6d. and 1½d.); heating and short-hour motors 2½d. per unit for first hour and 1d. after (in place of 3d. and 1d.); motors for long-hour supply 2½d. per unit for first half-hour and 1d. after (in place of 3d. and 1d.). These alterations are calculated to reduce the revenue on the present output by £3,329, a reduction of £2,930 for lighting and £399 for motors and heating.

The accounts, which were adopted by the Council on Tuesday, show revenue £41,656, an increase of £2,609 over previous year, and after paying expenses the gross profit was £24,639.

Cheltenham.—The report of the borough electrical engineer (Mr. W. J. Bache) on the working of the electricity undertaking was considered by the Council on Tuesday.

The report stated that during the last four years the receipts had increased from £16,906 to £23,576 per year, while the expenditure on generation and distribution remained about the same. The number of private consumers on March 31 last was 465 and the revenue £10,963. Traction receipts last year increased from £1,942 to £3,836, but the low price charged (1·6d. per unit) left little margin. The financial charges on the undertaking amount to £10,886, and the net result of the past year's work was a profit of £2,573.

Greenock—The accounts of the electricity department for the year ended June 30 show capital expenditure £111,115, increase of £13,164 on the year.

The revenue was £18,626, including £7,381 from private lighting, £4,391 from power, £845 from public lighting, £5,563 for current for Greenock and Port Glasgow tramways and £268 rentals of free-wired installations and motor hire. Expenditure was £11,140, including £400 to meet depreciation of hired installations and motors and £373 repaid on account of Parliamentary expenses. Rents, rates and taxes required £1,041. Out of the gross profit of £7,486 interest absorbed £2,290 and instalments off loans £3,802, leaving (with £394 brought from previous year) a balance in hand of £1,787. 3,063,621 units were generated (compared with 2,082,299 in previous year). 73,070 were supplied to public lamps (same as previous year), 1,061,091 (917,450) to the tramways and 1,399,036 (851,863) to private consumers. The maximum supply demanded was 1,490 kw. (1,160 kw.)

Ilkeston.—In the auditor's report on the Corporation accounts for the year ended March it is stated that the total receipts of the tramways department for the year were £10,270. 7s. 10d., of which £3,794. 12s. 11d. was from the borough fund. Total payments were £9,076. 9s. 7d.

In the electricity department the total receipts (including £1,656. 5s. 3d. from general district rate) were £3,167. 13s. 7d. Total payments, £2,505. 17s. 3d.

Nottingham.—The report of the city auditors upon the accounts of the various trading departments of the Corporation for the past year has been issued.

The elective auditor (Mr. Mellers) states that the total receipts of the tramways amounted to £129,748. 3s. 4d., against £126,329. 19s. 7d. in 1904-5. The gross profit of £52,217. 4s. 6d. was appropriated as follows: Interest £16,917. 11s. 7d., sinking fund £5,830. 18s. 4d., repayment of loans £9,219. 19s. 2d., contribution towards purchase of motor omnibuses £900, contribution to general district rate £15,000 and contribution to reserve £4,276. 15s. 5d. Reserve now amounts to £45,528. 9s. 10d.

The total revenue of the electricity department for the past year was £80,247. 11s. 1d., an increase of £5,523. 2s. After paying all charges and writing off £248. 12s. 11d. for bad debts, the gross profit was £41,677. 13s. 7d., out of which £10,000 was contributed in aid of rates and £3,514. 3s. 8d. transferred to reserve, which now amounts to £29,936. 17s. 4d.

Mr. Gath's (the Corporation auditor) report on the electricity department gives the following comparative percentages of income and expendidure for the past four years:—

	1906.	1905.	1904.	1903.
Expenditure	48·06	50·19	51·46	47·70
Profits	51·94	49·81	48·54	52·30

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Johannesburg Town Council invite tenders for supply and delivery f.o.b. (at a port suitable for shipment to South Africa) of one-phase alternate-current motors with accessories. General conditions, specification and forms of tender from the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Tenders to the town clerk, Municipal Offices, Johannesburg, by Oct. 15.

Oxford Corporation invite tenders for the reconstruction, extension and electrical equipment of the existing horse tramways in the city and the leasing thereof. Proposals based on the overhead system of working will not be considered. Conditions of tender from the town clerk (Mr. Richard Bacon), to whom tenders by Sept. 17.

Rathmines District Council invite tenders for supply of electric mains, house service boxes, house meters, extension of switchboards, extension of accumulators, and battery booster. Tenders to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, co Dublin, by 10 a.m. Sept. 12.

Barking Town Urban District Council invite tenders for cleaning, lighting, extinguishing and renewal of lamps, lanterns, fittings, &c., of the whole of the public incandescent, Nernst and arc lamps within the district for one, two or three years. Tenders to Chairman of the Electricity and Tramways committee, Public Offices, Barking, by noon Sept. 12.

Edinburgh Corporation invite tenders for the wiring, fittings, &c., for the electricity supply installation at the police fire station, Stockbridge. Tenders to the Town Clerk, City-chambers, Edinburgh, by Sept. 12.

TENDERS RECEIVED AND ACCEPTED.

Bruce Peebles & Co., Edinburgh and London, have received from Messrs. Preece & Cardew (on behalf of Shanghai Municipality) an order for extension plant for the Shanghai electricity works, including two Peebles-Belliss 600 kw. steam dynamos with condensers, pipe work, &c, one 300 kw. motor-generator, h. and l.t. switchboards, cables and sundries.

Dundee Tramways committee have accepted the following tenders for the conversion of the Main-street route to electric traction and for the reconstruction of part of the Perth-road route: Bolckow, Vaughan & Co., rails; P. & W. Maclellan, anchor plates and tie bars; John M. Fyffe, granite setts and chippings; Martin & Macfarlane, whinstone setts. The total value of the contracts is about £5,000.

The Key Engineering Co. have obtained the following orders for supply of fibre conduit:—

London Electric Supply Corpn. (50,000 ft. of 3 in. conduit), Melbourne Corporation (54,000 ft. of 3 in.), Bournemouth & Poole Electricity Supply Co. (36,000 ft. of 2 in.) and Glasgow tramways department (90,000 ft. of 2½ in.).

Bristol Corporation have placed an order with Bruce Peebles & Co. for one 500 kw. and two 300 kw. Peebles-La Cour motor converters to convert 6,000 volt three-phase to 500-550 volt continuous current. (A repeat order.)

Dover Corporation have accepted the tender of the Railway & General Engineering Co. to treat a quarter mile of tramway track on their renewable plate system of joining ends of rails, at a cost of about £100.

Plymouth Electricity committee have accepted the tender of Cory Bros. for supply of 5,500 tons of Powell-Duffryn coal at 14s. 5½d. per ton.

Gloucester Light Railways committee have accepted the tender of Johnson & Phillips for the supply of dynamo superfine and micanite tape for the ensuing 12 months.

Bruce Peebles & Co. have received from Messrs. Hubert Davies & Spain, as main contractors for the Natal Government railway, an order for a 200 kw. motor converter, converting 6,000-6,600 volt alternating to 500–550 volt continuous current. (Repeat order.)

The Agent-General for Tasmania has placed an order with Johnson & Phillips for the supply of motor booster and switchboard for the hospital for the insane, New Norfolk.

Heckmondwike Council have accepted the tender of the Tudor Accumulator Co. for the repair of the storage battery and 10 years' maintenance.

Calcutta Port Commissioners have accepted the tender of Balmer, Lawrie & Co., Calcutta, for supply and erection of two electric cranes at Rs. 18,800 (£1,253).

Babcock & Wilcox have received orders for four 1,000 H.P. boilers, steam and exhaust piping, &c., from Bombay Tramway & Electric Supply Co.

Scarborough Council have accepted the tender of Walker & Hutton for supplying and erecting electric motors for driving the municipal stone-breaking plant at £226. 5s.

Bolton Electricity committee have accepted the tender of J. Musgrave & Sons for two Lancashire boilers.

Bolton Scavenging committee have accepted the tender of the Bolton Electricity committee for wiring the Hacken works.

Chertsey Guardians have accepted the tender of the General Electric Co. for supply of telephones.

Wrexham Council have accepted the tender of the Triplex Co. for electric light fittings for the library at £46. 4s.

Totnes Council have accepted the tender of Lord & Shand for wiring the boardroom.

Bolton Electricity committee have accepted the tender of Ferranti Limited for a three-phase switchboard.

Bruce Peebles & Co. have secured the Duchy Development Association's order for two 200 k.v.a. rope-driven three-phase alternators.

BUSINESS NOTICES.

Mr. W. H. Patchell, who has been engineer-in-chief of the Charing Cross, West End & City Electricity Supply Co. for the last 13 years, has now completed a seven years' engagement with them in connection with their City of London extensions, and will in future engage in private practice as consulting engineer. He proposes to devote special attention to the use of electricity in mines. Mr. Patchell has now removed to his new offices at Caxton House, Westminster, S.W. Telegrams: "Patchell London"; tel ephone 898 Westminster.

Mr. Philip C. Pope, lately in charge of the consumers' department of the Lancashire Electric Power Co., has been appointed branch manager of the new Manchester office of Siemens Bros. Dynamo Works (Ltd.), 196, Deansgate, Manchester. Mr. H. Wynne Pierce has left Callender's Co. (with whom he has been for the past six years as construction engineer) to join the staff of Siemens Bros. Dynamo Works at the Manchester branch, and Mr. G. Seton Chisholm has resigned his position with the Howard Asphalte Troughing Co. to also associate himself with the Manchester Branch office of Siemens Bros. Dynamo Works.

Fras. Hy. Wells and Norbert Deutchberger, of the Electro-Mechanical Engineering Works, 211, Hackney-road, London, N.E., have dissolved partnership. Debts by Mr. Deutchberger, who continues.

H. M. Morris, Geo. Morris and Thos. Morris, electricians, &c., Railway-road, Leigh, have dissolved partnership. Debts by Messrs. H. M. and G. Morris, who continue as Morris & Morris.

Edgar Thornton and John C. Crowdy, electrical engineers, trading as the Swindon Motor Engineering Co., have dissolved partnership. Debts by Mr. Crowdy, who continues.

John Wm. Waring and Samuel P. Marsh (trading J. W. Waring & Co), electrical engineers and contractors, 27, Regent-street, Rugby, have dissolved partnership. Debts by Mr. Marsh, who continues under the old style.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of Bernard Sherman, electrical engineer, took place last week.

In 1902 debter commenced to trade alone (with £270) as a telephone specialist at 16 and 17, Devonshire-square, London, E.C., under the style of Sherman, Redfern & Trench. In January, 1903, he was joined by D. W. Muston, and in the following April Francis H. Regers, patent agent, also became a partner. In 1905 the partnership was dissolved, debtor taking over the assets and liabilities, and he had since endeavoured to exploit patents. In February last he sold his telephone business and connection. He attributed his insolvency to inability to realise patents and losses in connection therewith. Examination was closed, the accounts shewing liabilities £1,526. 5s. and assets £252. 17s.

A first and final dividend of 8d. will be payable on Sept. 12 at 26, Baldwin-street, Bristol, in the bankruptcy of James M. Vaughan, electrical engineer, 27, Harrowdene-road, Knowle, and Three Queens-lane, Bristol.

The Prism Globe Co. (Ltd.), 35, Brown-street, Manchester, is winding up voluntarily. Mr. W. Dearden, 36, Spring-gardens, Manchester, is liquidator.

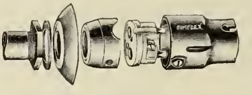
A meeting will be held at 35, New Broad-street, London, E.C., on Oct. 2, to receive an account of the winding-up of the Pioneer Electric Light & Power Co. of China (Ltd.).

Mr. John Butterfield, receiver and liquidator in the matter of the Sun Fan Co., Ltd. (in voluntary liquidation) announces that the plant, stock-in-trade and book debts have realised (net) less than £1,500. The first, second and third series of debentures, with interest, require £4,000. The first debenture holders have been paid up in full, holders of second debentures will get between 1s. and 2s. in the £, and the third debenture holders nothing. A similar division of nothing in the £ is all that is available for the ordinary creditors and shareholders of the company.

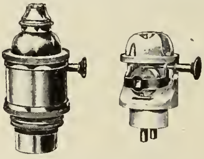
Sale by Auction.—Messrs. Horne & Co, 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Sept. 25, at 11 a.m., a quantity of unserviceable and obsolete stores, including one crane, four lathes, lead and founders' ashes, iron and steel, copper, gunmetal, lead, zinc, &c., electric cable, telegraph instruments, electric lamps, &c. The lots may be viewed on the Friday and Monday previous to and on morning of sale. Catalogues at the War Office, Pall Mall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Plant for Sale.—Rhyl District Council invite tenders for the purchase of one 165 kw. steam dynamo now in use at their works. Tenders by noon of 21st inst. Particulars from the electrical engineer, Mr. Ernest H. Wright, Electricity Works, Rhyl. See an advertisement.

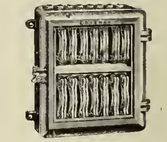
Simplex Specialities.—Simplex Conduits (Ltd.), have added to their already instructive series of leaflets, issued in connection with the large range of fittings, &c., on the Simplex system, a leaflet describing three additions to this system. One of these is an entirely new patent lampholder for use in damp situations and on underground railways, tramways, &c., where certain disadvantages of the ordinary brass lampholder have been found. We give an illustration of the new lampholder below. The holder is made of galvanised steel and can be used for screw bracket arms or pendant drops. It is in two parts only (as shown one-half size in the accompanying illustration) and can be readily wired and fixed up. It is provided with a drain cup and rubber washer, which prevents any moisture from entering the fitting. A new form of ceiling rose, direct mounting for socket or screw conduit, is also shown. This rose is specially designed for mill and factory lighting. It is mounted direct on the iron box, and will, it is claimed, be found to considerably cheapen the cost of wiring. The porcelain rose is in one piece, and the terminals, which are large and designed for loop-in wiring, are sunk into the porcelain in a manner to facilitate the wiring of the fitting. Finally, there is a novel type of wall fastener listed designed to facilitate the erection of conduits by dispensing with the necessity for plugging.



"**Ediswan" Fittings and Accessories List.**—A very complete catalogue of electrical accessories has been issued by the Edison & Swan United Electric Light Co., dealing exclusively with articles in actual present use, all obsolete types having been eliminated. There are a large number of excellent illustrations in the list and several entirely new lines are shown and described. Features to which attention may be particularly drawn are a new patent type wall and floor sockets, new pattern flush switch covers. "Wedge" tumbler switch with independent break (listed in a variety of combinations), and "Economic" boards in iron cases (of which we illustrate an example). The safety switch is a novel idea, and is specially suitable for places where high quality accessories are essential. It is claimed to be probably the finest switch on the market. Many other important items are included in the new list, which is provided with a good index for ready reference. We illustrate also a patent "Push-button" switch-holder (half-size).



Ediswan H.V. "Push-button" Lampholder.



Ediswan H V. "Economic" Fuseboard.

P.P.P. Plant List.—An excellently arranged and well illustrated pamphlet (No. 17) of continuous-current motors manufactured by Bruce Peebles & Co. is now ready, and recites that the continuous-current motors illustrated in the catalogue supersede the well-known octagonal and split circular motors manufactured by this company, the protected type of motor here described being specially designed to meet the modern demand for a more open and better ventilated machine than the earlier types. Protection from possibility of mechanical injury has been carefully arranged for, but where additional protection is required the machine can be converted from the protected to the enclosed ventilated type by fitting perforated covers over the openings in the end brackets. Absolute standardisation is a feature upon which particular stress is made by Messrs. Bruce Peebles & Co. A set of tables at the end of the pamphlet shows the large selection of outputs and speeds available to meet ordinary or particular needs of the consumer. Machines up to 125 H.P. for the standard voltages in common use are listed, and the arrangement of the list is one that will appeal to the purchaser from the evident endeavour made to meet his requirements.

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Aug. 29 to Sept. 4, with the ports of destination :—

Aden, £14 (including £6 telegraph material). *Africa*—Alexandria, £128 (including £78 telegraph material); Cape Town, £149 (including £91 telegraph cable); Delagoa Bay, £1,302 (including £565 telegraph material); Durban, £598; East London, £4,465; Port Elizabeth, £295; Port Said, £16; Port Sudan £15. *Argentina*—Buenos Ayres, £264 (including £213 telegraph material); Rosario, £590 (telegraph material). *Australasia*—Adelaide, £60; Auckland, £249; Brisbane, £36; Fremantle, £17; Lyttelton, £10; Melbourne, £1,102 (including £770 telegraph material); Sydney, £585 (including £30 telegraph material); Wellington, £550 (including £76 telegraph material). *Belgium*—Brussels, £796 (including £41 telegraph material); Ostend, £6. *Brazil*—Rio Janeiro, £1,215 (including £1,173 telegraph material). *Burma*—Rangoon, £495. *Canada*—Halifax, £1,000 (telegraph material). *Ceylon*—Colombo, £292 (including £156 telegraph material). *Chili*—Iquique, £42; Valparaiso, £29. *China*—Canton, £64; Foochow, £14 (telegraph material); Hankow, £481; Shanghai, £348; Tientsin, £174. *France*—Boulogne, £7; Paris, £20. *Germany*—Bremen, £20. *Gibraltar*, £142. *Holland*—Amsterdam, £36. *Hong Kong*, £324. *India*—Bombay, £2,624; Calcutta, £1,067 (including £84 telegraph material); Karachi, £9. *Japan*—Kobe, £116; Yokohama, £441. *Malta*, £125. *Norway*—Christiania, £93 (telegraph material). *Portugal*—Lisbon, £100 (telegraph material). *St. Helena*, £22 (telegraph material). *Straits Settlements*—Penang, £778 (including £311 telegraph material); Singapore, £1,948. *Russia*—Vladivostock, £28. *Sweden*—Gothenburg, £49; Stockholm, £508 (including £498 telegraph material). *Uruguay*—Monte Video, £6. Total £23,864, against £11,563 in the corresponding week last year (Aug. 30 to Sept. 5.)

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

July 28, 1906.

17,047 Knebn. Automatic spring points for tramways.
17,071 Parusel. Signalling apparatus for electric railways.
17,079 Hitching. Magnetic motors or generators.
17,086 Graham. Telephonic transmitters.

July 30, 1906.

17,115 Preuss. Making dynamo brushes. (Date applied for, July 28, 1905.)*†
17,130 Delany. Telegraphy.*
17,166 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges., Germany.) Apparatus for protecting circuits against excessive currents.*
17,171 Mitchell. Track of tramways and railways on the surface-contact system.
17,172 Mitchell. Surface-contact electric traction systems.
17,174 Buckeridge & Buckeridge. Electrical conduction.*

July 31, 1906.

17,201 Frost. Device for collecting and transmitting electrical energy.
17,225 Wilson. Price varying mechanism for pre-payment meters.*
17,226 Smith & Linzell. Electromagnetic devices for obtaining a sequence of effect as applied to automatic-controlling devices and the like.
17,236 Burnand. Multi-speed electric motors.
17,255 Johnson. (Felten & Guilleaume Lahmeyerwerke A.-G., Germany.) Direct-current dynamo-electric machines.*
17,259 Dakhyl & Galanti. Appliances for producing electric light displays.
17,268 Luxemburg & Rhmarczewski. Rotary motors.
17,272 Walker. Apparatus applicable to electric signalling.

August 1, 1906.

17,280 Bennett. Lubricating tramway rails to reduce friction.
17,293 Moule & Hasell. Automatic electric fire-alarm.
17,303 Cemar & Whitney. Lifeguard for tramway cars and other vehicles.
17,314 Leivesley. Apparatus for enabling telegraph stations to simultaneously communicate with each other.*
17,318 Crompton & Co., Macfarlane & Burge. Apparatus for automatically controlling speed of alternating-current commutator motors.
17,321 Waygood & Co. & Walker. Electrically-controlled lifts or hoists.
17,338 Moores & Petrides. Regenerative electric battery.
17,342 Felten & Guilleaume-Lahmeyerwerke A.-G. Electrical sterilising apparatus. (Date applied for, Aug. 1, 1905.)*†
17,343 Felten & Guilleaume-Lahmeyerwerke A.-G. Electrical current interrupters. (Date applied for, Aug. 18, 1905.)*†
17,349 Northcott. Wheels for overhead trolley for electric cars.

August 2, 1906.

3,677a Siemens Bros. & Co. (Siemens Schuckertwerke Ges., Germany.) Regulation of alternating-current circuits subject to fluctuations of load. (Date applied for, Feb. 14, 1906.)
17,355 Farrell. Dynamo-electric machines.
17,370 Nolden & Koch. Turbines.
17,378 Tweedale & Tweedales & Smalley. Electric stop motions of drawing slubbing, roving and like frames.
17,384 Walker. Electric circular rim and lever for nickel plating barrels.
17,404 Davies. Fittings to be used with electric lighting.
17,410 Cloud. Automatic fluid-pressure brakes.
17,419 Hahner. Switches or line selectors for telephones and the like. (Date applied for, Nov. 14, 1905.)*†
17,422 Mercader. Making car wheels.*
17,434 Allgemeine Elektricitäts-Ges. Electric metering apparatus. (Date applied for, Aug. 2, 1905)*†
17,447 McHardy & Bowell. Electric clocks and like instruments.
17,459 Felten & Guilleaume-Lahmeyerwerke A.-G. Electrical machines having flywheels. (Date applied for, Nov. 21, 1905.)*†

August 3, 1906.

17,484 Spencer. Automatic alarm for use with sand boxes.
17,490 White. Trays for storage batteries.
17,500 Veritys Limited & Worsley. Inclined carbon arc lamps.*
17,513 Butcher, Butcher & Brown. Arc lamps.
17,515 Stewart. Telephone call boxes.
17,526 Hagerty. Electrical alarm thermometers and like instruments.
17,537, 17,538, 17,539 & 17,540 Hannz & A.B.P. Accumulator Co. Acumulators.
17,560 Steinmetz. Dynamo-electric machines. (Date applied for, 8/7/05.)*†
17,561 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric distribution employing transformers and controlling apparatus therefor.
17,562 Warwick Machinery Co. (G.E. Co., U.S.) Turbines.
17,563 Gray. (A.E.G., German .) Signalling systems and apparatus therefor.
17,564 White & Hoegerstaedt. Electro-mechanically operated valves.
17,570 Bassett. Emergency brake for trams and other vehicles.

August 4, 1906.

17,585 Helmer. Telephone support.
17,589 Ellis. Securing shades of silk, paper or like materials to electric lamps.
17,590 Paterson & Ramsay. Turbines.
17,601 Fuller, Fuller, Fuller, & Moore. Magneto-electric ignition for internal-combustion engines.
17,614 Röchling & Rodenhauser. Materials for transmitting electric currents.*
17,615 Röchling & Rodenhauser. Obtaining thin liquid dross in electric furnaces for metallurgical purposes.*
17,647 Corthésy, jun., & Griffin. Turbines.
17,668 Lambert. Fittings and connections for incandescent lamps.

August 7, 1906.

17,703 Davies. Single-phase alternating-current motors.
17,735 Moore. Braking apparatus for tramways and the like.
17,742 Curtis & Adams. Solenoid-controlled switches.
17,760 Gardner. Construction of brake for tramcars and the like.
17,768 Bridge. Electrically treating air and other gases.*
17,771 Hicks. Fluid pressure brake systems.*
17,783 Haddan. (Soc. Anon. Etablissements Piquet & Cie., France.) Regulation of multiple-expansion turbines.*
17,785 Javaux. Regulating the P.D. at the terminals of dynamo-electric generators driven at varying speeds. (Date applied for, 9/8/05.)

August 8, 1906.

17,786 Wilkinson. Electricity supply systems.
17,790 Foster. Blading apparatus of turbines and pumps.
17,800 Scoccimarro. Cutout and distribution boxes.
17,804 Fox. Brakes of cranes, tramcars, &c.
17,812 Electric Ignition Co. & Hall. Appliances for use with electric ignition systems.
17,827 Siemens Bros. & Co. (Siemens & Halske, A.G., Germany.) Electrical signalling apparatus serving both as transmitter and receiver operated by alternating currents.*
17,845 Warwick Machinery Co. (G.E. Co., U.S.) Governing mechanisms for turbines.
1,9616a/05 Schauli. Batteries. (Date applied for, Sept. 28, 1905.)

August 9, 1906.

17,870 Feather. Bearings of axles of tramcar and like vehicles.
17,886 Carl Borg Fabrik für elekt Installationsmaterial Ges. Apparatus for adjusting the height of electric lamps.*
17,897 Vaux & McCullough. Appliance for grinding and trueing the treads of railway and tramway rails.
17,898 Vaux & McCullough. Appliance for sanding tramway and railway rails.
17,903 Allsop. Power stations and bath houses.
17,911 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges., Germany.) Controlling single-phase commutator electric motors.*
71,930 Auerbach. Switches.*

August 10, 1906.

17,944 Walter. Wireless telegraphy.
17,946 Anderson & Co. & Ross. Rotatory bar electrical ignition for internal-combustion engines.
17,981 Wetter. (Elektrizitäts-A. G. vorm. Schuckert & Co., Bavaria.) Electrolytic production and separate collection of gases.
17,987 Bosel & Dénéréaz. Accumulators. (Date applied for, 11/8/1905.*†)
18,010 Camp. Letters for electric signs.*
18,013 Johnson. (Hartmann & Braun A.-G., Germany.) Electricity measuring instruments.*
18,060 Allgemeine Elektricitäts-Gesellschaft. Cooling electrical machines or apparatus. (Date applied for, Aug. 12, 1905.*†
18,079 Bradley & Salis-Schwabe. Electro-deposition of metals or alloys.
18,080 Ramén. Precipitating metals electrolytically.*
18,083 Horch. Commutator switch for two igniting sources of electricity.*
18,086 Herberts & Herberts. Fuse boxes.*

August 13, 1906.

18,119 Lacy. Dynamos and motors.
18,120 Lacy. Electric motors.*
18,123 Lacy. Method and apparatus for producing radio-active effects.*
18,135 Ross. Instruments for indicating the flow of currents of electricity through conductors.
18,145 Hodges. Turbines.*
18,155 Wright. Turbines.
18,168 Siemens Bros. & Co. & Turner. Transmitting synchronous and equal movements to a distance.
18,179 Grob. Electric installations working with turbo-dynamos and accumulators. (Date applied for, Sept. 19, 1905.)*†

SPECIFICATIONS PUBLISHED.

1905 Specifications.

12,170 Edmunds & Dawson. Cables.
13,883 London. Balancing single-flow fluid pressure turbines.
14,995 Johnson (Badische Anilin & Soda Fabrik). Production of long stable arcs.
16,292 Kallmann. Starting and controlling devices for electric motors.
18,824 Miess. Incandescence vapour lamps.
19,923 Andrew & Seacombe. Dry seat for tramcars.
20,077 Willans & Robinson & Peache. Steam turbines.
21,034 Arnold & La Cour. Single-phase alternating-current motors with commutating poles. (Date applied for, Oct. 19, 1904.)
21,753 B.T.-H. Co. (G.E. Co., U.S.) Resistances.
22,061 Oppenheimer. (A.-G. Mix & Genest.) Telephones.
22,856 B.T.-H. Co. (G.E. Co., U.S.) Switches.
24,849 Harris. Apparatus for the generation of ozone.
25,255 Crosta & Bidder. Tramway crossings.
25,297 Smith. Steam turbine.
26,680 Edgar Allen & Co. & Warlow. Tramway points.

1906 Specifications.

1,804 Haigh, Wheeler & Appleyard. Rendering certain substances non-conductive of electricity, waterproof and acid proof.
2,548 Letroteur. Safety apparatus for overhead electric conductors. (Date applied for, Feb. 10, 1905)
2,641 Physikalisch-technisches Laboratorium Ges. Resistances. (Date applied for, Feb. 2, 1905.)
4,076 Fauvin, Amiot & Cheneaux. Dashpot or checking device for electric measuring apparatus.
7,889 Tingley. Dynamo-electric machines for rotation at high speeds. (Date applied for, April 10, 1905.)
8,786 Elektrizitäts A.-G. vorm W. Lahmeyer & Co. Dynamo-electrical machines. (Date applied for, April 28, 1905.)
9,273 Siemens Bros. & Co. (Siemens & Halske A.-G.) Reducing reflex action at points of connection of conductors or circuits differing in the values of their electrical properties.
10,513 Siemens & Halske A.-G. Alloy for bearings. (Date applied for, Sept. 22, 1905.)
11,300 Bergmann-Elektricitäts Werke A.G. Rotary field magnets for single and polyphase generators. (Date applied for, May 20, 1905.)
11,498 Trunkhahn. Obtaining electrolytic metallic deposits.
11,767 Consortium für Elektrochemische Industrie Ges. Producing calcium hydride. (Date applied for, May 19, 1905.)
12,488 Herde und Ofenfabrik Commanditgesellschaft F. A. C. Gutjahr & Co. Electrically heated stove. (Date applied for, May 9, 1906.)
12,493 Jackson. Connection system for supplying alternating currents of variable voltage. (Date applied for, June 12, 1905.)
14,712 Arnold. Continuous or alternating current electrical machines with commutating poles. (Date applied for, Oct. 20, 1905.)

COMPANIES' MEETINGS AND REPORTS.

ASCOT DISTRICT GAS & ELECTRICITY CO.—At the recent meeting the chairman (Mr. J. Manwaring) said the company's 1906 Act authorised the change of the company's name from the Ascot District Gas Co. to the Ascot District Gas & Electricity Co. The company was now in the unique position of possessing electric powers after having exercised those of gas for 24 years. The shareholders need have no apprehension that the directors had taken the proper steps and at the proper time. There were a large number of houses in the neighbourhood of Sunningdale that had already been wired for electric light, and had the company not obtained powers, it was more than probable the various would-be consumers would have established their own electric lighting plant, either separately or in co-operation with their neighbours. The directors would, in the immediate future, take steps to ascertain the requirements of the inhabitants so far as electricity was concerned, and he thought the result would justify their action.

BROWN, BOVERI & CO. (MANNHEIM).—During the past year the electrical and steam-turbine departments could (the directors' report states), although working day and night, hardly keep pace with orders. The orders in hand at the beginning of the current year are of the value of over £37,500. Electrical energy for driving the machinery at the works was formerly taken from the municipal supply station, but independent plant has now been erected at the company's works. During the year orders for steam turbines of an aggregate of 180,000 H.P. were received from German customers alone, the largest machine ordered being of 9,000 H.P. The electrical department was mainly engaged in the manufacture of generators and motors for mines and foundries, and the h.t. switchboard and switch-gear department was also actively employed. The revenue was £89,990, compared with £59,903 in previous year, and after paying general expenses and other charges and writing off £19,549 the profit was £22,878, against £9,480 in the previous year. A dividend of 6 per cent. has been declared, against 5 per cent.

YORK TRAMWAYS CO.—Mr. Joseph Kincaid stated at the meeting on Wednesday that the Corporation had resolved that it was advisable to purchase the tramways. The directors had taken the best possible advice in case the legal notice to purchase should be given. The Corporation had appointed a committee to effect the purchase by agreement and correspondence had passed between them. This, however, did not prejudice the rights of either party, and in view of the notice to purchase that might possibly be given at the beginning of next year it was not advisable to discuss the negotiations.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

CASCADE (1906) POWER CO. (LTD.) (89,964.)—Reg. Aug. 27, capital £75,000 in £1 shares, to acquire the assets and undertaking of the Kettle River Power Co. (Ltd.) and to carry on in British Columbia, U.S.A. and elsewhere the business of an electric light, heat, power, telegraph and telephone company. Reg. office, 695, Salisbury-house, London, E.C.

HOMOIL (LTD.) (90,010.)—Reg. Aug. apital £30,000 in £1 shares, to acquire certain patent rights for the production of gas from heavy hydrocarbons and apparatus used in connection therewith, to adopt an agreement with Gruenewald's Patents (Ltd.), and to carry on the business of electrical and mechanical engineers, constructors of and dealers in electrical and mechanical apparatus and appliances, &c. First directors, E. Phillips, A. M. Billington (managing) and F. Toni.

P. & H. SYND. (LTD.) (90,019.)—Reg. Aug. 31, capital £20,000 in £1 shares, to construct, maintain and work or lease or obtain running powers over any tramways or railways in the United Kingdom, and to carry on the business of tramway and railway proprietors, suppliers of electricity, manufacturers of and dealers in all apparatus and appliances used in connection with the generation, distribution and use of electricity, &c. Reg. office, College-hill-chambers, London, E.C.

ROBERT H. EDGAR (LTD.) (90,012.)—Reg. Aug. 30, capital £5,000 in £1 shares, to acquire business of R. H. Edgar and H. Roberts, and to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electrical, telegraphic, telephonic, and other apparatus, &c. First directors, R. H. Edgar, H. Roberts, N. Snell and A. Snell. Reg. office, Stanley-house, Eldon-park, Norwood, Surrey.

STATUTORY RETURNS.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The capital in return to July 3 is £120,000 in 60,000 preference and 60,000 ordinary shares of £1 each, all of which have been taken up. £1 per share has been called up on 50,000 preference and 50,000 ordinary, and £100,000 has been received. £20,000 is considered as paid on 10,000 preference and 10,000 ordinary. Mortgages and charges, nil.

A. HIRST & SON (LTD.)—Return to July 5 gives capital as £5,000 in 100 preference and 400 ordinary shares of £10 each, of which 100 preference and 310 ordinary have been taken up. £10 per share has been called up on 100 preference and 10 ordinary, and £1,100 has been received. 300 ordinary shares are considered as fully paid. Mortgages and charges, £2,000.

MORTGAGES AND CHARGES.

F. W. DICKINSON (LTD.)—A memorandum of satisfaction in full of a debenture dated April 4, 1906, securing £100, has been notified.

£300 $7\frac{1}{2}$ per cent. mortgage debentures, created Aug. 17 and dated Aug. 20, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have also been registered. No trustees.

CITY NOTES.

MEMORANDA (Sept. 6).—Bank rate $3\frac{1}{2}$ per cent. (since June 21, 1906). Price of silver $31\frac{1}{2}$d. per oz. Consols $86\frac{1}{2}$—$86\frac{5}{8}$ for money, $86\frac{11}{16}$—$86\frac{13}{16}$ for account; $2\frac{1}{2}$ per cent. annuities $85\frac{1}{4}$—$85\frac{3}{4}$. Consols Pay Day, Oct. 3; Stocks and Shares Continuation Day, Sept. 11; Ticket Day, Sept. 12; Pay Day, Sept. 13; Mining Share Carry-over Day, Sept. 10.

PREMIER ELECTRIC LAMP CO. (LTD.)—A petition for confirming a resolution reducing the capital from £100,000 to £35,630. 17s. will be heard at the County Palatine Court, Lancaster, at Liverpool, on Sept. 25.

RAND CENTRAL ELECTRIC WORKS (LTD.)—The result of the working for August was 1,065,000 units generated, yielding a gross revenue of £10,300, compared with 986,000 units, yielding £9,000, in the corresponding period of last year.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to allow a further issue of 10,000 £10 fully-paid 6 per cent. cumulative preference shares of the *County of London Electric Supply Co. (Ltd.)* to be quoted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 29	1,739	+ 218	13	401,982	− 75
Airdrie	,, 24	232	− 4	34	7,418	+ 654
Anglo-Argentine	Sept. 2	15,475	+ 2,162	35	518,180	+ 56,948
Ashton-under-Lyne Corp.	...	...	...	...	...	...
Ayr Corporation	,, 1	362	+ 5	16	6,597	− 31
Baker St. & Waterloo Ry.	,, 1	1,363	...	9	11,790	...
Barnsley	Aug. 24	230	− 1	34	5,575	+ 39
Barrow	,, 24	325	+ 17	34	8,751	+ 491
Bath Electric Trams, Ltd.	,, 29	1,075	+ 343	35	28,835	+ 5,079
Birkenhead Corporation	...	...	...	...	...	...
***Birmingham Corporation**	Sept. 1	1,423	+ 1,073	22	20,175	+ 12,337
Birmingham & Mid.	Aug. 24	9,909	− 303	34	346,212	+ 17,423
Blackburn Corporation	,, 29	1,039	+ 30	¶22	34,153	+ 1,329
Blackpool Corporation	,, 30	2,470	+ 153	21	34,418	+ 1,747
Blackpool and Fleetwood	Sept. 1	1,842	+ 395	...	...	...
Blackp'l, St. Anne's & Lytham	...	...	...	...	...	...
Bolton Corporation	,, 2	2,339	+ 481	22	48,753	+ 3,377
Bournemouth Corporation	Aug. 29	2,552	+ 629	†22	39,721	+ 8,232
Bradford Corporation	Sept. 1	4,851	+ 293	22	104,597	+ 4,191
Brighton Corporation	,, 2	1,434	+ 150	22	24,761	− 919
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	Aug. 31	5,376	+ 341	3	10,780	+ 467
Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trms.	,, 4	994	− 122	32	42,019	+ 7,225
Burnley Corporation	Sept. 1	1,281	+ 114	22	26,266	+ 1,382
Burton Corporation	,, 2	332	+ 9	§22	6,999	− 423
Bury Corporation	Aug. 26	1,032	..	21	21,422	...
Calcutta Tramways Co.	Sept. 1	R43,008	+ R742	9	R393,149	+ R9,203
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	Aug. 25	2,325	+ 189	21	45,457	− 718
Cavehill	,, 24	122	+ 73	34	3,066	+ 1,234
Central London Railway	Sept. 1	5,131	− 389	9	48,527	− 2,416
Chatham & Dist. Lt. Rys.	Aug. 30	933	+ 229	†35	23,140	− 314
City & South London Rly.	Sept. 2	2,336	+ 6	9	21,666	+ 1,302
Colchester Corporation	Aug. 30	262	+ 22	...	...	...
Cork Electric Trams Co.	,, 30	564	+ 37	35	16,908	− 302
Croydon Corporation	,, 31	1,577	+ 290	13	21,443	+ 1,549
Devonport & Dist. Trams	,, 24	533	+ 45	34	15,515	− 318
Dover Corporation	Sept. 1	372	+ 96	22	6,366	+ 917
Dublin & Lucan Railway	Aug. 31	153	− 4	§9	1,323	− 46
Dublin United	,, 31	7,912	+ 2,391	‡9	52,763	+ 2,272
Dundee Corporation	,, 29	1,143	+ 293	§15	16,947	+ 3,582
East Ham Council	Sept. 1	979	+ 169	22	21,149	+ 1,912
Exeter Corporation	Aug. 31	371	+ 51	22	6,811	− 313
Falkirk and District	,, 29	319	...	...	...	...
Gateshead & Dist. Trams	,, 24	1,051	+ 53	31	32,837	+ 1,775
Glasgow Corporation	Sept. 1	17,519	+ 2,392	14	224,312	+ 18,356
Glossop	Aug. 11	146	+ 9	35	4,504	+ 376
	,, 18	145	+ 8			
	,, 25	144	...			
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 24	297	+ 5	34	8,239	+ 317
Gt. Northern & City Rly.	Sept. 1	1,513	+ 47	9	13,891	+ 1,031
Greenock & Port Glasgow	Aug. 24	789	+ 67	34	22,693	+ 972
Halifax Corporation	,, 29	1,760	+ 89	22	38,419	+ 1,044
Hartlepool Tramways	,, 24	413	+ 82	34	10,274	+ 1,238
Hastings Elec. Trams Co.	,, 30	1,429	...	9	10,317	...
Huddersfield	Sept. 1	1,592	+ 154	22	344,731	+ 3,119
Hull Corporation	,, 1	2,275	+ 66	22	50,316	+ 1,018
Ilford Dist. Coun.	,, 1	528	+ 58	22	11,493	+ 67
Ilkeston Dist. Council	Aug. 29	154	+ 32	22	3,045	+ 280
Ipswich Corporation	Sept. 2	584	+ 88	22	10,559	− 154
Isle of Thanet Co.	,, 1	1,763	+ 394	47	27,746	− 560
Keighley Corporation	Aug. 30	170	+ 24	9	1,428	+ 40
Kidderminster & District	,, 24	154	+ 1	34	4,213	− 35
Kilmarnock Corporation	Sept. 1	163	+ 1	16	2,639	− 84
Kirkcaldy Corporation	Aug. 29	294	+ 68	9	2,354	+ 168
Lanarkshire Trams Co.	,, 30	989	+ 61	†35	30,498	+ 5,690
Leamington	,, 24	196	− 25	34	6,092	+ 2,708
Leeds Corporation	Sept. 1	6,561	+ 554	22	141,892	+ 7,688
Leicester Corporation	,, 1	2,316	+ 191	35	77,374	+ 4,719
Leith Corporation	,, 1	574	+ 210	‡16	8,633	+ 4,295
Lincoln Corporation	,, 1	125	..	22	2,668	...
Liverpool Overhead Rly.	,, 2	1,498	− 15	9	14,324	− 521
Liverpool Corporation	Aug. 25	11,124	+ 50	34	365,269	+ 5,482
***London County Council**	...	...	...	...	...	...
London United	,, 31	7,353	+ 1,551	†35	220,064	+ 14,102
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	Sept. 1	142	+ 14	22	2,893	− 275
Manchester Corporation	,, 1	14,835	+ 2,062	22	306,840	+ 16,831
Mersey Railway	,, 1	1,551	+ 39	9	14,688	+ 1,135
Merthyr	Aug. 24	199	+ 14	34	6,641	+ 135
Metropolitan Dist. Railway	Sept. 2	6,727	+ 383	9	64,731	+ 7,134
***Metropolitan Elec. Trams**	Aug. 24	3,946	+ 570	34	115,686	+ 27,501
Middleton	,, 24	514	+ 5	34	12,167	+ 321
Nelson Corporation	Sept. 1	163	+ 11	23	3,365	+ 271
Newcastle-on-Tyne Corp.	,, 1	3,957	+ 306	22	90,860	+ 5,771
Newport (Mon.)	,, 1	711	+ 110	22	14,449	+ 752
Northampton Corporation	Aug. 31	501	+ 58	22	10,383	+ 103
Oldham, Ashton & Hyde	,, 24	713	+ 17	34	19,339	+ 515
Oldham Corporation	Sept. 2	2,612	+ 449	23	42,440	+ 3,949
Perth (N.B.) Corporation	Aug. 29	205	...	15	2,604	...
Perth (W. A.) Elec. Trams	Sept. 1	1,417	+ 140	35	51,390	+ 3,148
Peterborough	Aug. 24	159	− 6	34	4,458	− 334
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	...	...	...	...	...	...
Potteries	,, 24	1,685	+ 70	34	60,048	+ 3,006
Preston Corporation	,, 29	780	+ 74	9	7,337	+ 868
***Reading Corporation**	...	...	...	...	...	..
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 30	518	+ 89	22	11,161	+ 1,129
Rothesay	,, 24	520	− 4	34	8,491	+ 1,079
Salford Corporation	Sept. 3	4,850	+ 709	22	102,613	+ 2,051
Sheerness	Aug. 22	87	− 14	34	2,024	− 422
Sheffield Corporation	Sept. 2	5,523	+ 788	23	122,853	+ 7,835
Singapore Trams	,, 1	$7,914	...	10	$68,276	...
Southampton Corporation	...	...	...	...	...	...
Southend Corporation	Aug. 29	708	+ 97	22	16,385	+ 366

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. ¶ Plus 3 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	Aug. 24	559	− 40	34	11,186	+ 192
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	Sept. 1	1,685	+ 276	22	32,803	+ 1,695
Sunderland & District	Aug. 29	450	...	35	13,859	...
Swansea Trams	,, 24	1,005	+ 8	34	28,302	+ 4,725
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 24	56	− 5	34	1,568	− 161
Tynemouth and District	,, 24	427	+ 22	34	9,146	− 158
Tyneside Trams Co.	,, 29	4,625	+ 59	35	15,965	+ 1,143
Wallasey District Council	Sept. 1	969	+ 132	22	19,240	+ 765
Walsall Corporation	,, 1	514	+ 40	32	18,090	+ 995
Warrington Corporation	Aug. 30	368	+ 23	22	8,227	+ 634
West Ham Corporation	,, 30	2,347	+ 255	22	51,230	+ 13,518
Weston-super-Mare	,, 22	458	+ 8	34	5,301	+ 222
Wolverhampton Corpn.	,, 29	815	...	9	8,093	...
***Worcester**	,, 24	351	− 13	34	9,700	− 771
Wrexham	,, 24	128	+ 21	34	3,495	+ 42
Yorkshire W.R. Trams	Sept. 2	1,003	+ 230	35	29,295	...
Yorkshire Woollen District	Aug. 21	971	+ 271	34	30,653	+ 8,805

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Sept. 5.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Sept. 5.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
5	5/0	Anglo-Argentine Ord. Shs.	$7\frac{7}{16}$—$7\frac{11}{16}$	5 4 6	Ap, Oct	7½	..
5	2/9	Do. 5½% Cnm. Pref.	5¾—6	4 11 8	—	$5\frac{31}{32}$	$5\frac{15}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	133—141	4 7 0	—	140½	140
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103—105	4 15 0	—	10 ¼	10 ½
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cnm. Pref.	4½—4¾	5 5 0	—	$4\frac{11}{16}$	$4\frac{19}{32}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99—104	4 6 6	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117—120	5 0 0	—	..	..
St.	5%	Do. Pref. Ord. Stk	110—113	4 8 6	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	106—109	4 11 6	—	108⅜	108
100	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	103½-105½%	4 5 3	—	104⅞	..
100	4½%	Do. Vancouver Power Debs.	101—104	4 6 0	—	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3⅜—3⅝	4 16 6	—	$3\frac{9}{16}$	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5½—5¾	5 4 0	—	5⅝	$5\frac{19}{32}$
5	8/0	Do. "B"	5—5½	5 0 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	104—106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102—105	4 15 0	—	104½	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	98—100	5 0 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101—105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102—107	5 12 0	..	..	..
6	4/6	Calcutta Tramways (Nos. 1 to 105)	8⅜—8⅞	4 10 6	—	8¾	$8\frac{17}{32}$
5	2/6	Do. Nos. 105,001 to 137,610	8⅛—8⅝	4 13 6	..	..	..
100	4½%	Do. 4½% 1st Deb. Stook (red.)	103—106	4 5 0	—	..	..
.	0/6	Cape Electric Tram Shares	½—¾	3 6 6	—	⅝	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100—108	4 18 0	—	103	101¾
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95—97%	5 3 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92—94	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	82—87	6 18 0	..	83	82½
1	1/0	Lisbon Elec. Trams Ord.	1⅜—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100—103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100—103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	100—102	4 8 0	—	..	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104—106	4 14 8	.	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	140—141	5 12 6	..	142¼	14[illegible]
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	99½	99¼
		ELECTRICITY SUPPLY.					
5	3/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞—5⅜	5 2 0	..	..	..
5	5/3	Calcutta Elec. (1-50,000)	5⅝—5⅞	4 8 3	..	..	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48—50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92—94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	88—92	5 8 6	—	91	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108—111	5 8 0	—	109	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$—$\frac{27}{32}$	7 8 6	—	..	..
1	1/6	Rand Electric	1—1⅛	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}$—$\frac{11}{16}$	..	..	..	..
1	1/2¾	Do. 6% Non. Cum. Pref	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99—102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99—102	4 8 0	Ap, Oct	—	...
—	5%	Shawinigan Water and Power 5% Bds., Scrip	99—101	4 19 0	..	99½	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Sept. 5.	Rate % Yielded.	Dividend Due.	Business, Week to Sept. 5. Highest.	Lowest.
				£ s. d.			
		ELECTRICITY SUPPLY.					
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10¼–11¼	6 4 0	..	–	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾–10¼	4 8 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾–11¾	5 2 0	..	11 1/16	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	104	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8½–8⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	8½–9	5 11 0	–	8⅝	..
5	3/6	Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	100 –103	3 17 9	–	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4½–5	5 0 0	Feb, Aug	..	..
5	2/8	Do. 4½ per Cent. Pref.	4½–5	4 10 0	Feb, Aug	4¾	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 0	–	102½	..
5	2/8	Do. City Undertaking 4½% Cm. Pref.	4 – 4½	5 0 0	–	4⅛	..
5	2/8	Do. Do. (1908)	4 – 4½	5 0 0	–	..	..
5	3/9	Chelsea Electric Supply Ord.	5½–6	5 4 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –108	4 3 3	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10⅞–11⅜	5 5 6	Feb, Aug	11¼	11
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	12 5/16	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 6 6	..	–	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞–3	4 0 0	April, Oct	..	–
5	5%	Do. Do. 5% non cum. pref.	5 3/16–5 5/16	4 5 3	April, Oct	.	..
10	4/0	County of London Elec. Supply Ord.	7⅞–8⅜	5 6 6	–	8 7/16	8 3/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾–12¼	4 18 0	Mar, Sept	11 31/32	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	8/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	–	..
5	5/0	Hove Electric Lighting Ord.	7⅞–8⅜	5 8 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5 0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	–	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	-
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 –101	3 19 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	102½	..
8	2/4½	London Electric Supply Ord.	1⅞–2⅛	4 4 0	–	.	..
5	3/0	† Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	5⅛	5
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 – 99	4 0 10	Mr,Jn,S,D	..	..
5	4 0	Metropolitan Electric Sup. Ord.	8½– 9	5 0 0	April, Oct	..	..
5	2/8	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 9	Jan. July	5 5/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞–11⅛	4 4 0	Feb, Aug	11	10 13/16
100	4½%	Do. 4½% Deb.	102½–103½	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝–7¾	5 5 11	Feb, Aug	7¾	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅝–5¾	4 8 0	Feb, Aug	5¾	5⅝
100	4%	Do. 4% Mort. Deb. red. 1907	100 –101	3 19 7	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1 7/32–1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March – –	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	.
5	4/6	Oxford Electric Ord.	6¼– 6¾	4 19 0	March ..	6½	6 7/16
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	10½–11½	5 8 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	7 - 8	4 7 0	Feb, Aug	..	–
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	3 – 3½	5 14 0	..	3⅜	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16– ⅞	..	..	..	–
1	0/8¾	† Do. 7% Cum. Pref.	1 1/16–1 3/16	5 5 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	-
5	2/6	Urban Electric Supply Ord.	3½ 4	6 10 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	4⅝	..
St.	4½%	Do. 4½% 1st Mort. Deb.	98 –101	4 9 0	..	100	..
5	5/6	Westminster Elec. Sup. Ord.	9¾– 10¾	6 6 0	Mar, Sept	10⅜	10 5/16
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 7/16	5 13/32
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	1 1/32	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	–	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	–	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	9½%	Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –108	3 17 6	Feb, Aug	..	.
10	6/0	British Electric Traction Ord.	5½– 6	5 0 0	–	5 13/16	5⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	9½–10	6 0 0	Feb, Aug	9 11/16	9 9/16
St.	5%	Do. 5 per Cent. Perpetual Debs	115 –118	4 4 8	..	116½	116¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	93½–95½	4 14 0	..	95	94¾
St.	4%	Central London Ordinary Stock	85 –87	4 12 0	June, Dec	86¼	85½
St.	4%	Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	98¾	..
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	..	..
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	109⅝	109¼
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 –91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 – 5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	44 –46	4 7 0	Feb, Aug	44	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 –122	4 2 0	Feb, Aug	–	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½– 4	10 0 0	..	3¾	3 23/32
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	101½	101¼
10	9%	‡ Imperial Tramways Ord	14½– 15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8⅛–8⅝	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	.	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾–9¼	5 8 0	–	9⅛	–
St.	4%	Do. 4% 1st Mort. Deb. Stock	94 –97	4 2 0	–	95½	..
St.	..	Mersey Con. Ord. Stock	5 –7	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 –10	–	–	..	..
1	..	Metropolitan Elec. Trams Def.	⅛ – 3/16	..	–	⅛	..
1	0/6	Do. 5% Cum. Pref.	13/16– 15/16	5 9 0	–	27/32	13/16
St.	4½%	Do. 4½% Deb. Stock	98½–100½	4 9 6	–	..	..
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May – –	..	..
10	8/0	Potteries Electric Traction Ord.	6½ 7½	5 8 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾– 8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 - 92	5 8 8	–	..	..
St.	3%	Waterloo and City Ord.	101 –104	2 17 9	June, Dec	–	..
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	..	–	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	–	..	–

Shre.	Last Dividend	Name.	Price Wed., Sept. 5.	Rate % Yielded.	Dividend Due.	Business, Week to Sept. 5. Highest.	Lowest.
				£ s. d.			
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½– ⅝	..	–	9/16	..
1	2/4½	Babcock & Wilcox Ord.	4⅛–4⅜	4 10 0	..	4 13/32	4¼
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	–
5	4/0	British Insulated & Helsby Cables Ord.	6¾–7¼	5 10 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5½–6	5 0 0	Jan, July	–	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	–
St.	4½%	† British Thoms'n-Houst'n 4½% 1st Mt. Db.	95 –97	4 12 9	..	..	..
5	..	British Westinghouse 6% Pref.	1¼–1¾	..	..	1⅝	1 9/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	..	..
2	1/0	Brush Electrical Engineering	⅞–1⅛	..	March ..	..	..
2	2/4¾	Do. 6 per Cent. Pref. Non-Cum.	1½–2	6 0 0	Mar, Sept	1 25/32	–
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –98	4 11 9	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	82¼	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	108	..
1	7⅜d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	1 3/32	1 1/16
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –100	4 8 0	–	..	..
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	–	..	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅝–1⅞	3 13 6	Jan, July	1 27/32	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–97%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	8⅝–8⅞	5 11 0	Sept – –	..	..
5	3/0	Do. 6% Cum. Pref.	7⅛–7⅜	4 5 0	Sept – –	..	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	–
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	4 5 6	Feb, Aug	1⅝	..
5	2/6	Do. (£5 paid)	2½– 3	4 3 0	Feb, Aug	–	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3⅜–3⅞	9 6 0	H'lf-yearly	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅞–5⅛	5 11 6	..	5 1/16	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	–	..
2	1/7½	Electric Construction Co.	¼– ½	14 0 0	July – –	..	..
2	2/9¾	Do. 7 per Cent. Cum. Pref	1¾– 2¼	6 4 0	July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	85 –88	4 11 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 – 9½	5 5 3	–	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 – 97	4 2 6	–	..	..
5	5/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	..	..
5	2/3	† Do. 4½ per Cent. Pref.	5¼– 5½	4 2 0	Feb, Aug	5 11/32	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½–109½	4 2 0	..	108¼	..
St.	2/6	Do. Do. Scrip (all paid)	107½–109½	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	..	..
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	101¼	..
10	5/0	† Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	–
1	1/2⅝	Richardsons, Westgarth & Co., Ltd. Ord.	31/32–1 1/32	5 16 0	..	..	..
1	7½d.	Do. 6% Cum. Pref.	1 –1⅛	5 7 0	–	1 3/32	..
St.	4½%	Do. 4½% Perp. Deb. Stock	99 –101	4 9 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33½–35½	5 12 6	Mar, July	34	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2½– 2⅝	5 16 6	..	2 19/32	2 9/16
1	6d.	Do. 5% Non-Cum. Preference	1 5/32–1 7/32	4 4 6	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	113 – 116	4 6 0	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	106	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 –107	4 4 6	–	106	10 ½
5	–	Willans and Robinson Ord.	¾–1¼	..	Apr. Oct	..	..
5	–	Do. 6 per Cent. Cum. Pref.	2¾ - 3¼	..	Apr. Oct	..	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	–
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½– 4	..	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	87 – 92	5 8 8	..	..	..
St.	15/0	Anglo-American	66 –68	4 15 9	F,My,Ag,N	67¾	..
St.	30/0	Do. Preferred	114 –115	5 4 0	F,My,Ag,N	11 ¾	114
St.	10/0	Do. Deferred	23¼–23¾	2 2 6	F,My Ag,N	24¼	23 1/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½ –98½	4 0 6	Jn Ap,Jy,O	98½	98
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	–
100	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..	..
20	6/8	Direct United States Cable	15¼–15¾	5 8 0	Ja,Ap,Jy,O	15¾	15 11/16
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	144 –147	4 15 0	Ja,Ap,Jy,O	146¼	145
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 17 9	Ja, Ap,Jy,O	92	91
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108½	107¾
10	2/6	Eastern Extension	14¼–14¾	4 15 0	Ja,Ap,Jy,O	14 11/16	14 7/16
St.	4%	Do. 4 per Cent. Deb. Stock	105 –107	3 14 9	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb. 1909	99 –101	3 19 0	Feb, Aug	.	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100% –102%	3 18 0	May, Nov	..	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37½–38½	6 0 0	Jan, July	38⅜	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	52/6	Indo-European	58 – 60	5 8 4	May, Nov	..	..
100	4%	Mackay Companies Common	75 3/16–76 1/16	5 5 0	Jan, July	–	..
100	4%	Do. Preference	73 3/16–73 11/16	5 8 0	Ja,Ap,Jy,O	..	–
1	..	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	1 1/16	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	–
5	–	West Coast of America	¾– ⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..	..
10	–	West India and Panama	⅜– ½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6½–6¾	8 18 0	May, Nov	6⅝	6½
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr,Jn,O,D	14 11/16	14⅝
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	104½	..
		TELEPHONES					
–	4%	Amer. Teleph. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	..	–
St.	5%	† Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	99 – 101	4 19 0	..	..	..
5	5 0	Chili Telephone (fully paid)	6¾–7¼	5 11 0	August ..	6¾	6½
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	–	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109 –111	5 8 0	–	110¾	109¾
St.	5%	Do. Def. Stock	109 –111	4 10 0	–	110½	109½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5⅝– 5⅞	4 7 0	Feb, Aug	5 23/32	5⅝
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	98¼	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½–104½	3 10 6	–	104½	103¾
1	0/2⅝	Oriental	1 1/16–1 3/16	4 3 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16–1 3/16	4 11 0	–	..	–
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	–	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	..	..
5	5/0	United River Plate	7 –7½	5 0 8	July – –	7¼	7⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾– 6¼	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½ – 5	6 0 0	–	..	..
10	2/0	Globe Telegraph and Trust	10⅞– 11⅜	4 10 0	Ja Ap,Jy,O	11 1/16	10 31/32
10	3/0	Do. 6 per Cent. Pref	14⅝– 14⅞	4 0 6	Ja Ap,Jy,O	14¾	14½
10	6%	Submarine Cables Trust (Cert.)	129 –132	4 11 0	April, Oct	..	–

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

WITH this issue of *The Electrician* readers will receive the first number of *The Electrician Industrial Supplement*. Supplements of one kind or another have often been issued in past years, but only as annual publications, or from time to time as occasion arose. From these the *Industrial Supplement* differs materially, for it will appear on the first Friday of every month, and will form a continuous record. For some time past we have found it impossible to devote adequate space to progress from the manufacturing point of view. No manufacturer can hope to maintain or improve his position if he is not continually introducing either novel appliances or improved designs. Such improvements are often of considerable interest, not merely to the manufacturer, but also to the user, and by dealing with such matters from month to month in the *Industrial Supplement* we hope to provide our readers with a continuous record which may be filed away separately for reference, and at the same time will not make *The Electrician* unnecessarily voluminous.

◆

SOME inventions have the misfortune of being before their time, and consequently suffer neglect. The Ward-Leonard system of traction with single-phase current is a case in point. This system has offered a solution of the problem of working long-distance railways for years past; it has frequently been referred to in discussions on the subject, but only recently has it been put to practical use. Yet, no sooner was it developed as the one solution of the single-phase problem, than the commutator motor, which had previously been discarded, was rendered suitable for doing the work in a simpler way. Nevertheless, the Ward-Leonard system has points in its favour, and the account of the Oerlikon locomotives given on another page will be read with interest, the more so that the Oerlikon Company have given attention to both these systems.

◆

IT is unfortunate that the District Railway, after a considerable trial of its new system, should find it necessary to raise its fares. A better course would have been to have started with somewhat higher fares and to have lowered them if the working cost permitted of doing so, though this course is always open to the objection that traffic may be discouraged. But the raising of fares gives a bad impression, which may be quite out of proportion to the loss in working. It is, perhaps, a little soon to criticise the increased cost of running as compared with the increased number of passengers carried. The additional cost in staff for the corridor trains is a serious item, and it is perhaps doubtful whether the gain in convenience is worth it. There is no doubt, however, that the increase in traffic as a whole is very considerable. It is not fair to consider the traffic per train-mile, as is done in one of our contemporaries, for the trains have less capacity than the old trains, and therefore the number of passengers per train-mile must be less. In fact, one of the advantages of electric traction is that the number of trains is largely increased, their capacity is less, the convenience is greater, and therefore the traffic becomes increased. Since, generally speaking, the trains on the District Railway are fairly well filled, it may be that a little judicious adjustment of fares and other details will give the desired result. Apparently one of the most serious items to be considered is that of workmen's trains. This part of the traffic has increased during the last 10 years from 5,000,000 passengers up to 16,000,000 per annum, and if they are carried at an unremunerative figure the loss may be very heavy. In this connection it is interesting to note that even the London County Council are unwilling to adopt a policy of unremunerative rates, and it can scarcely be expected that such a policy can be adopted beyond a certain point by any concern having to pay its own way.

We have received from Mr. B. H. Thwaite particulars of a somewhat ambitious electro-horticultural patent. Hitherto we have known Mr. Thwaite more in connection with gas power schemes, though also in the realms of horticulture. Now, however, the subjects are brought into more intimate contact; for by using a gas engine, coupled to a suction or pressure producer and a dynamo, electric light is the first product. This, in the form of an arc light, provided with reflectors and coloured lenses, is used to stimulate the growth of plants. In addition, the hot water from the gas-engine jacket is used for heating the glass-house containing the plants; the purified exhaust is used as an atmosphere, rich in carbon dioxide, from which the leaves extract their required carbon; and, finally, the ammonia is recovered as sulphate, to be used as a fertiliser. This is certainly ideal, but is it commercial? We fear that very few people would sink capital in gas plant and a small chemical works unless the profits were certain to be very large.

Japan, as a rule, is a very up-to-date country; but the Government monopoly of the telephone in Tokio is so far out of date that it seems to be run for the benefit of the Government and not of the people. According to the *Boston Financial News*, the yearly charge for a telephone is £8 in all cases, and there are 22,000 subscribers. Since the switchboard operators are paid only £1 per month and the linemen only 2s. per day, the profit should be very satisfactory. This in itself would be no cause of complaint if it were not that new subscribers find it impossible to get a service; and there are thousands who would willingly pay much more than the usual rate. But that is immaterial to the Government. The only thing to be done is to buy out an existing subscriber, or for the applicant to take his turn on the waiting list with 8,000 people ahead of him. There is just one other possibility. When a Japanese dies in Tokio his telephone remains as one of his assets, and one of considerable value, so that the would-be subscriber may pick up a service at times, if willing to pay the price; or, as a last resource, he must hope for an epidemic of disease among those on the waiting list.

Java–Cocos Submarine Cable.—The Ministry of the Colonies at the Hague has granted a concession to the Eastern Extension Australasia & China Telegraph Co. to establish telegraphic communication between Java and the Cocos Island.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Môle St. Nicholas—Port au Prince	Aug. 16, 1906
Sierra Leone—Conakry	Sept. 12, 1906

Engineering Exhibition at Olympia.—The opening ceremony of this exhibition is to be performed to-morrow (Saturday) by Sir Alex. R. Binnie, President of the Institution of Civil Engineers, who will arrive at one o'clock, and after making a tour of the building will formally declare the Exhibition open. Sir Alex. Binnie will subsequently be the guest of the President and committee at the inaugural luncheon.

Junior Institution of Engineers.—Mr. W. B. Bryan, chief engineer to the Metropolitan Water Board, has been elected President of the Junior Institution of Engineers for the ensuing session in succession to Mr. Dugald Clerk. A visit will be paid, on Saturday, September 22nd, by a party of members of the Institution, to the Knight Bevan and Sturge Portland Cement Works of the Associated Portland Cement Manufacturers. The train leaves Charing Cross at 1:25 p.m. for Northfleet.

New Submarine Cables.—The French Government has laid a submarine cable between the island of Poulo Condore, off Cape St. James, in Indo-China, and Pontianak, in Netherlands Borneo.

On August 1st last, the Japanese Government opened for traffic a new cable between Tokio and Guam, via Bonin Islands. It will also be remembered that a new cable between Shanghai and Manila was opened by the Commercial Pacific Cable Co. on May 7th.

The French Government are laying two new cables between St. Denis, Bourbon (Reunion), Tamatave (Madagascar) and Mauritius. The cable between Mauritius and Bourbon has already been opened.

Personal.—We offer our congratulations to Mr. Arthur A. Day, electrical engineer to the Bolton Corporation, upon his selection as successor to Mr. J. F. C. Snell for the post of electrical engineer and tramways manager to the Sunderland Corporation. Mr. Day, who is 38 years of age, having been born at Croydon in 1868, took the engineering course at King's College, London, and was afterwards in business on his own account for seven years. Subsequently he was appointed an assistant engineer in the Manchester Corporation electricity department, which he held for three years, when he was promoted to be chief assistant. Three years later he was appointed chief electrical engineer to the Bolton Corporation electricity and tramways departments, whilst at present he is also manager of the tramways. Mr. Day is a member of the Institution of Electrical Engineers and is on the Committee of the Manchester Local Section, an associate-member of the Institution of Civil Engineers, and a member of the Municipal Electrical Association.

Dr. Morris Travers, professor of chemistry at University College, Bristol, has been appointed director of the Indian Institute of Science which is to be established at Bangalore.

The Moore Tube Lamp.—A report by the New York Testing Laboratory on the efficiency of the Moore tube lamp is published in the *Electrical Review* of New York. The tube was installed in a picture dealer's premises where installations of Nernst lamps and of ordinary incandescent lamps were also provided, so that a comparison could be made of the different illuminants. The tube was 179 ft. in length and ¾ in. in diameter, fixed 9 ft. 6 in. above the floor. It gave a light of an orange tinge and had been in service about 1,000 hours before the tests. The Nernst lamps were of the six-glower alternating-current type with opalescent globes and were provided with new glowers shortly before the tests. Seven lamps were used fixed 8 ft. 10 in. above the floor. The alternative equipment of ordinary incandescent lamps consisted of 88 8 c.p. lamps and 25 16 c.p. lamps placed 10 ft. 8 in. above the floor. All had clear glass bulbs which were dusted immediately before the test. Measurements of illumination were made at seven points in a horizontal plane 34 in. above the floor by means of a Weber photometer. The results of the tests may be summarised as follows. The unit of illumination used, the lux, is defined as the illumination produced on a plain surface by a source of 1 c.p. at a distance of 1 metre, the rays of light falling perpendicularly on the surface; 1 candle ft. is equal to 10·76 luces.

System.	Moore.	Nernst.	Incandescent.
Average voltage	243	244	117
Kilowatts	3·15	3·92	4·13
Kilovolt-amperes	5·64	3·89	—
Power factor	0·56	1·00	—
Intensity of horizontal illumination—			
Station 1 (luces)	68	41	21
,, 2 ,,	68	67	16
,, 3 ,,	76	52	16
,, 4 ,,	77	39	19
,, 5 ,,	18	17	3
,, 6 ,,	68	78	12
,, 7 ,,	63	15	17
Average	63	44	15
Average variation from mean	20·3%	41·7%	28·1%
Average luces per watt	20·0%	11·2%	3·6%

Obituary.—We regret to have to record the death, at Duino last week, by his own hand, of Prof. Ludwig Boltzmann. Prof. Boltzmann was born in Vienna in 1844, and studied at the Vienna University, as well as at the Universities of Heidelberg and Berlin. In 1869 he was appointed Professor of Mathematical Physics at the University of Graz, where he remained until 1873, when the University of Vienna invited him to the chair of mathematics. In 1876, however, he was offered the chair of experimental physics at Graz, which he accepted and held until 1889, going in that year to Munich as Professor of Theoretical Physics. He returned to Vienna in 1894 as Professor of Theoretical Physics there, where he remained until his death. During the early part of this period Prof. Boltzmann devoted much attention to molecular physics, and his important researches into the kinetic theory of gases and the mechanical basis of the second law of thermodynamics are well known. It is said that whilst still a student at Vienna University he obtained Maxwell's essays on the kinetic theory of gases and the electromagnetic theory of light, and read them with the aid of a dictionary, although he understood not a word of English. Continuing this method, he quickly became at home with English scientific literature, though he had never heard a single word of English spoken. Prof. Boltzmann's electrical investigations resulted in his contributing to the *Wiener Sitzungsberichte* in 1872, 1873, and 1874, a theory supporting the views of Faraday, Maxwell, and others.

We have also to record the death, due to enteric fever, on August 11th, at Bombay, of Prof. Samuel Joyce, M.I.E.E. At the time of his death Prof. Joyce occupied the chair of electrical engineering at the Victoria Jubilee Technical Institute, Bombay. He was also associated with journalistic enterprise in that city, being one of the founders and proprietors of the *Indian Electrical, Mechanical and Textile News.* Prof. Joyce was born in 1863, and after being apprenticed to Messrs. Paterson & Cooper, remained in the service of that firm until 1891, when he was appointed to the post of assistant lecturer and demonstrator in the department of physics and electrical engineering of the municipal technical school, Manchester. In 1898 Prof. Joyce joined the Edison & Swan Co., and subsequently went to Bombay. He was the author of an electrical text book entitled "Examples in Electrical Engineering."

The Commercial Utilisation of Surplus Gases from Blast Furnaces.—A Paper, read before the Cleveland Institution of Engineers by Mr. G. Hooghwinkel in January last, has recently been published. After calling attention to the progress which has already been made, especially in Germany, in the production of power from furnace gases, the author gives figures of the amount of power available. Taking average proportions of coke and pig, and assuming that about two-thirds of the gas produced is utilised for heating the blast, working the blowing engines and other auxiliaries, it is calculated that 500 H.P.-hours per ton of pig should be available for outside use, or about 21 E.H.P. per ton of pig produced in a day of 24 hours. A blast furnace gas generating station at the Ilseder Steel Works produces over 10,000 kw. for power in the steel works and rolling mills, and results in a saving of 6s. per ton of pig produced, reckoning the power as sold at a normal price to the steel works. An estimate is then given of the costs for a 3,000 kw. power station in an iron-producing district supplying a traction load, and taking the purified gases from a blast furnace in the neighbourhood. The cost of such a station would be £60,000, and the works costs per unit, including depreciation, but excluding interest, are given as 0·5d. per unit. In this figure fuel costs would be about 0·08d. per unit, and the total fuel costs per year about £4,000. This price of 0·08d. per unit for fuel corresponds to a price of ½d. per 1,000 cubic ft. for purified gas. The blast furnace works, therefore, receive £4,000 a year for their spare gas. On the other hand, their charges are as follows: Capital cost of purifying plant £10,000; interest on that capital per 1,000 cubic ft. 0·0007d.; depreciation per 1,000 cubic ft. 0·0007d.; labour 0·0005d.; total 0·0017d. The net profits are, therefore, £3,000, or 30 per cent. on the capital expended on plant. In addition, there are the profits from the sale of by-products, and a saving of fuel cost from their power consumption. The total savings may be found to represent from 2s. to 4s. per ton of pig iron made. The Paper then gives a few notes on methods of purifying the gases, and concludes with a short *résumé* of the best known types of large Continental gas engines.

The Spokane and Inland Single-Phase Railway.—The equipment of the single-phase railway system which connects Spokane with several neighbouring cities in the State of Washington is now complete. The whole line is about 106 miles in length and passes through a farming district not hitherto served by any railway, so that a considerable development of goods traffic is expected in addition to the ordinary carriage of passengers. Power is purchased from the Washington Water Power Co. It is delivered at 4,000 volts, three-phase, 60 cycles to a frequency-changing station about 10 miles south of Spokane. This station will contain four motor-generator or frequency-changing sets, each of a normal rating of 1,000 kw., consisting of a 60 cycle, three-phase, 4,000 volt induction motor, a 1,000 kw., 25 cycle, 2,200 volt, single-phase alternator of the revolving field type, and a 750 H.P., 550 volt continuous-current generator which is to float on a storage battery acting alternately as a motor and as a generator. There are three exciter sets for the alternators, each consisting of a 75 H.P. three-phase 4,000 volt induction motor and a 50 k.w. continuous-current generator. The 2,200 volt 25 cycle current is stepped up to 45,000 volts by four 1,250 kw. oil-insulated water-cooled transformers, and at this pressure is transmitted to 15 static transformer sub-stations. Each sub-station is equipped with two 375 kw. transformers of the oil-insulated self-cooling type, which step down the current from 45,000 to 6,600 volts, which is the trolley line voltage. The cars and locomotives operate under three different potentials—6,600 volts alternating current in the country, 700 volts alternating current in the small towns, and 600 volts continuous current in the city of Spokane. The passenger cars are each equipped with four 100 H.P. Westinghouse single-phase motors, and the locomotives, which will be used for the goods trains, are each provided with four 150 H.P. motors, driving through gearing in the usual way and all controlled by a multiple unit system. Pantagraph collectors are used for the 6,600 volt circuits and ordinary wheel trolleys for the continuous-current portions of the line. The motors are arranged in two groups, each group consisting of two motors connected permanently in series; so for the purpose of control these groups may be considered as single units in a two-motor equipment. Two auto-transformers are used on the locomotives, and an automatic overload and no-voltage circuit breaker is placed between the trolley and the transformers, which acts on the current supply to the control magnets. The unit switches are essentially similar to those used on continuous-current systems. The control magnets are of the alternating-current type wound for 200 volts, and will also work on about 80 volts continuous current, but in both cases will operate down to about one-half voltage. These magnets control the valves admitting air to the cylinders which actuate the unit switches. The alternating current for the operation of the magnets by the master controller is obtained from the secondary of a small transformer which is connected to the 500 volt point of the main auto-transformer. When running with continuous current, a resistance is placed in series with this auxiliary transformer across the 600 volt mains, and direct current is taken from a suitable tap on this resistance. This dispenses with the use of a storage battery. The only mechanical operation in changing from alternating current to continuous current is to change the trolleys; the control is changed automatically by a commutating switch, consisting of a small pneumatically-worked drum for changing the control circuits. This drum is controlled by a magnet connected directly to a 200 volt tap on the main auto-transformer. The switch has one position for continuous current and another for alternating current, and it cannot be thrown to the alternating-current position unless alternating current is flowing through the magnet coil. The reversing switch is similar to the commutating switch in its operation, but is furnished with two magnets and air cylinders, one for each position. The locomotives are 29 ft. in length over all, and weigh 29 tons each. All the control and auxiliary apparatus is contained in the cab, which is entirely of steel.

THE TELTOW CANAL AND ITS EQUIPMENT.*

This canal, which has recently been constructed by the municipal authorities of Teltow at a cost of over £2,000,000, is intended to form one section of a great internal waterway between the Oder and the Elbe. The part between the Oder and the Spree has already been completed, and this section, which is some 25 miles in length, connects the Spree to the Havel. The remaining length has still to be built, and, although Government has made the necessary grant for its construction, the work has not yet been begun.

The canal is interesting as an example of German municipal enterprise. The province of Teltow is one of the wealthiest suburbs of Berlin, and the Landrat (Herr von Stubenrauch) of the province is responsible for the scheme. As is shown on the map (Fig. 1), the canal makes use of some of the many small lakes in the neighbourhood of Berlin. Round many of them, particularly those near the Havel, the country is well wooded, and the district is a favourite resort for many of the Berlin merchants, who have houses in the vicinity. On other sections, particularly that part of the canal between Machnow and the generating station, the country is flat and uninteresting. In many places marshes have been drained into the canal, and it is anticipated that the land in the neighbourhood of the canal will greatly increase in value, and thus repay the municipality, independently of revenue obtained directly from it. During the last year many important manufacturing companies have taken sites near the canal banks, and already two —a steel works and a porcelain factory—have begun operations. The land within 400 yds. of the canal bank is in the possession of a land company, and is sold at a price equal to five times its agricultural value.

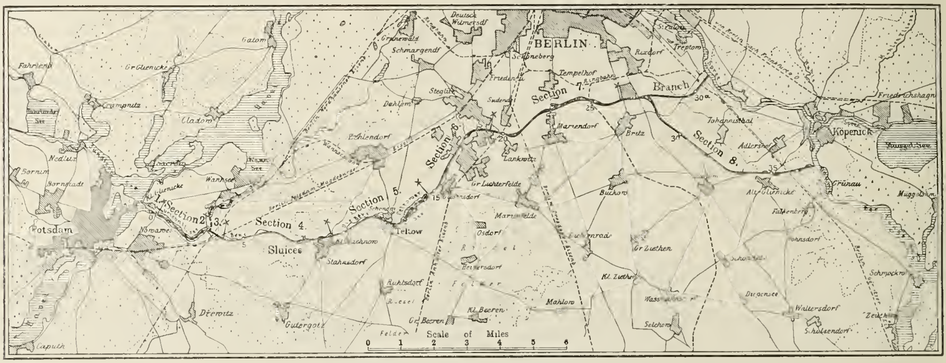

Fig. 1.—Map of the Teltow Canal.

The map shows the direction in which the canal runs and the various sections into which it is divided. It does not make any new connections between the waterways, as barges could already go from the Spree to the Havel by way of Berlin; but the route through the canal is much shorter and is designed to deal with heavier barges, and it is expected that a great part of the traffic now going by the longer route will be diverted into the new canal.

A section of the canal is given in Fig. 2. The depth at the centre is 8·1 ft., width at surface 98 ft., and at the sides the depth is 6·9 ft. The banks slope up from the water at a grade of 1 in 1·5 and 1 in 2, and at present the bank is at least a metre above water-level at the lowest point. On each side is a tow-path 6 ft. wide, and the canal banks have been protected by concrete slabs in some parts; in others a stone slope is arranged, and in some other parts rushes have been planted to break the waves that may be produced by the passage of tugs and barges through the canal. One of the most remarkable features of the canal is the number of bridges and railways that cross it. At one point five bridges cross in a length of ¼ mile; no less than eight railway bridges with altogether 16 tracks and 37 road bridges have had to be built. At some of these the water width at the surface has been reduced to 66 ft., but in the later sections of the canal the full width of 98 ft. at the water-level is given, thus greatly facilitating the passage of the tractors along the banks. The smaller width is still sufficient to allow two 600 ton barges to pass each other under the bridges, but the extra width was allowed to give greater room for manœuvring, and also, as already mentioned, to give an easier towing path.

At various points along its length harbours have been built, where barges can load and unload, and the canal has been widened at certain points for the same purpose. Close to the generating station for the supply of electrical energy to the canal a large harbour has been excavated specially for ship repairs; one side of it has a gently shelving bank, on which rails are laid, and along which carriages can run, which will draw any boat up to a certain length, out of the water, thus obviating the necessity for a dry dock. The winding gear for the carriages referred to above is, of course, like

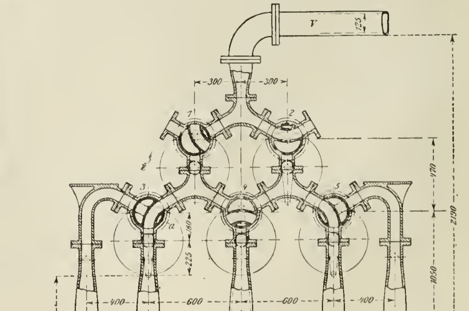

Fig. 4.—General Arrangement of Pipe Work in connection with Siphons for Changing Water Level.

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* Based on articles which have appeared in the *Elektrotechnische Zeitschrift.*

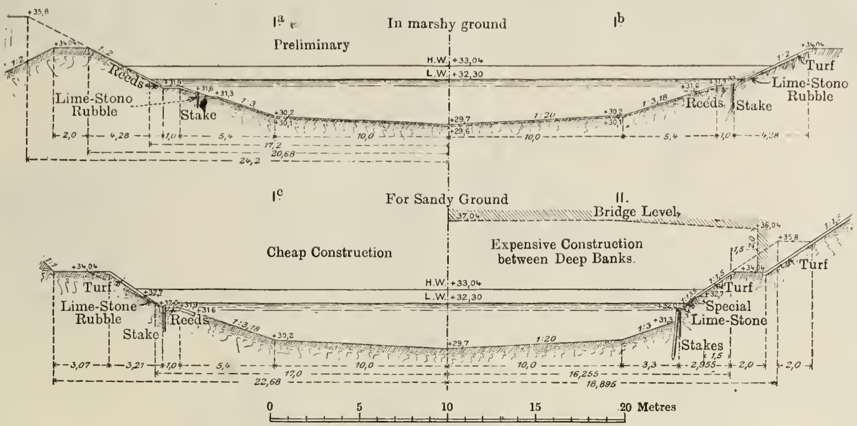

Fig. 2.—Sections of the Teltow Canal.

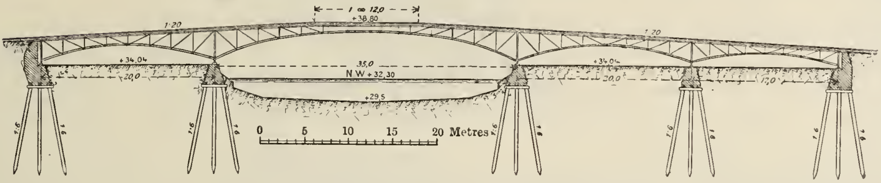

Fig. 3.—Tow-path Bridge over Halborn Entrance at Lichterfeld.

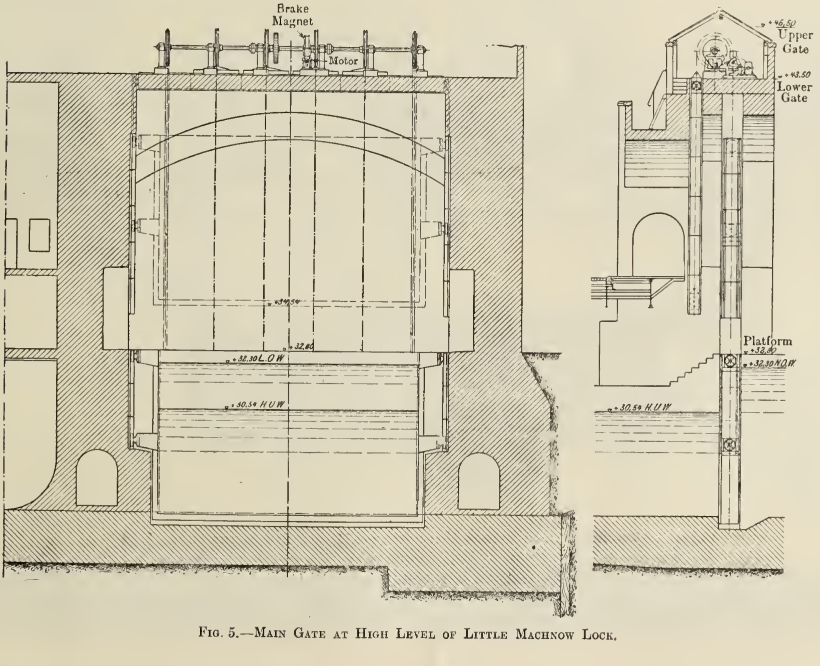

Fig. 5.—Main Gate at High Level of Little Machnow Lock.

everything else where motive power is required on this canal, electrically operated. Fig. 3 shows a bridge for the tow-path over the entrance into such a harbour.

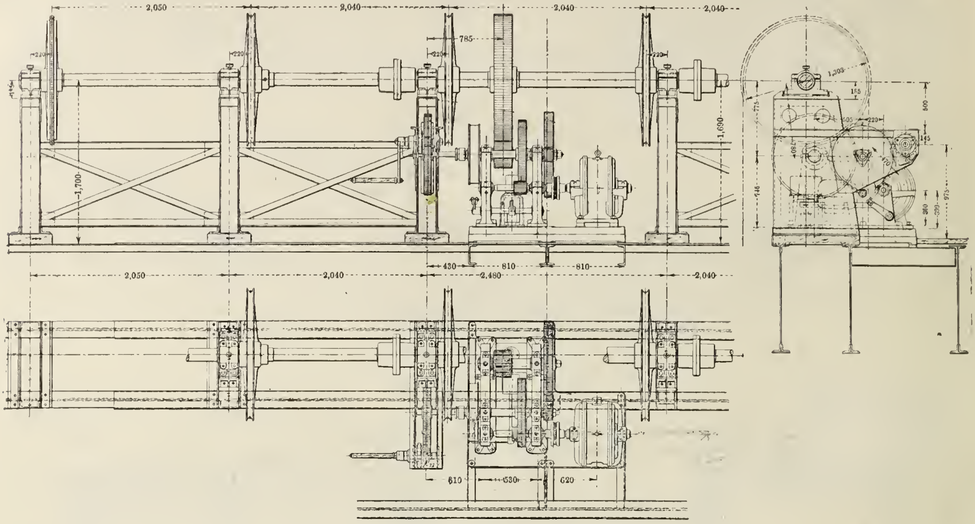

Fig. 6.—Winding Gear in connection with the Main Gate of the Little Machnow Lock.

The Lock.

One of the most interesting features of the canal is the lock. The water-level on the Havel side of the lock varies from +95·1 ft. to +100·2 ft. above datum level, while on the Spree side the level is constant at 106 ft, being maintained at this by the weir at Muhlendamm, in Berlin. Occasionally the water-level on the Upper Spree has been observed to rise to 108·3 ft., but should this occur now, the lock allows another path for the water to lower levels and thus prevents flooding. The difference of level, therefore, on the two sides of the lock varies from 5·8 ft. to 10·9 ft.

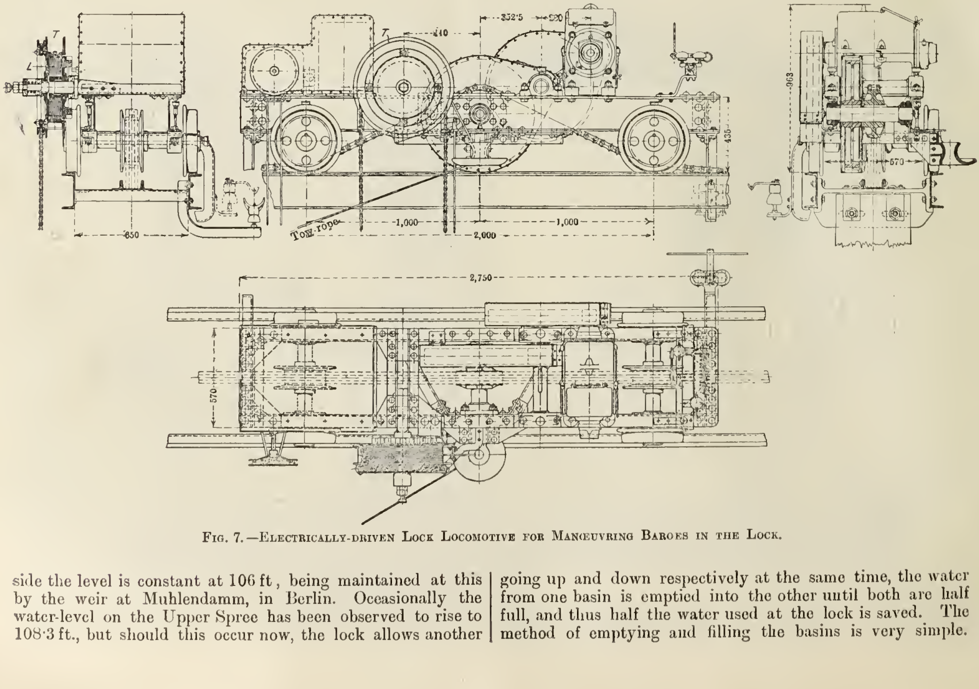

Fig. 7.—Electrically-driven Lock Locomotive for Manœuvring Barges in the Lock.

The lock is a double one with two basins, side by side; the net length of each basin is 220 ft., breadth 32·8 ft., and the two are separated by a platform 39·4 ft. wide. To economise water, arrangements are made by which, when two barges are going up and down respectively at the same time, the water from one basin is emptied into the other until both are half full, and thus half the water used at the lock is saved. The method of emptying and filling the basins is very simple.

Water flows from a higher level to a lower through a syphon tube of about 28 square ft. section. The upper part of this syphon can be connected to a vacuum produced by allowing water to flow out of a chamber built in the masonry, at the lower level. The syphon tube is thus filled and the water flows over until the levels on the two sides are the same.

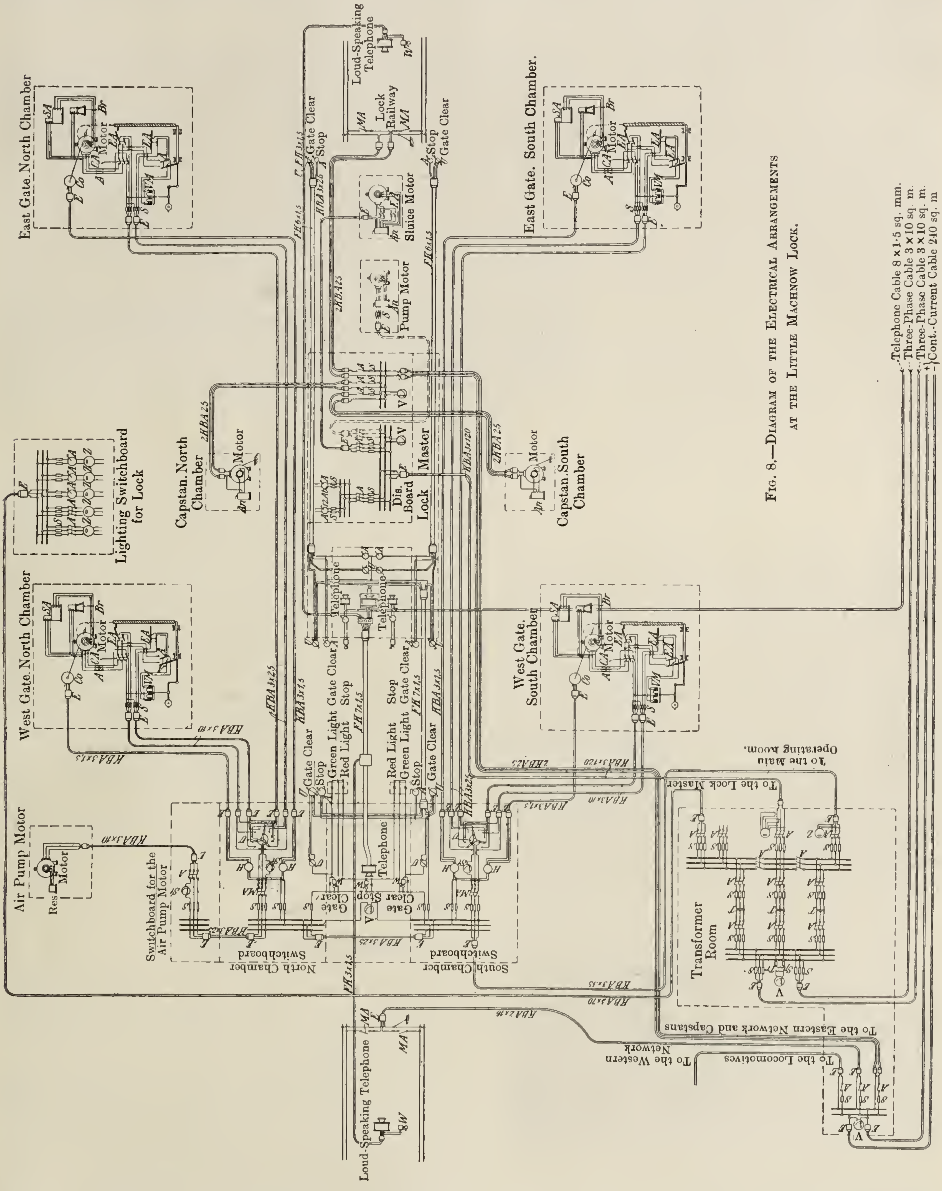

Fig. 8.—Diagram of the Electrical Arrangements at the Little Machnow Lock.

The valves controlling these syphons are all placed in the bridge house and are arranged as shown diagrammatically in Fig. 4, so that the lock-keeper can operate them with the least possible trouble. In the same room is placed the switchboard which controls the motors used for raising and lowering the gates. These are not of the kind ordinarily in use upon the canals in this country, but are of the "portcullis" type. The gate is a massive iron structure built up of iron plate supported at the back by a girder framework and moving in grooves in the lock walls. The arrangement is shown in Fig. 5. The gate is counterpoised by a weight which runs in a similar groove to that in which the gate itself moves. The gate and the counterpoise weight are driven by two chains gearing with two heavy spur wheels keyed to a shaft which is placed in the gallery over the lock gate; besides this main drive four steel ropes help to support the gate. These are placed over grooved wheels which are not keyed to the overhead shaft. The driving of the winding shaft is effected by a 220 volt 15 H.P. induction motor running at 600 revs. per min., and started by an automatically operated starting resistance in circuit with the wound rotor. The motor has to raise an unbalanced weight of 1 ton when the gate is in the water; when it is raised clear of the water-level the unbalanced weight increases to 3 tons. In this way the initial starting torque on the driving motor is only one-third of that required when the gate is fully raised, and similarly when the gates are closed the unbalanced weight automatically diminishes as the gate falls. The main switch for the motor is arranged so that it cannot be operated unless the gates are either in the up or down position, the switch arm being locked by a catch controlled by a magnet carrying the main current to the motor. The motor-circuit is broken automatically at the end of a lift by a pin attached to the gate operating a switch placed in the roof chamber, a similar pin attached to the counterpoise weight serves the same purpose when the gate is lowered.

The whole time occupied in raising or lowering a gate is less than 50 seconds—in fact, the whole time spent in passing a small boat through the lock, including that spent in raising the gates, was on one occasion less than six minutes. The general arrangement of the motor, together with the crab winch and hand brake installed for use in emergency, is shown in Fig. 6. The gates also work an automatic signal showing at night a green or red light to indicate whether the gate is lowered or raised.

In addition to the lock chambers a sluice gate is provided which allows water to flow from the Upper Spree to the Havel. This gate is opened by an 8 H.P. induction motor controlled from a switchboard in the same room as that for operating the gates, and, of course, under the control of the lock-keeper.

The passage of a barge through the lock is effected in the following way: The barge first enters a channel about 39 ft. wide flanked on one side by the canal bank and on the other by a row of piles driven into the centre of the canal on the top of which is arranged a special track about 50 yds. long upon which runs a special lock locomotive, to which the tow-rope is attached. The track is made up of two U-shaped iron girders which are bolted to iron sleepers, and the locomotive is driven through a chain by a continuous-current motor of 11 H.P. supplied at 600 volts and running at 1,000 revs. per min. The locomotive is shown in Fig. 7. It is capable of exerting a pull of 2 tons at starting or a steady pull of 1 ton at a speed of 1 metre per second. The weight of the locomotive is 1·5 tons. Current is collected from an overhead trolley and is led back through the rails. The winding drum T is not keyed direct to its axle, but a friction clutch is inserted as shown in Fig. 7. This, of course, is necessary to avoid excessive strains on the tow-rope.

The locomotive is used both to bring the barge into the lock chamber and to take it out. As soon as the signal shows that the gate is completely raised, the tow-rope from the locomotive is hitched to the towing mast on the barge and the latter is towed to the entrance of the lock. (The controller for the lock locomotive is operated by a rope which can be worked from the track immediately below it.) The operation of the locomotive and the method adopted of chain driving is clearly shown in Fig. 7. When the barge is inside the lock the gate is lowered by the lockkeeper, who, throughout, controls the operation from the lockhouse, the water-level is either raised or lowered, the other gate raised, the tow-rope from another lock locomotive on the other side of the lock hitched to the barge, and the latter towed out to the open canal where it is again hitched to one of the ordinary canal locomotives that will be described later. The time allowed for the whole of this operation, from the entrance of a barge and its connection to a lock locomotive to its final exit, is 15 minutes, and the actual time might easily be reduced below this. These operations may appear somewhat elaborate as compared with that adopted in locks in this country, but it must be remembered that the barges dealt with are of great weight, over 10 times as large as many used on English canals, and the actual time taken when this is considered is exceedingly small.

The switchboard for controlling the whole of the current in use at the lock is shown in Fig. 8.

On the south side of the lockkeeper's house is the transformer chamber containing three 6,000/200 volt transformers of 20 k.v.a. capacity. From these transformers run the mains for lighting the lockhouse and adjacent buildings and the power controlling the four gates, a third for lighting the lock itself and for operating the sluice gate. The low-pressure mains from the transformers are led through switches, and connections are left for a pump motor in case that is found necessary for maintaining the required quantity of water in the upper reaches of the canal. The distribution boards to the various circuits are all arranged in a room in the lockkeeper's house, and to this room connections are brought for the various signals, telephones both for ordinary communication to other points on the canal, and loud-speaking telephones for giving directions to the men in the boats. All circuits in connection with the lock are thus under the direct control of the lockmaster. As regards the traffic with which this double lock is competent to deal, the time allowed, as already stated, for the passage of a barge through the lock, allowing for raising and lowering the gates and for entry and exit, is about 15 minutes. Reckoning 400 tons as the normal load of a barge passing through, the total traffic that can be dealt with in a day of 10 hours is 2 × 400 × 4 × 10 = 3,200 tons in both directions. With 270 working days, this allows a yearly traffic of 8·64 million tons, and this could easily be doubled if the lighting of the lock were carried out so as to enable it to be used at night.

(To be continued.)

THE NEWPORT ELECTRIC TRANSPORTER BRIDGE.

For some time the want has been felt of a means of communication between the eastern and western portions of the Borough of Newport across the river Usk at the southern end of the town, and a number of schemes of various descriptions have been put forward from time to time. The erection of a bridge of the transporter type was eventually decided upon, and sanction was obtained from Parliament for its construction in 1900. Work was commenced in the autumn of 1902, and the bridge, now complete, was opened for traffic on Wednesday last by Viscount Tredegar (Lord Lieutenant of the County of Monmouth), when a large number of persons, including many Press representatives, were kindly entertained at lunch by the Mayor and Town Council of Newport.

The general principle of the bridge, that is to say, the conveyance of the traffic on a platform or car, level with the banks and slung from a travelling carriage running on a track some distance above the surface of the river, is similar to that of the transporter bridge over the Mersey between Widnes and Runcorn* and the bridges of the same type on the Continent at Rouen, Nantes and elsewhere. The construction and method of working, however, present some points of difference from these earlier examples.

The general appearance of the fixed structure is seen in Fig. 1, which is from a photograph taken just before the travelling truck carriage with the suspended car had been erected in position, and Fig. 2 shows the car hanging over the river. The span, from centre to centre of towers, is 645 ft. with a clear opening of 592 ft. between faces of piers. The clear headway from high water to the underside of the span is 177 ft., and the total height of the towers above the level of the approach roads is 242 ft.

Each tower is supported on a group of four foundation piers, distant 78 ft. 9 in. apart on the riverward faces and 36 ft. on the faces at right angles thereto. Each pier consists of a masonry well or monolith resting on a steel curb or shoe; these were sunk into position by excavating inside under compressed air, with an air-lock for the ingress and egress of workmen and the removal of material. The greatest pressure used during sinking was 36 lb. per square inch. The air pressure was reduced after each day's work to allow the well to move downwards, and the operations were continued until a satisfactory bottom was reached, when the whole was filled in with concrete.

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* *The Electrician*, Vol. LV., p. 250.

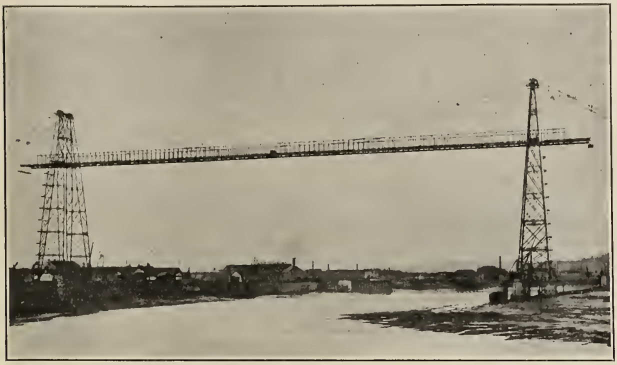

Fig. 1.—Fixed Framework of Newport Transporter Bridge.

The towers are of open lattice steel construction mounted at their feet on joints consisting of cast-iron saddles and steel rocking pins. The erection of the towers was carried out by means of an electrically-driven crane of special construction, designed by Mr. Arnodin. The jib of this crane is composed of a lightly-trussed arm, with a radius of 25 ft., and the platform of the crane is fitted with an arrangement of vertical screws, so that it could raise or lower the whole mechanism by its own power, and hoist itself into fresh positions as the work progressed. It is interesting to note that less than 1,000 units of electricity, costing under £8. 10s., were sufficient to lift and place in position the whole of the temporary scaffolding and staging, as well as the permanent structural steel work of both towers, a total weight of about 880 tons. The weight of steel in each tower is 277 tons.

Sixteen main suspension cables are employed, four inside and four outside of each of the stiffening girders. Each is composed of 27 wires, and has an aggregate cross-section of 3·945 sq. in. Each cable weighs nearly 4 tons. The anchor cables are also 16 in number, each composed of 127 wires and of 4·27 sq. in. cross-section. All the cables are provided with steel sockets at their ends, which are connected to the main saddle pins by steel shackles and to the anchor castings by steel bolts. A portion of the span is carried by diagonal cables, and the ends of the horizontal stiffening girders are moved by two cables of 91 wires, having a total section of 2·61 sq. in. All the cables were supplied by Messrs. W. B. Brown & Co., of Liverpool.

The stiffening girders serve to distribute the moving load over the suspension parts, while at the same time allowing the required degree of flexibility. The bottom members are built up as ordinary plate girders, the lower flanges carrying the rails, on which the wheels of the travelling truck run. The total depth of the girders is 16 ft., and a feature of their construction is the use of cables for the tension members of their bracing. The total weight of the girders, suspension rods and attachments is 539 tons. The travelling carriage, which is 104 ft. in length, is provided with 60 wheels, 15 on the inside and 15 on the outside of the web of the bottom members of each stiffening girder. These wheels are of steel carried in steel brackets, each of which is also fitted with two horizontal guide wheels, engaging on the edges of the girder flanges.

Suspended from this carriage is the platform or car itself, which is 33 ft. in length by 40 ft. wide. There is a central roadway and two footways, the latter being roofed in. Two four-wheel vehicles, each carrying 15 tons, can be accommodated simultaneously. The car is suspended by 30 cables, of a total length of 1,620 yards, some of which are crossed to prevent swaying during high winds. The weight of the travelling carriage is 16·3 tons and of the car 31·5 tons, while the suspension cables weigh 2·9 tons. We are informed that the bridge has been tested with a load of 120 tons.

The propulsion of the carriage is effected by a pair of steel ropes driven by an electrically-worked winding drum in the motor house on shore at the eastern end of the bridge, a method differing from that employed on the Widnes-Runcorn bridge, where the motors are carried on the truck itself. One of these haulage ropes passes from the drum to a guide pulley at the eastern end of the bridge, then along supporting pulleys on the upper part of the platform to a main return pulley at the western end. From here it returns under the platform, where it is supported by further pulleys fixed underneath, to a projection in the centre of the carriage to which it is secured. The other rope passes from the carriage under the bridge over the pulleys to a second guide pulley at the eastern end and thence to the drum. The rate of travel is 10 ft. per second, so that the whole journey will occupy about one minute.

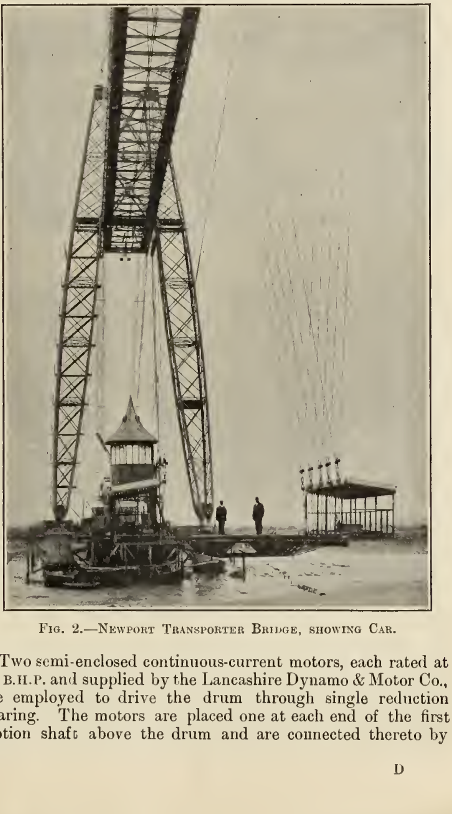

Fig. 2.—Newport Transporter Bridge, showing Car.

Two semi-enclosed continuous-current motors, each rated at 35 b.h.p. and supplied by the Lancashire Dynamo & Motor Co., are employed to drive the drum through single reduction gearing. The motors are placed one at each end of the first motion shaft above the drum and are connected thereto by jaw clutches, so that if either motor is disabled, it can be disconnected from the gear, although normally the two are used together. The motors are series wound and are connected permanently in series, a substitutional resistance being employed when either motor is cut out of circuit. Supply can be be taken either from the Corporation lighting mains at 460 volts or from the traction system at 500 volts. The controllers are of the rheostatic type, and are carried in the pilot house on the car. The starting, speed regulation and reversing are concontrolled by one handle, with which the rheostatic electric brake can also be applied. The resistances are also carried on the car. Connection to the controller on the car is made by six trolley wires mounted on the stiffening girder across the bridge, each composed of 7/12 stranded copper conductors, and each with its own trolley wheel. We believe that this is one of the first cases of a stranded trolley wire being used in this country. This practice was, however, followed in the transporter bridge at Nantes. Insulated leads are taken up the tower and down from the truck to the car. In addition to the two controllers on the car a third controller is provided at the motor house, which can be used in case of emergency.

The switchboard in the motor house contains, in addition to the usual instruments and circuit-breakers, the change-over switch for connecting either to the lighting and traction mains, a pair of four-pole throw-over switches for cutting out either motor or cutting in a resistance, and a six-pole throw-over switch for bringing the controller in the motor house into action instead of the car controllers. In addition to the rheostatic electric brake, mechanical brakes are fitted to the truck and a solenoid brake is provided on the drum, which is held off as long as the current is flowing.

Electric light is provided on the car, in the motor house and along the approaches to the bridge, and navigation lights, arranged to meet the requirements of the Trinity House, are exhibited on each tower and on the car.

The engineers to the work, which is a good example of municipal enterprise, were Mr. F. Arnodin (the designer of the Rouen Bridge) and Mr. R. H. Haynes (engineer to the Corporation of Newport), and the contractor was Mr. Alfred Thorne, who kindly lent us the photographs from which our illustrations are prepared, and to whom, in addition to Messrs. R. W. Blackwell & Co., the sub-contractors for the electrical equipment, we are indebted for information regarding the construction and equipment of the bridge. Mr. V. J. Kérihuel acted as resident engineer and Mr. John A. P. Thorne as contractor's engineer during construction. It is specially worthy of note that no lives were lost during the constructional work, and that such few accidents as have taken place were of a comparatively trivial nature.

PORTSMOUTH CORPORATION TRAMWAY ACCOUNTS.

The accounts of the Portsmouth Corporation's electric tramway undertaking for the year ended March 31, 1906 (which is the fourth complete year of working), have been presented in accordance with the standard form approved by the Institute of Treasurers and Accountants and the Municipal Tramways Association, a system which, the tramway manager states in his report, is now being generally adopted in most tramway undertakings throughout the country, as it renders comparison with other towns more reliable. There is an increase in the traffic receipts over the preceding 12 months of £1,465. 3s., but the gross profit is £517. 11s. less than that of the previous year. Deducting from the latter amount£375. 8s. 6d. received for bank interest on credit balances, this leaves a balance to meet capital charges and available for appropriation which is less by £142. 2s. 6d. than that of the preceding year. This reduced balance is attributed to the expenditure under some heads being heavier than for the previous year, and to the income not increasing in the same proportion. There is, however, a substantial net profit on the year's working. The repairs and maintenance of the rolling stock and overhead electrical equipment has been much heavier than last year, whilst rates and capital charges are also higher. In the following summary of the financial result it will be seen that the item "Revenue from other sources" is £2,285. 8s. less than that of last year. This is due to less electrical energy having been sold to other departments, and also to an adjustment of the figures under some heads in order to bring them more in conformity with the standardised form of accounts mentioned above.

Comparative Summary of Financial Results.

		1905-6.		1904-5.
Traffic receipts		£97,170 11 0	..	£95,705 8 0
Less tolls paid to the Portsdown and Horndean Light Railway Co.		—	..	1,478 5 7
		97,170 11 0	..	94,227 2 5
Revenue from other sources		4,461 1 9	..	6,746 9 9
Total revenue		101,631 12 9	..	100,973 12 2
Working expenses		45,341 11 4	..	44,165 19 9
Leaves credit balance of		56,290 1 5	..	56,807 12 5
Add bank interest on credit balances		375 8 6	..	—
Balance, being net profit		£56,665 9 11	..	£56,807 12 5
From which the following charges have been made:—				
Interest on capital, contribution to sinking fund, income tax, rent of leased lines and decoration of cars during visit of French Fleet		£38,030 2 4	..	£35,561 4 10
Balance left for appropriation		18,635 7 7	..	21,246 7 7
From which the following items have been deducted:—				
Revenue contributions to capital outlay	£21 14 5 ..	—	..	7,715 18 4
Renewal charges for the year	5,174 18 0			
		5,196 12 5	..	—
Net amount for appropriation		£13,438 15 2	..	£13,530 9 3

An analysis of the expenses in pence per car-mile is given below:—

Traffic Expenses.	Year ending Mar. 31, '05.		Year ending Mar. 31, '06.
Salaries and wages	2·21d.	..	2·304d.
Cleaning and oiling cars, depot expenses, &c.	0·37d.	..	0·369d.
Cleaning and salting track	0·06d.	..	0·041d.
Ticket check	0·21d.	..	0·140d.
Uniforms	0·06d.	..	0·085d.
Miscellaneous	0·01d.	..	0·023d.
Total traffic expenses	2·92d.	..	2·962d.
General Expenses.			
Salaries and wages	0·01d.	..	0·165d.
Rent, rates and taxes	0·58d.	..	0·563d.
Printing, stationery and office expenses	0·02d.	..	0·032d.
Legal expenses, compensation, &c.	0·01d.	..	0 014d.
Insurance	—	..	0·003d.
Miscellaneous	0·28d.	..	0·082d.
Total general expenses	0·90d.	..	0·859d.
Repairs and Maintenance.			
Permanent way	0·19d.	..	0·146d.
Electrical equipment of line	0·10d.	..	0·164d.
Cars, workshop tools and sundry plant	0·43d.	..	0·458d.
Total repairs and maintenance	0·72d.	..	0·768d.
Power Expenses.			
Salaries and wages	0·12d.	..	0·116d.
Fuel and water	0·38d.	..	0·359d.
Oil and waste	0 01d.	..	0·014d.
Repairs	0·04d.	..	0·043d.
Miscellaneous	0·03d.	..	0·033d.
Total power expenses	0·58d.	..	0·565d.
TOTAL WORKING EXPENSES (excluding capital charges)	**5·12d.**	..	**5·154d.**
Capital Charges, &c.			
Interest	2·27d.	..	2·220d.
Sinking fund	1·94d.	..	1·802d.
Income tax	0·12d.	..	0·107d.
Cost of generating current sold	0·24d.	..	—
Rental of leased lines	—	..	0·157d.
Decoration of cars during visit of French Fleet	—	..	0·038d.
Revenue contribution to capital outlay	0·94d.	..	0·001d.
Renewals of permanent way	—	..	0·588d.
Total capital charges	5·51d.	..	4 913d.
TOTAL EXPENSES (including capital charges)	**10 63d.**	..	**10 067d.**
Net amount for appropriation	1·64d.	..	1·528d.

The cost of generating the current sold for lighting the car shed, workshops and traffic offices has now been charged to the respective accounts, therefore the power station expenses this year show the actual cost of energy supplied for working the cars. The net income per car-mile, after deducting bank interest on credit balances was 11·552d.

The total number of units generated at the power station, which is independent of the lighting station, was 3,207,937, the generating costs being 0·524d. per unit, as against 0·537d. in the previous year when the output was 3,019,955 units. The details of cost of generation are as follows :—

	Per unit
Salaries and wages	0·107d.
Fuel	0·318d
Water	0·015d.
Oil and waste	0·012d.
Miscellaneous supplies	0·031d.
Repairs to steam plant	0·032d.
,, electrical plant	—
,, ducts and cables	0·003d.
,, power and sub-station buildings	0·006d.
	0·524d.
Proportion of rates and taxes	—
,, insurance premiums	0·025d.
Interest on capital expenditure	0·082d.
Sinking fund	0·067d.
	0·698d.

The number of car-miles run during the year was 2,111,350, an increase of 136,354 over 1904-5, and the units used per car-mile were 0·98.

The table below accounts for the units generated :—

	1905-6		1904-5
B.O.T. units used for Corporation cars..........	2,070,240	..	1,829,589
,, ,, at power station	200,997	..	175,935
,, ,, for car-shed lighting..........	111,000	..	95,000
,, ,, for workshop lighting	9,320	..	5,460
,, ,, for workshop power	24,421	..	8,586
,, ,, for traffic office lighting	6,140	..	5,242
,, ,, for line cleaning	15,720	..	22,060
,, ,, for grinding rail corrugations..	2,700	..	—
,, ,, for grinding points and crossings	1,040	..	—
,, ,, for lift at Town Hall	669	..	733
,, ,, for light railway	765,690	..	877,350
Total B.O.T. units generated	3,207,937	..	3,019,955

The number of passengers carried during the year was 20,141,674, compared with 19,625,329 in the previous year. The percentage of working expenses to total receipts was 44·61.

The length of line in operation is 28½ miles equivalent single track, and the rolling stock consists of 84 electric cars, one motor water car, one emergency trolley, one tower waggon, one ticket van, two carts and one rail grinder.

The tramway manager again draws attention to the necessity for building up a strong reserve or renewals fund, as some portions of the undertaking are beginning to show signs of wear and tear. In fact, renewals have had to be carried out upon the permanent way this year.

The capital expenditure of the undertaking is very high indeed in proportion to the extent of the undertaking, namely, £22,833 per mile of single track, the interest and sinking fund charges for the year amounting to 4·022d. per car-mile, which is much above the average of a number of other similar undertakings. The total capital expenditure to date is £650,722. 19s. 7d.

Municipal Tramways Association.—The fifth annual conference of the Municipal Tramways Association will be held at Leeds on Wednesday, Thursday and Friday next. The headquarters will be the Town Hall. In addition to the Presidential Address of Mr. J. B. Hamilton, the following Papers are down for reading : "Municipal Tramway Operation," by Councillor R. A. Smithson of Leeds ; "Car Brakes," by Mr. Henry Mozley of Burnley ; "Tramway Track Work," by Mr. R. C. Bullough of Colchester ; and "Depreciation and Renewals Funds in Relation to Tramway Undertakings," by Mr. G. W. Holford of Salford. A reception will be held by the Lord Mayor of Leeds at the City Art Gallery.

OERLIKON SINGLE-PHASE WARD-LEONARD CONVERTER LOCOMOTIVES.

The Oerlikon Company, in addition to developing single-phase commutator motors for traction, have for some time been experimenting with the Ward-Leonard system of single-phase traction in which a motor-generator is carried on the locomotive and continuous-current motors are used for driving. The results of these experiments, which have been spread over a considerable time, would appear to indicate that under certain conditions the system shows no small advantage over the comparatively simpler methods more usually adopted. In cases where the contour of the railway is such that opportunity is given for returning energy into the line by regenerative braking, the system is particularly suitable, and again it is recommended for adoption on lines where the starting and stopping is frequent and at the same time it is of importance to economise power at the generating station.

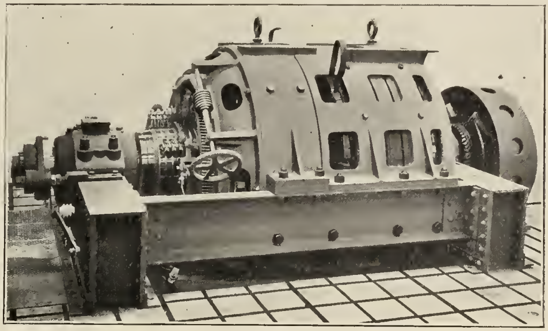

Fig. 1.—Motor-Generator Set.

The general features of the system are, of course, well-known. The locomotive carries a motor-generator set consisting of a single-phase induction motor supplied directly from the line or through a transformer and driving a continuous-current generator at a practically constant speed. The continuous-current traction motors are controlled by variations in the excitation of the generator. The table given later show the weights and estimated cost of the various constituent parts of such an equipment for two cases, for 6,000 and 15,000 volts respectively, at 25 cycles, the former without and the latter with a main transformer. Both cases are for locomotives capable of exerting from 1,320 lb. to 8,800 lb. tractive effort, and running at speeds from 22 to 44 miles per hour. The weight of

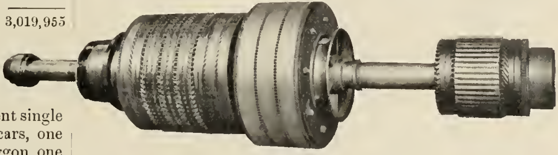

Fig. 2.—Armature Shaft of Motor-Generator.

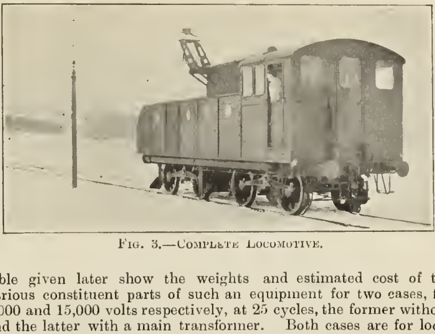

Fig. 3.—Complete Locomotive.

the 6,000 volt locomotive would be 44 tons and of the 15,000 volt locomotive 46·5 tons.

—	6,000 volt locomotive.		15,000 volt locomotive.	
	Weight.	Cost.	Weight.	Cost.
	lb.	£	lb.	£
Motor-generator (including exciter, starter and regulating rheostats)....	33,400	1,620	33,400	1,620
Traction motors (four)	17,600	1,025	17,600	1,025
Collector, switchgear, connections, &c.	1,210	164	1,210	164
10 kw. auxiliary transformer, with fan, vacuum pump, motor and tools, &c.	2,990	168	—	—
500kw. main transformer and auxiliaries	—	—	8,750	428
Total for electrical equipment......	55,200	2,977	60,960	3,237
Mechanical portion	41,800	920	41,800	920
Total	97,000	£3,897	102,760	£4,157

The motor-generator is similar in both cases, the only difference being in the winding of the primary side. Its general appearance is shown in Fig. 1. The induction motor has a short-circuited rotor mounted on the same shaft as the continuous-current generator armature, as shown in Fig. 2. The generator is provided with auxiliary commutating poles and is excited by a separate exciter on the same shaft, which is also employed as a motor at starting to run the set up to synchronism. The speed of the set is 730 revs. per min., and the motor is rated at 520 H.P. normal load and 1,100 H.P. maximum load. The four traction motors are separately excited and each is rated at 95 H.P., but is capable of working up to 200 H.P.

A diagram of connections is given in Fig. 4. Starting up of the motor-generator is effected by bringing the starting barrel of the controller CS into position V which causes current to be supplied to the exciter machine E from the auxiliary transformer T so that it starts up the set, working as a single-phase series commutator motor by means of a special field winding. When the set is up to speed, a switch is closed which connects the stator of the induction motor to the line, and a further movement of the starting controller into position IV breaks the alternating-current connection to the exciter, and connects its terminals to the field circuit of the dynamo, at the same time connecting one pole of the exciter shunt winding to one of the exciter brushes and short-circuiting the series winding used for starting up. The first step of the second controller barrel (KS) connects the other terminal of the exciter shunt-field winding to its brush and also connects the exciter terminals to the dynamo field windings through the variable resistance C and to the traction motor field windings. The other position of the controller, CS, which is for running in the reverse direction, reverses the field connections of the motors, their armatures being permanently connected to armature of the continuous-current generator.

All speed regulation is accomplished by varying the resistance in the dynamo and motor-field circuits, and recuperative braking is obtained by strengthening the fields of the motors so that they act as dynamos and supply power to the continuous-current side of the motor-generator, causing the induction motor to be driven above synchronism and to return power to the line by acting as an asynchronous generator.

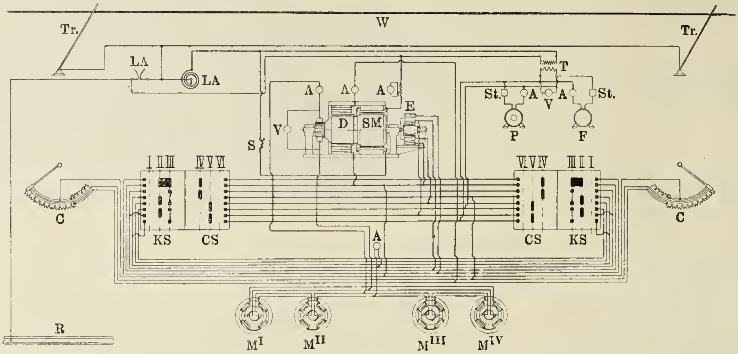

FIG. 4.—DIAGRAM OF CONNECTIONS.

W, Overhead wire; Tr., Collector; LA, Lightning arrester; S, H.T. main switch; A, Ammeter; SM, Induction motor; D, Continuous-current generator; E, Exciter; T, Transformer; St., Starters for auxiliaries; P, Vacuum pump motor; F, Fan motor; C, Speed regulating rheostat; CS, Starting barrel of controller; KS, Reversing barrel of controller; MI, MII, MIII, MIV, Traction motors; R, Track.

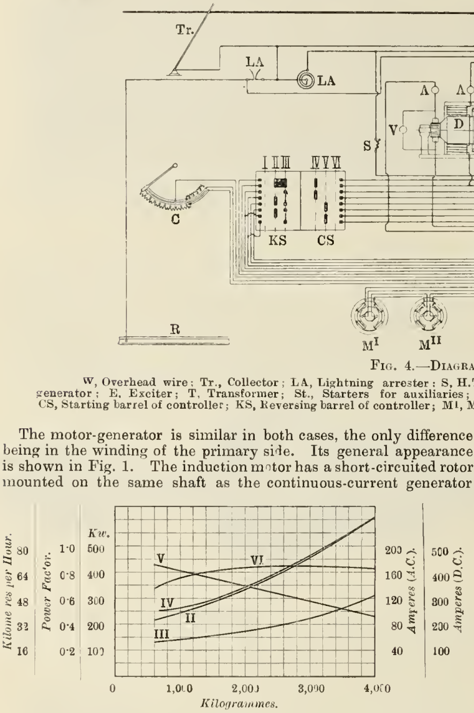

FIG. 5.

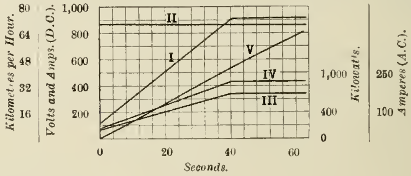

FIG. 6.

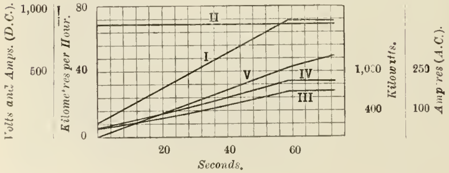

FIG. 7.

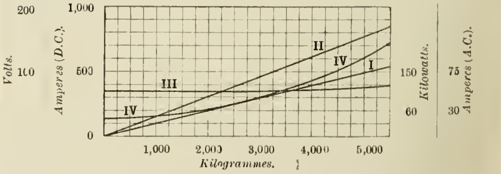

FIG. 8.

Curve I.—Voltage of continuous-current generator.
,, II.—Current given by continuous-current generator in amperes.
,, III.—Current taken by induction motor.
Curve IV.—Kilowatts absorbed by induction motor.
,, V.—Speed in kilometres per hour.
,, VI.—Power factor.

A view of a complete locomotive on this system is given in Fig. 3, and some characteristic curves of its performance are given in Figs. 5 to 8. Of these, Fig. 5 represents the conditions when the generator is giving its full pressure of 900 volts. In this diagram, curve V shows the speed as a function of the tractive effort for constant excitation to the motors. Fig. 6 gives curves for starting with a 170 ton train on the level, and Fig. 7 shows the effect of starting the same train on an up grade of 1 in 100. The curves in Fig. 8 give the maximum tractive efforts which can be developed at the commencement of acceleration together with the corresponding electrical data. In this case the excitation to the motors is kept constant and the different tractive efforts obtained by regulation of the generator voltage. This figure also shows the constant losses in the motor-generator, which are 28 kw., and the current absorbed when running light (34·5 amperes) for the line voltage of 6,000 volts.

Experimental observations with the locomotive illustrated showed that the amount of energy which could be returned to the line was quite considerable. For example, when reducing the speed of a 170 ton train from 40·5 to 16·8 miles per hour with a negative acceleration of 0·2 metre per second per second, that is, during 52·5 seconds, the quantity of energy returned to the line was 3 kw.-hours. Also when the train was descending a gradient of 1 in 100 at a constant speed of 40·5 miles per hour, 4·7 kw. could be returned to the line.

The locomotive shown in Fig. 4 has been in regular service on the Wettingen–Affoltern section of the Swiss Federal railways for two years on a 15,000 volt circuit. It was originally designed for 50 cycles, but was afterwards altered to be suitable for 15 cycles by rewinding the stator of the induction motor.

THE ELECTRIC CAR EQUIPMENT OF THE LONG ISLAND RAILROAD.*

BY W. N. SMITH.

(*Concluded from page 810.*)

ELECTRICAL EQUIPMENT.

The selection of the electrical equipment of the motor cars of the Long Island Railroad, whether operated singly or in trains, required the most careful study of the loads to be handled, the schedule conditions under which the apparatus is to be operated, and the limitations of the apparatus itself. Whether all cars of a train should be motor cars; whether all axles of the motor cars should be equipped; what the motor characteristics, the ratio of gearing, and the wheel diameter should be; the maximum speed that could be depended upon to make up time, and the amount of time to be allowed for "laying over" at terminals, were, among others, considerations of the utmost importance in coming to a decision on the equipment that would most economically serve the purpose of the Long Island Suburban lines.

The variable number of motor and trailer cars per train caused some variation in the load per motor on different trains. There were also various classes of express and local service to deal with, involving different schedule speeds and average lengths of runs between stops, for all of which it was desirable to provide a uniform equipment, so that any car could be devoted to any desired type of service without discrimination. The motor equipment to be adopted must handle traffic efficiently under any and all of the varying conditions of train weight and schedule speed that occur in the operation of the suburban lines of the Long Island Railroad.

Careful investigation showed that the greatest flexibility would result from a two-motor car equipment, using the most powerful motors practicable. The limitations were mainly the dimensions imposed by the largest trucks that could be operated under the conditions prescribed by the tunnel and curve clearances, which restricted the wheel base of the motor truck to 6 ft. 8 in. This restricted the size of the motor to about 200 H.P., and the study of the conditions was consequently reduced to an examination of the characteristics and gear ratio most suitable for this motor, and of its power of endurance to resist overheating.

At the outset, a series of speed tests was made on various steam trains of the Long Island Railroad in order to compare the actual running time with that laid down in the time tables, and with the times which the railroad officials desired to be met by the electrical equipment. An ordinary passenger coach was fitted with speed-recording devices and a number of speed curves were obtained. The best performance of a relatively light steam locomotive train weighing 171·9 tons with the locomotive is shown in Fig. 7. The difference in the running time of an equivalent electric train is shown in the same diagram, and in general indicates that for all average lengths of run between stops in suburban service up to about two miles the electric train is the faster. The average length of a run over the Atlantic Division, the first to be equipped, was originally estimated at 1·6 miles, but in practical operation since the road was equipped this has been reduced to about 1 mile, giving the electric trains a still greater advantage in speed, due, of course, to their higher rate of acceleration. These same tests also threw some light on the time to be allowed for various delays to which the trains were likely to be subjected, and, together with the actually derived speed curves and calculated best performance curves, showed the relation between the schedule time ordinarily allowed for a train on a given run and the best time that it could possibly make over the same distance.

An idea of the scope of the problem may be had from the statement that there had to be compared about 23 different types of train runs, local and express, on eight different routes, with the average distance between stops (herein called average length of run), different in practically every case. The general solution of the problem was worked out by the aid of speed-time curves.

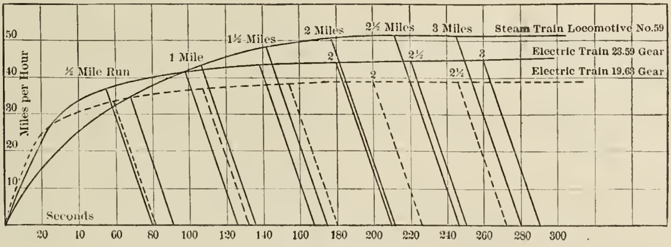

FIG. 7.—SPEED TIME CURVES.

Considerable work was done in the early stages in comparing results previously obtained by former experimenters with a view to determining the train resistance which had to be properly assumed in order to compute the speed of trains, and the power required by them. With this data secured, the next step was to determine, first, the schedule speeds that could be maintained by certain motor and train combinations; second, the heating effect upon the motors when run continuously through the cycles of operation representing the average length of run, and the minimum permissible lay-over at the end of a run, for trains in continuous operation; and third, the power consumption of the system, with average and maximum service.

The schedule speeds were derived directly from the speed-time curves. The most rational method available for estimating the heating effect developed in each motor was to compute the "square root of the mean square" current per motor, averaged over the entire time of any given run or succession of runs, and to compare it with the limiting value set by the manufacturers for the motor selected. The power consumption was easily computed from the current-time curve corresponding to each speed-time curve. The time-distance curve was used to determine the location of the amount of current at any instant, thus enabling the ready computation of third-rail and track drop and the distribution of load between substations. Fig. 8 gives each of these curves for a typical run of three-car multiple-unit trains.

The general result of the motor computations, as determining the size of the car equipment, was that a medium gear ratio (25 : 58 for the No. 113 Westinghouse motor) was fixed upon and the number of motor cars and trailers per train was recommended in accordance with the following table :—

---

* Abstracted from the *Street Railway Journal.*

Length of train.	Local.	Express.
Two-car train ……	Two motor cars No trailers	One motor car One trailer
Threo-car train ….	Two motor cars One trailer	Two motor cars One trailer
Four-car train ….	Three motor cars One trailer	Two motor cars Two trailers
Fivo-car train……	Three motor cars Two trailers	Three motor cars Two trailers
Six-car train ……	Four motor cars Two trailers	Three motor cars Three trailers
Seven-car train ….	Four motor cars Three trailers	Four motor cars Three trailers
Eight-car train ….	Five motor cars Three trailers	Four motor cars Four trailers

Two motors are used per car, and both motors are mounted on the same truck.

MOTORS.

The No. 113 motor was brought out in 1905. It was the first motor built by the manufacturers to use the diagonally divided field frame. With this frame the armature can be taken out without removing the motor from the truck by lifting off the top half of the frame, or the motor can be lifted entirely from the truck by removing the gear case and axle cap. Nose suspension is employed, and the motor is oil lubricated from below.

The pinion has 25 teeth, 2½ in. pitch, and is cut from a solid steel forging. It is keyed to a tapered seat on the armature shaft and held in place by a nut and lock washer. The gear has 58 teeth and is machined from solid cast steel and pressed and keyed to the axle. The diameter of the gear seat is 7$\frac{13}{16}$ in., and the face of the gear is 5¼ in. wide. The gear case is of malleable iron, divided in halves horizontally and supported at both the front and rear ends by lugs projecting from the motor frame and housing.

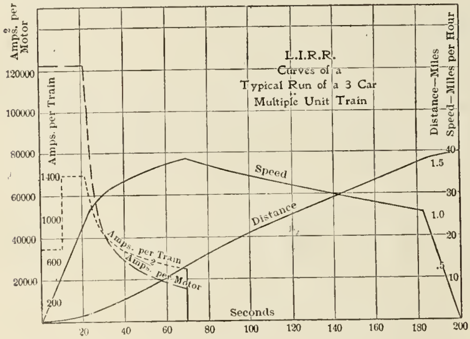

FIG. 8.—CURVES OF A TYPICAL RUN OF A THREE-CAR MULTIPLE-UNIT TRAIN.

CONTROL SYSTEM—MODIFICATIONS FROM PRECEDING TYPES.

The Westinghouse electro-pneumatic multiple control* is employed, and the equipment on the Long Island Railroad differs somewhat from that used in any other important installations made by the Westinghouse Company, such as on the Metropolitan West Side Elevated of Chicago, the Brooklyn Rapid Transit, and the South Side Elevated Railway of Chicago.†

As the principal features of the electro-pneumatic system of control are familiar to the readers of this paper, it will be necessary only in this article to point out such modifications as have been made in previous equipments and the reasons for their adoption, and include a diagram of the connections as used on the Long Island cars.

In the Metropolitan Elevated and Brooklyn systems, which were the earlier installations, the unit switches were grouped in a turret, whereas on the South Side and Long Island installations the switches are arranged in a row in a long box in such a manner that a hinged cover gives access to the main contacts on one side and to the interlocking fingers on the other.

The master controller, which might be considered the next important feature of the system, is the same in all of the installations. With the exception of that on the Long Island; it is fitted with a connection for operating an automatic brake cut-out somewhat similar to that used on the Interborough Subway cars in connection with the type M control. This cut-out permits the handle of the master controller, when on the central notch, to complete a circuit which energises the emergency train brake magnet valve, immediately releasing the air from the train pipe and setting the brakes. This arrangement makes effective the "dead man's handle" feature of this type of control. If the motorman removes his hand from the master controller handle from any cause whatever, it returns immediately to the central position and sets the brakes.

On the face of the Long Island master controller there are nine notches or stops, one in the centre and four on either side, which engage the spring catch of the handle. The central portion, as stated, causes an emergency application of the train brakes.

The first notch is really the "off" or coasting position of the controller, and when the handle is at this point the train brakes are not applied, but all switches, including the line switch, are open. Reversal is accomplished by moving the handle to the opposite side of the centre notch.

When on the second notch or switching position, the controller establishes such connections with the train line that the reverse switch is thrown to the correct position, the line switch is closed, and the switch group closes the circuit of the motors with all the resistance in, thus effecting a slow movement of the train. This, of course, can only happen with all the train line jumpers connected up, so that the auxiliary control apparatus on each motor car is in parallel across the wires of the train line.

The third notch is the series running position, and the fourth and last notch is the multiple position.

One new feature, in addition to those mentioned, is in the arrangement of the motor cut-out switch. This switch, in the Metropolitan installation, actually cuts the motor circuits, but on the Long Island road does so by rearranging the control circuits. In Brooklyn and on the South Side Elevated it is not made a part of the control circuits. The Long Island cut-out switch is placed under one of the seats in the centre of the car, and, of course, is designed to enable the motorman to cut out either or both of the motors under the car. It consists of a small drum-type controller with a permanently attached operating handle, which may be moved to four different positions under which the conditions of the motor connections are as follows: (1) Both out, (2) both in, (3) No. 1 out, (4) No. 2 out. The drum upon this control cut-out switch is provided with a number of contact segments which engage with 14 fingers which are directly connected into the auxiliary control system. When this control cut-out switch is in the off position, none of the fingers makes contact, so that the auxiliary control system is then entirely open circuited. In the other three positions, however, the connections are so made in the auxiliary circuit or so rearranged that the desired effect is obtained by enabling only certain switches to be closed, the balance remaining open.

A line relay is used, as in the Metropolitan installation; it is not employed on the South Side Elevated nor in Brooklyn. This coil is connected across between the main motor control circuit, after passing the line switch, and the ground. That is, it is a 500 volt coil. When the line switch closes and there is a current on the motors, the coil of the line relay is energised and lifts the plunger, causing the disc to close the circuit between the contacts. These contacts are directly in series with the battery circuit of the switch group, so that if they are opened the unit switches of the switch group cannot close, and even if closed the opening of the line relay contacts, due to the cutting off of the line E.M.F. for any cause, causes the battery connection to the switch group switches to be instantly broken, and they at once drop open, cutting off the current supply to the motors. In other words, the line relay constitutes a "no voltage" circuit breaker for the main circuit. This action takes place on each car individually, so that if the current supply is interrupted on any car the switch group on that will be cut out independently of the other cars in the train. If the current supply is restored after being broken, while the master controller is in one of the running positions (for example, when the car traverses a gap of the third rail that is longer than the distance between its third-rail shoes), the line relay will then lift and restore the battery connections to the switch group, which will then go through the prescribed cycle of operations under the control of the limit switch as above described, and again supply current to the motors, just as if the controller handle had been thrown to the off position and then turned on again. The line relay is mounted upon the switchboard panel at one end of the car, and its object is to prevent a sudden rush of current after an interruption in this circuit, and thus avoid danger of flashing over on the motors.

The reverser and line switches are the same in all four installations. There is a difference, however, in arrangement of the line relay and limit switch, which on the Long Island car are placed on the switchboard, whereas in Brooklyn and on the Metropolitan Elevated they are carried under the car.

Another slight variation consists in the method of charging the storage batteries. On the Brooklyn and South Side Elevated Railways they are connected to the light circuit, whereas in the Long Island and Metropolitan equipments they are charged through the pump circuit. This is done by connecting the battery in multiple with an adjustable resistance so arranged that the proper charging current will pass through the batteries when the compressor is operated, the circuit through the battery being closed by a relay mounted on the switchboard panel. The position of the battery switches on the switchboard is changed but once a day when the car is in ordinary operation.

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* See *The Electrician*, Vol. LI., p. 5, and Vol. LIII., p. 516.

† *The Electrician*, June 8, 1906.

The supply system comprises, first, the four third-rail shoes mounted upon the trucks, and previously described. Each shoe is provided with an enclosed fuse. The two shoes on opposite sides of the same truck are connected together by a cable run in conduit. From a point just above the inner terminal of one of the shoe fuses is connected the supply main, which runs direct to a switchboard panel (mounted in an enclosed space in one of the vestibules) with two taps, one of which leads through a 'bus fuse to a pair of 'bus-line receptacles at each end of the car. The 'bus line may be considered as a jumper run from one motor car to the next, tapping at each end through a fuse into the supply main wiring of the motor car, thus equalising the main motor supply circuits throughout the train.

LIGHTING.

The lighting of the car is divided into five independent circuits for interior illumination, besides a separate circuit at each end controlling the vestibule dome lights and the signal markers. The incandescent headlight is in series with a resistance and independent of all other circuits. The headlight is controlled by a separate switch, but the marker and dome lights are so controlled that when the latter are turned out on either end of the car the former are turned on. This is for the accommodation of the motorman, whose vestibule at night must be dark, except for the gauge lamp, while the headlight and markers are to be lit only at his end of the car. The interior of each car is lighted by 26 16 c.p. incandescent lamps.

HEATERS

The cars are heated throughout with electric heaters of the panel type, each having a ventilated sheet-iron back and being placed under the seats. There are 24 heaters in the body of the car, and at each end there is one of a special type in the motorman's cab. The heaters inside the body of the car are proportioned so that each can radiate the heat generated by 600 watts without sufficient rise of temperature to endanger passengers' clothing. The variation in the amount of heat is accomplished by having two sets of heater coils, one of twice the capacity of the other. Either or both sets may be cut in by switches, thus providing 3 degrees of heat, the distribution being uniform in all parts of the car on any step.

The heaters in the steel motor cars were supplied by the Consolidated Car Heating Co., and are of their usual style. Those in the wooden trailer cars were manufactured by the Gold Car Heating & Lighting Co., and are of the truss plank type of construction. The internal arrangement of the Gold heater is of their usual construction, consisting of a special resistance wire wound as a helix and supported on a crimped and enamelled steel rod. There are two elements, as in the case of the motor-car heaters.

The heating switches are mounted at the top of the switchboard panel at the end of the car.

WIRING.

All wires and cables, for whatever purpose, are run in iron conduits. The sizes of wire used in the car wiring were No. 12 and No. 14 for the auxiliary control, and No. 0, No. 00, 144,000 cm. and 250,000 cm. for the main motor control circuit. These various sizes of conductor are all made up in standard cable.

The rubber insulation was tested to show an insulation resistance of not less than 500 megohms per mile after 48 hours immersed in water at 70°F. The wires also withstood a puncture test of 3,000 volts alternating current at 25 cycles per second on the $\frac{4}{64}$ in. rubber wall and 5,000 volts at 25 cycles per second on the $\frac{6}{64}$ in. rubber wall.

In the vestibule at the motor end of the car is mounted the switchboard. A compartment is provided in the end bulkhead with a metal door lined with asbestos material, which, when opened, exposes the entire front of the switchboard panel. The panel is supported by a steel frame, being held in it against a rubber cushion, and arc shields of asbestos are provided at all points where arcing from the switches is liable to reach the framework of the car. Additional insulation is provided in the form of electrobestos at the sides and top of the switchboard compartment. The power cables are brought into the bottom of the switchboard through loricated conduit, the ends of which are capped with special bell-mouthed castings fitted with rubber rings to prevent damaging the insulation on the cables.

The conduits are of the "loricated" type, and are run through the framing of the car according to a well-worked-out plan which is uniform for all cars, the framing being drilled at the proper points before the cars left the builder's shops. To aid in this work a steel subway car was temporarily secured through the courtesy of the Interborough Rapid Transit Co., and upon it the various details of assembling the electro-pneumatic control and the air-brake equipment were so perfected that a standard system of parts, attachments and drillings was determined upon which simplified and hastened the work of installing the equipments upon all cars. A temporary plant was placed in operation at the Locust Avenue shops of the Long Island Railroad, fitted with all the necessary tools for manipulating the iron conduit, and the work, after being started at this shop, proceeded with great rapidity until the entire number of 130 steel cars was completely equipped. The motors and all the equipment pertaining to the cars, except the air brakes, were mounted upon them at these shops.

All the switches, except the headlight, marker and platform light switches, which are installed in the platform hoods, are mounted upon this switchboard, as well as certain other parts of the auxiliary control system which have been mentioned in various parts of the preceding description.

AUXILIARY EQUIPMENT.

The steel cars as thus constructed and equipped have now been in successful operation for over a year.

Besides the steel cars above described, 55 wooden trailer cars, which had been built six or seven years previously with a view of using them in electrical trains, were equipped to run in trains with the motor cars.

Five electric express cars were provided, equipped with the standard type of motor and trailer trucks, two 200 H.P. standard motors, and with the standard multiple-unit control apparatus. These cars are built of wood, 52 ft. 5 in. over all in length, 9 ft. 9½ in. in width, and with roof 12 ft. 6¾ in. above the top of the rails. They are equipped with standard M.C.B. couplers, and haul the old standard steam baggage and express cars as trailers. The weight of these baggage cars is about 76,500 lb. without load. A view of the completed car is given in Fig. 24.

A rotary snow plough has also been provided, built by the Peckham Mfg. Co., and equipped with one motor and one trailer truck of standard type, and all of the standard motor-car electrical equipment. A set of revolving blades with fan and housings is mounted at each end of the car, operated by one line shaft running through the car and fitted with two friction clutches, one for each end section, the centre section carrying two 50 H.P. railway type motors, run by a series parallel controller of the standard platform type.

In order that all the electric car equipment might be given a thorough service test, and the apparatus properly adjusted before going into the regular passenger service, the section of the line known as the Old South Road, between Jamaica and Springfield Junction, was equipped with third rail and all the car electrical equipments were subjected to service-running tests in trains of various lengths, and given a continual inspection to insure that all apparatus was in proper order.

These tests also served the purpose of instructing the motormen and familiarising them with the care and operation of the car equipments and brakes.

CONCLUSION.

With the preceding account of the electric car equipment, the description of the newly-installed system for operating the Long Island Railroad trains with electric power is brought to a close. The car equipment has proved itself in every way equal to the demands made upon it both for regular and emergency conditions of travel. The electro-pneumatic multiple unit control system has worked perfectly from the start, and throughout the entire installation, including the power station, transmission system, sub-stations and cars, the endeavour was made, not only to take advantage of the most recent progress, but, as opportunity offered, to establish new precedents in the art. In achieving the distinction of being the first one of the main steam railroad lines to initiate and make effective the change of motive power for its suburban service to meet the needs of its territory, the Long Island Railroad Co. has set an example of foresight, thoroughness and sufficiency in the execution of the undertaking.

BOOKS RECEIVED.

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"Proceedings of the Royal Society": Series A, Vol. LXXVIII., No. A523, "Mathematical and Physical Sciences." Series B, No. B524, "Biological Sciences." (London: Harrison & Sons.) 3s. and 2s. 6d.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Session 1905-06. Parts 8 and 9. August, 1906. (London and Newcastle-on-Tyne: Andrew Reid & Co.)

"Arithmetic of Electrical Measurements." By W. R. P. Hobbs. 12th edition. (London: Thomas Murby & Co.) 1s.

"Applied Electricity: A Text Book of Electrical Engineering for Second Year Students." By J. Paley Yorke. (London: Edward Arnold.) 7s. 6d.

"L'Electricité à l'Exposition Universelle et Internationale de Liége." 1905. By J. A. Montpellier, with an introduction by E. Gartiaux, President of the Electrical Committee. (Paris: H. Dunod & E. Pinat.) 18fr.

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CANAL HAULAGE.

At a time when the canals in this country are in a more or less moribund condition, and many of them derelict, the description of the Teltow Canal, which we begin in this issue, will be read with interest. Here we have an instance of German municipal enterprise on a large scale. Realising the importance of joining up such rivers as the Oder, the Spree and the Havel, the municipal authorities of the province of Teltow, one of the wealthiest suburbs of Berlin, have spent a sum exceeding £2,000,000 in carrying out a suitable scheme. As far as the canal itself is concerned, the cost has been materially kept down by making use of several small lakes along the route. Notwithstanding the somewhat numerous railways, this part of the country does not seem to have opened up to any great extent, partly, no doubt, because much of the land is of a marshy character. Now, however, these marshes are being drained into the canal, land is being reclaimed, and the municipal authorities expect to gain considerably by the increased value of the land. Not only so, but many manufacturing firms have recently taken sites for new works along the canal.

With characteristic German thoroughness, several different methods of haulage were tested before the system described was finally adopted. A trial was held of different forms of traction for the canal itself, while for the lakes tugs equipped with petrol motors, with suction gas plant, with liquid-fuel-steam plant and with accumulators, as well as tugs taking electric energy by ordinary trolleys and by the Lombard-Gerin system, were all submitted to trial. Naturally, accumulators did not give such a cheap result as the electric tractor, and petrol also was expensive, but the suction gas plant appeared promising, though not sufficiently definite to give a final result.

The history of our own canals has been rather unfortunate. The Bridgwater Canal, opened in 1761, was the first of any importance, and owing to its success, a general system of canals developed rapidly and earned large revenues. But about 1830, when the railways started, canal owners became alarmed, and a number of the properties passed into the hands of the railway companies. This was probably the worst thing that could have happened, for a company cannot compete against itself, and it was not to the interest of the railway companies that canal traffic should be encouraged. In some cases the tonnage carried has continued to increase, but owing to competition the revenue has not increased in anything like the same proportion. It appears that when the terminal facilities are good a canal can compete for short distances, up to 60 miles, but over longer distances the railways have the advantage.

According to the Board of Trade returns there are in operation 3,907 miles of canals in the United Kingdom, the locked parts of navigable rivers being also included in this figure. The traffic carried in 1898 was 39,350,000 tons, as compared with 36,300,000 tons in 1888, so that there was some increase, though not nearly so much as in the case of railways in the same period. But the tonnage per mile per annum on the average is only 10,000, whereas on the Teltow Canal it is about 100,000 tons per mile, and higher figures are expected. Although such figures are not very suitable for a fair comparison, because ton-miles are the important item rather than tons, they serve, nevertheless, to show that the traffic on the Teltow Canal is much more considerable than over here. Moreover, this canal is built for heavier work. The depth is over 8 ft., and therefore suitable for 600-ton barges, and the minimum width is 66 ft., whereas the canals in this country are generally about two-thirds of this width and with less depth, suitable only for barges intended for horse haulage. The problem, therefore, is not very simple. The outlay for electrical working, however, need not be so heavy as in the case of the Teltow canal, for there are probably electric power companies available on most of the waterways for the supply of energy. There is no reason why increased facilities should not cause new works to spring up on the banks of a canal, the inducements being a supply of water coupled with easy transport for coal and manufactured goods. Other countries, at all events, regard the subject of canal working as one which is still of importance, and we therefore hope that the work of the Royal Commission now sitting will result in more attention being paid to the waterways of this country than has been the case during the last decade.

NOTES ON GLOW-LAMP STANDARDS AND GLOW-LAMP PHOTOMETRY.

BY J. S. DOW, B.Sc.

The secondary standards of light now in general use are practically restricted to standard glow lamps and flame-standards, usually of the Methven screened type. It is generally considered preferable to use a flame standard, when testing gas lamps of any kind, and a glow-lamp standard when testing glow lamps. The variations in candle power of flame standards and flames in general, due to the influence of water vapour and barometric pressure, are now known to be considerable, and it is probable that under the usual conditions of testing the effect of vitiation of the atmosphere of the photometry room is quite as important. If a glow-lamp standard, which is presumably independent of atmospheric conditions, is used for testing gas lamps, all these causes of uncertainty would affect the gas lamps tested and not the glow lamp, while, if a gas standard is used, the influence of water vapour, &c., would affect both the standard and the lamp tested simultaneously, and will therefore be less noticeable. At the same time we have no right to assume that two different types of lamps such as a Methven standard and an incandescent mantle, would be affected in the same degree. If accurate results were wanted, probably the best plan in such a case would be to use an incandescent mantle as a temporary standard, so that any atmospheric change affected both standard and lamp tested in exactly the same way.

Further, when a glow-lamp standard is used for testing gas lamps, the regulation of the P.D. to the necessary degree of accuracy is usually a difficulty.

In the same way it is not advisable to use a secondary gas standard when testing glow lamps, for in this case all atmospheric changes will affect the standard and not the glow lamps, while if the standard glow lamp is used this difficulty is, of course, absent. Moreover, if the standard glow lamp and the glow lamp to be tested are run in parallel off the same P.D. any change in the pressure affects both lamps together, and hence it is quite sufficient if the P.D. is regulated to 1 or even 2 per cent.

It is to be noted, however, that as a rule two glow lamps, even of a similar class, are not affected by a change of P.D. in exactly the same way, and hence the ratio of the candle-power of one to the other is distinctly affected by a change in the P.D. of 5 per cent. or so.

For instance, Table I. below shows the result of comparing two 100 volt nominally 50 c.p. glow lamps when run in parallel off several different P.D.s.

Table I.—*Comparison of the 100 volt 50 c.p. Glow Lamps.*

P.D. (volts).	Ratio of candle-power : $\frac{\text{Lamp No. 1.}}{\text{Lamp No. 2.}}$
87·4	0·767
91·2	0·778
95·0	0·785

A change of 1 per cent. in the P.D. would thus cause an error of something like 0·25 per cent. in the determination of the candle-power.

When we are comparing a Nernst, tantalum, or osmium lamp with a standard glow lamp, run in parallel with it off the same P.D., the exact regulation of this P.D. becomes much more important. For, while the candle-power of the glow lamp varies with about the seventh power of the P.D., the candle-power of tantalum and osmium lamps appear to vary with about the fourth and fifth power respectively, and the candle-power of the Nernst lamp, on account of the iron wire resistance in series with it, is practically independent of small variations in the P.D.

Table II. shows the result of comparing a tantalum lamp with a standard glow lamp, run in parallel with it off the same P.D., for several values of the P.D.

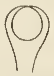
Table II.—*Tantalum Lamp compared with 100 volt Glow Lamp.*

P.D. (volts).	Ratio of candle-power : $\frac{\text{Tantalum lamp.}}{\text{Glow lamp.}}$
91·2	0·576
95·0	0·530
97·0	0 505

Here a difference of 1 per cent. in the P.D. across the two lamps would make a difference of as much as 2·5 per cent. in the candle-power of the tantalum lamp.

It will also nearly always be found that if two glow lamps —even two lamps having precisely the same type of filament —be compared at distances varying from 1 metre up to 3 metres, the results tend to gradually change as the distance increases. Below are the results of comparing an ordinary 100 volt 8 c.p. Robertson lamp against a similar 100 volt 16 c.p. lamp, both having filaments of the usual type for low-voltage lamps, at distances varying from 1 to 2½ metres. In the figure is shown the appearance of the filament looking down the photometrical bench towards the lamps. The lamps were therefore placed in the position in which they are usually tested—*i.e.*, the position in which the candle-power is a maximum.

Table III.

Type of lamps compared.	Distance between lamps.	Ratio of C.P.: $\frac{\text{16 c.p. lamp.}}{\text{8 c.p. lamp.}}$
Robertson 100 volt 8 c.p. and 16 c.p. lamps. 	250 cm.	2·38
	220 ,,	2·37
	200 ,,	2·35
	170 ,,	2·33
	140 ,,	2·34
	120 ,,	2·33
	100 ,,	2·32

In spite of every care in the centring of the lamps and the photometer, the writer has almost invariably found differences of this kind, and when the lamps are of quite *different* types, the differences may be very much greater. They are presumably due to the fact that the true centre of illumination rarely lies on the central axis of the lamp bulb from which we measure. For accurate work, therefore, it is desirable that a certain distance between the lamps compared should be generally agreed upon. Standard lamps should have filaments of the simple horseshoe type, lying entirely in one plane. In this case, when the plane of the filament is set perpendicular to the bench, a slight turning of the lamp about a vertical axis only affects the candle-power very slightly, while the centre of illumination must lie within the plane of the filament.

When a glow-lamp standard is used to study the variations of a flame standard the P.D. must, of course, be very exactly known. Dr. Fleming, indeed, in 1902 (*Proc.* Inst. of Elec. Eng., 1902, Vol. XXXII., p. 144) put on record his opinion that no voltmeter in existence was sufficiently accurate for this purpose, but there seems no reason why a reflecting voltmeter, constantly compared against a potentiometer, should not answer for all but very accurate investigations indeed. The writer, when working at the Central Technical College, used a reflecting electrostatic voltmeter with a very open scale in the neighbourhood of 100 volts with satisfactory results. A change of 1 per cent. in the P.D. at this point corresponded to a division nearly ½ in. in length on the scale, and calibrations of this instrument, with a potentiometer, over nearly six months agreed to within $\frac{1}{10}$ per cent. The reflecting voltmeter now in use at the National Physical Laboratory enables measurements to be made which are well within the limits of photometrical observation.

As the P.D. across the standard lamp must be known so exactly, contact resistances in the lampholder may quite possibly give trouble, especially if the resistance of the lamp is low. For this reason screwholders are preferable to those of the bayonet type. At the Reichsanstalt the results of contact troubles are entirely avoided by measuring the current through the lamp instead of the P.D. across it. This method has also the incidental advantage that the candle-power of the lamp is proportional to a lower power of the current than the P.D., and hence the former need not be known so exactly. It has also advantages which will be referred to shortly.

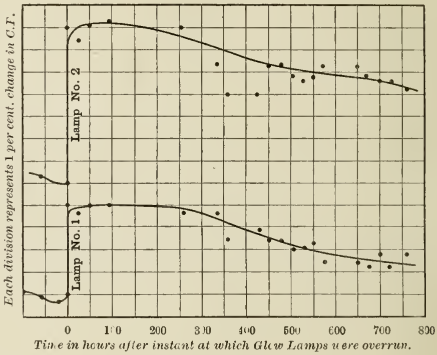
All glow lamps appear to be more or less subject to the "hysteresis effect." If the P.D. across a lamp be maintained for a short time at a higher value than that at which the lamp is normally run, both the current and the candle-power are usually perceptibly higher than before, when the P.D. is brought down again to the usual value. Table IV. shows the effect in the case of two new ordinary 100 volt 16 c.p. lamps, taken at random, of the Robertson and Sunbeam makes respectively. The lamps were tested at 95 volts. They were then run at 110 volts for three minutes and again tested at 95 volts, then at 120 volts for three minutes and again tested at 95 volts, and finally at 130 volts for three minutes and then again tested at 95 volts.

The effect seems perceptible even when the lamps had only been run at 110 volts, and the writer has usually found that overrunning a lamp by only 10 per cent. for 10 minutes or so produces a distinct effect. As a rule the increase in candle-power at a given P.D. seems to be caused mainly by a temporary decrease in the resistance of the lamp, and consequent greater power consumption. But in some cases there seemed to be a small change in candle-power without any noticeable change in current, showing that the efficiency of the lamp had been increased, for the time being, by overrunning. But if the current through a standard lamp, instead of the P.D. across its terminals, is always maintained at a constant value, the increase in candle-power caused by slightly overrunning the lamp will be, to a great extent, avoided. Nevertheless it is desirable that the P.D. across a standard lamp should never be carried above that at which the lamp is normally used.

Table IV.

Type of lamp.	Before overrunning. At 95 volts.		After overrunning.					
			At 110 volts, for 3 min. at 95 volts.		At 120 volts, for 3 min. at 95 volts.		At 130 volts, for 3 min. at 95 volts.	
	Current.	C.P.	Current.	C.P.	Current.	C.P.	Current	C.P.
Sunbeam ..	0·535	9·48	0·535	9·53	0·538	9 68	0·542	10·00
Robertson ..	0 543	9·70	0·544	9·72	0·545	9 70	0·550	9·97

As a rule, when left alone, the lamp tends to gradually return to its former state, the time of recovery depending on the severity of the strain to which it is subjected. The behaviour of two 100 volt 50 c.p. large bulb lamps, which were used as secondary standards, is shown in the figure.



EFFECT OF OVER-RUNNING.

These two lamps were always used at a P.D. of 95 volts, but one day they were accidentally run at—probably—nearly twice this value for a few seconds. The filaments, however, did not give way, and the lamps were immediately retested, when it was found that their candle-powers had increased by about 4½ and 7 per cent. respectively. A record was kept of the candle-powers of these for about a month afterwards. They were run at 95 volts, and were always compared, in exactly the same position, with the same standard. The gradual fall of candle-power during the month showed that the lamps were gradually returning to their original state, but at the end of the month they were still about 2·2 and 4·2 per cent. respectively above their former values. It should be explained that the small length of time during which the lamps were in use, and the low efficiency at which they were run, showed that this change could not be accounted for by the natural ageing of the lamps. Previously to the accident, the lamps had been used in the same way for about two months without any distinct fall in candle-power being noticed.

This recovery of lamps is of interest in that it may affect the question of the ageing of standard lamps before use. The candle-power of most glow lamps changes very rapidly for a short time at the commencement of their lives and it is customary to age standard lamps by running them for 50 to 100 hours or so, at their prescribed voltage, or slightly above it, in order that this change may be complete before they are put into use. It seems possible, however, that in so doing a strain may be put upon the filament, resulting in a subsequent slow recovery and gradual fall of candle-power. The lamps, therefore, should be allowed to rest for some time after the "ageing," in order to reach a steady state.

There is one other possible source of uncertainty connected with standard glow lamps to which reference should be made. In the discussion of Dr. Fleming's Paper, in 1902, Mr. J. T. Morris (*Proc.* of Inst. of Elec. Eng. *ref. cit.*) drew attention to the variation in candle-power of a glow lamp owing to changes in the temperature of the photometer room. He found that a change in temperature of 9°C. produced a change of 1 per cent. in the candle-power of the glow lamp. At the Central Technical College the temperature of the photometer room varied about 12°C. from the beginning of February till August in the present year, and according to the above figures this would produce quite sufficient effect to be worth taking account of in a standard lamp.

It seems likely that the study of some of the newer metallic filament lamps may lead to a greatly improved incandescent standard. The tantalum lamp, for instance, has the advantage that the candle-power is only proportional to about the fourth power of the P.D. across the lamp, while it seems likely that at low efficiencies its life would be distinctly better than that of glow lamps. On the other hand, the difficulty of producing such lamps for high voltages would be of little importance in the case of a laboratory standard.

Dr. Kuzel's metallic filament lamps (*Electrician*, February 9 and March 9, 1906), so far as may be judged from the information which has at present been published about them, might also prove valuable. The fall of candle-power with use at moderate efficiencies is said to be very much less than with carbon filament lamps, and, from the fact that the lamps are said to be very little affected by being overrun even 300 per cent., one would suppose that "hysteresis effects" would be inconsiderable, and that such a standard would not easily be damaged by incautious regulation of the P.D.

THE MAGNETIC FIELD IN THE SINGLE-PHASE INDUCTION MOTOR.*

BY A. S. McALLISTER.

As is well known, when the circuits of a polyphase induction motor operating near synchronism are so arranged as to convert the machine into a single-phase motor, the revolving field, which was previously due to the combined actions of certain components of the displaced polyphase currents, continues to exist, and the action of the machine in developing mechanical power is subjected to almost no change. It is equally well known that the quadrature "speed" component of the magnetic field is produced by current in the secondary, and that the magnetomotive force represented by this secondary current must be supplied by a component of primary current. On account of the fact that the secondary current which produces the quadrature "speed-field" occupies a position in space such that it cannot possibly react directly on the field produced by the primary current, it is not immediately apparent in what manner the "quadrature watts" for the "speed-field" are supplied by the primary exciting magnetomotive force.

A popular method of treating the internal behaviour of a single-phase induction motor is the one due to Ferraris, who showed that the simple alternating field can, in all of its effects, be replaced by two revolving fields moving in opposite directions, the maximum value of each being equal to one-half of the maximum value of the alternating field. By means of this method it is possible to ascertain the distribution of current in the secondary, and the reaction of certain components of the secondary current upon the primary; but the present writer believes that the actual significance of the results obtained, as viewed by the average reader, are greatly obscured by the difficulty in distinguishing the imaginary from the real when the two are so closely interwoven.

A prominent writer of the present day states that "the cause of the cross magnetisation in the single-phase induction motor near synchronism is that the induced armature currents lag 90 deg. behind the inducing magnetism and are carried by the synchronous rotation 90 deg. in space before reaching their maximum"; and that "below synchronism the induced armature currents are carried less than 90 deg., and thus the cross magnetisation due to them is correspondingly reduced, and becomes zero at standstill." It is greatly to be doubted if these statements convey any physical idea whatever to a mind not already thoroughly familiar with the facts.

Although the method outlined below will not serve to present any facts which cannot be ascertained by other methods which have frequently been employed, yet it is believed that much good can be accomplished by drawing attention to the fact that all of the phenomena connected with the production of the magnetic field in the single-phase induction motor can be investigated with the utmost simplicity by dealing directly with well-known electromagnetic relations without resorting to imaginary physical or mathematical representations.

Fig. 1 shows a two-pole model of a single-phase induction motor which is represented as possessing four mechanical poles, two of which (1 and 3) are excited by single-phase alternating current. Merely for sake of simplicity in explanation, mechanical poles 2 and 4 are indicated as subjected exclusively to the flux of the "speed-field." Under any condition of operation the flux in poles 1 and 3 is determined directly by the primary E.M.F., modified by the volts consumed in the local impedance of the primary coil by the current which flows therethrough. That is to say, the flux in these poles follows the laws which relate to stationary transformers; no action which takes place in the secondary can rob the primary of this transformer feature. In dealing with the secondary, however, it is necessary to recognise the fact that each rotor conductor is subjected to four distinct E.M.F.s—the E.M.F.s produced by the rate of change of the transformer and of the speed-fields, and the E.M.F.s generated by the motion of the rotor through the transformer and the speed-fields. Each of these E.M.F.s will be treated separately and the combined effects will then be investigated.

When the rotor is moving across the transformer field in the direction indicated, there will be generated in each of the conductors under the poles an E.M.F. proportional to the product of the field magnetism and the speed of the rotor. Evidently if the speed be constant, of whatsoever value, this E.M.F. will vary directly with the strength of magnetism; that is, it will be maximum when the magnetism is maximum, and zero at zero magnetism. Other conditions remaining the same, the maximum value of this secondary E.M.F. will vary directly with the speed of the rotor.

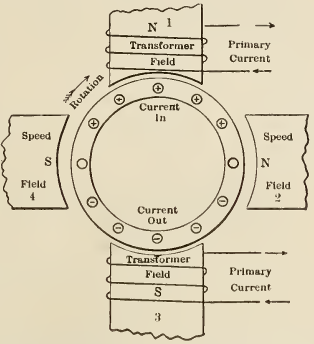


FIG. 1.—PRODUCTION OF "SPEED FIELD" CURRENT.

If the circuits of the rotor conductors be closed, there will tend to flow therein currents of strengths depending directly upon the E.M.F.s generated in the conductors at that instant and inversely upon the impedance of the rotor conductors. The current which flows through the rotor circuits at once produces a magnetic flux which by its rate of change in value generates in the rotor conductors a counter E.M.F. opposing the E.M.F. that causes the current to flow, and of such a value that the difference between it and this E.M.F. is just sufficient to cause to flow through the "local" impedance of the conductors a current whose magnetomotive force equals that necessary to drive the required lines of magnetism through the reluctance of their paths. Since this latter magnetism must have a rate of change equal (approximately) to the E.M.F. generated in the rotor conductors by their motion across the primary field, and since this E.M.F. is in time phase with the primary field, it follows that this magnetism must have a value proportional to the rate of change of the primary magnetism—that is, it is (approximately) in time quadrature to the primary magnetism.

A study of the direction of the currents in the rotor under the conditions assumed will show that when a north pole at 1 (in Fig. 1) has reached its maximum value and is decreasing towards zero, the speed-field is building up with a north pole at 2, and that this pole continues to increase in strength until the magnetism at 1 reverses its direction. Thus, it may be stated that the north pole of the resultant magnetism travels in the direction of motion of the rotor. Since the rapidity of reversal in sign of the "transformer-field," poles and of the "speed-field" poles depends solely upon the frequency, it may be stated that the resultant field revolves at synchronous speed. The "speed-field" is equal (approximately) to the product of the "transformer-field" and the speed, with synchronism as unity. Thus the resultant field is at any speed elliptical as to electrical space representation; one axis of the ellipse is determined by the "transformer-field," while the other depends upon the speed. At synchronism the ellipse becomes a circle; above synchronism the ellipse has its major axis along the "speed-field"; at zero speed the ellipse is a straight line, which means that at standstill there is no "space" quadrature flux, and hence no revolving field.

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* From the *Electrical World.*

Reviewing the electromagnetic processes just discussed, it will be noted that the E.M.F. which produces the "speed-field" current is caused by the motion of the rotor through the "transformer-field" and is opposed by the rate of change of the "speed-field" through the rotor circuits. The mechanical position of the "speed-field" current with reference to the primary coil prevents it from reacting directly on the "transformer-field." It remains to investigate the effect of the E.M.F.s generated in the secondary by the rate of change of the "transformer field" through the rotor conductors and by the motion of the rotor conductors through the "speed-field." It will be noted at once that a current due to either of these E.M.F.s would be in position to tend to affect the "transformer-field."

Referring now to Fig. 2, assume initially for sake of simplicity that the rotor revolves at absolutely synchronous speed (being driven by some external means). As noted above, the transformer E.M.F. of the "speed-field" in the rotor is *slightly less* than the speed E.M.F. of the "transformer-field," and is out of time phase therewith, by an amount equal to the E.M.F. necessary to cause the "speed-field" current to flow through the "local" impedance of the rotor conductors. It is seen at once, therefore, that the speed E.M.F. of the "speed-field" in the rotor differs from the transformer E.M.F. of the "transformer-field" by an *exactly* equal amount, so that a current *exactly equal* to the "speed-field" current is produced in the rotor in an electrical space position such that its magnetomotive force tends directly to affect the "transformer field." Since the "transformer-field" must have the value demanded by the primary E.M.F., a current equal in magnetomotive force and opposite in direction to this component of the secondary current must flow in the primary coil. As indicated in Fig. 2, and as may be verified by a study of the fluxes and currents, this component of the secondary current has a time-phase position to tend to *decrease* the "transformer-field," so that the opposing current in the primary appears as an added component of the primary exciting current. Thus the "speed-field" current is accurately represented in the exciting magnetomotive force supplied by the primary current.

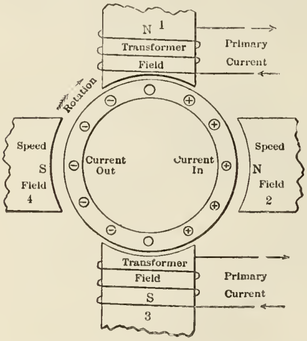

Fig. 2.

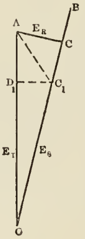

Fig. 3.

Production of Transformer Secondary Currents and E.M.F.s.

It is interesting to note that the "added" component of the primary exciting current depends upon the reluctance of the path taken by the flux of the "speed-field"; when the air-gap traversed by the "speed-field" is much greater than that through which the "transformer-field" passes (as shown in Figs. 1 and 2) the "added" component is likewise much greater than the true primary "transformer" exciting current. Thus, the total quadrature exciting watts are equal to the *sum* of the watts which would be required for producing the same magnetic field by means of two-phase currents in coils wound symmetrically on poles 1, 2, 3 and 4, and not necessarily equal to twice the value initially taken by the windings on poles 1 and 3.

It is instructive to investigate the conditions which would exist if the two components of secondary current at synchronous speed could be caused to continue to flow unaltered with the primary on open circuit. As noted above, the "speed-field" current and that component of the secondary current which tends to oppose the transformer field flow in "electrical time quadrature" and occupy positions in "electrical space quadrature"; thus, if acting without opposition, they would produce a rotating magnetic field. It is a curious fact, easily appreciated from a study of Figs. 1 and 2, that this magnetic field would travel around the air-gap in a direction opposite to the motion of the rotor. Since the two exciting components of the secondary current in reality combine in the rotor structure to produce a resultant single current distributed throughout the several conductors, it may be stated that a band of secondary exciting current revolves synchronously in a negative direction. If one considers the time value of the current in a single rotor conductor, it will be discovered that at synchronous speed this current is of double frequency. As will be shown below, at other speeds the "secondary exciting current" has a value proportional (approximately) to the speed, and it continues to revolve synchronously in a negative direction; thus the frequency of this current in an individual rotor conductor is equal to the primary frequency f_p multiplied by one plus the speed S with synchronism as unity. That is, $f_s = f_p\ (1 + S)$.

Consider now the effect of operating the rotor at a speed somewhat below synchronism. Since there is no opposing magnetomotive force in line with the "speed-field," the "speed-field" component of the rotor current acts as though it alone occupied the secondary conductors, and its value is in no way affected by the presence of any other component of secondary current. Thus the E.M.F. necessary to force the "speed-field" current through the secondary conductors depends solely on the value of the "speed-field" component of the rotor current. Since the E.M.F. generated in the secondary by the motion of the conductors through the "transformer field" depends directly upon the product of this field and the speed, it follows that a definite percentage of this speed-generated E.M.F. is consumed in the "local" secondary impedance at all speeds, and that the time-phase displacement between the speed-generated E.M.F. and the transformer E.M.F. of the "speed-field" is constant at all times. Thus the "speed-field" at speed S bears to the "transformer-field" a ratio equal to the product of S and a certain constant which denotes the difference in value and phase position of the "speed-field" and the "transformer-field" at exact synchronism. The significance of this statement is that the "speed-field" component of the secondary current has a value proportional accurately to the product of the speed S, the "speed-field" current at synchronism and the ratio of the "transformer field" at speed S to that at synchronous speed.

Since the transformer E.M.F. of the "transformer-field" in the rotor depends upon the strength of this field, but is independent of the rotor speed, while the opposing speed E.M.F. of the "speed-field" varies with the product of the speed and the "speed-field," it follows that the resultant E.M.F. which tends to produce "power" current in the secondary at speed S is equal (approximately) to the product of the quantity $(1 - S^2)$ and the transformer E.M.F. (see Fig. 3). This component of secondary current occupies at all times a space position magnetically in line with the "transformer-field," and it reacts upon the primary just as though it flowed through the secondary of a stationary transformer into a non-inductive (fictitious) load resistance; it is superposed in space, but not in time, upon that component of the "revolving secondary exciting current" which directly opposes the "transformer field."

In Fig. 3 let the line OA represent the value of the transformer E.M.F., E_T, of the "transformer-field" in the rotor; E_T varies directly with the "transformer-field," and hence decreases as the primary current increases. Let the angle AOB represent the time-phase difference between E_T and E_S, the speed E.M.F. of the "speed-field" in the rotor; the angle AOB is constant at all speeds. At synchronous speed, E has a value OC such that the resultant of E_T and E_S gives the E.M.F. E_R, which produces that component of rotor current which reacts upon the primary. At some lower speed, S, E_S has a value OC_1, such that $OC_1 = S^2\ (OC)$, neglecting the relative decrease in the value of E_T, and the resultant E.M.F. which produces current to react upon the primary is shown by AC_1. Of this latter E.M.F. the component C_1D_1 in time quadrature with the transformer E.M.F. varies with S^2, the square of the speed; (that is, it decreases when S decreases) while the component AD_1, in time phase with the transformer E.M.F., varies with $(1 - S^2)$; that is, it increases with decrease of speed. To the latter of these components may be attributed the secondary "load" current, whileto the former may be attributed that component of the "negatively revolving exciting current" which directly opposes the "transformer field."

When the rotor is stationary the "load" component of the secondary current in the individual conductors is of the primary frequency; at nearly synchronous speed it pulsates in value in each separate rotor conductor, being unidirectional in certain conductors and alternating at double frequency in certain other conductors situated 90 electrical space degrees from the former.

It is seen, therefore, that there exist in the rotor three components of secondary current, each of the primary frequency with reference to space representation: the "speed-field" current, the current having a value closely equal to the product of the "speed-field " current and the speed, but displaced therefrom both in space and in time by 90 electrical degrees, and the load current. Each of these varies in value with the " transformer-field." The first varies directly with the speed S. The E.M.F. which produces the second varies with S^2, while the E.M.F. which produces the third varies with $(1-S^2)$. At synchronous speed the first two components are equal in value, while the third is practically zero. At zero speed the first two components are zero and only the third flows in the rotor. Under all conditions the second and third components combine to form the secondary current of the machine considered as a transformer; the second component acts as a continually decreasing (with decrease of speed) wattless current, while the third acts in all respects as though it flowed through the secondary into a non-inductive load resistance.

The relations which exist between the several components of the fluxes, the currents and the E.M.F.s in the rotor at various speeds are shown graphically in Figs. 4 and 5. In Fig. 4, let the distance AD be given an arbitrary value of unity, and let the curve AEFD be a semi-circle. Then if DE is made equal to the speed S, BD is equal to S^2. Consider the condition when the speed S has the value represented by FD; the ratio of the " speed-field " to the " transformer-field " is shown directly by the line FD; this line also shows the ratio of the true " speed-field " current to the true " transformer-field " current, and likewise the ratio of the component of the secondary current, which directly opposes the " transformer-field " to the true " speed-field " current. Thus, if at the speed shown by FD, AD is assumed equal to the " transformer-field " current, DF is equal to the true " speed-field " current and CD is equal to the " opposing " component of the secondary current. Furthermore, if, at the speed FD, AD be made equal to the E.M.F. which would be produced in the secondary by the " transformer-field " with the rotor stationary, CD is the actual speed E.M.F. due to the motion through the " speed-field," and AC is the E.M.F. which causes " load " current to flow through the secondary impedance.

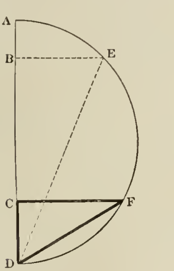

FIG. 4.—NUMERICAL VALUES OF FLUXES, CURRENTS AND E.M.F.S.

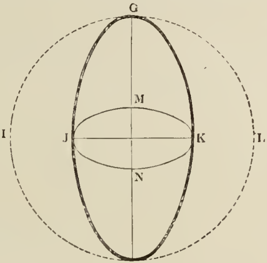

FIG. 5.—TIME AND SPACE VALUES OF FLUXES AND CURRENTS.

It is to be noted especially that the diagram of Fig. 4 gives only the relative numerical values of the various components, and does not indicate their time-phase or electrical space positions. The electrical space and time values of the E.M.F.s are shown in Fig. 3, while the equivalent values for the fluxes and currents are represented in Fig. 5. In this diagram GH is equal to AD of Fig. 4, while the curve GLHI is a circle; JK is made equal to FD and the curve GKHJ is an ellipse; MN is equal to CD and curve MKNJ is an ellipse. The electrical space value of the flux at synchronous speed is shown by circle GLHI, while at speed DF it has the value indicated by ellipse GKHJ. If the line GH shows the value and phase position of the true " transformer-field " current, the line JK simultaneously shows the value and phase position of the true " speed-field " current; these currents are in separate electrical structures, and they do not combine directly, but their magnetomotive forces combine to produce the elliptical revolving magnetic field. The value and phase position of the " opposing " component of the secondary current is shown by the line NM; this current is in the same electrical structure with current JK, and the two combine to produce the " negatively revolving secondary exciting current," shown by curve KMJN, which is elliptical as to space representation.

It is interesting to observe that the actual " speed-field " current in the secondary varies directly with the speed, but that the component of the secondary current which reacts directly upon the transformer field varies with the square of the speed, or, more correctly, with the square of the transformer-field. It will be noted that on account of this fact the total " quadrature exciting watts " of the single-phase induction motor vary directly with the square of " transformer-field " plus the square of the " speed-field." Thus the true exciting watts of the machine at any speed are directly proportional to the sum of the squares of the densities of the fluxes traversing the several magnetic paths.

ON THE EXPERIMENTAL DETERMINATION OF THE RATIO OF THE ELECTRICAL UNITS.*

BY LORD RAYLEIGH, O.M., PRES.R.S.

(Concluded from page 828.)

But although the condenser method may be the best, it is not so perfect but that a desire remains to see results so obtained confirmed otherwise. The construction of an absolute electrometer is beset with difficulties, some of which have been remarked upon by M. Abraham. In point of theory the best arrangement is that described by Maxwell (" Electricity," § 127, 1873), in which (Fig. 3) an inner cylinder C moves coaxially in the interior of fixed coaxial cylinders A, B. It will suffice to suppose that C and A are at potential zero while B is at electrostatic potential B.

" The capacities of the parts of the cylinders near the [gap] and near the ends of the inner cylinder will not be affected by the [motion] provided a considerable length of the inner cylinder enters each of the hollow cylinders. Near the ends of the hollow cylinders, and near the ends of the inner cylinder,† there will be distributions of electricity which we are not yet able to calculate, but the distribution near the [gap] will not be altered by the motion of the inner cylinder provided neither of its ends come near the [gap], and the distributions at the ends of the inner cylinder will move with it, so that the only effect of the motion will be to increase or diminish the length of those parts of the inner cylinder where the distribution is similar to that on an infinite cylinder."

Thus, if a be the radius of the inner cylinder and b of the outer, the force with which the former is drawn into B is

$$F=\frac{\frac{1}{4}B^2}{\log(b/a)}.$$

It appears that F depends only on the *ratio* of the diameters of the cylinders B, C. Suppose, for example, that $2a=2$, $2b=4$ (perhaps in inches), then $\log(b/a)=\log 2=0{\cdot}69$. If the potential B correspond to 2,000 volts,

$$B=\frac{2\times10^{11}}{v}=\frac{2\times10^{11}}{3\times10^{10}}=\frac{20}{3},$$

and $F=16$ dynes or megohms weight. This is rather small; but since $F\propto B^2$, we get 64 megohms for 4,000 volts, and 144 megohms for 6,000 volts.

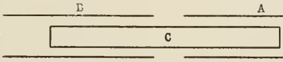

FIG. 3.

As regards the effect of errors in the fundamental measurements b, a, we have, if $y=\log(b/a)$,

$$\frac{dy}{y}=\frac{db}{by}+\frac{da}{ay};$$

or with the above proportions

$$\frac{dy}{y}=\frac{d(2b)}{0{\cdot}7(2b)}-\frac{d(2a)}{0{\cdot}7(2a)}.$$

The outer cylinder is the more difficult to measure, but a given absolute error in it is less important. If we suppose $2b=4$ in., and $d(2b)=\frac{1}{1000}$ in.,

$$\frac{d(2b)}{0{\cdot}7(2b)}=\frac{1}{3{,}000}\text{ about,}$$

and the proportional error in y is halved when we pass to that of B.

It should be borne in mind that what we have to do with here is *not* the *mean* diameters of the cylinders, if such diameters vary.

This form of absolute electrometer was employed in the researches of Hurmuzescu,‡ who mounted the cylinders on a torsion balanced so that the motion was horizontal and not strictly axial. Some advantages are attained in this arrangement, especially perhaps that of being able to reverse the force and so to double the rather inadequate value of the subject of measurement; but upon the whole it appears to me preferable to suspend the moving cylinder C vertically in an ordinary balance, C and the upper fixed cylinder A being in connection with earth by wires which may be very fine.§ The force is then evaluated in gravitation measure; and it may of course in effect be doubled by duplicating the cylinders on the other side of the balance.

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* From the *Phil. Mag.*, August, 1906.

† A solution of this problem for the case of *two dimensions* has been given by Prof. J. J. Thomson (*Recent Researches*, § 237, 1893).

‡ *Ann. d. Chim.* X. p. 433, 1897. This author erroneously attributes Maxwell's reasoning above, by which the unknown parts of the electrical distribution are eliminated, to Bichat & Blondlot (1866).

§ Further screens in connection with earth may be introduced to protect the moving parts of the balance more effectually from the influence of the electricity upon B.

When we come to actual design the question at once obtrudes itself as to how long the cylinders really need to be. In theory it is easy to treat them as infinite, but in practice some concession must be made. In particular the weight of C must not be increased unnecessarily.

The penetration of potential arising at the gap between B and A into the annulus between C and A is easily investigated. For practical purposes it suffices to treat the problem as in two dimensions. If r be the radius and z (the axial co-ordinate) be measured from the end of A, the potential V in the annulus may be taken to be

$$V = \Sigma H e^{-m\pi z/(b-a)} \sin \frac{m\pi(r-a)}{b-a},$$

where m is an integer and H an arbitrary constant variable with m. At the surfaces of the cylinders where $r=a$ or $r=b$, V vanishes. The term whose influence extends furthest is that for which $m=1$. Limiting ourselves to this, we take, since $e^{\pi} = 23{\cdot}2$,

$$V = H_1 (23{\cdot}2)^{-z/(b-a)} \sin \frac{\pi(r-a)}{b-a},$$

showing that when $z=b-a$ the value of V is already reduced to one twenty-third part of that at $z=0$. When $z=4\,(b-a)$, that is, at a distance from the end equal to four times the thickness of the annulus, this term is attenuated 290,000 times, and it is safe to conclude that the whole disturbance of potential may be neglected. A similar argument applies to the annulus between B and C; so that a total length of eight or nine times the thickness of the annulus—8 in. or 9 in. in the example spoken of above—should amply suffice.

There is less objection to increasing unnecessarily the length of the fixed cylinders, but even here there must be some limit. It is easy to see that the prolongation of the upper cylinder A at zero potential above C, also at zero potential, is of little importance. But the case of the charged cylinder B requires further consideration.

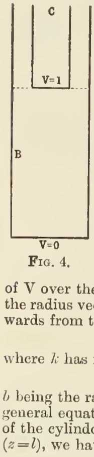

FIG. 4.

For the sake of definiteness it is convenient to suppose B provided with a metallic bottom as in the figure annexed, and the question is as to the effect of the finite distance l of this bottom. If we regard the bottom as a movable piston at the same potential (taken as zero) as the cylinder B which it closes, we may regard it as mechanically attached to the suspended cylinder C, in spite of electrical attachment to B. In this case, *i.e.* when C and the bottom of B move together as a rigid body, Maxwell's argument applies exactly as if the cylinder B were infinite. The correction of which we are in search is therefore equal to the electrical force of attraction which tends to draw the piston towards C.

The potential V in the interior of B is expressible by means of Bessel's functions in terms of the values of V over the plane which includes the bottom of C. Thus, if r be the radius vector and z the vertical axial co-ordinate measured downwards from the above plane, we may write

$$V = \Sigma A J_0(kr) \sinh k(l-z),$$

where k has in succession a series of values such that

$$J_0(kb) = 0,$$

b being the radius of B. Each term in the above satisfies Laplace's general equation and reduces to zero on the walls and on the bottom of the cylinder. If σ denote the density of electricity on the bottom $(z=l)$, we have

$$4\pi\sigma = dV/dz(=l),$$

and for the force of attraction upon the bottom as a whole

$$\text{Force} = \frac{1}{8\pi}\iint \left(\frac{dV}{dz}\right)_l^2 dS,$$

dS representing an element of area. Now

$$\frac{dV}{dz(=l)} = -\Sigma k A J_0(kr);$$

and thus, since the products of the various terms must vanish when integrated over the circle $r=b$,

$$\text{Force} = \frac{1}{4}\int_0^b r\,dr\,\Sigma k^2 A^2 [J_0(kr)]^2 = \tfrac{1}{8}\Sigma k^2 b^2 A^2 J_0'^2(kb),$$

by a known theorem. The values of kb are 2·404, 5·520, 8·654, &c.

$$\text{When } z=0, \qquad V = \Sigma A J_0(kr) \sinh kl;$$

and the values of A can be found if we know that of V over the whole circle $r=b$. As usual we have

$$\int_0^b V J_0(kr)\,r\,dr = A \sinh kl \int_0^b J_0^2(kr)\,r\,dr$$
$$= \tfrac{1}{2} b^2 A \sinh kl J_0'^2(kb);$$

so that

$$\text{Force} = \Sigma \frac{\tfrac{1}{2}k^2 \left[\int_0^b V J_0(kr)\,r\,dr\right]^2}{b^2 \,.\, \sinh^2 kl \,.\, J_0'^2(kb)}.$$

This would determine the force if we knew the value of V over the whole circle $r=b$. We know that $V=1$ from $r=0$ to $r=a$, and that from $r=a$ to $r=b$ it falls from 1 to 0, but we do not know the precise law of this fall. A pretty good estimate of the integral would be made by taking $V=1$ up to a radius $\frac{1}{2}(a+b)$ and afterwards $V=0$. In this case we get[*]

$$\int_0^b V J_0(kr)\,r\,dr = -\frac{\frac{1}{2}(a+b)}{k} J_0'[\tfrac{1}{2}k(a+b)];$$

and

$$\text{Force} = \Sigma \frac{(a+b)^2 J_0'^2[\frac{1}{2}k(a+b)]}{8b^2 \,.\, \sinh^2 kl \,.\, J_0'^2(kb)}.$$

If the object be merely to find an upper limit to the force of attraction, we may suppose the value $V=1$ to extend up to $r=b$, and this in practical cases will not really alter the result very much. Writing $a=b$ in the above formula, we get the simple expression

$$\text{Force} = \tfrac{1}{2}\Sigma[\sinh kl]^{-2}.$$

This is the force with which the piston is attracted towards C when the P.D. is unity, and it expresses the excess of the force by which C is drawn in over that which would act if $l=\infty$. In the case above considered of $b=2a$, the latter is equal to about $\frac{1}{3}$.

As has been stated, the principal value of kl is $2{\cdot}404\ l/b$. If we suppose that the distance between C and the bottom of B is equal to the diameter of the latter, $l=2b$, and sinh (4·808) may be identified with $\frac{1}{2}e^{4{\cdot}808}$, while the other terms corresponding to higher values of k may be neglected. Hence

$$\text{Correction to force} = 2e^{-9{\cdot}6} = (6{,}500)^{-1}.$$

This compares with $\frac{1}{3}$; so that if the correction be neglected altogether the error would be less than 1 in 2,200. This error, although finally halved, is too great. It would be necessary either to increase the value of l a little, or to calculate the correction and allow for it.

Perhaps the weakest point in the use of an absolute electrometer on these lines is the rather high potential required to attain the necessary sensitiveness. There should be no difficulty over $\frac{1}{20}$ megohm, especially if the necessary changes could be made without taking the moving parts of the balance off their knife edges. But even then 2,000 volts would scarcely suffice, and it is likely that 3,000 or 4,000 would prove necessary.[†]

The objection to a high potential is not so much the difficulty of obtaining it with steadiness as the risk of a brush-like discharge through the air, the occurrence of which would probably be fatal to the success of the measurements. In order to diminish the risk the edges of the cylinders A, B, C should be rounded off, as can be done without theoretical objection.

I scarcely know whether the necessity of measuring a high potential in electromagnetic measure (say in volts) is to be regarded as a disadvantage in this method of determining v. It would seem that such measurements are needed in any case and that they constitute a separate problem.

Upon the whole, while still disposed to give the preference to the condenser, I am of opinion that the electrometer method is worthy of further trial.

THE THEORY OF "MOVING COIL" AND OTHER KINDS OF BALLISTIC GALVANOMETERS.[‡]

BY PROF. HAROLD A. WILSON, F.R.S.

A formula which is usually given for ballistic galvanometers is

$$Q = \frac{HT}{G\pi} \sin \frac{\theta}{2},$$

where Q = quantity of electricity passed through galvanometer.
H = magnetic field controlling the galvanometer needle.
G = magnetic field at needle, supposed perpendicular to H, due to unit current in the coil.
T = time of a complete oscillation of the needle.
θ = angle of swing of the needle from rest, corrected for damping.

If ϕ is the steady angular deflection due to a current i, then $i = \frac{H}{G}\tan\phi$; so that

$$Q = \frac{Ti \sin \theta/2}{\pi \tan \phi}.$$

The above formulæ are, of course, strictly speaking, only applicable to ballistic galvanometers consisting of a coil of wire having a single small magnet freely suspended at the centre of the coil, and arranged so that at its equilibrium position the axis of the magnet is in the plane of the coil.

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[*] See for example "Theory of Sound," § 204, equation (8).

[†] Hurmuzescu employed about 2,000 volts.

[‡] Paper read before the Physical Society.

In the following Paper the proper formulæ for ballistic galvanometers of several types in general use are obtained, and it is found that in several cases they differ appreciably from the above.

In Prof. Fleming's "Handbook for the Electrical Laboratory and Testing Room," Vol. II., the formula for a moving-coil galvanometer is worked out; but owing to an approximation used in the calculation it is not obtained exactly, and it is afterwards given as applying to both moving-coil and moving-needle galvanometers.

The first type of galvanometer that will be considered is the moving-coil type with a rectangular coil, cylindrical iron core and cylindrical pole-pieces symmetrically arranged. In galvanometers of this type the magnetic field is approximately radial, so that the couple on the coil due to a steady current is proportional to the current and independent of the deflection. The controlling couple is due to the torsion of the wire by which the coil is suspended, so that the work required to turn the coil through an angle θ from its zero position is $\frac{a\theta^2}{2}$, where a is the couple exerted by the wire when the coil is turned through the unit angle. Let Ci denote the couple due to a current i, then we have $Ci = a\phi$. When a current i is passed through the galvanometer for a short time dt, we have

$$Ci\,dt = C\,dQ \quad K\,d\omega,$$

where K is the moment of inertia of the coil and ω its angular velocity. Hence

$$Q = \int i\,dt = \int \frac{K\,d\omega}{C} = \frac{K\omega}{C}.$$

We have also $\quad T = 2\pi\sqrt{\frac{K}{a}}$ and $\frac{a\theta^2}{2} = \frac{1}{2}K\omega^2$;

hence $\quad T = 2\pi\sqrt{\frac{\theta^2}{\omega^2}} = \frac{2\pi\theta}{\omega}.$

Thus $\quad Q = \frac{K\omega}{C} = \frac{a\theta^2}{C\omega} = \frac{Ta\theta}{2\pi C}.$

But $\frac{a}{C} = \frac{i}{\phi}$; so that finally

$$Q = \frac{Ti\theta}{2\pi\phi} \text{ exactly.}$$

Since the couple on the coil due to the current is independent of θ, it is not necessary with this type of instrument that the time during which the transient current passes should be very small compared with T.

Another type of moving-coil instrument in common use has a narrow coil suspended between the poles of a magnet and no iron core. In this case the couple on the coil due to a current, i, will be nearly $Ci\cos\phi$, so that $Ci\cos\phi = a\phi$ or $\frac{a}{C} = \frac{i\cos\phi}{\phi}$; hence the exact formulæ for this type of instrument are

$$Q = \frac{Ta\theta}{2\pi C} = \frac{Ti\theta\cos\phi}{2\pi\phi}.$$

In these formulæ it is assumed that the plane of the coil at its zero position is parallel to the magnetic field.

It appears, therefore, that the first type of moving-coil ballistic galvanometer considered is superior to the second in respect of the simplicity of the exact formulæ to be used with it, and the absence of error when the transient current lasts an appreciable time.

Moving-needle instruments will now be considered. The formulæ

$$Q = \frac{HT\sin\theta/2}{G\pi} \text{ and } Q = \frac{Ti\sin\theta/2}{\pi\phi}$$

apply to what may be called a tangent ballistic galvanometer. The time of the transient current must of course be small compared with T, and its greatest value must not be sufficient to appreciably change the magnetism of the needle.

In many ballistic galvanometers an astatic system of needles is used. First, suppose the system is exactly astatic and that the torsion of a wire or quartz fibre supplies the controlling couple. In this case, $Ci\cos\phi = a\phi$ and $K\omega^2 = a\theta^2$, so that the formulæ are

$$Q = \frac{Ta\theta}{2\pi C} = \frac{Ti\theta\cos\phi}{2\pi\phi},$$

as with the second type of moving-coil instrument. Also $C = M(G_1 + G_2)$, where M is the moment of each needle and G_1 and G_2 the fields due to unit current at the two needles respectively.

One other case will be considered—viz., when the needle system is more or less astatic and is controlled by magnetic fields at each needle. Let the horizontal component of the controlling field at one needle be H_1 making an angle a_1 with the plane of this needle, and let M_1 be the moment of this needle. Let M_2, H_2 and a_2 be the corresponding quantities at the other needle. Then in the equilibrium position,

$$0 = M_1H_1\sin a_1 + M_2H_2\sin a_2.$$

The controlling couple when the needle is deflected through an angle ϕ is

$$M_1H_1\sin(\phi + a_1) + M_2H_2\sin(\phi + a_2)$$
$$= \{M_1H_1\cos a_1 + M_2H_2\cos a_2\} \times \sin\phi:$$

and if ϕ is the deflection due to a current i, then

$$iM_1G_1\cos\phi + iM_2G_2\cos\phi = \sin\phi\{M_1H_1\cos a_1 + M_2H_2\cos a_2\}.$$

Hence $\quad i = \frac{M_1H_1\cos a_1 + M_2H_2\cos a_2}{M_1G_1 + M_2G_2}\tan\phi.$

It can now be easily seen that the formulæ for a ballistic galvanometer of this type are

$$Q = \frac{T(M_1H_1\cos a_1 + M_2H_2\cos a_2)\sin\theta/2}{\pi(M_1G_1 + M_2G_2)} \text{ and } Q = \frac{Ti\sin\theta/2}{\pi\tan\phi}.$$

So far the correction of the observed deflection θ for damping has been neglected. The method usually described depends on the "logarithmic decrement," and is cumbrous and, moreover, inexact unless the damping is very small. The following method has the great advantages of simplicity and exactness; it is not new: the writer learned it about 10 years ago from Prof. W. Stroud.

Let θ_1, θ_2, θ_3, &c., be the successive swings of the galvanometer needle. Then

$$\frac{\theta_1}{\theta_2} = \frac{\theta_2}{\theta_3} = \frac{\theta_3}{\theta_4} = \&c. = f \text{ say.}$$

To find f observe, say, θ_1 and θ_3, or θ_1 and θ_5.

Then $\quad f^2 = \frac{\theta_1}{\theta_3}$ or $f^4 = \frac{\theta_1}{\theta_5}.$

Also the corrected value of the first swing is

$$\theta_1\sqrt{f} = \theta_1\left(\frac{\theta_1}{\theta_3}\right)^{\frac{1}{4}} = \theta_1\left(\frac{\theta_1}{\theta_5}\right)^{\frac{1}{8}}.$$

In most cases the angular deflections may be taken as proportional to the deflections on the scale. Let these be δ_1, δ_2, δ_3, &c. Then the corrected value of the first swing is

$$\delta_1\left(\frac{\delta_1}{\delta_3}\right)^{\frac{1}{4}} \text{or } \delta_1\left(\frac{\delta_1}{\delta_5}\right)^{\frac{1}{8}}.$$

If the damping is small the corrected value is very nearly $\delta_1 + \frac{1}{4}(\delta_1 - \delta_3)$ and this formula is sufficiently exact for most purposes in practice.

The following table contains a summary of the results obtained:—

Type of Galvanometer.	*Formulæ.*
(1) Tangent Galvanometer with small needle at centre of coil.	$Q = \frac{HT}{G\pi}\sin\frac{\theta}{2}$, $\quad Q = \frac{Ti\sin\theta/2}{\pi\tan\phi}$.
(2) Astatic Galvanometer with purely torsional control.	$Q = \frac{Ta\theta}{2\pi M(G_1 + G_2)}$, $\quad Q = \frac{Ti\theta\cos\phi}{2\pi\phi}$.
(3) Astatic Galvanometer with purely magnetic control.	$Q = \frac{T(M_1H_1\cos a_1 + M_2H_2\cos a_2)}{\pi(M_1G_1 + M_2G_2)}\sin\frac{\theta}{2}$ $Q = \frac{Ti\sin\theta/2}{\pi\tan\phi}$.
(4) Moving-coil Galvanometer with iron core and radial magnetic field.	$Q = \frac{Ta\theta}{2\pi C}$, $\quad Q = \frac{Ti\theta}{2\pi\phi}$,
(5) Moving-coil Galvanometer with narrow coil and no core.	$Q = \frac{Ta\theta}{2\pi C}$, $\quad Q = \frac{Ti\theta\cos\phi}{2\pi\phi}$.

It will be seen that type (4) is superior to all the others as regards the simplicity of the exact formula to be used with it. It is also superior in most other respects. Galvanometers are often met with in practice which, strictly speaking, do not belong to any of the simple types considered in this Paper. In such cases the exact formulæ are more complicated, and the best plan to adopt is to determine experimentally the relation between θ and Q.

THE CADMIUM STANDARD CELL.*

BY GEORGE A. HULETT.

A standard cell with a low temperature coefficient was devised by Mr. Edward Weston in 1891.† By substituting cadmium sulphate and cadmium amalgam for the zinc sulphate and zinc of the Clark cell, it was found that the temperature coefficient of the cell was reduced 95 per cent., and when the solid cadmium sulphate was dispensed with, and only a solution of cadmium sulphate used in the cell, the temperature coefficient was still less. With a solution saturated at 0°C., Barnes and Lucas found‡ that the E.M.F. of the cell was constant for all ordinary temperature changes. This latter combination is a valuable laboratory instrument, but is not sufficiently reproducible or constant to serve as a standard of E.M.F.

The Clark cell has a variation of E.M.F. of over a millivolt per degree, and for accurate work requires a very exact control of the temperature for a considerable time. The saturated cadmium cell has only one-twentieth of the temperature coefficient of the Clark cell and many other desirable features, so that considerable work has been done in testing its reproducibility and constancy.

A. Dearlove§ found that attention must be given to the cadmium amalgam and concluded that it was best to use a 12·5 per cent.

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* From the *Physical Review*.

† U.S Patent No. 494,824. Applied for, April 24, 1891.

‡ *Jour.* Phys. Chem, VIII., 196, 1904. § *Electrician*, XXXI., 645, 1893.

amalgam, made by melting together one part of cadmium and seven parts of mercury. Since then considerable work has been done on cadmium amalgams. Kerp and Boettger [*] concluded that the solid which separates from cadmium amalgams of over 5 per cent. was a compound represented by the formula Cd_2Hg_7. However, from the work of Bijl[†] and Puschin[‡] it appears that between about 5 and 15 per cent. of cadmium, the amalgam is a two-phase system, composed of a solid and a liquid phase, and that the solid phase is not a compound, but an isomorphous mixture of cadmium and mercury. The composition of this mixed crystal varies with the temperature, but has a definite composition and E.M.F. for each temperature. The result is that on adding cadmium to mercury the E.M.F. of the amalgam, towards a cadmium sulphate solution, increases with the increasing per cent. of cadmium until the mixed crystal appears. If the temperature is constant, further additions of cadmium will not affect the E.M.F., but only the relative amounts of the two phases. When the liquid phase disappears a further addition of cadmium will increase the E.M.F. of the system. From Bijl's results this two-phase range is between 10 and 18 per cent. of cadmium at 50 deg., 5·3 to 15 per cent. at 25 deg. and 4 to 14 per cent. of cadmium at 18 deg. Jaeger[§] showed that all amalgams in a two-phase range have, for a given temperature, the same E.M.F. almost to the limit of measurement, and it is this property that makes the cadmium amalgam valuable for a standard cell, since little attention need be given to the exact composition of the amalgam, only that it must always remain in the two-phase range for all temperatures at which the cell is used. The 12½ per cent. amalgam first proposed by Dearlove [||] satisfies these conditions and also has the desired solidity.

It will be concluded from the above that there must be a temperaature coefficient for the E.M.F. of the junction : Cd-amal.||cadmium sulphate solution. To test this the following combination was set up :—

$$\begin{array}{c||c||c} \text{Cd-amal.} & \text{CdSO}_4\text{ solution sat. at }4^\circ & \text{Cd-amal.} \\ 0^\circ\text{C.} & \longrightarrow \qquad\qquad \longrightarrow & 30^\circ\text{C.} \end{array}$$

This showed a thermo-E.M.F. of 0·00917 volt in the direction of the arrow, also the following combination :—

$$\begin{array}{c||c||c} \text{mercury} & =\text{Hg}_2\text{SO}_4\text{ cadmium sulphate solution sat. at }4^\circ\text{C. Hg}_2\text{SO}_4 & \text{mercury} \\ 0^\circ\text{C.} & \longrightarrow \qquad\qquad\qquad\qquad \longrightarrow & 30^\circ\text{C.} \end{array}$$

showed the same 0·00917 volt and in both cases the cold metal was the anode. Therefore both legs of the cadium cell have a decided temperature coefficient, but when the directions of the E.M.F.s at the two electrodes are considered, it will be seen that the two temperature effects are oppositely directed as far as the total E.M.F. of the cell is concerned, and it is merely a coincidence that the E.M.F. of the cadmium cell is so little affected by temperature changes.

The amalgam may be made by depositing cadmium electrolytically in a weighed amount of mercury. An excess of cadmium is deposited, the amalgam weighed, and then the correct amount of mercury added to make it 12·5 per cent. Very pure cadmium is obtained in this way if recrystallised cadmium sulphate is used for the electrolyte. This method was devised and used for the amalgams of the (D) and (F) cells of 1903, but it has since been found that a trace of other metals, even zinc, has hardly a measurable effect on the E.M.F. of the cadmium amalgam and that ordinary pure cadmium answers every purpose. The later amalgams have been made by melting together one part of Merck's cadmium with 7 parts of pure mercury, and this was done on a water bath with the metals covered with a cadmium sulphate solution.

Cadmium sulphate ($CdO_48/3H_2O$) is a well-defined salt and is easily obtained in large monoclinic crystals which do not seem to carry other salts isomorphously mixed.[¶] The rate of growth of the crystals is very slow and the clear ones are quite free from inclusions, but in every crop there are many white crystals which grow more rapidly and may have inclusions. It is an easy matter to pick out the clear crystals and, due to their slow rate of solution, they may be thoroughly rinsed with water. In the work so far the cadmium sulphate crystals have been dissolved by grinding them in a mortar with water until a saturated solution was obtained. This solution was treated with a little cadmium carbonate to neutralise any excess of acid which might have been present. The solution was then carefully filtered and placed in a crystallising dish to a depth of one centimetre, the dish was covered with thin filter-paper to keep out dust and the solution allowed to evaporate until a good crop of crystals formed. Samples of cadmium sulphate from various sources and with known impurities have been used, but it has been found that, after one crystallisation and thorough rinsing that there was not a detectable difference in their behaviour of the clear crystals in cadmium cells. The solution from these crystals is slightly acid as the result of hydrolysis, but the solution of these crystals in distilled water is exceedingly well defined and reproducible, and it has been found unnecessary and undesirable to change it in any way. Kohnstamm and Cohen[*] thought that they had detected a transition point for this salt at 15°C., but the changes on which they based their conclusion have been traced to the 1 to 6 amalgam used.[†] This strength amalgam is not a two-phase system below 23 deg. and may undergo slow changes.

The mercury used in all this work on standard cells has been distilled under diminished pressure with a current of air passing through with the mercury vapour. This method insures the removal of all oxidisable metals.[‡]

The Depolariser.

The most extensive observations on the cadmium cell have been published by Jaeger and Lindeck.[‡‡] From their results it seemed that the cadmium cell was reproducible to one or two parts in 10,000, and the authors attributed the observed variations to the fact that the mercurous sulphate used as polariser was from different sources, just as Lord Rayleigh had previously[§] traced variations in the Clark cell to differences in the mercurous sulphate.

Commercial mercurous sulphate is usually made from solutions of mercurous nitrate and sodium sulphate. The precipitate is exceedingly finely divided and carries with it traces of the reagents and is acid. Also an insoluble basic salt is formed and, while these impurities are not present in large quantities, they increase the mercury in the solution made from such preparations and give too large a value to the E.M.F. of the cell.

A fine-grained powder is more soluble than a coarser-grained sample of the same salt, and while the fine-grained powder slowly becomes coarser-grained when left in contact with its solution, there is here a possible source of variation, as has been pointed out by H. v. Steinwehr.[||] The "Board of Trade" specifications advise the washing of the mercurous sulphate with water, and while this removes some of the impurities, it also hydrolyses some of the salt. A rather insoluble basic sulphate is left with the salt, while a soluble acid salt goes into solution, and the wash water with the acid salt is not entirely removed even by suction. It will be seen that the materials and methods which have been used in making the paste for cells afford abundant opportunity for variations. Experiments have shown that acids, and particularly the basic salt, cause irregular variations in the E.M.F. of the standard cells.

In 1903 the electrolytic method of preparing mercurous sulphate was devised by the author[¶] and independently by Dr. F. A. Wolff, of the Bureau of Standards.[**] By this method pure mercurous sulphate, mixed only with dilute sulphuric acid and mercury, was obtained. The acid was removed either by washing with the saturated solution of cadmium sulphate or by using alcohol and ether. Both methods were effective in removing the acid and seemed to prevent hydrolysis. The first cells made with this properly-washed electrolytic mercurous sulphate were four (D) cells on December 21, 1903, and 10 (F) cells on February 15, 1904. These cells agreed among themselves to one part in 100,000, assumed their constant value at once, but were 0·00028 V. lower than cells made in the old way with commercial mercurous sulphate.

These cells seemed so much superior to those made according to the old specifications that attention was at once turned to thoroughly testing samples of mercurous sulphate made by the electrolytic method. In brief, it was found that it was possible to use a very considerable range of acid strength and current density in making the sulphate. Also that the preparation was sufficiently coarse-grained to entirely avoid any effect due to the size of particles on the solubility, and that it was the most reproducible and reliable preparation for use in standard cells. The details of this work as well as a complete description of the method of preparing electrolytic mercurous sulphate and making the paste for cells have already been described.[††]

Slow Changes in the E.M.F. of the Cadmium Cell.

After the (D) and (F) cells have been under observation for nearly two years, six cadmium cells, A1 to A6, were made and the materials and construction were, as nearly as it was possible to make them, a duplication of the (D) and (F) cells, *but these new cells were 0·00011 volt higher than the older ones.* More cells were made with different samples of electrolytic mercurous sulphate and with variations in the other materials and in the construction, but they all agreed with the new (A) cells. Fortunately 10 Clark cells had been made in 1904, and with some of the same electrolytic mercurous sulphate which had served for the depolariser of the (F) cells. These Clarks did not show the usual "ageing" but

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[*] *Zeit. f. Anorg. Chem.*, XXV., 1, 1900.

[†] *Zeit. Phys. Chem.*, XLI., 641, 1900.

[‡] *Zeit. f. Anorg. Chem.*, XXXVI., 201, 1903.

[§] *Wied. Ann.*, LXV., 106, 1898.

[||] *Loc. cit.*

[¶] Retgers, *Zeit. f. Phys. Chem.*, XVI., 594, 1895.

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[*] *Wied. Ann.*, LXV., 344, 1898.

[†] Cohen, *Zeit. Phys. Chem.*, XXXIV., 631, 1900; and Jaeger and Lindeck, *Zeit. Instk.* XXI., 33, 1900.

[‡] *Phys. Rev.*, XXI., 387, 1905.

[‡‡] *Zeit. f. Instk.*, XXI., 33, 1901.

[§] *Phil. Trans.*, CLXXVI., 781, 1886.

[||] *Zeit f. Instk.*, XXV., 201, 1905.

[¶] *Trans.*, Amer. Electrochem. Soc., V., 59, 1904; *Trans.*, Internat. Elect. Congress, St. Louis, Vol. II., 109, 1904; *Zeit. Phys. Chem.*, XLIX., 483, 1904.

[**] *Trans.*, Amer. Electrochem. Soc., V., 49, 1904.

[††] *Phys. Rev.*, XXII., 321, 1906.

appeared to have their constant value at once. After two years, however, they appeared to have slightly increased in value (0·00011 volt.). The cadmium cells had been assumed constant and had been made the basis of all the comparisons. If, now, the Clarks had been assumed to be constant and taken as the basis, the cadmium cells would, of course, appear to have decreased by this 0·00011 volt, and the difference between the new and the old cadmium cells is then explained by a slow change in the cadmium cell.

More Clark cells (H11 to H16) were made on July 30, 1905, and on February 25, 1906, cells H17 to H21 were made, and for depolariser some of the same sample of electrolytic mercurous sulphate was used as had served for the new (A) cells. The following table gives some of the many observations that have been made on these cells. All the cells have been maintained in a large oil-bath since October, 1905. The bath was electrically heated and controlled and the temperature has remained constantly at 25°C. to within $\frac{1}{50}$ deg. The basis of all the results given in this Paper are the Clark cells H1 to H21, which were made on three different dates and are now in good agreement. The value chosen is the one obtained by Dr. Guthe for these cells and is 1·42040 volt at 25°C.* This gives a calculated value of 1·43300 at 15 deg., but it should be added that these Clark cells were all made with electrolytic mercurous sulphate as depolariser: the paste was prepared as previously described,† and they are 0·00030 volt lower than Clark cells made in the old way with commercial mercurous sulphate.

Cell.	Date.	Mar. 18, 1904.	Mar. 24, 1905.	Aug. 5, 1905.	Dec. 14, 1905.	Mar. 4, 1906.	June 4, 1906.
D4	Dec. 21, '03	1·01842	1·01831	1·01928	1·01832	1·01832	1·01830
F1	Feb. 15, '04	42	31	27	30	32	29
F2	,,	42	32	26	31	30	15
F3	,,	42	32	28	32	31	34
F4	,,	42	31	28	32	32	27
F5	,,	42	32	32	31	33	33
F6	,,	42	32	27	32	33	32
F7	,,	42	32	28	34	32	32
A1	Oct. 21, '05				1·01843	1·01843	1·01842
A2	,,				43	43	42
A3	,,				42	43	42½
A4	,,				43	43	42½
A5	,,				43	43	42½
A6	,,				43	43	43
H2	Mar. 15, '04	1·42040	1·42040	1·42038	1·42038	1·42040	1·42039
H3	,,	40	37	38	..	40	39
H4	,,	40	38	37	40	43	42
H6	,,	39	..	42	37	40	42
H7	,,	41	41	44	38	40	40
H8	,,	41	40	41	..	40	40½
H11	July 30, '05				1·42040	1·42041	1·42039
H15	,,				41	41	41
H16	,,				41	41	42
H17	Feb. 25, '06					1·42039	1·42041½
H18	,,					39	42
H19	,,					40	42
H20	,,					38	37
H21	,,					43	41
C1	Nov. 21, '03	1·01868	1·01864	1·01858	1·01862	1·01861	1·01860
A7	Nov. 15, '06				72	70	67

The results given in the above table from December 14, 1905, on are the observed values, but the values for March 18, 1904, March 24, 1905, and August 5, 1905, have been recalculated, for the sake of comparison, from the observations which were made at 21 deg. and 18 deg. These cells all follow the accepted temperature coefficient so closely that the calculated values are reliable, but the conclusive facts are based upon the observations made since October 1905, when the control of the temperature and the conditions of comparison have been particularly exact.

It is to be observed that the new cadmium cells A1 to A6 are now 0·00011 volt higher than the older (F) series, and that the values of the (A) cells are now very close to the values the (F) cells originally had. On the other hand, the Clark cells, made on three different dates, are now all in excellent agreement. The depolarisers of the (F) cells and the H1 to H10 Clarks were all from the same sample, while the sample of mercurous sulphate which was used for the new A1 to A6 cells was also used for the Clarks H17 to H21. This indicates that the change observed in the (D) and (F) cells is not a peculiarity of the electrolytic mercurous sulphate. Further proof that the electrolytic mercurous sulphate is not at fault is at hand in the observations on some cadmium cells which were made in 1903 with commercial mercurous sulphate according to the old specifications. These cells have also changed as indicated by the record of cell C1 given in Table I. On November 15, 1905, cell A7 was made with commercial mercurous sulphate, and according to the old specifications, and it will be seen that this cell is now higher than the older (C) cell. All of the cells made with commercial mercurous sulphate and according to the old specifications were very high at first and showed the usual "ageing" for a month before becoming "constant."

In the literature there is some evidence of this "drift" of the cadmium cell, Mr. F. E. Smith* describes some cadmium cells which were made in April, 1902, and two years later another cell was made with exactly the same materials, but the new cell was 0·00007 volt, higher than the older ones

This observed change in the E.M.F. of the cadmium cell is small and slow and from a practical standpoint is of little consequence, but it is not to be overlooked when it comes to a question of a standard of E.M.F. The change seems to be more rapid at higher temperatures and especially does the depth of the paste in the leg of the cell play an important rôle. Some cells were made on November 29, 1904, with the paste only 3 mm. or 4 mm. deep; the object was to make a cell with a smaller internal resistance. These cells showed the normal value of 1·01844 volt when first made, but began at once to noticeably decrease. On January 10, 1905, they were 1·01839; April 4, 1905, 1·01811; and by June, 1905, were about 1·0177 volt and were very irregular; only two of these cells were retained and in December, 1905, they were 1·0172 and 1·01815, and now, June, 1906, they are 1·0160 and 1·01813 respectively. It is to be noted that the (F) cells are no longer in as good agreement as when first constructed. The paste in the (F) cells is about 10 mm. deep and it is 20 mm. deep in the A cells and in all cells made since these facts appeared. It might be added that the (A) cells have not yet shown a decided change, but it is probably only a question of time.

From the foregoing it is to be concluded that slow changes take place in the cadmium cell, and, during the past two years, a number of results have been obtained which indicate that it is the system in the cathode leg of the cell which is not in equilibrium. Mercurous sulphate has been formed electrolytically in a cadmium sulphate solution. The apparatus and method was the same as used for preparing electrolytic mercurous sulphate. The mercury from the anode went into the cadmium sulphate solution and separated as mercurous sulphate, while cadmium was deposited at the cathode; the solution remained neutral and was saturated as cadmium sulphate crystals were present. The idea was that this preparation might be used directly in the cell without removing the mother liquor. It was expected that with this method and the rapid stirring that the product obtained would be in equilibrium with the cadmium sulphate solution and the mercury. Two samples were prepared and different current-densities were used. The preparations were white and sufficiently coarse-grained to avoid the effect of size of particles on the solubility. One sample was made with a current-density of 0·12 ampere per 100 sq. cm. mercury anode surface, and was used, with some of the solution in which it was made, for the depolariser of cell A17. Some of this same sample was used for cell (A18), but its solution was first removed by suction and then it was washed with a fresh cadmium sulphate solution. The second sample was made with a current-density of 0·5 ampere, and was used direct in cell A19. These cells were made November 23, 1905, and the following results have been obtained:—

Cell.	Nov. 30.	Dec. 14.	Jan. 1, 1906.	Feb. 7.	Mar. 4.	April 13	May 12.	June 4.
A17	1·10878	1·01872	1·01871	1·01870	1·01873	1·01871	1·01869	1·01868
A18	86	78	75	67	65	60	58	55
A19	48	48	47	49	48	49	48	48

It will be seen that the samples made with the different current-densities do not agree, and that the one made with the larger current-density (A19) has remained quite constant and is nearest to the A1 to A6 cells. The sample which was made with a low-current density was used in cell A18, but the solution in which it was made was first removed by suction and then the salt was washed with a fresh cadmium sulphate solution. This cell was high at first and has decreased the most.

Two years ago an attempt was made to bring mercurous sulphate into equilibrium with a cadmium sulphate solution and mercury. The system—cadmium sulphate, mercurous sulphate, mercury and saturated solution—was rotated at 25 deg. for 10 days, and then the mercurous sulphate was brought on to a filter and washed with a fresh solution of cadmium sulphate. With this preparation three cells were made on May 6, 1904, and the following observations, calculated to the present basis and 25 deg., have been made:—

Cell.	May 6.	May 9.	June 13.	July 13.	Aug. 9.	Apr. 14, 1904.	June 3.	July 25.
I6	1·01975	1·01934	1·01900	1·01889	1·01887	1·01817	1·01800	1·01816
I7	77	32	01	88	91	15	1,797	1,799
I8	63	31	03	93	96	32	1,807	1,818

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* *Phys. Rev.*, XXI., 117, 1906.

† *Phys. Rev.*, XXII., 334, 1906.

* *The Electrician*, LIII., 832, 1904.

† *Phys. Rev.*, XXII., 334, 1906.

The cells had become irregular and had not become constant and it was concluded that the system, which had been rotated 10 days, had not reached equilibrium, so the observations on these cells were discontinued. This question was taken up again after the "drift" in the (D) and (F) cells had been detected. It was decided to rotate this system in the cathode leg until it should come to equilibrium. When this point is reached there should be no further change in the solution or in the E.M.F. between the system and mercury. It was found most convenient to measure the E.M.F. at frequent intervals as a means of deciding on the absence of further change in the system.

(*To be concluded.*)

CORRESPONDENCE.

SYNCHRONOUS CONVERTERS *v.* MOTOR-GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our attention has been drawn to an excellent article in your issue of July 20th, in which Mr. Clarence P. Fowler compares the rotary converter with the synchronous motor-generator. No reference is, however, made to the Peebles-La Cour motor-converter, and as this machine is daily coming into more general use for A.C.–D.C. conversion, and vice versa, we think that the following remarks indicating its bearing upon the problem will be of interest to your readers.

The motor-converter consists essentially of a rotary converter and induction motor coupled together not only mechanically but electrically. The induction motor, which is of smaller dimensions than those of a corresponding motor-generator set, fulfils a double function, and besides imparting a torque to the D.C. generator transforms half the input to low-tension 12-phase current. This is transmitted at about half the primary frequency to the D.C. machine which acts as a converter.

The action of a 50-cycle motor-converter is thus very similar to that of a 25-cycle rotary, and the advantages which Mr. Fowler has shown for the latter are equally applicable to the motor-converter. In several respects, however, and especially as regards the simplicity of starting and running, the motor-converter possesses considerable advantages over the rotary.

The efficiency of a motor-converter is much higher than that of the motor-generator, especially so at half and quarter load. The "all-day" efficiency, as with the "rotary," is thus very satisfactory. It may be noted that the high efficiency is in part due to the use of 12-phase connection between the armature and rotor. This also results in less heating, as may be inferred from the tables given by Mr. Fowler. The regulation and voltage control may be varied to suit almost any requirements without choking coils, and are such as to fulfil the requirements of any normal motor-generator specification. With motor-generators, however, in order that a steady D.C. voltage may be maintained, a fairly constant frequency is essential, while with motor-converters it is only necessary that the A.C. voltage should not fluctuate too widely. Owing to the use of 12-phase windings, the overload capacity is very high, and 100 per cent. overload can easily be carried for short periods without sparking. The power factor remains unity over a considerable voltage range, or with constant voltage from $\frac{1}{4}$ to $\frac{5}{4}$ load, while the use of a 12-phase synchronous booster allows still further voltage regulation, should such be required, with unity power factor, or in the case of an inverted converter allows the A.C. voltage to be controlled.

The motor-converter, as already mentioned, is especially suitable for the higher frequencies in general use, such as 40, 50 and 60 cycles. The difficulties of the 50-cycle rotary to which Mr. Fowler calls attention—viz., high peripheral speed, crowded brush holders, and liability to hunting and flashing over, are entirely absent in the motor-converter, and since the D.C. side of the latter operates with only half the primary frequency it can be designed with all the good features of the 25-cycle rotary, and in fact with even less liability to hunting. The motor-converter on account of its higher reactance has the further advantage of taking a lower synchronising current than the rotary.

The simplicity and convenience of the motor-converter are especially marked. The sets are started in the same manner as large induction motors, and they automatically come into synchronism within one minute. No auxiliary starting motor is required, and beyond the starting rheostat no low-tension A.C. switch gear is employed.

These points, taken together with the small dimensions of the main machines and the absence of transformers and choking coils, result in a considerable economy of sub-station space, a feature which is of great importance in the majority of stations. The space occupied by a motor-converter of the latest two-bearing type is the same as that required by a rotary *without* transformers.—Yours, &c.,

For BRUCE PEEBLES & Co. (LTD.),
(Signed) MORTON BEALES, Manager.

London, Sept. 10.

LEGAL INTELLIGENCE.

Smoker v. Dick, Kerr & Co.

In the City of London Court on Tuesday plaintiff sought to recover £60 damages for personal injuries.

It was stated that defendants were carrying out a large contract on behalf of London County Council in constructing electric tramways at Woolwich. They erected gangway crossings to enable the public to get from one side of the road to the other. Plaintiff said that one of the crossings was so slightly built that when he stepped on it the planks broke and his foot went into the hole. He alleged that for eight weeks he was unable to carry on his business.

Witnesses called by defendants said that the crossing did not give way, that there was no hole and that plaintiff did not fall into a hole. He had, moreover, been working without cessation.

Judge RENTOUL, K.C., after commenting upon the serious conflict of testimony, said the evidence was overwhelming. Plaintiff had apparently slipped, but he had no case. Judgment for defendants, with costs. Plaintiff's doctor (continued the judge) unfortunately was induced to enter in his books a number of visits that did not take place at all. He (the judge) regretted that such a circumstance should have taken place, as it was very suspicious. [Probably the Medical Council will consider this a case for investigation and report.—ED. ELEC.]

Firth & Son v. Cardiff Corporation.

The arbitrator (Mr. W. H. Patchell) has now issued his award in this arbitration. The proceedings were reported in our issues of April 13 and 27.

Mr. Maurice Drucquer (instructed by Mr. R. Tweedy Smith, solicitor for the Electrical Contractors' Association) appeared for plaintiffs, and Mr. Sankey (instructed by the Town Clerk of Cardiff) for defendants.

It will be remembered that plaintiffs had entered into a contract with Cardiff Corporation to carry out certain work in wiring and supplying plant, &c., for the electric lighting of the Whitchurch Asylum, Cardiff, for £6,421. Before the contractors received a penny on account they ceased work, and the Corporation terminated the contract, and counterclaimed for £3,600. The contractors alleged that the engineer to the Corporation (Mr. A. Ellis) had improperly withheld certificates and made requisitions for work which was not set forth in the original specification. The contractors had completed work of the value of nearly £1,500, but did not receive payments on account, although from time to time applications had been made for certificates and information given to the engineer as to the amount expended for labour and material. Technical evidence was given as to the work which Mr. Ellis had ordered the contractors to carry out, which it was contended was not included in the original specification. The counterclaim was in respect of expense to which the Corporation had been put in having to make other arrangements for the boarding out of patients at 5s. 3d. per head per week. The amount of the counterclaim was £3,600, the number of patients boarded out being 600.

The arbitrator now finds that: (1) A certificate was withheld within the meaning of clause 26 of the contract, which gave the contractors the right to suspend the works and deprived the Corporation of the right to determine the contract; (2) that the notice of Nov. 29, 1905, given by the Corporation terminating the contract was unreasonably and vexatiously given within the meaning of clause 26 of the contract; and (3) that the contractors did not fail for 14 days after the notice of Nov. 29, 1905, to proceed with the work so as to give the Corporation the right to determine the contract. The arbitrator found for plaintiffs for materials delivered the sum of £979. 16s. 2d., for labour done £287. 16s. 7d. and reasonable profit £154, making a total of £1,421. 12s. 9d.

Mr. Patchell awarded nothing to Cardiff Corporation on their counterclaim, and ordered them to pay the whole of the costs.

Hayes v. Electrical Bleaching Co. (Ltd.).

In the Chancery of Lancaster, at Liverpool on Tuesday, Mr. Talbot moved for the approval of the sale of this undertaking and assets. Plaintiff was suing on behalf of himself and all other debenture-holders, and the Manchester and Liverpool District Banking Co. were second mortgagees. The affidavit of the receiver showed that the business was losing money at the rate of £75 per week.

The usual debenture-holders' judgment was taken by consent. The property was directed to be sold by private tender, public auction, or otherwise, with the approbation of the Registrar, the company to have notice of any tender or bid submitted.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A second assistant electrical engineer is wanted in the electric light branch of the Public Works Department of Southern Nigeria. Salary £300. Single furnished quarters provided for small annual rent and first-class passages out and home. Applications to the Crown Agents for the Colonies, 4, Whitehall-gardens, London, S.W., until Sept. 24. See also an advertisement.

The North Wales Power & Traction Co. want a junior shift engineer with mechanical and electrical training. Salary, £85 per annum. Applications by Sept. 18 to Mr. H. T. Hincks. A.M.I.C.E., Power Station, Cwydyli, Beddgelert, North Wales. See an advertisement.

A junior test-room assistant is required by the Cambridge Scientific Instrument Co. (Ltd.), Cambridge. See an advertisement.

An asistant lecturer and demonstrator in engineering (design and drawing) and applied mechanics is required at the University of Liverpool. Salary £100. Particulars from the Registrar. See an advertisement.

A demonstrator in physics is required at the Boy's Secondary School, Portsmouth. Salary £110, rising to £135. Applications to the secretary, Municipal Technical Institute, by Sept. 19.

An assistant inspector of scientific supplies is required for the India Store Depot. Salary £200, rising to £350. Further particulars from the Director-General of Stores, India Office, Whitehall, S.W., until Sept. 29.

An assistant lecturer and demonstrator in mechanics and an instructor in engineering drawing are wanted for Bradford Technical College. Commencing salaries £150 and £120 respectively. Particulars from Prof. G. F. Charnock. Applications by 19th inst.

Two telegraph inspectors and one telegraph mechanic are required for Southern Nigeria. Inspectors' salaries £240 each per annum, rising by annual increments of £15 to £300 per annum ; mechanic's salary £240. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., by Sept. 17.

Sunderland Corporation confirmed on Wednesday the appointment of Mr. A. A. Day, of Bolton, as borough electrical engineer, in succession to Mr. John F. C. Snell, who has retired to engage in consulting practice.

The names of the six selected candidates were given in our last issue, and at the meeting of the Electricity committee on Monday it was announced that Mr. H. Faraday Proctor, of Bristol, had withdrawn his application. The committee then interviewed Messrs. A. S. Blackman (Bradford), A. A. Day (Bolton), C. E. C. Shawfield (Wolverhampton), C. D. Taite (Salford) and T. P. Wilmshurst (Derby). In the final voting Mr. Day received 11 votes and Mr. Taite 5.

Some particulars of Mr. Day's career are given in another column.

Mr. W. S. Stafford, now second assistant at Watford, has been appointed first assistant and station superintendent of the electricity works at £110, rising by annual increments of £10 to £170. Mr. S. J. Riddell, of Islington, has been appointed second assistant, and Mr. Taylor, third assistant, has been promoted to the position of mains superintendent.

Nelson Council have appointed Mr. Dacre Helme, chief assistant, as electrical engineer and manager of the tramways at £150 per annum, rising by £25 a year to £250. Mr. G. F. Naylor becomes chief assistant, and Mr. Wm. Hartley mains superintendent.

Mr. J. W. Dawson, engineering foreman of Bradford tramways department, has been appointed assistant electrical engineer (in succession to Mr. G. R. Blackburn) at £175 per annum, increasing to £200 at the end of a year.

Mr. A. Zoller, shift engineer at Fulham, has resigned and Mr. Alec. Hayward, of Croydon, has been appointed to succeed.

Mr. J. J. Stieltjes has been appointed inspector-general of Netherlands East Indian Government posts and telegraphs, in succession to Mr. H. Rudolph.

Mr. W. Dancer, of Uxbridge, has been appointed shift engineer at Walsall.

Mr. D. Low, B.Sc. (Eng.), has been appointed to the post of lecturer in engineering at Rutherford College.

EDUCATIONAL NOTICES.

University of Liverpool.—The 1906-7 session commences on Oct. 9. The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng. (or the certificate in engineering) are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are also afforded for postgraduate work and research. Prospectuses may be obtained from the Registrar.

King's College, London.—The 1906-7 session commences on Wednesday, Oct. 3. In addition to the ordinary day courses in engineering and applied science there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Prospectuses from the dean (Prof. D. S. Capper), or the Secretary, King's College, Strand, W.C.

Courses of instruction are arranged (in connection with the evening classes at this college) for the intermediate and final examinations for the B.A. and the B.Sc. degrees of the University of London. There are also classes in engineering and architectural subjects. Full information and prospectuses from the Dean (Mr. R. W. K. Edwards), or the Secretary.

University College, Bristol.—The 1906-7 session begins on Oct. 2. Lectures on inorganic, organic and physical chemistry will be delivered during the session. The laboratories are fitted with the most recent improvements for study and research in chemistry and metallurgy. Prospectuses of the lectures, &c., may be obtained from the registrar and secretary, Mr. James Rafter, and copies of the calendar, which contains particulars of scholarships, prizes, lectures, &c., are published post free at 1s. 4d.

There are courses of instruction in electrical, civil, mechanical and mining engineering and surveying at this college, and special facilities are offered in connection with college and engineering works scholarships. Favourable arrangements have been made with firms in or near Bristol for practical training to be obtained concurrently with the college course. Applications for vacancies should be made as early as possible to the registrar and secretary, Mr. Jas. Rafter.

Heriot-Watt College, Edinburgh.—The winter session opens on Oct. 2. There are day courses in electrical and mechanical engineering, technical chemistry, &c. The courses are recognised by the University of Edinburgh as qualifying for the degree of B.Sc. and also by the Institute of Chemistry. Arrangements have been made with leading engineering firms in Edinburgh and elsewhere whereby students may combine their apprenticeship with studies at the college. Copies of the college calendar (giving particulars of fees, &c.) may be obtained from the principal, Dr. A. P. Laurie, M.A., F.R.S.E.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1 ; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Evening technical courses in all branches of electrical and mechanical engineering will commence on Sept. 24. The laboratories are well equipped for both alternate (single and polyphase) and continuous-current work and for all kinds of electrical testing.

Hackney Technical Institute.—The session commences on Sept. 24. There are evening courses in electrical engineering subjects, including alternating currents, dynamo design, wireless telegraphy, &c. Prospectuses from the secretary of the institute, Dalston-lane, London, N.E.

South Western Polytechnic (London, S.W.)—A complete three years' course in electrical engineering is given in the day classes and a four years' course in the evening classes at this polytechnic. Courses of lectures and practical work are also given in electrical engineering (elementary, intermediate and advanced) and electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting and calculus for engineers. These lectures may be taken separately or as part of a course. Particulars from the Secretary, Manresa-road, Chelsea, London, S.W.

Sir John Cass Technical Institute, London.—The new session begins on Sept. 24. There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the electrical, metallurgical and chemical industries and in trades associated therewith. Every facility is afforded for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. Courses of instruction in glass blowing will also be given during the session by Mr. A. C. Cossor. Details of the classes can be obtained at the Institute, Jewry-street, Aldgate, E.C.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

College Calendar.—We have received a copy of the calendar for the 1906-7 session of the Northampton Institute (St. John-street, London, E.C.), which contains full details of the syllabuses and the equipment of the Institute. The day and evening courses include engineering (electrical and mechanical), technical optics, applied chemistry, artistic crafts, horology, &c., and enrolments for the evening courses, which begin on 24th inst., have already commenced.

Accrington.—The sub committee recently appointed to collect information on tramways recommend the Council to equip the local lines on the overhead system. The total cost of construction and electrical equipment is put at £84,100.

Argentina.—The "Review of the River Plate" says the contract is now being prepared by the Minister of Public Works of Buenos Ayres for the electrification of the lines of the La Plata and Ensenada Tramway Co. There are to be eight sections. The concession is for 80 years.

Aspull.—The Board of Trade have deferred the revocation of the Council's electric lighting order (1901) for six months.

Association of Chambers of Commerce.—At the meeting of this association on Tuesday and Wednesday the following resolutions were passed:—

Designs and Trade Marks.—That having regard to the hardship inflicted on British manufacturers by the operation of the laws of Continental countries relating to the registration of designs which give no protection to designs not worked in such countries, this association is of opinion that steps should be taken with the view of securing such an amendment of the Patents, Designs and Trade Marks Acts, 1883 to 1905, as will make it compulsory for designs registered in the United Kingdom to be worked in the country; and that the President of the Board of Trade be asked to receive a deputation from this association on the subject.

London-Paris Telephone.—It was resolved that the telephone lines between London and Paris are inadequate for commercial requirements, and that the fee for conversation should be reduced to 4s. or five francs for three minutes' conversation.

Charges for Telegrams.—That the present tariff for Anglo-French telegrams is excessive and unwarranted, and that it be reduced to 1d. per word, thus giving the full inland rate to each country.

Municipal Trading.—That it is most desirable that action should be taken by the Association to induce the Government to consider the necessity of adopting the recommendations of the Joint Select Committee of the House of Lords and House of Commons on Municipal Trading of 1903.

Miscellaneous.—Resolutions in favour of the amendment of the Companies' Act, the extension of the franchise to limited liability companies and for the enforcement of the provisions of the Merchandise Marks Act, 1897 by the Government, were also carried.

Bacup.—The Council, who have decided to take electricity in bulk from the Lancashire Electric Power Co., have selected a site for a transformer station. The Council's provisional order was obtained as far back as 1890.

Bath.—The Rural Council, having been interrogated by the Board of Trade as to their electric lighting order, the Council replied that difficulties have arisen with regard to obtaining a supply of current in bulk, and they ask for an extension of time.

Battersea (London).—Main extensions are to be carried out at an estimated cost of £575.

Bexhill.—The Council have decided to give a supply of electricity to the Bexhill Golf Club house by an overhead cable if the club agree to take current for three years and repay the capital outlay incurred in respect of laying service by equal instalments extending over that period.

Billinge (Lancs.).—The Council have applied for a licence to supply electricity in the district.

Bradford.—On Tuesday the City Council adopted a recommendation of the Tramways committee that for a period of five years from April 1 last electrical energy supplied for tramway traction be fixed at an advance of $\frac{1}{8}$d. per unit on the prices at present paid.

Bridgend.—The Council, who take current in bulk from the South Wales Electrical Power Distribution Co., are considering the question of extending their area of supply.

Carlisle.—The Council have received sanction to a loan of £4,722 (repayable in 16 years) for electric lighting extensions.

Negotiations are proceeding between the Council and the Rural Council in regard to the supply of electric current for pumping at the sewage works of the latter authority.

Cauvery Falls Power Scheme.—The Mysore Government have passed the estimates and sanctioned the initial work for the construction of a third and final unit of generating plant of 4,000 H.P. additional for the Cauvery Falls power works. Already over £300,000 has been spent on this undertaking, but additional plant is required to meet the increasing demand for electric power at the Mysore mines.

Crewe.—The borough treasurer has reported to the Council that there is a surplus of about £4,000 on the electric lighting undertaking. The Finance committee have decided to invest £3,000 of this in a safe security.

Dewsbury.—Application has been made for sanction to a loan of £9,500 for the electrical equipment of the portion of the Dewsbury, Batley and Birstall tramways within the borough, and for costs in connection with the purchase of tramways; and also for approval of the lease to the British Electric Traction Co. of the lines within the borough.

The agreement between the Corporation and the National Electric Construction Co. for the construction and leasing of tramways from Dewsbury to Ossett has been sealed, and the work of permanent-way construction and overhead equipment is to be proceeded with as Soothill Nether Council receive sanction to certain street widenings.

Dublin.—The Corporation Lighting committee are issuing a well-illustrated pamphlet on "The Uses of Electricity." The advantages of electricity for lighting, heating, power and other purposes are clearly set out. The Corporation have a system of hire-purchase of electric motors, and intending consumers of current for power can obtain their motors on easy terms. The pamphlet gives extracts from testimonials from many users of power in the Dublin area.

Dundee.—The selection of a site for the new power station is still exercising the minds of the members of the Electricity committee.

At the meeting on Monday the clerk was instructed to take steps for securing in the provisional order powers which would permit of electrical development being made co-extensive with the enlargement of the city boundaries. Application has been received for current to the Craigie Estate, Stannergate, which is outside the present area of supply, and so the commitee have been obliged to defer consideration of the matter for the present.

Edinburgh.—The Electric Lighting committee recommend that the chief assistant engineer's salary be increased from £375 to £400, and that the salary of the assistant superintendent of mains be raised from £150 to £160. The superintendent of mains has been voted an honorarium of £50 in respect of an improved method of cleaning lamps.

Electricity in Paper Mills.—Messrs. A. Pirie & Sons, the well-known paper makers, who proposed to take electric current from Aberdeen Corporation for electric lighting and power for their Stoneywood Mills, have been compelled to abandon the scheme, as the works are outside the Corporation's area. The company will, however, put down independent generating plant.

Electricity in Steel Works.—At the meeting of the Steel Company of Scotland last week Mr. Wm. Lorimer said the additions to plant and the reconstruction of plant in course of the year had cost £34,559. 0s. 4d. They had replaced their old soakers by new soaking pits worked by electric cranes, which enabled them to handle their ingots with less waste and less loss in every way. They had got two new locomotives, and they had got additional gas-producer power. But the most important improvement was the adoption of the Rateau system of generating power. What they had got from it was this—they had laid off the equivalent of three steam boilers, they had saved all the coal consumed in those boilers, and they had saved the wages, because they got the power for this machine from the waste steam which would otherwise have gone off into the atmosphere. They had purchased a duplicate plant, and when that was installed they would have no steam-driven machinery at Hallside, with the exception of their mills and hammers. He called that real and true economy.

Electricity Generation by Water Power in Wales.—On Monday, on the occasion of the christening of an electric launch on Lake Vyrnwy (the chief source of Liverpool's water supply) Ald. Burgess, chairman of Liverpool Water committee, said the committee had often been reproached that they had not utilised the great resources of the lake for electrical purposes. Lately they had established an electrical installation of 114 H.P. capacity, the power for which was derived from the overflow water The plant supplied current to a church, a hotel and to the waterworks for power, and would also supply power for the launch which was to bring the workmen to their work, to tug barges laden with stone and to carry the superintending and inspecting engineers. The boat could develop a speed of 7 miles an hour.

Fulham (London).—On Aug. 30, 1,953 premises were connected with the mains for an equivalent of 97,504 8 c.p. lamps, compared with 1,554 premises and 78,033 8 c.p. lamps 12 months ago.

Gas Works Statistics.—We have received a copy of the 29th (1906-7) issue of the "Gas Works Directory and Statistics," and the book, which has been revised up to July, appears to be as accurately and carefully compiled as usual. In addition to technical, financial and other information concerning the various gas works, there are alphabetical lists of chairmen, managers, engineers and secretaries, and of associations of engineers and managers. The directory proper is divided into four sections—viz., for England and Wales, Scotland, Ireland, and foreign and colonial gas works with London offices. The book, which is published at 10s. 6d. net by Messrs. Hazell, Watson & Viney, 52, Long-acre, W.C., does for the gas industry what "The Electrician" Electrical Trades Directory and Handbook (the Big Blue Book) does for the electrical world, and performs this pleasant if heavy duty with equal thoroughness.

Hackney (London).—Main extensions are to be carried out at an estimated cost of £103.

Halifax Tramway Strike.—This strike may be deemed at an end. The Tramways Emergency committee had decided to leave open 100 vacancies to noon of Tuesday, but as only two of the old hands returned to work up to that time now men have been engaged.

On Tuesday evening the tramways manager (Mr. F. Spencer) announced that practically all the vacancies had been filled. The total number of strikers who have gone back to work since Saturday is five, and about 220 men have had their places filled. The men's representatives assert that they "will never go back to work unless the Tramway committee sends for them." There is now a full service on all routes.

A special meeting of the Council was held on Wednesday to consider a proposal by the Labour members to refer the questions involved in the strike to arbitration.

The chairman of the Tramways committee (Ald. Hey) said the proposal came too late. The vacancies on the staff were practically all filled, and to dismiss the new men in order to reinstate the strikers could not be arranged.

The motion was defeated by a large majority.

On Wednesday evening a tramcar from Brighouse to Halifax left the metals while turning a curve. Two iron nuts were found in the rails. After a delay of ten minutes the car was replaced on the metals and the journey resumed.

Harrogate.—The Council have decided not to support a proposed application for powers to construct a tramway from Harrogate, through Starbeck, to Leeds.

Hebburn.—The British Electric Traction Co. is to be approached with the view of having tramways constructed in the district.

Hove.—The Lighting committee are making experiments in street lighting with a metallic filament lamp. At the outset only four lamps are to be tried.

Huntingdon.—The application of the Electricity Works Development Co. for a provisional order will not be opposed by the Council.

Incandescent Lamp Prices in Germany.—The "Elektrotechnischer Anzeiger" states that, in consequence of increases in wages and in the cost of raw material the Verkaufsstelle Vereinigter Gluklampen-Fabriken (G.m.b.H.) have increased their prices for incandescent lamps by 5 per cent. as from Aug. 25.

Inquests.—At the *City of London* Coroner's Court, on Wednesday, an inquest was heldon Gilbert Edwards (a signal fitter employed on the District Railway) who received an electric shock while at work on the morning of the 5th inst. and died on Saturday.

A brother said that deceased told him electric current of 500 or 600 volts passed through his body. Deceased was straining up a bolt when the spanner came in contact with the live rail and he was drawn on to it. The electric current was (he alleged) switched on 20 minutes before the proper time.

Herbert Tracey, fitter, who worked with deceased, stated that notices were put up in the cabins used by the workmen, intimating at what time current would be turned on and off, and cautioning the men to allow a good margin. Witness saw deceased later than 4:20 a.m. and the accident had not then happened. The workmen could see when the current was turned on by the lights which appeared in the signal boxes, and also in the tunnel. If the spanner had not slipped deceased could have continued his work, even with the current on, without sustaining injury.

Harry Porter, sub-station operator at the Mansion House Station, said the time of turning the electric current off and on was invariably entered in a book, and on Wednesday morning the current was switched on at 4:30, the proper time, not earlier.

Dr. Davis, house-surgeon at St. Bartholomew's Hospital, said deceased when admitted was suffering from severe burns on the right arm and face and slighter burns on the left arm. His hair was singed and there was a large hole in the right arm, apparently the result of coming in contact with a live rail. The arm was afterwards amputated, which was the only chance of saving life. Deceased, however, sank and died from shock.

Mr. Strange, signal engineer to the Metropolitan District Railway Co., said the proper course for workmen engaged on electrified lines was at all times to regard the live rails as dangerous. The company did everything possible to minimise the risk of accident.

The jury returned a verdict of accidental death, and added a rider that the company would do well to adopt some means of giving warning to the men employed on their line a few minutes before switching on the electric current.

An inquest was held at *Darlington* on Friday into the death of Enoch Archer, night foreman at the electricity works, who was killed whilst repairing a switch in the overhead equipment of the tramways on the previous day.

Mr. F. W. Hewitt, assistant manager of the Corporation electricity and light railways department, said deceased had done a considerable number of repairs to the overhead equipment at one time and another. Every other week it was his duty to attend to the overhead work outside. On Thursday, though off duty, he happened to be in the Market Place, saw something was wrong with the switch, and without instructions he got a ladder to attend to it. He ought to have notified the electricity works and sent for the proper appliances. Deceased was a skilled workman, and no doubt thought he could easily put the defect right. An overhead movable switch, where the trolley wire branched in two directions to go round the corner, was out of order. Indiarubber gloves were provided for that sort of work, both on the cars and in the traffic office, but deceased was not wearing any. Instead of sending for the tower ladder, Archer borrowed an ordinary ladder from the National Telephone Co.'s office. If he had had the tower ladder it would have been impossible for him to fall down. The repair was not an easy one, and should never have been attempted from an ordinary ladder.

By the Coroner: If he came in contact with the live wire the highest voltage would be 500. Archer would frequently have had a shock of 500 volts in his work in putting up the wires. The fatal voltage varied very largely. It was usually considered about 700 or 800 at the least for an average man. But it depended how a man got it, and on the state of his health; whether he had a weak heart or anything of that sort. If it had been a very wet day, even with 500 volts he would have had a bad shock. But the day was quite fair. The fatal voltage was usually 1,000 or more; 700 or 800 was the very least.

Dr. Archibald Simpson said deceased had a compound fracture of the skull. The cause of death was obstruction of the left side of the brain, due to the fracture. If the electric current had killed him, he would have died on the spot.

Samuel P. Goldsmith said there was a rule in the handbook supplied to all the electricity employés which said: "Never touch the wire or anything with which it is in contact with the bare hands or with anything of a metallic nature, or which is wet or damp, or a severe shock may be received." He did not think the accident would have occurred if deceased had used rubber gloves.

The jury returned a verdict of "Accidentally killed by falling from a ladder."

An inquest was held last week at *Blackpool* on the body of a man named M'Keag who was killed by being run over by an electric tramcar.

Evidence was given that M'Keag was walking obliquely across the tram lines. The driver shouted, but the man took no notice and was knocked down. M'Keag got between the brake block and the front wheels, and was so wedged that it took 20 minutes to release him by lifting the car. The lifeguard was down and seemed to act.

One Witness said the lifeguard did not act until M'Keag was under the wheels and then it fell.

The Driver of the car said the lifeguard acted, but he could not explain the accident.

The general manager (Mr. J. Lancaster) did not think the lifeguard was to blame. His theory was that the man had been struck by the car, knocked on one side, and in trying to get away got his legs between the lifeguard and the wheels. The guard could not drop from anything being underneath, but only from the action of the gate. If the man had fallen in front of the car no doubt the lifeguard would have picked him up. There was no guard on the market that could prevent cases of that kind. The Corporation lifeguard was the best, and had been suggested and approved by the Board of Trade. The same type was in almost universal use.

The jury returned a verdict of accidental death.

Japan.—Mr. Harrington, the British Acting Vice-Consul at Yokohama, has prepared an interesting report of the trade of the district for 1905.

He particularly calls attention to the increased imports of machinery, which exceeded in value those of 1904 by £265,865, or 39 per cent. (£951,274 against £685,409). Two noticeable items in these imports are electric motors, which increased from £95,199 in 1904 to £167,799 in 1905, and machine tools from £69,480 to £103,735. A good proportion of electric motors and machine tools were supplied by Great Britain. Other large increases were in electric lighting apparatus, accessories and materials, which came chiefly from the United States. There was an import of telegraph wire to the value of £74,869 in 1905, an increase of £9,159 over 1904. Great Britain contributed only £3,532 of this material. There was a decrease in the value of imported submarine and underground telegraph cables of £49,885, compared with 1904. These cables are almost entirely of British manufacture.

Throughout the principal districts and cities in Japan electric tramways are gradually extending. Tokio and Yokohama are now connected up in this way, and this method of intercommunication is being employed on a large scale. The imports of electric railway carriages show an increase of £4,589, and a fair proportion of these carriages are supplied from Great Britain.

The American Consul at Kobe, writing on the subject of water power in Japan, says:—

Water power, one of Nature's greatest gifts to Japan, has hitherto been little developed, its use being limited to operating the primitive Japanese rice and flour mills. However, a notable development in the use of the water power in the Kohe district for the generation of electricity appears to be at hand. Since the Russo-Japanese war the great increase in the cost of coal (more than 60 per cent.) has caused the various companies using steam to seek a more economical motive power, and with this object in view a number of undertakings are now in course of formation, and the promoters being among the most prominent and influential business men of Japan there is little doubt but that they will be carried to completion. The most prominent of the proposed companies is the Ujikawa Electric Power Co., with a capital of £2,000,000 and an equipment equal to 40,000 H.P. This company will furnish the city of Kioto and vicinity with electric power. Among other companies is one for supplying Nagoya, where electric power will be used by the Miye Cotton Spinning Co., Nagoya Electric Light Co., Nagoya Electric Tramway Co. and the Atsuta Arsenal. It is also the intention of the Hanshin Electric Railway Co. of Osaka, which connects that city with Kobe, to use water power for generating electricity for operating its lines.

King's Norton.—At the Council meeting this (Friday) afternoon a report will be submitted announcing the receipt of sanction to the borrowing of £40,000 for the reconstruction of the Moseley and King's

Heath tramways and the construction of the extension to Alcester Lanes End. The period of the loan is 27 years.

Lowestoft.—There are now 684 consumers, representing the equivalent of 35,732 8 c.p. lamps connected to the mains.

On Tuesday the Council adopted a suggestion of the electrical engineer (Mr. G. A. Bruce) to lay a main for the lighting of the new offices at the Herring Market. After considering Mr. Bruce's report as to the supply and repair of arc lamps and the supply of current thereto, it was resolved not to provide lamps, but to maintain arc lamps of approved makes at from 5s. to 10s. per quarter, according to size and make of lamp, in addition to the ordinary charge for current.

Luton.—Sanction has been received to a loan of £7,000 for electricity supply extensions.

Mansfield Tramways Strike.—The drivers and conductors of the Mansfield & District Electric Tramways came out on strike on Monday owing to their demand for higher wages not having been conceded. New men have been imported, but only six cars were running on Monday. On Wednesday more outside motormen and conductors were engaged, and cars were being run on all sections of the system.

Mansfield Woodhouse.—The Council have applied for an extension of 12 months for carrying out their provisional electric lighting order, 1904.

Marylebone (London).—The town clerk has issued a notice to consumers of the electricity department, announcing that

For electricity supplied at 240 or 480 volts for ordinary lighting 8d. per unit will be charged for the equivalent of 500 hours' use of the maximum demand in each year, and 1d. per unit for all energy consumed in excess of this quantity. For electricity supplied at 240 or 480 volts through special circuits and meters for all purposes other than lighting 2d. per unit for 125 hours' maximum demand in each quarter, and 1d. per unit after. For electricity supplied by separate circuits and meters to basements not used for dwelling purposes a flat rate of 2d. per unit consumed. Meter rents 10s. per annum for each 50 8 c.p. (32 watt) lamp installed, or the equivalent. Additional rentals will be charged at the foregoing rates for separate meters required for special circuits. All bona fide consumers will be allowed 25 per cent. discount off the excess of each quarter's account above £50, provided the accounts are settled within 30 days, and provided, also, that any outstanding claim against the Council, on account of the change of pressure, has been withdrawn.

Otley (Yorks.)—The Council decided on Wednesday to transfer their provisional electric lighting order (1902) to the British Westinghouse Co.

Perth—At the Council meeting on Monday Councillor Chrystal, convener of the Tramways committee, moved, and it was agreed, that the offer of the National Electric Construction Co. to lease the tramways be not entertained. Mr. Chrystal anticipated that in a year or two it would be a prosperous concern. From May 16 to July 15 the receipts averaged more than the expenditure, so if they had a little patience they would yet have a valuable property.

Presentation.—Mr. Geo. Wilson, Norwich electricity works, was on Friday presented by the employés with an oak secretaire bookcase on his marriage.

Redcar.—The Council are in negotiation with the Cleveland & Durham County Electric Power Co. for a supply of electricity in the district. It is probable that arrangements will be made for lighting some of the streets electrically.

St. Helens.—The Council have decided to let out arc lamps on hire and to maintain them for private consumers.

Salford.—The committee of the Salford branch of the Tramway and Vehicle Workers' Association has advised the employés of the tramways department not to accept the terms offered by the Tramways committee, set out in our last issue. A special meeting of the men was held last (Thursday) night to further discuss the position.

Sheffield.—Out of the profit on the past year's working of the Corporation tramways over £21,000 has been contributed in relief of rates, equal to 3½d. in the £, and the department also provides a special fund out of which grants are made to various objects not supportable out of the rates, such as the maintenance of municipal winter concerts, and the preliminary expenses of an electrical exhibition which is being promoted by the Corporation.

At the meeting of the Corporation on Wednesday it was decided to adopt electric lighting for The Moor.

South Africa.—The "British and South African Export Gazette" states that—

Potchefstroom Town Council has submitted to the ratepayers a scheme for various works, including electricity supply.

The Municipality of *Umtata*, Tembuland, Cape Colony, have invited tenders for lighting the town by electricity (or by acetylene gas). It is estimated that from 2,000 to 4,000 8 c.p. lamps will be required.

Cathcart (Cape Colony) Council are again considering an electric lighting scheme, the concession granted some time ago having lapsed.

Krugersdorp Council have resolved to establish electricity works in their district. The cost is estimated at about £15,000. Tenders for generating plant will shortly be called for locally.

The "Gazette" further states that in the *Indwe* collieries about half the coal won is cut by electric machines of the chain type pattern, that almost all the underground haulage is done by electric locomotives, and that experience has shown that if current is unobtainable in the vicinity of the coal mines it is cheaper for the collieries to instal their own plant, as it permits of their using the most up-to-date labour-saving machinery and appliances for cutting and screening coal and working the winding, hauling, lighting and pumping plants.

Hubert Davies & Spain have installed a new generating set for *Kroonstadt* Council.

The Namaqua Copper Co. intend to substitute electric for steam plant at their mines.

South Shields.—On Wednesday the Council adopted a recommendation of the Electrical committee to increase the salary of the borough electrical engineer (Mr. J. H. Cawthra) from £500 per annum to £550, rising by annual increments to £700.

The Chairman of the committee (Ald. RENNOLDSON) said that South Shields had occupied the proud position of having the lowest works cost of any electrical station in the Kingdom for lighting purposes only. That showed they had an efficient engineer and one who was deserving of every consideration at the hands of the Council.

Southport.—The Corporation have given permission to the National Telephone Co. to place their wires underground.

Steel Tube Combination.—The South Wales "Daily News" announces that a combination has been agreed upon by the steel tube trade of Scotland and England to affect both the home and export trades. Two years ago a combine was arranged to regulate the home trade alone, but, as export interests clashed, the combine fell through 18 months since. The new understanding has also the support of American producers.

Stirling.—The National Electric Construction Co. recently opened negotiations with the local electric tramway company for the acquisition of their lines and their conversion to electric traction. The National Company offered £10,000 in cash and £9,000 in shares in a new company to be formed. This offer has not been accepted, as the local company wish to negotiate for sale on a cash basis exclusively.

Stockport.—At the meeting of the Council last week the chairman of the Finance committee (Ald. Bell) stated that the profit on the electricity department last year was £4,675, and £2,000 was to go in aid of rates. The tramways department had shown a considerable improvement over last year, the profits having increased by 50 per cent. The gross income was £40,698, and the surplus over expenditure £5,545. £2,500 of this would go in aid of rates and £3,045 to a renewals fund.

Swindon.—It is stated that claims amounting to £30,000 have been received in consequence of the tramway accident at Swindon on June 1.

Swinton and Pendlebury.—The Council, who have made an agreement with the Lancashire Electric Power Co. for a supply of electricity in bulk, have applied for sanction to a loan for carrying out their electricity supply scheme.

Torquay.—The local tramways are approaching completion, and it is expected that some of the lines will be opened for traffic early next month.

Trade Union Congress.—At the sitting of the Congress on Friday a resolution was unanimously passed urging upon the Government

The necessity of establishing a national system of old age pensions to be universal in its application to all citizens (men and women) on attaining 60 years, the pension to be at the rate of at least 5s. per week, and the entire cost of the scheme to be contributed by means of Imperial taxation; and instructing the Parliamentary Committee of the Trades Union Council to circularise all unions affiliated, urging them to bring pressure upon members of Parliament through the local branches, and to use every other effort to ensure the passing of an Old Age Pensions Bill during next session.

It was resolved at the concluding day's (Saturday) sitting

That in view of the efforts made to press into effective service the Unemployment Act of 1905, and recognising that the working of overtime operates materially against the fuller employment of workpeople, this Congress resolves to recommend that a limit to the amount of overtime worked by the members constituting it be adopted; also that, with a view of carrying this into effect, the Parliamentary Committee of the Trades Union Council is instructed to organise conferences between representatives of kindred trades as a means of appealing to the workers upon the question.

It was also resolved

That any method of organisation which seeks to divide workmen employed by public authorities or private employers from their fellows in the same occupations employed by private firms is detrimental to the best interests of trade unionism, and that the Parliamentary Committee use its best endeavours to prevent the spread of such methods of organisation.

Resolutions were also adopted in favour of "Compulsory State Insurance" and "Municipal Banking."

The next meeting of the Congress will be held at Bath.

Train Lighting in India.—In an article on the electric lighting of trains in India "Indian Engineering" states that there are only a few lines that have introduced the practice seriously.

The Kalka-Simla Railway, which passes through a series of tunnels from end to end, is an exception, and the whole of the company's 72 coaching vehicles are provided with apparatus for switching on the electric current without the passenger's intervention. The Rajputana-Malwa State Railway has 340 of its coaching vehicles, which are used on the Delhi-Ahmedabad through mail and passenger service trains, fitted with the electric light, and it is stated that electric lighting has proved a success. The South Indian Railway, which has 99 of its coaching vehicles provided with electric lights, is still dealing with the matter experimentally; while the Madras Railway has decided to give the system a practical trial with a view to its adoption in mail and fast passenger trains. A few other railways have nibbled at the improvement, including the Indian Midland and Great Indian Peninsula Railways, which have 29 coaches fitted with electric lamps; the Jodhpur-Bikaner Native State line, with 80 vehicles; the Burma Railways, with 20 vehicles; the Bombay, Baroda & Central India Railway, with two vehicles; and the Bengal-Nagpur, Eastern Bengal and Oudh & Rohilkhand Railways, with one coach each. The Kathiawar Railway installation is the last but not least.

Visit to the Bennis Works.—On Saturday last about 40 members of the Darwen branch of the National Amalgamated Union of Engineers visited the modern engineering and constructional works of Ed. Bennis & Co., at Little Hulton, when the firm's various manufactures were explained to the visitors by Mr. Alfred W. Bennis, M.I.Mech.E., and members of the staff.

Bennis patent stokers and self-cleaning compressed air furnaces and the new improved patent smokeless chain-grate stoker were shown in operation, and were objects of great interest to the members of the party. Other manufactures inspected were elevators and portions of conveying plant approaching completion. The process of multiple moulding by machinery in the foundry likewise attracted attention. A visit was made to the laboratory, where one of the firm's chemists gave a practical demonstration by calorimeter as to how the heat value of any given coal is ascertained. During the afternoon, Mr. A. W. Bennis addressed the visitors, and pointed out that the average efficiency of Lancashire boilers in Lancashire was higher than that usually obtained in other parts of the country, but that, even so, the average in hand-fired boilers was only between 55 and 60 per cent. That was due to the fact that the temperature of combustion by hand-firing was not as continuously high as in firing by a first-class machine stoker and furnace. A point usually lost sight of (he said) was that the higher the initial temperature of the furnace, the more rapid was the transmission of heat through the furnace plates, so that, given a good clean boiler, the higher the furnace temperature at the front of the boiler the lower it was actually possible to get your terminal gases. It was obvious that the amount of heat transferred to the boiler was the difference between the initial temperature and the terminal temperature, therefore, if they could make a hotter fire in the furnace and start with a higher temperature they could put a greater percentage of heat into the boiler. Than was the place where a well-designed mechanical stoker and furnace could show economy over the best hand-firing. He wanted to emphasise the particular fact of high temperature; it was the point they had been striving for and making experiments to retain for many years. A high initial temperature not only meant high economy, it meant large evaporation from the boilers, entailing fewer boilers to do a given duty. It, therefore, minimised the losses through radiation, both from extra boiler surface and its steam pipes, and meant less boilers to attend to, and generally in mill working a spare boiler, which could be cleaned out during the week, and therefore the work was properly done and never scamped. Now-a-days the price of coal must be largely considered in the running cost of a mill; therefore, it generally paid to buy the cheapest coal in the market if they could burn it. The cheap coal contained so much clinker and dirt that it was impossible to deal with them satisfactorily by handfiring. A moving self-cleaning furnace of some description must be provided. If they got a moving furnace with wide air spaces, the fine fuel tumbled through the spaces in large quantities, and, therefore, a fine air space was essential. If they got a fine air space, and had not a particularly good draught, they could not get the air through, so that entailed some method of controlling the amount of air to be passed through the furnace. Those were the steps that led Messrs. Bennis gradually from the ordinary moving bar with natural draught to a moving bar with fine air spaces, and through the fine air spaces to the necessity for a means of forcing or pushing the air through these fine spaces.

After justice had been done to a substantial repast provided, the president of the Darwen Society (Mr. Peers) expressed the hearty thanks of the visitors for the interesting afternoon they had spent, and for the courtesy shown by Messrs. Bennis and their staff in opening the works and explaining everything everything to them. He felt that if engineering firms would give their employés greater opportunity of actually seeing new machinery and mechanical processes as well as reading about them both would derive benefit therefrom.

Mr. A. W. Bennis said he agreed that more opportunity should be given to the employés for increasing their engineering knowledge practically in the mutual interest of employers and employed. He thanked them for the keen appreciation shown in going thoroughly into details in the works, and hoped they would benefit by their visit.

Water Power in Canada.—Surveys which are now being made for the Georgian Bay Canal show enormous undeveloped power in the Ottawa river. It is estimated that the water available is equivalent to 1,250,000 h.p.

Yarmouth.—On Tuesday the Corporation authorised extensions of the tramcar sheds depot (including the erection and equipment of a workshop and a car-painting and repairing shop) at an estimated cost of £2,000.

Cricket.—On Saturday last the annual cricket match between the Birmingham works of the General Electric Co. and the Robertson Electric Lamp Works took place at Shepherd's Bush (London). Hammersmith works batting first made 67 runs. Parrott, who contributed 34, was unlucky in being run out. Birmingham works made 103, Morris (who gave a fine exhibition) making 48 before being bowled by Furnell. In the evening the teams dined together, and a smoking concert followed.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Ayr.—The annual report of the tramways manager (Mr. W. Grant) was presented to the Council on Monday.

The total capital expended is £79,362. The annual revenue was £15,252. 17s. 6d., an increase of £170. 17s. 7d. The receipts per car-mile were 9·5d., against 9·72d. The number of passengers carried was 3,551,538, against 3,578,650. The total number of car-miles run was 372,062, against 365,646. The parcels carried numbered 11,326, against 8,481. The electricity consumption was 372,597 units (1 unit per car-mile), an increase of 37,532 units.

Govan.—The annual report of the burgh electrical engineer (Mr. Theo. C. Parsons) was submitted to the Council on Monday.

27 additional motors were connected to the mains during the past year, the total number now let out on hire being 42 motors, equal to 454 h.p. During the year those motors consumed 197,582 units, for which the electricity department received £1,161. 8s. 10d., and for motor rent £242. 0s. 4d. The increase in units sold for power was 94 per cent., and the increase in revenue from power 79 per cent. The report states that only five stations in the kingdom have lower works cost, and only 14 have lower total working costs. The units generated were 2,031,214, units sold 1,602,606; used in works 207,363, street and stair lighting 466,897, private lighting 496,853, and power 638,856, total 1,809,969 units accounted for, against 1,166,280 units in the previous year. The revenue was £13,136. 1s. 4d., and the total charges (including interest and sinking fund) £11,525. 0s. 9d., the net profit for the year being £1,611. 0s. 7d.

TELEGRAPH AND TELEPHONE NOTES.

Brighton.—Brighton Corporation on Thursday last were informed by the chairman of the Telephone committee (Councillor Lintott) that the Postmaster-General had notified that he would take over the municipal telephone system on Oct. 1.

The Postmaster-General demands that he shall be at liberty "to make such arrangements with the National Telephone Co. as may be necessary to facilitate intercommunication, or the combination of the two systems, so as to avoid the duplication of plant prior to the acquisition of the company's system by the Postmaster-General in 1911, or to increase the efficiency and economy of working." The committee have agreed to all other conditions, but in respect to this suggestion recommended that the Postmaster-General be requested to retain the working of the Corporation system in his own hands.

The minutes were approved.

Chiswick.—The Council have granted permission to the Postmaster-Generel to erect telephone poles in the district, and have come to an arrangement that when 16 wires are attached to a pole the wires shall go underground.

Glasgow.—On Monday Glasgow Corporation telephone undertaking was formally transferred to the Postmaster-General.

A number of Government officials were in attendance at the head-office in Renfield-street, taking stock of plant and checking books, and the convener of the Telephone committee (Mr. H. Alexander) received a cheque for £308,066 in full payment, including incidental charges above the purchase price as agreed. The staff are being taken over by the Government without any change at present. The system will be worked as hitherto until arrangements have been completed for its reorganisation, which will take place with the least possible delay. In the meantime all terminal trunk lines will be abolished. Circulars will be issued shortly to all subscribers indicating the intentions of the Government with regard to charges. The service will now be known as the Glasgow Post Office Telephone service.

At the meeting of the Corporation last week Mr. J. Alexander, in moving the minutes of the Telephone committee, said that the Postmaster-General had agreed to take over all the Corporation employés under terms and conditions not less favourable than they at present enjoyed, and he fully anticipated that all officers who were able and zealous would find that the transfer would result in their ultimate benefit. He understood that the employés had had a meeting with the Post Office authorities and that the employés were satisfied with the conditions under which they were being transferred. With regard to future rates, the Postmaster-General had refused to consider that matter. The Postmaster-General could now call on the National Company to give intercommunication, and that would necessitate a revision of the rates. The Postmaster-General, on taking possession, could abolish terminals, which would lead to a saving of from £1,200 to £1,500 a year to telephone subscribers. Should the Postmaster-General unduly raise the present rates, the Corporation would have something to say. They had all along been able to carry on their undertaking at £5. 5s. for an unlimited service, and the revenue from that rate had been more than sufficient to meet expenditure. He was sorry the Corporation had been compelled to part with the undertaking. The refusal of the Postmaster-General to prolong their license and the continued unfair and unprofitable competition of National Company would have resulted in the Corporation losing heavily by 1913, when their license expired, as the Postmaster-General would only take over what he chose. The Corporation telephone undertaking, notwithstanding all that paid and unpaid critics had stated, had amply justified its existence. Something like £500,000 had been saved to telephone users by the cheaper and better service they had enjoyed.

Bailie BRUCE MURRAY challenged Mr. Alexander's statement that the Corporation's loss was due to the unfair competition of the National Co. That was an absolute misstatement. The unfair competition was entirely on the side of the Telephone committee. The committee were carrying on that enterprise under conditions which must involve loss.

After a lively debate the minutes were approved.

The following official notice is issued by the Postmaster-General: —

The telephone system of the Corporation of Glasgow has now become part of the Post Office telephone system. The exchanges named below in the Glasgow area, which were formerly in the Corporation system, are accordingly now Post Office exchanges :--

Central
Bell
Western
Bridgeton
Kinning Park
Queens Park
Govan
Maryhill
Springburn
Milngavie
Shettleston
Clydebank
Rutherglen
Kirkintilloch
Stepps
Clarkston
Cambuslang
Bearsden
Duntocher
Balmore

Subscribers at Glasgow whose premises are connected with the Trunk exchange at the Post Office, and who have hitherto been known simply as Post Office subscribers, Glasgow, will now be known as subscribers to the Post Office Trunk Exchange, Glasgow, and should be asked for as Glasgow Trunk, No. ——. Care should be taken to avoid any confusion between these subscribers and subscribers to the Post Office Central exchange, Glasgow.

Telephone Trunk Line Service.—The Postmaster-General has notified the Newcastle and Gateshead Chamber of Commerce that additional trunk telephone lines are being constructed between Newcastle and London and other places. The time limit (six minutes) for trunk calls is not now enforced unless there are other calls in hand.

At a special meeting of the Norwich Chamber of Commerce on Monday a communication was received from the Postmaster-General to the effect that arrangements have been made to provide new telephone trunk lines to London, Cambridge, Ipswich and Yarmouth respectively, while Thetford is to be removed from the London line and given a separate line to Norwich. In addition, the existing trunk line between Lowestoft and London is to be worked between Norwich and London. There will thus be four trunk lines between Norwich and London. The telephone system is also being extended to Bungay, Wymondham, Aylsham, Harleston, Eye and Diss.

Telephone Wires Damaged by Fire.—The fire which occurred in a seven-storey building at Holborn-viaduct, London, on Tuesday caused considerable damage, by breakage and otherwise, to the National Telephone Co.'s cables, which radiated from the adjacent Holborn exchange to a derrick on the party wall of the building. About 300 subscribers were temporarily cut off, but some of these were re-connected the same day and the repairs are now nearly completed.

Spanish Telegraphs and Telephones.—The Spanish Government have appointed a commission to report on the best means for improving the Spanish telephone and interior telegraph services.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Blackpool Electricity and Tramways committee invite tenders for supply and erection of (1) one 800 to 1,000 kw. turbine, direct-coupled to one 800 kw. single-phase alternator ; (2) one 500 kw. d.c. tramway generator and (3) surface-condensing plant. Specifications, &c., may be obtained at the office of the borough electrical and tramways engineer, Mr. Charles Furness. Tenders (addressed to the chairman of the committee, West Caroline-street, Blackpool) by 29th inst. See also an advertisement.

Limerick Electric Lighting committee invite tenders for gas plant, gas engine and dynamo, switchboard extensions and cables. Specifications, &c., from the electrical engineer, Mr. James Gallinagh. Tenders, to the town clerk (Mr. W. M. Nolan), before 2 p.m , Oct. 2. See also an advertisement.

The Magistrates of the City of *Utrecht* (Holland) invite tenders for (1) supply of 12 complete electric motor cars for the city tramways, and (2) supply and erection of the complete overhead line work, consisting of standards, trolley wire, span wire and other accessories. Tenders (which must be delivered to the magistrates) must be at the Town Hall, Utrecht, by 2:30 p.m. Sept. 29. See also an advertisement.

Oxford Corporation invite tenders for the reconstruction, extension and electrical equipment of the existing horse tramways in the city and the leasing thereof. Proposals based on the overhead system of working will not be considered. Conditions of tender from the town clerk (Mr. Richard Bacon), to whom tenders by Sept. 17.

Tenders are wanted by 3 p.m. 22nd inst. for the erection at *Blackrock* (Co. Dublin) of an electric installation for the transmission of power for Blackrock and Kingstown Drainage Board. Form of tender, &c., from the Town Hall, Blackrock.

Edinburgh School Board want tenders by 20th inst. for an electric light installation at Gilmore-place school. Mr. Carfrae, 3, Queen-street, Edinburgh, is engineer.

Pontypridd Council want tenders by 24th inst. for supply and erection of tramcar sheds.

Gillingham Corporation want tenders by noon Sept. 24 for coal for the electricity station.

Dublin Technical Education committee want tenders by noon 19th inst. for electric lighting of the Technical Schools, Lower Kevin-street.

Johannesburg Town Council invite tenders for supply and delivery f.o.b. (at a port suitable for shipment to South Africa) of one-phase alternate-current motors with accessories. General conditions, specification and forms of tender from the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Tenders to the town clerk, Municipal Offices, Johannesburg, by Oct. 15.

The *Bombay, Baroda & Central India Railway Co.* (2, 3 and 4, Bishopsgate-street Without, London, E.C.) want tenders by noon Sept. 25 for various stores, including accumulator cells.

Umtata (Cape Colony) municipality require tenders by Oct. 31 for electric or acetylene gas lighting. Particulars from the town clerk, Mr. E. J. Ramsay.

TENDERS RECEIVED AND ACCEPTED.

Among work recently executed by the Phœnix Mfg. Co. is :—

A 600 kw. set for Gloucester Corporation, coupled to an engine by W. Sisson & Co. ; for Johannesburg Municipality (to the specification of Messrs. Mordey & Dawbarn), four 54 B.H.P. 460 volt motors for driving blowers in connection with the gas plant. These are of the "Phœnix-Pohl" type, and satisfactorily passed through an exhaustive series of tests by the consulting engineers ; for West Riding County Council, two 80 kw. sets with Willans engines ; for Barrow-in-Furness Corporation electricity department, a balancer booster set ; for the Great Western Railway works at Swindon, three 165 kw. slow-speed sets, running at 200 revs. per min. for direct coupling to gas engines.

Among contracts recently secured by this company are a 200 kw. set with Willans engine for Nuneaton electricity works ; a large contract for auxiliary machinery for Birmingham Corporation, comprising two 100 kw. balancer sets, one 200 kw. motor-generators, four 50 kw. balancer booster sets and two trunk main-feeder boosters, each consisting of two 42 kw. machines. The total capacity of this order is approximately 2,100 H.P. ; for the Farnley Iron Co. (Leeds), a special 140 kw. dynamo for direct coupling to a Premier gas engine ; for the South African Technical College (Cape Town), some £800 worth of plant for the complete equipment of the electrical laboratories ; for the Kent Electric Power Co., some 350 B.H.P. three-phase motors and motor-generators ; for the Campbell Gas Engine Co. (to the specifiation of Messrs. Shepherd & Watney), seven motors, totalling 400 H.P. ; and for the Urban Electric Supply Co. (Hawick), motors totalling 200 H.P. We are informed that the machines on order total about 5,000 H.P.

Sydney (N.S.W.) Municipal Council have decided to instal two 2,000 kw. steam turbine sets, and the order for the turbines and the necessary condensing plant, has been placed with Willans & Robinson of Rugby, who are manufacturing the plant to the order of Dick Kerr & Co., the main contractors. The turbines are being arranged for driving the Dick Kerr turbine type of alternator.

Colchester Corporation have accepted the tender of Thomas Moy (Ltd.) for 12 months' supply of coal for the electricity works as under : Babbington hard steam coal, 15s. 11d. per ton during the half-year to March 4, 1907 ; and Shirebrook hand-picked loco. hard steam coal, 16s. 2d. per ton during the succeeding half-year to Sept. 4.

South Shields Corporation received the following tenders for the construction of the permanent way of tramway extensions :—

W. Underwood & Bro (*acc.*).	**£4,330**	W. Griffiths & Co.	£4,703
J. L. Miller	5,543	G. Freeman & Sons........	4,071
A. Stark & Sons	5,260	Thos. C. Starkey..........	4,041

Dundee Corporation have accepted the following tenders :—

Bolckow, Vaughan & Co., rails, &c., £2,144 ; P. & W. Maclellan, anchor plates, £109, and tiebars, &c., £78 ; J. M. Fyfe, granite setts, £1,327, and granite chippings, £77 ; Martin & Macfarlane, Whinstone setts, £590.

Hackney (London) Council received 10 tenders (varying from £399. 14s. 3d. to £167. 15s. 4d.) for wiring and fitting up the Town Hall for the electric light, and the lowest (that of J. H. Golding) was accepted.

Bruce Peebles & Co. have received an order (through Messrs. Willans & Robinson) for one 2,000 kw. 6,000 volt 40-cycle turbo-alternator for the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board.

The General Electric Co., W. T. Henley's Co., Siemens Limited (Johannesburg), Stewarts & Lloyds, the Telegraph Mfg. Co. (Colonial) and the Western Electric Co. have received orders for telephone material for Cape Colony post and telegraph department.

Battersea (London) Council have accepted the tender of W. T. Glover & Co. for cable at £167. 19s. 9d., and that of West Bros. for 10,000 tiles at £25. 15s.

Neath District Council have placed an order with Johnson & Phillips for supply and laying extensions of distributor cables and wires and erecting street lanterns.

The managers of the West London District Schools have accepted the tender of Johnson & Phillips for supply and erection of two steam dynamos, switchboard and cables.

Brandon Council have accepted the tender of W. Fletcher for the supply of poles, cables, lamps, &c., for electric lighting at Sleetburn and Waterhouses.

A. Reyrolle & Co., Hebburn-on-Tyne, have obtained an order from Manchester Electricity committee for supply of motor starters during 1906-7.

Carlisle Electricity committee have accepted the tender of R. Percival to supply 1,000 tons of coal at 7s. per ton delivered at the railway siding, and 7s. 7d. per ton carted.

Stalybridge, Hyde, Mossley and Dunkinfield Tramways and Electricity Board have accepted the tender of W. T. Glover & Co. for cables.

Sittingbourne Council have accepted the tender of Jabez Smith for alterations to the electric light installation at the waterworks.

Frome Council have accepted the tender of Rawlings & Son for an electric fire-alarm installation.

Heanor Council have accepted the tender of Carpenter & Mayfield for a fire-alarm installation.

East Ham Council have placed an order with Geipel & Lange at £23. 10s. for a small testing set for locating electric leakages.

Belliss & Morcom have received orders for two 60 kw. generators and a 170 B.H.P. engine for the New Modderfontein Gold Mining Co.

Halifax Council have accepted the tender of the British Insulated & Helsby Cables for the supply of two feeder cables at £1,283.

The tender of Ferranti Limited has been accepted by Watford Council for 12 months' supply of electricity meters.

Torquay Council have accepted the tender of Mr. Tizzard for the supply of electrical fittings for the new library at £105. 10s.

The Allgemeine Electricitäts-Gesellschaft, Berlin, recently received an order for laying the h.t. transmission network in connection with the supply of current in Lauben, Marklissa, Greiffenberg, Friedeberg, Hirschberg, Schmiedeberg, Lichtenau, Rengersdorf, Rabischau, Liebental, Berthelsdorf, Erdmannsdorf, &c., in Germany, from the electricity works to be erected at Mauer and Marklissa, and also for the equipment of transformer stations. The mains will traverse about 100 km. (62 miles) of streets, and will transmit polyphase current at 10,000 and 20,000 volts.

Turbo-Generator Orders.—Messrs. Brown, Boveri & Co. report that their turbine shops continue full of work, and that the orders booked for turbo-generators during last month (usually the quietest in the year) amounted to 30,000 kw., the average size of the units ordered being 1,800 kw. At the present time there are 13 sets of over 5,000 kw., individual output, in course of construction in the company's works, including several 7,500 kw. turbo-alternators and half a dozen turbo-dynamos (single armature machines) of 1,000 kw. to 1,500 kw., individual output.

BUSINESS NOTICES.

Messrs. Haslam & Schontheil, Western Mail Chambers, Cardiff, have been appointed agents for the South Wales district for the Igranic motor and dynomo controlling apparatus of the Adams Mfg. Co.

R. J. Nicholson & Co. have removed to Macdonald's-lane, Corporation-street, Manchester. As soon as arrangements are completed a showroom will be opened for the display of their "Ideal" lighting outfits.

Messrs. Jay, Broll & Co., 31, Old Queen-street, Westminster, S.W., have been appointed London managers of the Asbestos Fireproof Paint Co., Birmingham.

Robert W. Blackwell & Co. (Ltd.) have removed to Parliament Chambers, 14, Great Smith-street, London, S.W.

Watlington & Co., 59, City-road, London, E.C., have taken over the traction sales department of Robt. W. Blackwell & Co. as from Aug. 31 last.

Increase in Prices.—Owing to the continued increase in the price of all raw materials the Electrical Power Storage Co., 4, Great Winchester-street, E.C., notify that they are compelled to further increase all prices in their 1903 list as under: Renewal sections (p. 30) 15 per cent., and all other prices 10 per cent. These increases take effect as from 10th inst.

BANKRUPTCIES, LIQUIDATIONS, &c.

At London Bankruptcy Court on Tuesday the public examination took place of Lazarus Blumenthal, 78, Queen Victoria-street, E.C., dealer in telephones, &c., and in second-hand motor vehicles. Liabilities £2,477, assets nil.

In July, 1897, debtor formed the News & Entertainments Telephone Synd. (Ltd.), which purchased from him a P.O. telephone licence for £15,000, and of this syndicate he became managing director. The syndicate was unsuccessful in forming a company to take over the licence, and it ultimately became moribund in 1902. From 1899 to 1903 he dealt in second-hand motor vehicles under the style of the Imprimus Motor Car Co. During the same period he dealt in telephones, electric lamps and fittings as the Simplex Telephone Co., as the Simplex Electrical Co., and as the Ajax Electrical Co. His insolvency was mainly due to the loss of £1,775 in connection with a patent telephone system, to the loss of £450 on two electric motor vans, and to his profits not having been sufficient to meet his personal expenditure.

Examination concluded.

Chas. Leonard Ford, electrician, &c., 13, Hyde-road, Woodley (formerly trading at 55, Market-street, Stalybridge), has been adjudicated bankrupt.

A receiving order has been made against Albert E. Butterfield, electrical engineer, &c., 4, Saltaire-road, Shipley.

The trustee (Mr. Thos. Hindle, District-chambers, Darwen) in the failure of Alex. Holmes & Alex. McCallum, electrical engineers, Crown Works, Darwen, has been released.

Claims against Thos. Clement Hodgkinson, trading as the Electro-Neurotone, 186, Goldhawk-road, London, W., to be sent to Mr. Percy Coles, Tower-chambers, Moorgate-street, London, E.C., by Sept. 22.

The first meeting of creditors and contributories of the Empire Electric Light & Power Co. (Ltd.) will be held on Oct. 2, at 33, Carey-street, London, W.C.

The Cooper Patent "Anchor" Rail Joint Co. (Ltd.) is being wound up voluntarily. Mr. Wm. Crosland, 43, Albion-street, Leeds, is liquidator.

Deed of Assignment.—A deed of assignment has been executed by Thos. Bogle, lately trading as the United Electric Co., 38, South Castle-street, Liverpool. Claims to Mr. A. A. W. Jones, 41, North John-street, Liverpool, by Oct. 1.

Sale by Auction.—Messrs. Wheatley, Kirk, Price & Co. have received instructions from the liquidator of Christian & Phipps (Ltd.) to sell by public auction on the works premises, 23 and 24, High-street, Hampton Wick, on Sept. 25, at 10:30 for 11 a.m., the whole of the modern plant (including dynamos, motor, switchboards, battery of chloride cells, tools, &c.) and the finished and unfinished electrical stock and materials (consisting of manufactured switches, fuse boards, fuse boxes and fuses, electric light fittings and lamps, &c.). Further particulars and catalogues from the liquidator (Mr. F. Beddow), 41, Finsbury-pavement, E.C., or the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester. See also an advertisement.

Sale by Tender.—Tenders are invited for electric lighting plant at the Science and Art Museum and adjoining building, Kildare-street, Dublin. The plant is in good condition, but is no longer required. Tenders (addressed to the Secretary, Office of Public Works, Dublin) by noon Oct. 1. Some particulars of the plant are set out in an advertisement.

The Journal.—Part 179 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. The contents are set out in an advertisement.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during August, 1906:—

Electrical machinery, £61,128 (increase of £22,870); telegraph and telephone cables, £19,400; telegraph and telephone apparatus, £33,618; other electric wires and cables (rubber insulated), £5,608 (with other insulations), £4,950; other electrical goods and apparatus, £38,350. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £101,926 (increase, £21,258), and for the eight months ended Aug. 31, £769,840 (increase £119,736).

Exports of Electrical Apparatus and Material.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Sept. 5 to 11, with the ports of destination:—

Africa—Alexandria, £146 (including £100 telegraph material); Beira, £35; Cape Town, £415 (including £410 telegraph material); Delagoa Bay, £554; Durban, £829; East London, £2,333; Mombasa, £110; Port Elizabeth, £295; Port Said, £35; Suakim, £55 (telegraph material). *Argentina*—Buenos Ayres, £1,916 (including £1,870 telegraph material); Rosario, £218. *Australasia*—Adelaide, £80; Auckland, £30; Fremantle, £25; Hobart, £44; Lyttelton, £74; Melbourne, £219; Otago, £847; Perth, £63; Sydney, £586; Wellington, £20. *Belgium*—Ostend, £188 (including £21 telegraph material). *Brazil*—Santos, £228. *Burma*—Rangoon, £34 (telegraph material). *Canada*—

Halifax, £6; Montreal, £11; Toronto, £84. *Ceylon*—Colombo, £6. *China*—Hankow, £125. *France*—Paris, £14. *Gibraltar*, £919. *Holland*—Amsterdam, £8; Flushing, £22. *Hong Kong*, £36. *India*—Bombay, £210 (including £39 telegraph material); Calcutta, £1,102 (including £323 telegraph material); Karachi, £102. *Japan*—Nagasaki, £829 Yokohama, £684. *Madeira*—£30 (telegraph material). *Malta*, £419 (including £150 telegraph material). *Mauritius*, £224. *Portugal*—Lisbon, £7. *Straits Settlements*—Penang, £213; Singapore, £351 (including £48 telegraph material). *Sweden*—Gothenburg, £280. *Uruguay*—Monte Video, £45. *U.S.A.*—New York, £18. Total £15,124, against £29,690 in the corresponding week last year (Sept. 6 to 12.)

CATALOGUES, &c.

P.P.P. Polyphase Alternators.—Pamphlets on alternate-current machinery are usually attractive and interesting, as this particular electrical product is peculiarly suitable for treatment in special literature. Pamphlet No. 13 on P.P.P. Polyphase Alternators, recently issued by Bruce Peebles & Co., is no exception to this rule, being in respect of size, style and typography an admirable advocate of the merits of the machines dealt with. Bold headings make it easy to hit upon the main features of the plant in a hurried glance through the booklet. The weights and price tables at the end will be found useful for reference.

"*Sarco*" CO^2 *Recorder.*—A booklet on "Fuel Economics," from Sanders, Rehders & Co., 108, Fenchurch-street, E.C., draws attention in a practical manner to the merits of the "Sarco" CO^2 recorder. Other interesting literature accompanies the booklet, and we gather that the firm will be pleased to show the apparatus in working order at Stands Nos. 69 and 104 at the Engineering Exhibition at Olympia.

Premier Lift Controllers.—Messrs. E. P. Allam & Co., 11, Red Lion-street, Clerkenwell-road, E.C., have just issued two leaflets (numbers 28 and 40) dealing with their solenoid lift controllers and motor starting and reversing switches. The former are made in two sizes. Type A is for hand rope control, and is fitted with quick-break reversing switch and compressed air retarded solenoid rheostat; type B is an electrically-operated pattern with quick-break reversing switch, having renewable adjustable carbon contacts, magnetic blow-out and dynamic brake. These controllers can be operated either by a small switch in the lift cage or by a push-button arrangement.

Siemens' Publications.—Many manufacturers now realise the necessity of making their pamphlets and general literature a standard size to facilitate easy filing, thereby ensuring that the matter will be kept handy for reference. The publications of Siemens Bros. are sent out ready holed for dropping into their standard binder, and are of a convenient size. We have just received circulars on electricity meters and electric rock drills, and pamphlets dealing, in extenso, with "Tools and Machinery Electrically Driven" and "Electric Winding Engines." All these publications contain interesting matter, and particularly the last named, which should be read carefully by colliery proprietors. We notice, in looking through the text, no references to Figs. 7, 8, and 9, and that omission seems strange because all the other illustrations are dealt with in the reading matter. The literature is all well printed and clearly illustrated.

Four-pole Dynamos and Motors.—A handsome publication dealing with four-pole continuous-current dynamos and motors has been issued by the Lancashire Dynamo & Motor Co., Trafford Park, Manchester. As regards size and style of production the booklet, which comprises some 40 pages, is a model of industrial literature. It is holed for a standard file and is uniform with the company's other booklets. A complete illustrated specification of enclosed and semi-enclosed dynamos and motors as made in standard sizes forms a preface of some four pages to the rest of the matter, which mainly comprises illustrations and tables of dimensions and prices.

J. & P. Wires and Cables.—Johnson & Phillips' V.I.R. wire and cable catalogue (No. 14) has just come to hand. It is a comprehensive publication of some 40 pages, containing full particulars and prices of vulcanised indiarubber wires and cables made to the standards of the Cable Makers' Association, as well as of the non-association classes. Readers will have no difficulty in distinguishing the association cables, as these are clearly indicated in an effective yet non-obtrusive way. There is a useful thumb index to facilitate reference. The list will be sent to anyone interested immediately on request.

Tubes and Fittings.—Messrs. John Spencer (Ltd.), of Wednesbury, Staffs., have ready a new trade list of wrought-iron, steam and water tubes and fittings, trolley wire, telegraph and telephone poles, &c. The list is illustrated.

The "Electrical Bulletin."—"Speech is silvern, silence is golden." Whether the adage included printed matter under the head of "speech," or whether the London electric supply companies are tired of gilded silence, we know not; but probably one or other of these companies is responsible for the issue of the "Electrical Bulletin." The sub-title, "A Quarterly Budget of Information for Electricity Users," is somewhat misleading, for the ostensible object of the reading matter is the advocacy of the use of electricity for all purposes in place of gas or other illuminating and power agents. The appeal, therefore, is hardly to the electricity user, but rather to the present user of other sources of light and power. It is rather the "prospective" user of electric energy whom the London electric supply companies are catering for in their "Bulletin"—and very well catering for. The existing consumer of electrical energy must certainly be encouraged, cajoled, enticed, what you will, to increase his consumption, but when he is once on the mains he may rightly be regarded as a "certainty" for further business. The task of the "Bulletin," or of any similar piece of soliciting literature, is, in the main, to interest prospective customers and not to amuse consumers with light literature. This point conceded, the "Bulletin" has many good features, and should do useful service in a general way as an introduction to the canvasser or the more specialised pamphlet upon electricity applications. We are glad to see that the London companies have at last made a move in this direction.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

CHRISTY BROS. & CO. (LTD.) (90,039).—Reg. Sept. 3, capital £12,000 in £1 shares (3,000 deferred), to acquire the business carried on at Chelmsford by Christy Bros. & Middleton, and to carry on business of civil, mechanical, electrical, hydraulic, consulting and contracting engineers, &c. F. Christy and L. F. Christy are governing directors.

PILKINGTON & GIBBS (LTD.) (90,072).—Reg. Sept. 7, capital £5,000 in £1 shares, to carry on the business of engineers, dealers in machinery and manufactured articles (excepting in Great Britain), steam and power hammers, founders, metal workers, electric cable manufacturers, electrical engineers, electricians, coppersmiths, &c. First directors, W. R. Pilkington and G. J. Gibbs (permanent governing directors). Reg. office, 7, Lime-street, Preston.

STATUTORY RETURNS.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—In return to Aug. 6 capital is £800,000 in 80,000 ordinary and 80,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 146,800 shares and £734,000 has been received. £66,000 is considered as paid on 13,200 shares. Mortgages and charges £435,000.

POWER PLANT CO. (LTD.)—Return to Dec. 31, 1905 (filed Aug. 9, 1906), gives capital as £5,000 in £1 shares, of which 2,501 have been taken up. £1 per share has been called up on seven and 17s. per share on 2,494, and £2,126. 18s. has been received. Mortgages and charges nil.

MORTGAGES AND CHARGES.

ELECTRICAL TURNERY (LTD.)—A 5 per cent. debenture, dated Aug. 31, to secure £322. 14s. 1d., charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, H. H. Sanders.

ST. AUSTELL & DISTRICT ELECTRIC LIGHTING & POWER CO. (LTD.)—Issue on Aug. 21 of £200 5 per cent. debentures, part of series created June 1, 1904, to secure £2,000 charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £800.

CITY NOTES.

MEMORANDA (Sept. 13).—Bank rate 4 per cent. (Sept. 13, 1906). Price of silver 31½d. per oz. Consols $86\frac{7}{16}$—$86\frac{9}{16}$ for money, $86\frac{9}{16}$—$86\frac{11}{16}$ for account; 2½ per cent. annuities 85—85½. Consols Pay Day, Oct. 3; Stocks and Shares Continuation Day, Sept. 25; Ticket Day, Sept. 26; Pay Day, Sept. 27; Mining Share Carry-over Day, Sept. 24.

CANADIAN GENERAL ELECTRIC CO.—A quarterly dividend of 2½ per cent. has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and to grant a quotation to a further issue of 100,000 £1 ordinary shares of the *Lisbon Electric Tramways (Ltd.)*, to appoint a special settling day in a further issue of 20,000 £5 (fully and £2. 10s. paid) ordinary shares of the *United River Plate Telephone Co. (Ltd.)*, and also to grant quotations to 29,330 £5 fully paid 5 per cent. cumulative preference shares of the *Calcutta Tramways Co. (Ltd.)*, and 27,474 £5 fully paid ordinary and 40,000 £5 fully paid 6 per cent. cumulative preference shares of the *Hastings & District Electric Tramways Co. (Ltd.)*

UNITED ELECTRIC CAR CO. (LTD.)—The report of the directors for the year ended June 30 states that the works have been efficiently maintained as regards buildings and machinery at cost of revenue. After paying interest (£2,500) and charging £6,464. 19s. 1d. for depreciation, the profit for the year is £13,532. 6s. 2d., adding £3,462 from last year. Interim preference dividend required £2,712. 13s. 11d., leaving £14,281. 12s. 11d. After paying the balance preference dividend (£3,000), writing off portion of preliminary expenses (£1,645. 14s. 3d.) and paying a dividend on the ordinary shares of 5 per cent. (less tax) for the year (£7,500), £2135. 18s. 8d. is carried forward.

WESTERN UNION TELEGRAPH CO.—The directors have called a meeting of shareholders for Oct. 10 to authorise the issue of $25,000,000 redeemable 4 per cent. bonds, of which $10,000,000 will be issued immediately.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 5	1,801	+ 236	14	22,145	+ 162
Airdrie	Aug. 31	236	+ 6	35	7,685	+ 661
Anglo-Argentine	Sep. 9	15,317	+ 1,534	36	533,497	+ 58,482
Ashton-under-Lyne Corp	„ 1	379	+ 77	24	8,706	+ 1,051
	„ 8	376	+ 94			
Ayr Corporation	„ 8	303	+ 29	17	6,901	− 1
Baker St. & Waterloo Ry.	„ 8	1,390	...	10	13,180	...
Barnsley	Aug. 31	158	+ 12	35	5,733	+ 52
Barrow	„ 31	336	+ 39	35	9,088	+ 530
Bath Electric Trams, Ltd.	Sept. 5	1,136	+ 358	36	29,972	+ 5,437
Birkenhead Corporation	„ 2	1,160	− 53	...	...	...
*Birmingham Corporation	„ 8	1,419	+ 1,052	23	21,594	+ 13,389
Birmingham & Mid.	Aug. 31	10,187	+ 390	35	356,399	+ 17,813
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	Sept. 6	2,599	+ 486	22	37,018	+ 2,211
Blackpool and Fleetwood	...	...	...	...	...	...
Blackp'l, St. Anne's & Lytham	...	..	...	...	..	...
Bolton Corporation	„ 9	2,173	+ 341	23	50,927	+ 3,719
Bournemouth Corporation	„ 5	2,420	+ 403	†23	41,141	+ 8,635
Bradford Corporation	„ 8	4,898	+ 651	23	109,495	+ 4,842
Brighton Corporation	„ 9	1,281	+ 93	23	26,044	− 826
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	„ 7	5,608	+ 493	4	10,984	+ 960
Buenos Ayres & Belgrano	„ 2	3,832	− 56	36	128,934	+ 6,403
	„ 9	3,841	− 89			
Buenos Ayres Elec. Trms.	Aug. 11	1,443	+ 176	33	34,462	+ 7,401
Burnley Corporation	Sept. 8	1,325	+ 264	23	27,591	+ 1,646
Burton Corporation	„ 9	308	− 14	§23	7,308	− 438
Bury Corporation	„ 2	1,132	...	22	22,555	...
Calcutta Tramways Co.	„ 8	R45,250	+ R794	10	R438,399	+ R9,997
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	„ 1	2,337	+ 331	22	47,795	− 387
Cavehill	Aug. 31	143	+ 94	35	3,209	+ 1,328
Central London Railway	Sept. 8	5,478	− 195	10	54,005	− 2,611
Chatham & Dist. Lt. Rys.	„ 6	991	+ 252	†36	24,131	− 62
City & South London Rly.	„ 9	2,378	− 179	10	24,044	+ 1,123
Colchester Corporation	„ 6	284	+ 41	...	...	...
Cork Electric Trams Co.	„ 6	581	+ 31	36	17,489	− 270
Croydon Corporation	„ 7	1,600	+ 180	14	23,042	+ 1,730
Devonport & Dist. Trams	Aug. 31	528	+ 60	35	16,044	− 258
Dover Corporation	Sept. 8	333	+ 62	23	6,700	+ 979
Dublin & Lucan Railway	„ 7	144	− 10	§10	1,466	− 56
Dublin United	„ 7	6,225	+ 948	‡10	58,988	+ 3,177
Dundee Corporation	„ 5	1,376	+ 389	§16	18,323	+ 3,975
East Ham Council	„ 8	991	+ 171	23	22,139	+ 2,083
Exeter Corporation	„ 7	361	− 22	23	7,173	− 335
Falkirk and District	„ 5	339	...	...	...	...
Gateshead & Dist. Trams	Aug. 31	967	+ 60	35	33,804	+ 1,836
Glasgow Corporation	Sept. 8	18,046	+ 2,533	15	242,358	+ 20,889
Glossop	„ 1	146	+ 21	36	4,650	+ 397
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	Aug. 31	297	+ 31	35	8,536	+ 349
Gt. Northern & City Rly.	Sept. 8	1,589	+ 88	10	15,480	+ 1,122
Greenock & Port Glasgow	Aug. 31	839	+ 89	35	23,532	+ 1,061
Halifax Corporation	...	..	...	...	...	...
Hartlepool Tramways	„ 31	398	+ 90	35	10,672	+ 1,328
Hastings Elec. Trams Co.	Sept. 6	1,367	...	10	11,684	...
Huddersfield	„ 9	1,577	+ 268	23	36,030	+ 3,389
Hull Corporation	„ 8	2,231	+ 113	23	52,547	+ 1,131
Ilford Dist. Coun.	„ 8	521	+ 37	23	12,014	+ 104
Ilkeston Dist. Council	...	...	...	...	...	...
Ipswich Corporation	„ 8	564	+ 47	23	11,122	− 117
Isle of Thanet Co.	„ 8	1,608	+ 275	48	29,354	− 285
Keighley Corporation	„ 6	170	+ 32	10	1,599	+ 104
Kidderminster & District	Aug. 31	161	+ 21	35	4,374	− 14
Kilmarnock Corporation	Sept. 8	163	+ 15	17	2,802	− 68
Kirkcaldy Corporation	„ 5	329	+ 113	10	2,683	+ 281
Lanarkshire Trams Co.	„ 6	993	+ 91	†36	31,491	+ 5,781
Leamington	Aug. 31	204	− 18	35	6,296	+ 2,689
‡Leeds Corporation	Sept. 8	6,680	+ 933	23	148,572	+ 8,563
Leicester Corporation	„ 8	2,340	+ 259	36	79,714	+ 4,937
Leith Corporation	„ 8	583	+ 212	‡17	9,216	+ 4,507
Lincoln Corporation	„ 8	125	..	23	2,793	...
Liverpool Overhead Rly.	„ 9	1,502	+ 10	10	15,826	− 511
Liverpool Corporation	„ 1	11,280	+ 587	35	376,549	+ 6,070
*London County Council	Aug. 25	26,193	+ 10,688	22	584,423	+ 248,815
	Sept. 1	26,568	+ 12,041			
London United	„ 7	7,439	+ 1,213	†36	227,503	+ 15,315
Lowestoft	„ 8	387	+ 22	50	9,011	− 543
Maidstone Corporation	„ 8	136	− 4	23	3,029	− 280
Manchester Corporation	„ 8	15,014	+ 2,488	23	321,854	+ 19,141
Mersey Railway	„ 8	1,611	+ 96	9	16,299	+ 1,211
Merthyr	Aug. 31	209	+ 16	35	6,851	+ 152
Metropolitan Dist. Railway	Sept. 9	7,028	+ 584	10	71,759	+ 7,718
*Metropolitan Elec. Trams	Aug. 31	3,963	+ 886	35	119,649	+ 28,387
Middleton	„ 31	449	+ 45	35	12,616	+ 366
Nelson Corporation	Sept. 8	179	+ 44	24	2,345	+ 316
Newcastle-on-Tyne Corp.	„ 8	3,922	+ 92	23	94,782	+ 5,863
Newport (Mon.)	„ 8	682	+ 73	23	15,131	+ 825
Northampton Corporation.	„ 7	502	+ 50	23	10,885	+ 154
Oldham, Ashton & Hyde	Aug. 31	646	+ 23	35	19,985	+ 538
Oldham Corporation	Sept. 9	1,861	+ 349	24	44,301	+ 4,298
Perth (N.B.) Corporation	„ 5	180	...	16	2,784	...
Perth (W. A.) Elec. Trams	„ 7	1,386	+ 105	36	52,776	+ 3,253
Peterborough	Aug. 31	163	+ 21	35	4,621	− 314
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	Sept. 8	2,687	+ 503	23	52,620	− 788
Potteries	Aug. 31	1,774	+ 45	35	61,822	+ 3,051
Preston Corporation	...	...	...	...	...	...
Reading Corporation	Sept. 6	724	+ 13	...	...	..
Rochdale Corporation	...	.	...		...	...
Rotherham Corporation	„ 6	521	+ 80	23	11,682	+ 1,209
Rothesay	Aug. 31	584	+ 162	35	9,076	+ 1,398
Salford Corporation	Sept. 10	4,475	+ 417	23	107,088	+ 2,467
Sheerness	Aug. 29	80	− 13	35	2,105	− 434
Sheffield Corporation	Sept. 9	5,358	+ 491	24	128,211	+ 8,325
Singapore Trams	„ 8	$9,601	...	11	$77,877	...
Southampton Corporation.	„ 5	1,162	+ 68	...	...	...
Southend Corporation	„ 5	667	+ 101	23	11,053	+ 468

(a) These comparisons are with the corresponding period last year. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	Aug. 31	465	+ 27	35	11,651	+ 220
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	Sept. 9	1,571	+ 188	23	34,376	+ 1,885
Sunderland & District	„ 5	536	...	36	14,395	...
Swansea Trams	Aug. 31	975	+ 76	35	29,278	+ 4,802
Swindon Corporation	...	...	...	...	...	...
Taunton	„ 31	56	− 6	35	1,624	− 167
Tynemouth and District	„ 31	384	+ 58	35	9,530	− 99
Tyneside Trams Co.	Sept 5	565	+ 146	36	16,530	+ 1,289
Wallasey District Council	„ 8	932	+ 116	23	20,172	+ 881
Walsall Corporation	„ 8	524	+ 17	33	18,614	+ 1,012
Warrington Corporation	„ 6	370	+ 22	23	8,597	+ 656
West Ham Corporation	„ 6	2,419	+ 212	23	53,649	+ 13,759
Weston-super-Mare	Aug. 29	461	+ 101	35	5,762	+ 324
Wolverhampton Corpn.	Sept. 5	901	...	10	8,994	...
*Worcester	Aug. 31	358	+ 20	35	0,059	− 750
Wrexham	„ 31	128	+ 14	35	3,623	+ 56
Yorkshire W.R. Trams	Sept. 9	872	+ 119	36	30,167	...
Yorkshire Woollen District	Aug. 31	980	+ 281	35	31,639	+ 9,087

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Sept. 12.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Sept. 12.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		High-est.	Low-est.
5	5/0	Anglo-Argentine Ord. Shs.	$7\frac{5}{16}$—$7\frac{9}{16}$	5 5 0	Ap, Oct	$7\frac{17}{32}$	$7\frac{3}{8}$
5	2/9	Do. $5\frac{1}{2}$% Cum. Pref.	$5\frac{3}{4}$—6	4 11 8	—	6	$5\frac{3}{4}$
St.	6%	Do. Permanent 6% Deb. Stock	135 —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103 —105	4 15 0	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	$1\frac{1}{2}$—$1\frac{3}{4}$	.	..	$1\frac{1}{2}$	..
5	2/6	Do. 5 per Cent. Cum. Pref.	$4\frac{1}{2}$—$4\frac{3}{4}$	5 5 0	—	..	—
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	..	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117 —120	5 0 0	—	..	—
St.	5%	Do. Pref. Ord. Stk	110 —113	4 8 6	—	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	106 —109	4 11 6	—	..	..
40	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. 1st Mort. Dbs.	$103\frac{1}{2}$-$105\frac{1}{2}$%	4 5 3	—	—	—
100	$4\frac{1}{2}$%	Do. Vancouver Power Debs.	101 —104	4 6 0	—	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	$3\frac{3}{8}$—$3\frac{5}{8}$	4 16 6	—	$3\frac{1}{2}$	..
5	3/0	Do. 6 per Cent. "A" Cm. Pref.	$5\frac{1}{4}$—$5\frac{3}{4}$	5 4 0	—	..	..
5	3/0	Do. "B"	5 —$5\frac{1}{2}$	5 0 0	—	5	..
St.	5%	Do. 5 per Cent. Debs.	104 —106	4 14 4	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	$104\frac{1}{2}$	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —101	4 19 0	..	..	..
100	$5\frac{1}{2}$%	Buenos Ayres Grand National $5\frac{1}{2}$% Pref. Debs.	101 —105	5 4 9	..	..	—
100	6%	Do. 6% 1st Deb. Bonds	102 —107	5 12 0	..	..	—
5	4/6	Calcutta Tramways (Nos. 1 to 105)	$8\frac{3}{8}$—$8\frac{7}{8}$	4 10 6	—	$8\frac{11}{16}$	..
5	2/6	Do. Nos. 105,001 to 137,610	8 —$8\frac{1}{2}$	4 14 0	—	..	..
10	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$% 1st Deb. Stock (red.)	103 —106	4 5 0	—	105	..
.	0/6	Cape Electric Tram Shares	$\frac{1}{2}$—$\frac{3}{4}$	3 6 6	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —103	4 18 0	—	..	—
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95 —97%	5 3 0	..	$96\frac{1}{2}$	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	83 —87	6 18 0	..	85	..
1	1/0	Lisbon Elec. Trams Ord.	$1\frac{3}{8}$—$1\frac{9}{16}$	3 4 0	..	$2\frac{1}{16}$	..
1	$0/7\frac{1}{2}$	Do. 6% Cum. Pref.	$1\frac{1}{8}$—$1\frac{3}{8}$	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	$4\frac{1}{2}$%	Montreal St. Ry. Sterling $4\frac{1}{2}$% Debs. (1922)	101 —103	4 7 3	—	$101\frac{1}{2}$	—
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	..	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	141 —143	5 12 6	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	$99\frac{3}{4}$	..
		ELECTRICITY SUPPLY.					
5	3/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	$4\frac{7}{8}$—$5\frac{3}{8}$	5 2 0	..	..	..
5	5/3	Calcutta Elec. (1-60,000)	$8\frac{3}{8}$ - $8\frac{7}{8}$	4 19 0	..	$8\frac{5}{8}$	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	$2\frac{1}{2}$—3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 8 6	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108 —111	5 8 0	—	$102\frac{5}{8}$	..
1	$0/7\frac{1}{2}$	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$—$\frac{27}{32}$	7 8 6	—	..	..
1	1/6	Rand Electric	$1\frac{5}{16}$—$1\frac{7}{16}$	—	—	.	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}$—$\frac{11}{16}$	..	..	$\frac{11}{16}$	..
1	$1/2\frac{2}{5}$	Do. 6% Non. Cum. Pref.	$\frac{7}{8}$—1	6 0 0	—	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	$5\frac{1}{8}$—$5\frac{5}{8}$	5 8 6	—	..	..
100	$4\frac{1}{2}$%	*Royal Elec., Montreal $4\frac{1}{2}$% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101%	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but not for redemption. † Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Sept. 12.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Sept. 12. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	10 —11	6 7 0	..	10 5/16	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾—10¼	4 8 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾—11¾	5 2 0	..	..	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 —106	4 4 10	..	..	—
5	8/6	Bromley (Kent) El. Lt. & Power Shares	5⅛—5⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 —104	4 7 6	—	102½	102
5	4/6	Brompton & Kensington Elec. Sup. Ord.	8½—9	5 11 0	—	8¾	..
5	3/6	Do. 7 per Cent. Pref.	7½—8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	101 —104	3 17 0	—	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4¾—5¼	4 15 0	Feb, Aug	5⅛	4¾
5	2/8	Do. 4½ per Cent. Pref.	4½—5	4 10 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 —104	3 17 0	—	..	..
5	2/8	Do. City Undertaking 4½% Cm. Pref.	4 —4½	5 0 0	—	..	..
5	2/8	Do. Do. (1908)	4 —4½	5 0 0	—	..	..
5	3/9	Chelsea Electric Supply Ord.	5½—6	5 4 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 —109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10¾—11¼	5 7 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 0	Jan, July	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	128 —126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 —104	4 6 6	..	103	102¼
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞—3	4 0 0	April, Oct	..	—
5	5%	Do. Do. 5% non cum. pref.	5 3/16—5 5/16	4 15 3	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	8⅞—9⅛	5 5 0	—	8⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¼	4 18 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 —110	4 2 0	..	110	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 —104	4 6 6	..	102½	..
5	3/6	Folkestone Electricity Supply Co. Ord.	5⅛—5⅝	5 2 6	..	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 —102	4 8 0	—	—	..
5	5/0	Hove Electric Lighting Ord.	7⅞—8⅜	5 8 0	—	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 —101	4 9 0	—	..	—
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾—10¾	4 13 0	..	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½—7	4 5 9	Jan, July	—	—
St	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —101	3 19 0	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 —103	3 17 6	—	..	..
3	2/4⅘	London Electric Supply Ord.	1⅞—2⅛	4 4 0	—	—	..
5	3/0	† Do. 6 per Cent. Pref.	5 —5½	5 7 0	—	5 1/16	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 —99	4 0 10	Mr, Jn, S, D	..	..
5	4/0	Metropolitan Electric Sup. Ord.	8½—9	5 0 0	April, Oct	8½	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5¼—5½	4 1 9	Jan. July	5 13/32	5 11/32
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 —113	4 1 10	Jn, Dec ..	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 —97	3 12 0	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 —101%	4 9 1	—	99½	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	10⅞—11⅛	4 4 0	Feb, Aug	11¼	..
100	4½%	Do. 4½% Deb.	102½—103½	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7⅝—7¾	5 5 11	Feb, Aug	7¾	7⅝
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5⅝—5¾	4 8 0	Feb, Aug	5⅞	5¾
100	4%	Do. 4% Mort. Deb. red. 1907	100 —101	3 19 7	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	1 7/32—1¼	2 8 9	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 —103	4 7 4	Jan, July	—	—
10	6/0	Notting Hill Electric Ord.	13½—14½	5 3 5	March —	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 —99	4 1 0	..	..	—
5	4/6	Oxford Electric Ord.	6¼—6¾	4 19 0	March ..	6⅝	..
St.	4%	Do. 4% Deb. Stock	98 —100	4 0 0	—	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	10½—11½	5 8 0	Feb, Aug	11 1/16	10¾
5	3/6	Do. 7 per Cent. Pref.	7 —8	4 7 0	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 —97	3 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	2 —2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 —78	5 2 0	—	..	..
5	4/0	South London Electric Supply Ord	3 —3½	5 14 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16—⅞	—	..	..	—
1	0/8⅘	† Do. 7% Cum. Pref.	1 1/16—1 3/16	5 5 0	..	1¼	1 3/16
St.	4½%	Do. 4½ 1st Db. Stk. Red.	105 —106	4 5 0	—	..	—
5	2/6	Urban Electric Supply Ord.	3½—4	6 10 0	—	..	..
5	2/6	Do. 5% Cum. Pref.	4½—5	5 0 0	—	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	99 —102	4 8 0	..	100¾	—
5	5/6	Westminster Elec. Sup. Ord.	9¾—10¾	6 6 0	Mar, Sept	10⅛	10
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼—5½	4 11 0	..	..	..
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 —91	4 8 0	..	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16—1 1/32	4 14 0	..	1	..
1	0/6	Do. 5% Cum. Pref.	15/16—1 1/16	4 9 0	..	—	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 —104	4 6 6	—	103	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 —100	4 10 0	..	98	..
10	9½%	Bristol Tramways and Carriage Ord.	14¾—15¼	6 2 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	9½—10	4 0 0	..	..	—
St.	4%	Do. 4 per Cent. Debs.	101 —103	3 17 6	Feb, Aug	..	—
10	6/0	British Electric Traction Ord.	5½—6	5 0 0	—	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	9⅜—9⅞	6 1 6	Feb, Aug	9 13/16	9 7/16
St.	5%	Do. 5 per Cent. Perpetual Debs	115 —118	4 4 8	..	116	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92½—95½	4 14 0	..	94¾	94⅜
St.	4%	Central London Ordinary Stock	85 —87	4 12 0	June, Dec	86⅛	85¼
St.	4%	Do. 4 per Cent. Pref. Stock	97 —99	4 1 0	..	98¼	..
St.	4%	Do. Deferred Stock	78 —76	5 5 0	..	75	..
100	4%	Do. 4 per Cent. Debs.	108 —110	3 12 8	..	109⅜	109⅛
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	88 —91	4 8 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 —5¼	4 15 0	..	5¼	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 —103	3 17 6	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	43 —45	4 9 0	Feb, Aug	44½	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 —122	4 2 0	Feb, Aug	—	..
St.	5%	Do. (1896)	114 —117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 —116	4 6 0	—	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 —107	3 14 8	May, Nov	—	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 —15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 —15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½—4	10 0 0	..	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 —103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	14½—15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 —11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103½—104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 —2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16—8 5/16	3 13 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾—10¼	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 —102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾—9¼	5 8 0	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock	94 —97	4 2 6	—	95	94
St.	..	Mersey Con. Ord. Stock	5 —7	—	—	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 —10	—	—	..	..
1	..	Metropolitan Elec. Trams Def.	⅛—3/16	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	13/16—⅞	5 9 0	—	⅞	..
St.	4½%	Do. 4½% Deb. Stock	98½—100½	4 9 6	—	99⅞	—
5	—	New Gen. Tract. 6 per Cent. Cum Pref.	¾—1¼	..	May —	..	..
10	8/0	Potteries Electric Traction Ord.	6½—7½	5 8 0	..	6 7/16	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¼—8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	—	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 —92	5 8 8	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 —92	5 8 8	—	91¼	90
St.	3%	Waterloo and City Ord.	103 —106	2 16 6	June, Dec	102	—
5	..	Yorkshire W.R. El. Trs. Ord.	1¼—1½	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 —3½	..	—	..	..
St.	4½%	Do. 4½% 1st Debs.	93 —96	4 14 9	—	..	—

Shre.	Last Dividend	Name.	Price Wed., Sept. 12.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Sept. 12. Highest.	Lowest.
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½—⅝	..	—	..	—
1	2/4⅘	Babcock & Wilcox Ord	4⅛—4⅜	4 10 0	—	4 5/16	4 3/16
1	7½d.	Do. Pref	1½—1⅝	3 14 0	..	..	—
5	4/0	British Insulated & Helsby Cables Ord.	6¾—7¼	5 10 0	July, Feb	6¾	..
5	3/0	Do. 6 per Cent. Pref.	6⅛—6⅜	4 18 0	Jan, July	—	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 —105	4 5 6	..	..	—
St.	4½%	† British Thoms'n-Houst'n 4½% 1st Mt. Db.	95 —97	4 12 9	..	—	..
5	..	British Westinghouse 6% Pref.	1¼—1¾	..	..	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 —80	4 16 6	..	..	..
2	1/0	Brush Electrical Engineering	13/16—1 1/16	—	March —	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1⅜—1⅞	6 8 0	Mar, Sept	..	—
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	96 —98	4 11 9	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 —84	5 7 2	Jan, July	..	—
5	10/0	Callender's Cable Con. Ord.	10½—11½	4 10 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝—5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 —110	4 2 0	Nov, May	..	..
1	9⅗d.	Castner-Kellner Alkali Co.	1 1/32—1 3/32	5 4 6	..	1 3/32	—
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 —102	4 8 0	—	—	—
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1¼—1⅜	7 5 6	—	..	—
1	7½d.	Do 6% Cum. Pref.	1 1/16—1 3/16	5 8 0	..	..	—
3	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅝—1⅞	3 13 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%—97%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord	1⅝—1⅞	5 11 0	Sept —	..	..
5	8/0	Do. 6% Cum. Pref.	1⅛—1⅜	4 5 0	Sept —	..	..
St.	4½%	Do. 4½% Deb. Stock	103 —106	4 5 0	..	..	—
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—1¾	4 5 6	Feb, Aug	1 11/16	..
5	2/6	Do. (£5 paid)	2½—3	4 3 0	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 —87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 —95	5 5 0	—	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3⅝—3⅞	9 6 0	H'lf-yearly	3½	..
5	8/0	Do. 6 per Cent. Cum. Pref.	4⅞—5⅛	5 11 6	..	5⅛	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 7 4	—	101	..
2	1/7½	Electric Construction Co.	¼—½	14 0 0	July —	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	1¾—2¼	6 4 0	July —	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	85 —88	4 11 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 —9½	5 5 3	..	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 —97	4 2 6	—	..	—
5	5/0	† Henley's Telegraph Works Ord.	12 —13	5 15 0	Feb, Aug	12 1/16	..
5	2/8	† Do. 4½ per Cent. Pref.	5¼—5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½—109½	4 2 0	..	..	..
St.	22/6	Do. Do. Scrip (all paid)	107½—109½	4 2 6	..	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 —18	2 17 2	Feb, Aug	17⅝	17 1/16
100	..	Do. 4% Debs. Red.	100 —102	3 19 6	..	..	..
10	5/0	† Mather & Platt 5 per Cent. Cum. Pref.	11½—12	4 3 4	Mar, Sept	..	—
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	15/16—1	6 0 0	..	1	..
1	7½d.	Do. 6% Cum. Pref.	1 —1⅛	5 7 0	—	1 1/16	1 1/32
St.	4½%	Do. 4½% Perp. Deb. Stock	98 —101	4 9 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	83½—85½	5 12 6	Mar, July	85	..
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 —102	3 18 3	Jan, July	..	—
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2½—2⅝	5 16 6	..	2 19/32	2 9/16
1	6d.	Do. 5% Non-Cum. Preference	1 5/32—1 7/32	4 4 6	..	..	..
St.	5%	Do. 5% Non-Cum. Preferred	113 —116	4 6 0	—	..	—
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 —106	3 15 6	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	105 —107	4 4 6	—	106	..
5	—	Willans and Robinson Ord.	¾—1¼	..	Apr, Oct	1	..
5	—	Do. 6 per Cent. Cum. Pref.	2¾—3¼	..	Apr, Oct	2¾	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 —82	4 17 6	May Nov	..	—
		TELEGRAPHS.					
10	—	Amazon Telegraph	8½—4	—	Jn, Dec —	..	..
100	5%	Do. 5% Debs. (red.)	87 —92	5 8 8	..	..	..
St.	15/0	Anglo-American	66 —68	4 15 9	F, My, Ag, N	..	—
St.	30/0	Do. Preferred	113½—114½	5 0 0	F, My, Ag, N	114¾	114
St.	10/0	Do. Deferred	23¼—23½	2 2 6	F, My Ag, N	25 3/16	23
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½—98½	4 0 6	Jn. Ap, Jy, O	97¾	..
10	5/0	Cuba Submarine Ord.	8½—9	6 1 0	Feb, Aug	..	—
10	10/0	Do. Preference 10 per Cent.	17 —18	5 11 2	Feb, Aug	..	—
5	2/0	Direct Spanish Ord	3⅜—3⅝	5 11 9	April, Oct	..	—
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾—9¼	5 8 0	April, Oct	..	—
50	4½%	Do. 4½ per Cent. Deb.	98%—101%	3 19 0	Jan, July	..	..
20	6/6	Direct United States Cable	15½—16	5 6 0	Ja, Ap, Jy, O	15¾	15½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	144 —147	4 15 0	Ja, Ap, Jy, O	146¾	145
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 —92	3 17 9	Ja, Ap, Jy, O	92	91
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 —109	3 13 4	May, Nov	108¼	107½
10	2/6	Eastern Extension	14⅝—14⅞	4 12 6	Ja, Ap, Jy, O	14 11/16	14 9/16
St.	4%	Do. 4 per Cent. Deb. Stock	106½—107½	3 14 3	Feb, Aug	106½	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 —101	3 19 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%—103%	3 17 6	May, Nov	102½	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37½—38½	6 0 0	Jan, July	37⅛	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —102	4 8 0	June, Dec	..	..
25	52/6	Indo-European	58¾—60¾	5 7 0	May, Nov	..	..
100	4%	Mackay Companies Common	75 1/16—76 3/16	5 4 0	Jan, July	—	..
100	4%	Do. Preference	74 3/16—75 3/16	5 6 0	Ja, Ap, Jy, O	..	—
1	..	Marconi's Wireless Teleg. Co.	15/16—1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 —102	3 18 6	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾—10¼	3 17 6	..	..	—
2½	—	West Coast of America	¾—⅞	..	—	..	..
100	4%	Do. 4 per Cent. Debs.	100½—103½	3 17 3	Jan, July	..	..
10	—	West India and Panama	⅜—½	..	May, Nov	—	..
10	4/0	Do. 6% 1st Pref.	6¼—6¾	8 18 0	May, Nov	..	..
10	—	Do. 6 per Cent. 2nd Pref.	4½—5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	3/0	Western Telegraph	14¼—14¾	4 15 0	Mr, Jn, O, D	14 11/16	14½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	--	4 17 0	June, Dec	..	.
St.	4%	Do. 4% Deb. Stock (red.)	103 —106	3 15 6	..	..	..
		TELEPHONES					
—	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 —96	4 3 4	..	95¾	—
St.	5%	† Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	99 —101	4 19 0	..	..	—
5	5/0	Chili Telephone (fully paid)	6¾—7¼	5 11 0	August —	..	..
1	0/4½	Monte Video Telephone Ord.	15/16—1 1/16	3 16 3	—	—	..
1	0/6	Do. 5% Pref.	⅞—1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109 —111	5 8 0	—	111	109½
St.	6%	Do. Def. Stock	109 —111	4 10 0	—	110⅜	109¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 —13	4 13 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 9/16—5 13/16	4 7 6	Feb, Aug	5 21/32	5¾
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½—104½	3 16 6	—	104	103¾
1	0/9⅗	Oriental	1 3/16—1 5/16	4 8 6	April, Oct	1 5/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16—1 5/16	4 11 0	—	..	—
St.	4%	Do. 4% Red. Deb. Stock	97 —99	4 1 0	—	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 —104	4 6 6	..	..	—
5	5/0	United River Plate	7 —7½	5 6 8	July —	..	—
5	9/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 —112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	4½—5	6 0 0	—	..	..
10	2/0	Globe Telegraph and Trust	10⅞—11⅛	4 19 0	Ja, Ap, Jy, O	11⅛	10 15/16
10	3/0	Do. 6 per Cent. Pref	14⅛—14⅜	4 0 6	Ja, Ap, Jy, O	14⅛	14 3/32
10	6%	Submarine Cables Trust (Cert.)	129 —132	4 11 0	April, Oct	..	—

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

SUPPLEMENT to "The Electrician," September 14, 1906.

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THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

Dick Kerr Standard Motor-Generator.

Electrician No. 1478.
Ind. Suppt. No. 1.

SEPTEMBER 14, 1906.

In adding to the normal issues of *The Electrician* a monthly Supplement dealing exclusively with Industrial and Commercial matters, the Proprietors are consummating plans which they have had under consideration for some years past. The idea of publishing a separate and distinct record of the various phases of the industrial development of electrical engineering, at that time conceived, was not given practical shape because the value of such a record to the Electrical and Allied Manufacturers appeared then somewhat less obvious than it is to-day. The present moment is distinctly propitious to the inauguration of a scheme which has for its object co-operation with manufacturing firms to secure effective publicity for their latest products and to adequately record industrial developments generally.

Matters relating to the industrial branches of electrical engineering require not only a special position in the pages of a technical journal, but their character also demands that the text and illustrations be so proportioned, displayed and printed as to create the best possible impression of the particular subjects described. In "The Electrician" Industrial Supplement it is intended that the most effective representation shall be given to the latest progress and products of the electrical and allied trades. Its literary contents will be specially compiled, its photo illustrations and line drawings will be prepared by experts, and its typography and printing will be of the best.

To the manufacturer this publication will represent a combination of great value in ensuring for his products that class of publicity which is distinctive in every way, as the main object of the Supplement will be to afford him a direct and efficient channel by which to reach those chiefly concerned in the purchase and installation of his machinery, apparatus and material.

The fact that the Industrial Supplement is owned and published by "The Electrician" Company is a guarantee, we think, for its intrinsic value, both as a record of achievement by the manufacturer and the contractor, and as a representative medium between all engaged in the several branches of applied electrical and general engineering. To those who desire that the greatest possible prominence shall be given to their work in the manufacturing and contracting fields "The Electrician" Industrial Supplement will be found to offer exceptional facilities, and to provide just that publicity which compels business. Such facilities have not, we consider, hitherto been regularly at command.

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In the conduct of "The Electrician" Industrial Supplement we shall always welcome the co-operation of manufacturing and contracting firms, especially in regard to descriptions of new plant and apparatus, of completed contracts, and of the latest developments in electrical applications to industrial purposes.

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Extra Copies can be obtained price 4d. per copy post free.

Protective Appliances.

Fuses.

THE superior merits of automatic circuit-breakers, compared with fuses, in the broad field of electricity generation, transmission and distribution, are now generally admitted, but present-day practice has unquestionably reserved many important uses for the fuse. Ten years ago, the fuse was universally acknowledged the best device for the automatic protection of all circuits, but it now only finds place where considerations of economy and simplicity exclude other more elaborate appliances. Paradoxical as it may seem, there are cases in which automatic circuit-breakers are less expensive to instal than is the apparently simple and cheaper fuse. The automatic circuit-breaker is now regarded as such an indispensable agent for circuit protection that it will be instructive to briefly review the advantageous features of the fuse, emphasising their special relation to the problem of satisfactorily safeguarding the consumer of electrical energy.

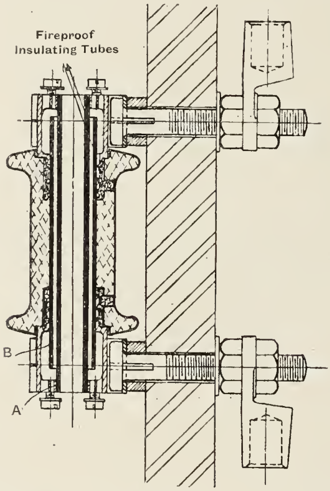


Fig. 1.—Sectional View of 500 volt Fuse and Supporting Slab.

The main essentials of the fuse may be itemised as follows:—(1) Simplicity in design. (2) Low initial cost. (3) Time element without extra complication or cost. (4) Combination of fuse and isolating switch.

Simplicity in Design.

Metal wire surrounded by a strong non-inflammable tube with open ends briefly describes the ideal fuse for power circuits. When the fuse blows a pressure is created inside the tube which effectually disrupts the arc at each end. The pressure varies with the rapidity of the action of the fuse in volatilising, and the time varies with the amount of current passing, the pressure, and the explosive action. Generally speaking, the effective blow-out varies automatically in intensity and violence with the character of the fault.

Nothing could be simpler than this either in application or in action. Figs. 1 and 2 illustrate a 500 volt fuse designed upon the principle enunciated. The tube and the fuse wire are carried upon blocks of metal mounted in a porcelain handle for convenience to form a plug which can be inserted or withdrawn whilst the terminals are alive. This arrangement obviously introduces other considerations. For instance, the *question of ventilation* arises, because a fuse must increase in temperature with the current passing. To meet this an air gap is provided around the inner tube to prevent damage to the handle, caused in some designs by the inequality of temperature between the inside and outside of the porcelain. Metal contacts are also necessary to prevent the conduction of the high temperature of the fuse underload to the other parts of the panels or connections upon the circuit which is being protected by the fuse. Again, there is the *question of clearance.* When placed upon a switchboard panel the fuse wire in the type of fuse illustrated is mounted well away from the surface of the slate or marble, and there is usually no difficulty in allowing sufficient room above and below the fuse for the tube to discharge. In another application this fuse handle is mounted within an iron box, the clearance for 500 volts in such cases being not less than 6 in.

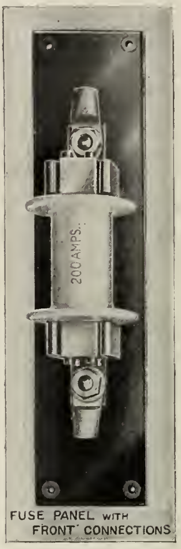


Fig. 2.—Complete 500 volt Fuse Mounted on Slate Base.

Low Initial Cost.

In practice most technical considerations are subordinated to economy, and in the majority of cases the cheapest appliance survives. Hence the importance of studying the cases in which the fuse can be economically applied.

Upon all lighting and heating circuits, in private houses and factories, the fuses are contained in separate porcelain or metal boxes, or branch circuits are distributed from multiple way boxes, as depicted in Fig. 3. Any additional supply to the house or building may be protected by separate fuses in boxes of the type illustrated on Fig. 4. The efficacy of the fuse in this particular province is a matter of general agreement. But

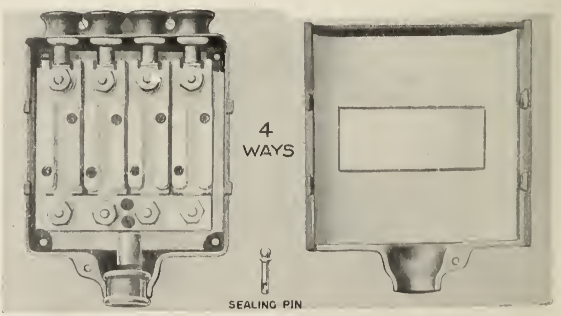


Fig. 4.—Small Distributing Fuse Box for House, Workshop and Yard use.

for power in shipyards, factories, &c. (which can be considered under one head, *i.e.*, the automatic protection of motors, taking motors of average and limiting these remarks to those not exceeding 100 H.P.), the motor is usually provided with a starting device, and the extra cost of adding to this an automatic overload release is comparatively trifling. Economical considerations would appear to preclude the use of fuses for the protection of power-consuming devices, but the automatic overload release on the starter is not always to be relied upon, and then it is that the fuse acts as a fitting stand-by.

An isolating switch is often considered a needful accessory to the starting device, in which case a fuse may be included in the same panel, or a combined switch fuse may be economically used. The pattern depicted in Fig. 2 is an example. Considered on a cost basis, a separate automatic overload release switch may be used instead of a switch fuse, but when a time-limit device is added, and the whole enclosed as parallel to the mechanical design, the switch fuse possesses a great advantage in the matter of capital outlay. The replacement of the enclosed fuse in the switch fuse, however, requires careful consideration in the case of a motor likely to make frequent demands upon its protective devices.

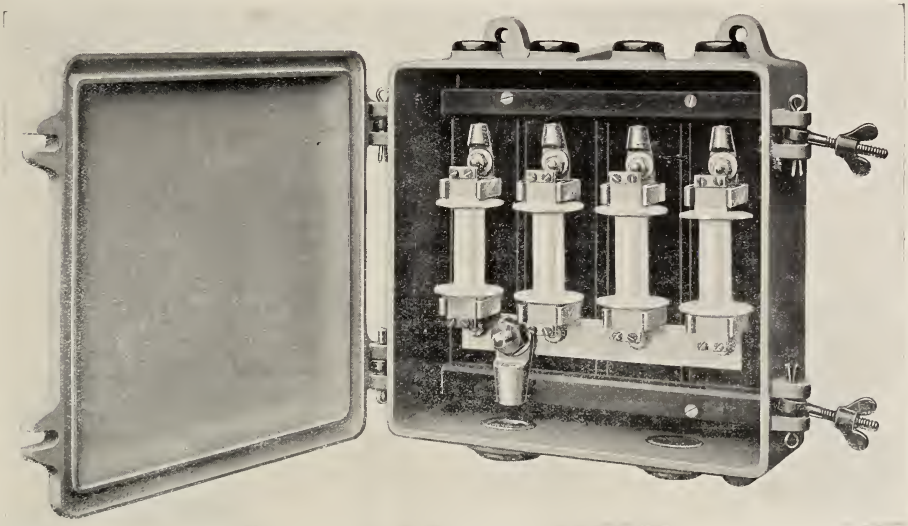


Fig. 3.—View of Iron Box containing Four-way Distributing Fuseboard.

A concrete instance of the economy and utility of the fuse may be cited here. A factory motor installation involves an extensive cable system which must be protected against faults with equal certainty as must the motors connected to it. The value of fuses is here very great, because they can be assembled in self-contained distributing boxes which serve as conveniently accessible distributing points on the network. Each shop as a section of the factory may be equipped in a selected central position with a box of the type shown in Fig. 3. These boxes receive the main feeders from the outside supply, or on a larger system from main switchboards, and branch cables are taken off through fuses to the several meters, &c. This arrangement on a question of cost places circuit-breakers at an undoubted discount. Considering the same example further, the reasoning may be applied to the case of the main switchboard at the receiving and distributing centre, still with economy in view. Up to this juncture it has only been necessary to take count of the matter on the ground of "simplicity in design" irrespective of the system, but here both the system and the capacities of the circuits to be dealt with must receive careful consideration. It may be very generally stated that there is a limit to the size of a fuse over a certain capacity, say 600 amperes at 500 volts; the heat generated becomes excessive and wasteful, and an automatic circuit-breaker for this reason alone is the most economical. But for the smaller sizes the next heading bears directly on the problem in view.

Time Element without extra Complication or Cost.

All fuses have a time element, and so will allow of a transitory rise in current without opening circuit; and the length of this interval may be controlled within certain limits by a selection of metals and fuse cross-sections. As the time function is essential on the class of circuit under consideration, because an automatic switch without a time element would open before a fuse, any comparison made must be based upon automatic switches with time limit. Generally it should never be necessary to switch out whilst the circuit is loaded, then plug fuses can be used at a great advantage, but where the circuit must be opened by hand under load it is a very moot point whether fuses are cheaper in first cost. As a rule, however, a separate knife switch and fuse is used for low-tension continuous-current circuits, whereas for three-phase alternating-current circuits (using oil break switches) economy is in favour of automatic overload attachments with a simple form of time element. One arrangement of the latter is shown in diagram in Fig. 5, from which it will be seen that in normal working the tripping coil of the switch is short-circuited by a fuse. When the current is excessive the fuse melts and all the current in the tripping circuit passes round the coil, the switch being thereby opened.

Combination of Fuse Isolating Switch. Outside consumers' premises the use of fuses is less commendable, because larger capacities must be dealt with. On many single-phase systems plug fuses serve for the protection of transformers and on continuous-current systems of mains. But present-day experience tends towards the installation of electro-mechanical protective gear for large generators and feeders. It is not the object of this article to deal with the factors controlling this practice, but, in passing, we may mention the now familiar Mordey pattern fuse handle, which still has a place upon H.T. switch gears as a plugging device. By its aid it is possible to conveniently isolate the fittings from the 'bus bars. This fuse serves also as a safeguard in the event of fault occurring on a switch panel on the 'bus bar side of the automatic switch.

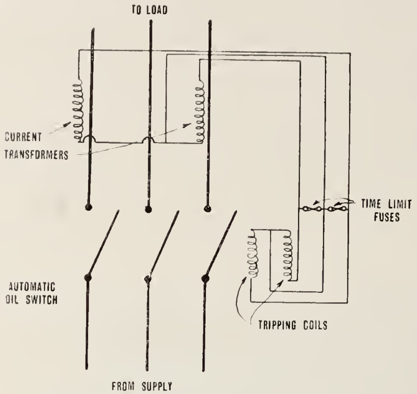


Fig. 5.—Diagram of Connections of Switch Fuse.

Instrument Transformer Fuses. Small transformers of the current and potential types used for instruments afford opportunities for the use of the fuse. The fuse can be of the Mordey type, mounted upon the lid of a box of insulating material. For dealing with very small currents at high potential a fuse is the only reasonable means of protection, but the greatest care becomes essential in mounting it so as to ensure safety and freedom from shock through neglect. The term neglect is used advisedly because the presence of a small fuse is often overlooked together with the fact that danger attends its manipulation to an equally great extent as would the larger and more important looking appliances upon a switch panel.

The foregoing review of the utility of fuses is based upon unbiassed observation of conditions now prevailing in important manufacturing districts, by Messrs. A. Reyrolle and Co., of Hebburn-on-Tyne, who, as switch gear specialists, are able to gauge the requirements of the market and also to study the most economical means of catering for the dictates of time and experience.

Commercial Development of Central Stations. See page 28.

Evolution in Industrial Measuring Instruments.

WHATEVER may be said for or against the Darwinian theory in the realms of biology, everyone must have been struck with the equally ruthless way in which the law of the survival of the fittest takes effect in the industrial world. Possibly in no branch of electrical engineering enterprise has this been more strikingly exemplified than in the case of electrical measuring instruments. Some years ago, anyone with a few hundred pounds capital and a rudimentary knowledge of Ohm's law considered himself perfectly competent to start business as an electrical instrument maker. Moreover, several electrical manufacturing firms regarded it as quite a sound proposition to set aside some out-of-the-way corner of the works for the turning out of so-called measuring instruments.

All this, however, is now a thing of the past. The instrument manufacturing firms of any account in this country can be counted on the fingers of one hand, and probably all the general manufacturing firms have, one by one, given up instrument making, finding it impossible to compete either in price or quality with the goods they were able to buy in the open market.

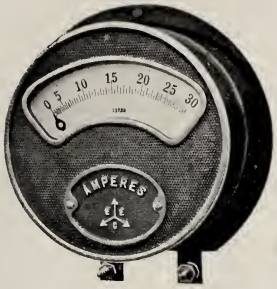
Evolution has, moreover, been by no means restricted to the manufacturers themselves. Their products have indicated an even more radical change, and this has been particularly marked in the direction of what might be called "industrial" instruments—that is to say, ammeters, voltmeters, wattmeters, and others intended particularly for use in connection with motor installations and the like.

The truth of this will be at once apparent to anyone comparing the accompanying illustrations with their prototypes of, say, six years ago, selling at perhaps three or four times the price. The instruments illustrated are the so-called "Gauges" manufactured by Messrs. Everett, Edgcumbe and Co., who have devoted special attention to this particular branch of the industry. Although known as their Gauge pattern moving-iron instruments, the name does not imply any inferiority, but has merely been adopted to distinguish them from their well-known "Universal" instruments, which possess several features not called for in a Gauge. The "Universal" ammeters and voltmeters of their manufacture, for example, still remain the only moving-iron instruments on the market which are practically unaffected by changes of wave-form or frequency, being equally applicable, as their name implies, to direct or alternating currents, and that without special calibration. Owing to the absence of frequency and wave-form errors, the "Universal" pattern are practically the only instruments which can be used satisfactorily for

Everett Edgcumbe Voltmeter.

alternating-current switchboard work, and are particularly well adapted for use through transformers on high-tension circuits.

In the Gauge, on the other hand, this is unnecessary, and the leading idea has been to produce an instrument at once reliable and accurate under *working* conditions of vibration, dampness, stray magnetic fields, rough handling, and all the other ills which an industrial instrument is heir to. They are perfectly deadbeat (a pneumatic damper, similar to that which has been fitted for years to the "Universal" instruments, being employed), and a special feature is made of the openness of the readings at the lower part of the scale, which, be it remarked, is often wanted—as, for example, when a motor is running under a light load.



Everett, Edgcumbe Ammeter.

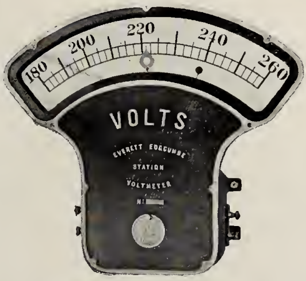
To the casual observer, the most striking advance lies, perhaps, in the case, which is of cast iron, and thus practically indestructible, with the exception of the small glass window through which the scale is seen; and even should this become broken it can be replaced at a cost of a few pence. This has to be compared with the older spun-brass cases which became dented with the slightest rough usage, and the glass fronts of which were a continual source of trouble. It may be added that the bases of these instruments are also of cast iron, as distinguished from the fragile base plates of insulating material which were often seen in the past.

As will be gathered from the illustrations, these gauges are supplied with either front or back terminals, and as regards the former, it will be noticed that, by means of the special construction of case, the vertical space occupied by an instrument so fitted is but little greater than that of one provided with back connections. This is often an important consideration where space is limited.

It may well be asked how it is that it is possible at the present day to turn out reliable ammeters and voltmeters at a fraction of their price a few years ago. The explanation is to be sought partly in the greatly increased demand, but still more in the enormously improved methods of manufacture now in vogue. Instruments were formerly *made*, they are now *manufactured*, and this in such a way as to secure that absolute interchangeability so essential in every industry.

It may incidentally be of interest to note, as throwing light on this question of cost, that various attempts have been made from time to time to reduce calibrating charges by using printed scales, to which the instrument has to be set as closely as may be. Messrs. Everett, Edgcumbe & Co., however, while admitting that the prospect is an attractive one, long ago decided against it, and the scale of every instrument which they supply, whether of a cheap or expensive pattern, is separately calibrated against a standard.

Altogether these Gauges have proved so successful in practice, and have become so popular, that the only complaint of the makers is that their customers are so well pleased with them that they are being specified for many boards on which more expensive instruments could well have been afforded.



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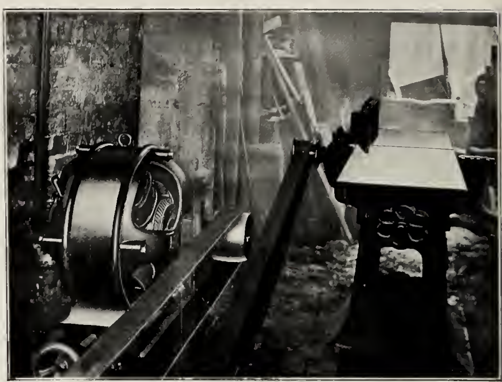
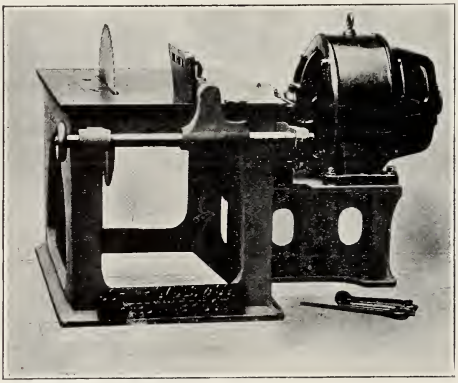
Electric Power Applied to Industry.

I.—Wood-working Shops and Timber Yards.

THE use of high-class machinery in the timber trade has now become so general that there are few engaged in the business who carry on the necessary operations by hand. Where work is undertaken on a large scale the employment of labour-saving machinery is imperative, and in such instances it is customary to find only the best and most modern types of apparatus installed. As is usually the case competition compelled the introduction of machinery, and as ruthlessly it requires the use of only the most highly developed forms by those who wish to maintain a favourable position among the recognised heads of this branch of industry. It is not surprising therefore to find prosperous timber merchants and heads of wood-working shops taking full advantage of the most efficient machines for their respective purposes that it is possible for specialists to place at their immediate service. What is, however, more noticeable to the power engineer is that the employment of such machinery is altogether disproportionate to the operation of it by electrical energy.



Motor Belted to High-speed Wood Planer.
The motor, by Dick, Kerr & Co., is belted to a countershaft and thence to the planer pulley.



5 H.P. Motor Direct Coupled to Circular Saw.
A compact arrangement by the Lancashire Dynamo and Motor Co.

The Power Problem.

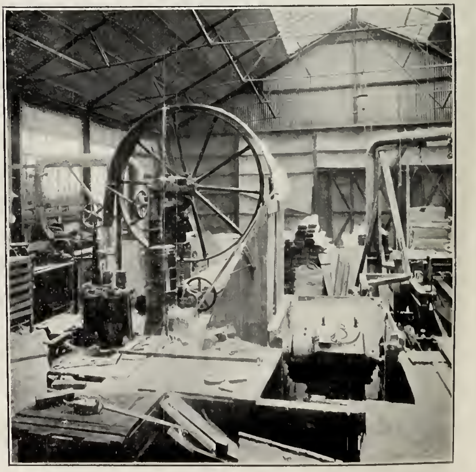
The application of power to machinery of this class has assumed the nature of a compromise. At the advent of such machines steam power alone was available, and was most naturally convenient. Oil and gas have gradually supplemented steam, and from these three the power user now makes the selection he thinks most likely to meet his requirements. But in the light of electrical developments his choice is still a compromise because he has not procured the ideal for his purpose. Moreover he occupies an anomalous position in that he possesses the most modern machines in his particular field, but is operating them by obviously inefficient means which fail to give the best possible results.

The Ideal Power.

The peculiar nature of wood-working operations, the straggling character of the buildings and the space required around each machine, all present the most suitable conditions for the electric drive, more particularly by individual motors. The main features of the electric motor are too well known now to need reiteration. It will be sufficient to introduce that handy power agent with the brief remark that is represents an ideal which the power user has long been seeking. Steam, gas and oil are convenient enough in their respective ways, but they are restricted in their application to one form which admits of no modification. Neither one nor the other can be directly applied to its work, nor is any subdivision of the main power unit possible. The electric motor is superior because, in contradistinction, it can be applied in units of almost any desired size, and it may also be built in to form a part of the machine it is installed to operate.

In Practice.

Practice is at all times better—more convincing—than precept; consequently the argument may well be continued in company with appropriate illustrations culled from the records of motor makers who have already faced and solved the problem. The



View in an Electrically-driven Woodworking Shop.
One of the motors can be seen in the foreground; they were installed by Bruce Peebles & Co.

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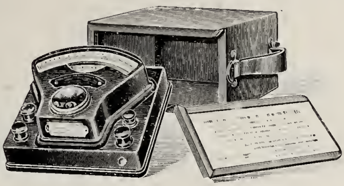

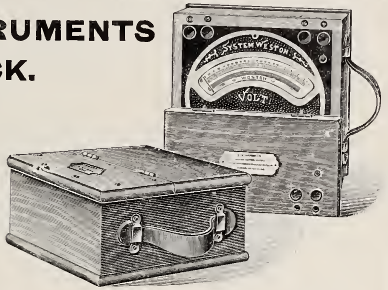

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AUDREY HOUSE, ELY PLACE, HOLBORN, LONDON, E.C.
WESTON ELECTRICAL INSTRUMENT CO.

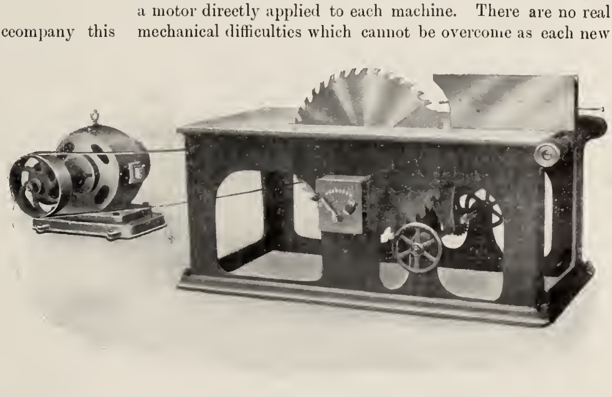
suitability of the electric drive in the province we have under consideration may now be taken for granted, despite all that may be advanced in favour of steam, gas and oil power. The source of electrical energy need occasion the least anxiety in considering conversion to the electric drive. Most large industrial centres now boast a supply service, and favourable rates are not difficult to obtain from the central station authorities. Expert advice is also readily procurable as to the best method to adopt in the particular circumstances, so that in the main the power user is faced only with the problem of initial capital cost.

The Group Drive.

The illustrations which accompany this article depict more clearly than words the manner in which electric motors can be applied to the various machines used in wood-working shops. Where steam or gas engines have driven lengths of shafting under the floor or overhead, a motor can be installed with advantage and belted or roped up to one or more of these lines. Any desired subdivision of the original transmission can be carried out, the governing factor being the time over which the use of the particular tools driven is spread. To secure the benefit of shutting down sections doing irregular service, machines in these sections can be grouped on a length of shafting separately motor-driven, and the power consumption can be better proportioned to the work done. Although the electric motor consumes energy in accordance with its load, this is no excuse for allowing it to run light on shafting from which but one machine, among a group of "idlers" is taking power. From the examples given it will be noticeable how compact the motor is and how conveniently it can be placed in positions quite impossible for any steam oil, or gas engine, no matter how small.

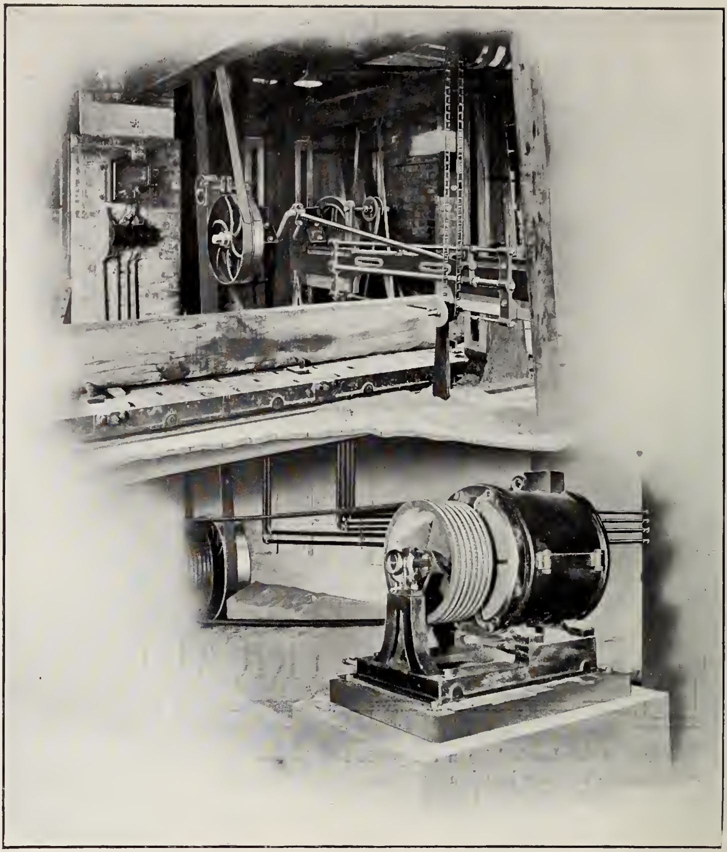
Individual Driving.

The conditions of the case we have under consideration seem, as will be gathered from the trend of the argument up to this point, peculiarly to favour the use of individual motors—that is, of a motor directly applied to each machine. There are no real mechanical difficulties which cannot be overcome as each new



Individual Motor Belt Driving a Large Circular Saw.
The starter is in a convenient position near the Workman's hands. The motor, by Electromotors Ltd., can be placed under the floor if necessary.

example arises in this particular, so that the power consumer has merely to consider the economies of operation possible with this method beside the initial cost of installation, which is heavier than with the system of group driving. When each machine has its own motor its independence of all others is assured, and, should breakdown occur either to motor or machine, the advantage of such isolation is immediately apparent. Transmission losses are also reduced because less energy is absorbed in a power cable than by a length of shafting. Further, in the case of the former, the loss ceases when the motor is shut down, while with the latter the loss continues until stoppage of all the machines admits of stopping the motor also. The individual drive confers a degree of flexibility upon the installation which cannot be obtained by any other means. Machines can be started and stopped as required, and only when they are in operation is electrical energy consumed. There are practically no engineering obstacles in the way of this method, but each particular installation must receive separate consideration when this plan is regarded with favour.



An Admirable Example of the Convenience of Electric Driving in a Woodworking Shop.

The floor is shown cut away to expose the motor, which is fixed below the floor on a substantial foundation. The arrangement was installed by Mather and Platt (Ltd.) in a large timber yard.

Running Cost. The cost of operating an installation of electric motors on the systems above outlined will vary directly as the power tariffs in different parts of the country. One or two instances may, however, be quoted to admit of comparison with other driving methods. An installation of five motors, comprising one 12 H.P. motor driving circular saw, one 5 H.P. driving planer, one 5 H.P driving band saw and vertical spindle machine, one 5 H.P. driving tenoning machine, and one ½ H.P. driving emery wheel, consumed energy costing £3. 1s. 6d. for one quarter and £2. 13s. another. In this case the power rate was 1d. per unit, except between the hours of 5 p.m. and 10 p.m. in winter and 6 p.m. and 10 p.m. in summer, when the rate was 5d. per unit. In another installation, aggregating 20 H.P. in motors, the charge for power in one quarter amounted to £4. 6s. 10d., but as this was supplied at 3d. per unit some two years ago the sum may be easily halved to bring it into line with prices now more regularly charged. Larger installations requiring upwards of 100 H.P. would obtain energy at very favourable figures, and 1d. per unit may be taken as a fair average rate in the more important towns giving a power supply. Side by side with the charges for energy must be placed the greater flexibility, reliability and efficiency of electric driving compared with steam, gas or oil.

Conclusion. The manufacturer who uses labour-saving tools, particularly in the timber trade, will have gathered that it is not only greatly to his advantage to adopt electric driving, but also that it is imperative he should do so. The machine tool has increased his output and reduced his works costs, but the combination of electric motor and modern tool will do still more to enhance his position among his competitors. It is a matter for immediate consideration on his part whether adherence to the older methods can be successfully maintained in the face of industrial developments, which persistently tend toward higher rates of production and reduced cost of manufacture. The engineering side of the problem is now definitely solved. The manufacturer has questions of economy and expediency alone to consider, and, judging by the present trend of events, unless he adjusts his position to that of his more enterprising rivals, he must remain content with a reduced turnover and a decline in his business.

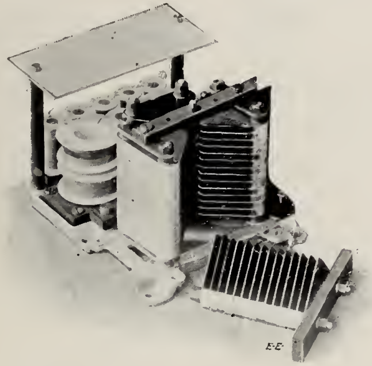
New Combined Insulation Test Set.

The "Ohmer."

An instrument constructed for the measurement of insulation resistances which possesses many features of novelty, has recently been brought out by Messrs. Nalder Bros. & Thompson, 34, Queen-street, Cheapside, E.C. This instrument has achieved a great deal of popularity by virtue of its lightness, general excellence of design and low price.

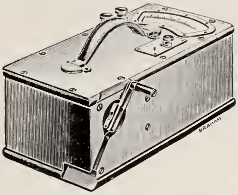
Each instrument consists of an ohmmeter of the electrostatic type combined with a generator in one case. The advantages of this combination speak for themselves, as the two great features of electrostatic apparatus—namely, its lightness and its immunity from disturbances due to stray magnetic fields—render any inaccuracy due to the close proximity of the generator impossible.

The general appearance of the instrument may be gathered from the illustration in the adjoining advertisement. The terminals are mounted on the top and so arranged that in screwing them to insert the test wire the heads cannot be removed, thus obviating trouble on the score of lost terminals. The scale window is protected by thick glass and is practically unbreakable, an obvious advantage with an instrument of this class as the scale is always exposed for use without the need for removing any protecting device.



Special attention has been giving to the generator, which has proved satisfactory in practice from both an electrical and mechanical standpoint. The driving handle is of the free-wheel type, thus making it impossible to damage the teeth of the gear wheels by too forcibly retarding the speed of the armature on the completion of a test. The armature itself is most carefully wound and insulated and dried in a vacuum. The advantage of this will be appreciated, as it insures the expulsion of damp and also that the insulating material used thoroughly permeates all windings.

The commutator is of special design, the object being to secure long life and freedom from sparking. The brushes are of carbon and so arranged that chattering is practically impossible; consequently errors due to capacity in the resistance under test are almost eliminated. These generators are being wound for two pressures, namely, 500 and 1,000 volts.



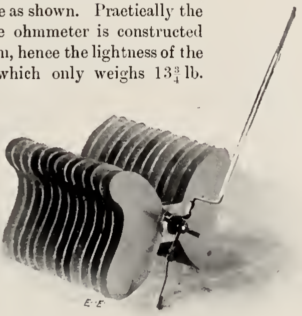
NALDER BROS. & THOMPSON, LTD.,
Makers of ELECTRICAL
MEASURING INSTRUMENTS
For all Purposes.

N.G.S. "OHMER"
For the Measurement of Insulation.

LATEST,
LIGHTEST,
BEST
AND
CHEAPEST.

34, Queen Street, LONDON, E.C.
Telephone Nos.:— 124 and 161 Bank.
Telegrams:— "OCCLUDE LONDON."

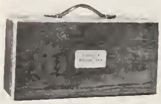
The ohmmeter is of the electrostatic type, and consists of a vertical needle with 12 parallel vanes, which work into four sets of fixed inductors of specially calculated shape. The vanes of the moving system are fixed about 0·3 in. apart, and are of mica covered with aluminium. This needle is remarkably strong and at the same time is very light, and consequently the moment of inertia is extremely small. Arrangements are made for rendering the instrument deadbeat by fitting the needle with an aluminium vane moving in the field of a permanent magnet. The fixed inductors are made up of aluminium stampings and, together with aluminium distance-pieces, are mounted on the frame as shown. Practically the whole of the ohmmeter is constructed of aluminium, hence the lightness of the apparatus, which only weighs 13¾ lb. complete.



The instrument is made for two-standard pressures, 500 and 1,000 volts, giving three standard ranges of resistance—namely, up to 20 megohms, 50 megohms and 100 megohms at 500 volts, and up to 50 megohms and 100 megohms at 1,000 volts; but in each case a switch is provided to reduce the top readings to one-tenth of this value, thereby greatly increasing the length of the scale.

Portable Testing Instruments.

The Crompton Testing Set.



Testing Set in Case ready for carrying.

THERE seems always to exist a steady demand for portable electrical instruments, and of these the testing set appears constantly to be in requisition. This form of instrument has undergone many changes since its introduction, and the types on the market to-day, by reason of evolution in design and manufacture, represent the high standard of efficiency and construction now prevailing.

Messrs. Crompton & Co. are just introducing a pattern of portable testing set which should prove very useful in electricity stations and manufacturers' works.

The set is mounted in a light yet strong oak case, which affords great convenience in handling without affecting in any way the design of the instrument. It comprises a sensitive moving coil instrument, which can be used either as a voltmeter in conjunction with a series resistance, or as an amperemeter in conjunction with a set of shunts. The instrument, with its accessory switches and terminals, is mounted on a substantial ebonite slab, which ensures good insulation. A switch is also mounted on this slab and is used for coupling the instrument either as an amperemeter or as a voltmeter. The voltmeter resistances are self-contained, the range being altered by means of a second switch.

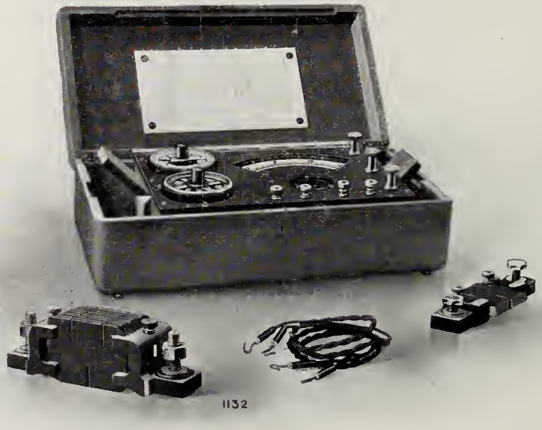
An important feature of these switches is that they are fitted with silver contacts, and to prevent the accumulation of dust are shielded with a strong glass cover. The shunts are specially designed, and are constructed of manganin with copper terminals, thus avoiding any thermoelectric troubles arising from difference in temperature at the ends.

The instrument is adjusted to a standard resistance and degree of sensibility, and, without its shunts or resistances, forms a milliamperemeter reading to 15 milliamperes, and a millivoltmeter reading to 75 millivolts. In these last respects it should fill a long-felt want. The shunts are also adjusted as standard resistances, and can be replaced, or shunts of other capacities supplied without special calibration. The scale of the instrument is marked 0–15. The shunts are marked with the maximum currents which respectively produce full deflection upon the indicating instrument. The voltmeter range switch has its contacts marked with the voltage, which likewise produces in each case full deflection on the scale. To avoid disturbance from stray fields the movement of the instrument is shielded magnetically.

The set is standardised for the following ranges:—

As Voltmeter.	As Ammeter.
0–75 millivolts.	0–15 milliamperes.
0–3 volts.	0–1·5 amperes.
0–30 ,,	0–15 ,,
0–150 ,,	0–150 ,,
0–300 ,,	0–600 ,,
0–600 ,,	

Additional shunts with special screw-down cable terminals can be supplied if desired. These are not fitted in the oak case, but are provided with separate carrying cases of oak to match the set.



View of complete Crompton Testing Set, showing also Large and Small Shunts.

A schedule of instructions is attached to each set giving the resistance of the instrument circuit on the various volt ranges, and the resistances of the external shunts. The latter may be used as standard resistances for the measurement of low resistance by the method of comparing the volt drops, the indicating instrument of the set being used as a millivoltmeter.

The resistance of the 150 amperes shunt is 0·0005
,, ,, ,, 600 ,, ,, 0·000125

The resistance of the 3 volt range is ... 200 ohms.
,, ,, ,, 30 ,, ,, ... 2,000 ,,
,, ,, ,, 150 ,, ,, ... 10,000 ,,
,, ,, ,, 300 ,, ,, ... 20,000 ,,
,, ,, ,, 600 ,, ,, ... 40,000 ,,

The complete set, in oak case as shown, for a range of 600 volts and 600 amperes, weighs 26 lb., and the overall dimensions are $18\frac{3}{4}$ in. × $9\frac{3}{8}$ in. × 6 in.

CROMPTON & COMPANY, LTD.

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AMPEREMETERS AND VOLTMETERS, WITH MOVING COIL ACTIONS.

SWITCHBOARD INSTRUMENTS,
PORTABLE INSTRUMENTS,
POTENTIOMETERS,
GALVANOMETERS,
AND OTHER HIGH-CLASS
TESTING APPARATUS.

Industrial Electrical Undertakings.

I.—W. T. Henley's Telegraph Works Co., Ltd.

THIS company was formed in 1880 to take over the business carried on by the late Mr. W. T. Henley, which was established about the middle of the last century, and is therefore one of the oldest firms in existence in the electrical industry. The business mainly consists of the manufacture and laying of all descriptions of cables and accessories for telegraphy, telephony, electric lighting, traction and power transmission, as well as for house wiring, &c.

It was in the year 1853 that Mr. Henley built his North Woolwich Works, about 12 acres in extent, his activities at that time being confined, of course, so far as cable work was concerned, to the manufacture of submarine telegraph cable, insulated with gutta percha. The first cable made by Mr. Henley was successfully laid between Ceylon and India in 1857, and since that time some 20,000 miles of submarine telegraph cables have been made, and for the most part laid, by this firm, including the shore end of the first Atlantic cable in 1865, the London–Paris telephone cables for the British Post Office, &c.

For some time pure indiarubber and gutta percha were the only materials used for insulating wires and cables, but about 45 years ago vulcanised indiarubber was employed by Henley's for insulating purposes, although it was not until the advent of the telephone and the practical application of electric lighting, particularly the latter, that any considerable quantity of vulcanised rubber-insulated cable was made. Since the year 1880 the department of Messrs. Henley's Works devoted to the manufacture of cables insulated with vulcanised indiarubber has rapidly grown, the firm being at the present time one of the largest manufacturers of this type of cable.

Some 12 years ago, Messrs. Henley gave their attention to the manufacture of telephone cables insulated with paper, by what is known as the dry-core or air-space process. This type of cable has now practically superseded rubber-insulated cables for telephone work, owing to its lower cost and much greater efficiency. Since that time they have turned out many thousands of miles of dry-core telephone cables for underground and aerial use. Amongst their customers are most of the principal users throughout the world—the British Government (for whom they manufactured a large amount of the cable used on the London–Glasgow underground telegraph line), the National Telephone Co., the Australian Commonwealth Government, the Swedish Government, the Japanese Government, many of the principal telephone companies, and five out of the six municipal authorities which have carried on telephone work in Great Britain.

About the same time (1894) Messrs. Henley commenced the manufacture of paper-insulated cables for electric lighting, traction and power work, including E.H.T. cables for underground transmission work, the insulation on these cables being formed of paper impregnated with oil or compound. This class of cable has superseded vulcanised indiarubber cables for underground mains in the same way as dry-core telephone cables have superseded rubber-insulated telephone cables. Recently, in order to cope with the extension of their business in this direction, the company purchased a site, covering 12 acres, at Northfleet (Kent), upon which a new factory has been erected especially for the manufacture of heavy underground power and lighting mains. These new works, which are known as the Gravesend Works, are of the most up-to-date construction, and form one of the finest factories on the banks of the river Thames, comprising four bays, each 700 ft. in length and 36 ft. in breadth. The company do not intend to vacate their North Woolwich Works, but shops of such dimensions could not have been erected there owing to the restrictions of the Metropolitan Buildings Act. The power plant of the Gravesend Works consists of Westinghouse direct-coupled vertical gas engines and generators supplied with Dowson producer gas. Electricity is, of course, used as the motive power throughout the shops. Practically the whole of the machinery at the North Woolwich Works is also driven by electricity, generated (in this instance) by steam power.

The company supplied to the Newcastle-on-Tyne Electric Supply Co.—or, rather, to their predecessors, the Walker & Wallsend Co.—in 1900 some of the first 6,000 volt three-phase underground cable ever laid in Great Britain.

Among the many other important contracts secured by the company were those for the supply of the whole of the cables for Devonport and Gibraltar dockyards under contract to the British Admiralty, for the Waltham Abbey Gunpowder Factory for the British War Department, and two or three contracts for the London United Tramways Co., for whom they have recently completed one of the largest contracts for cables in connection with tramway work ever placed in this country, comprising some 20 miles of L.T. feeder and distributor cable, some 26 miles of pilot and telephone cable, and about 27 miles of 0·05 sq. in. E.H.T. 11,000 volt three-phase cable. The latter cable was nearly all laid in earthenware troughing filled-in solid with bitumen and jointed by means of lead sleeve joints. The two feeders laid between Lots-road (Chelsea) generating station and Kingston sub-station, a distance of 10⅜ miles, after being tested up to 33,000 volts at the factory, were tested after laying to a pressure of 22,000 volts applied between each core and earth for 20 minutes. Not the slightest trouble was experienced either with the cables or with any of the numerous joints (about 300) throughout the entire length, this being considered one of the most satisfactory tests ever made on a high-tension feeder.

In conjunction with the manufacture of cables Messrs. Henley undertake the design and manufacture of all descriptions of joint boxes, feeder pillars, &c., as well as of all kinds of jointing materials, insulating tapes, &c., and have in addition a well-equipped factory for the manufacture of mechanical rubber goods of every description, golf balls, &c.

The head offices of the company are situated in Blomfield-street, London Wall, E.C., and, in addition to branches in several of the most important towns in the United Kingdom, they have branches all over the world, including Australia, South Africa, South America, Canada, Japan, India, Sweden Holland, &c.

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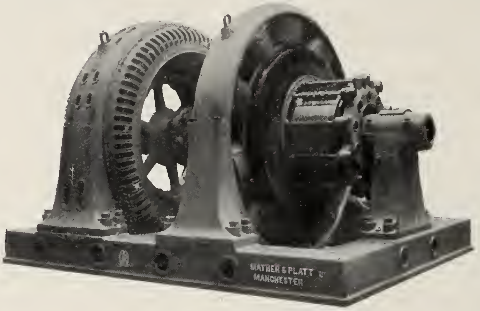
BIRMINGHAM ADDRESS:
34, MIDLAND BUILDINGS, NEW STREET.

Large Motor-Generators.

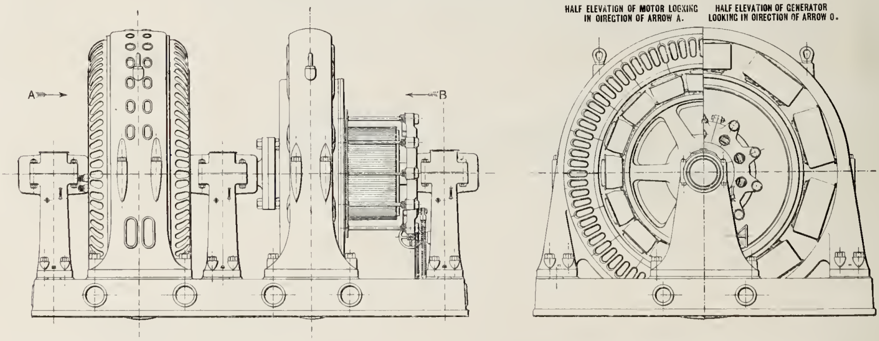
THE construction of high capacity converting plant has been much encouraged of late years by the more extended development of power transmission schemes, involving the use of machines which will change the form of the energy received from the line to render it suitable for special industrial purposes. Sub-station machinery often exceeds, both in the output of individual and collective units, the aggregate capacity of many large stations, so rapid has been the progress in designing and building this class of plant. The modern "converter" for either a traction, power or lighting load is now practically standardised, and can be built up quickly almost at short notice. It has settled into the crowd of dynamo-electric machines, and excites little or no comment. In certain instances, however, a particular type is constructed for special duty, which presents features of interest.



General View of 600 kw. Motor-Generator.

Messrs. Mather & Platt (Ltd.) have lately manufactured three large motor-generators for the new works of the Castner-Kellner Alkali Co., at Newcastle-on-Tyne, two of which are already erected and the third is nearing completion.

Each set comprises a high-tension synchronous motor, direct-coupled to a continuous-current generator, as shown in the accompanying illustrations. The machines are mounted on one bedplate and the revolving parts are supported on three bearings. The A.C. motor is of Mather & Platt's usual construction with stationary armature and revolving field magnets. Three-phase current is supplied to the stator from the Newcastle-upon-Tyne Electric Supply Co.'s mains at a pressure of 5,750 volts and a frequency of 40 cycles per second, and the continuous-current machine can give an output of 2,500 amperes at 240 volts, or 600 kw. By means of rheostats regulating the field the A.C. motor can be worked between 5,500 and 6,000 volts, and 39 to 41 cycles, the power factor being capable of variation from 95 per cent. on the lagging side to 90 per cent. on the leading side.


A
B
HALF ELEVATION OF MOTOR LOOKING IN DIRECTION OF ARROW A.
HALF ELEVATION OF GENERATOR LOOKING IN DIRECTION OF ARROW B.

Side and End Elevations of 600 kw. Motor-Generator for Castner-Kellner Co.'s Newcastle Works, built by Mather & Platt.

The continuous-current generator is of Mather & Platt's standard construction, and very careful attention has been paid to the design to meet the special circumstances under which the machines have to work. These are exceptionally severe as they necessitate their running at full load day and night for months at a time without a stop. The generators are also required to carry an overload of 15 per cent. for two hours without undue rise of temperature, and of 50 per cent. for a short time under emergencies without any risk of injury. The generator, moreover, has to meet a somewhat unusual requirement, in that it must give its full working current of 2,500 amperes at any pressure between 252 and 80 volts, a very wide range: this is satisfactorily effected by means of field regulating rheostats. It will be noticed from our illustrations, which were kindly furnished by the makers, that good appearance has been studied in the design and distinctly emphasised in the construction.

From the manufacturer's point of view it should be a matter of some importance that transmitted electrical energy can be converted at his end of the line into a form suitable for almost any industrial purpose. The case cited above serves admirably to typify this convenience. The electrical energy as generated by the Newcastle-upon-Tyne Electric Supply Co. is not suitable for the electrochemical purposes to which the Castner-Kellner Co. wish to put it, but they can take advantage of this exceptionally cheap source of supply by the use of well-designed and substantially constructed motor-generators.

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Civil, Mechanical & Electrical Engineers.

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A Model Test Room.

"A LARGE, well-lighted room, measuring about 80 ft. by 36 ft., and completely isolated from all vibration," describes the test room of Messrs. Elliott Bros., at Lewisham. It is arranged for testing all kinds of instruments, both continuous and alternating current, being equipped with various standards, over which the most careful watch is kept. The ordinary testing is done with sub-standards, which are being constantly checked against these master standards. Continuous, single-phase, two-phase and three-phase current at all frequencies is obtained from four motor-generators. One set gives current waves of sinusoidal form, the second set produces flat-current waves, while the third set generates current the waves of which are peaky. As the generator of the first set is built up of two halves, it is easy to obtain any phase displacement between voltage and current by shifting the halves relatively to one another; this can be done while the machine is running. The equipment of the testing room also includes a storage battery of eight E.P.S. "K 58" cells for heavy currents, and a battery of 1,000 small cells, made at Century Works, for pressures up to 2,000 volts and small currents. Three other shops lead out of the test room, namely, the coil winders, where all the coils and resistances used in the various instruments are wound, being baked after winding in a vacuum oven; the galvanometer and standard resistance department; and also the magnet store. Magnets, of course, play an important part in the moving coil instrument, and special precautions have to be taken to ensure permanence.

The Engineering Exhibition.

THE pronounced success of the Electrical Exhibition held last year at Olympia may be taken as a good augury for the Engineering and Machinery Exhibition which opens to-morrow, September 15th. Over 20 years are said to have elapsed since any attempt at an organised exposition of engineering products was made in this country. This in itself is somewhat remarkable having regard to the great progress made in Great Britain in the application of engineering appliances to industry during that period. The preliminary list of exhibitors points to a comprehensive display of machines and processes, and indicates also that the support of many representative engineering firms has been accorded the project.

We have ourselves taken a Stand in the Central Avenue, "near the fountain," where we shall be pleased to meet friends, and where we hope to make many new ones. In another part of this issue we publish some details of the location of our Stand, and of our exhibit of books and electrical publications.

We did not anticipate that the Exhibition would be strong on the electrical side, nor is there a prospect of anything particularly new, speaking of the electrical exhibits, but there are evidences that many mechanical devices will be introduced which may prove serviceable to the electrical engineer.

In our next issue we shall devote space to the exhibits from the industrial side, and we may remind exhibitors that we shall be pleased to receive details and illustrations of practical application of their products and specialities to industrial uses. These details, &c., should reach us promptly.

THE ENGINEERING & MACHINERY EXHIBITION

At OLYMPIA, LONDON

(President: Sir Wm. H. WHITE, K.C.B., D.Sc., LL.D., F.R.S.),

WILL BE OPENED BY

SIR ALEXANDER R. BINNIE (President Institution of Civil Engineers),

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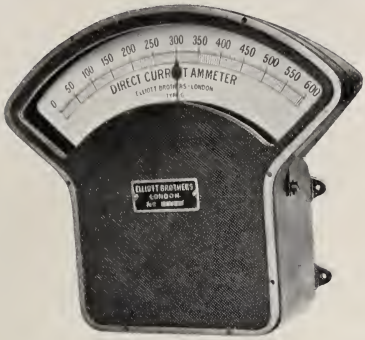

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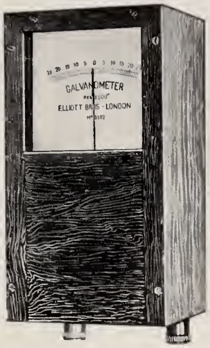

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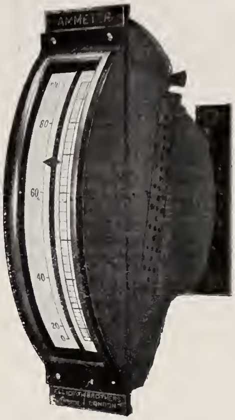

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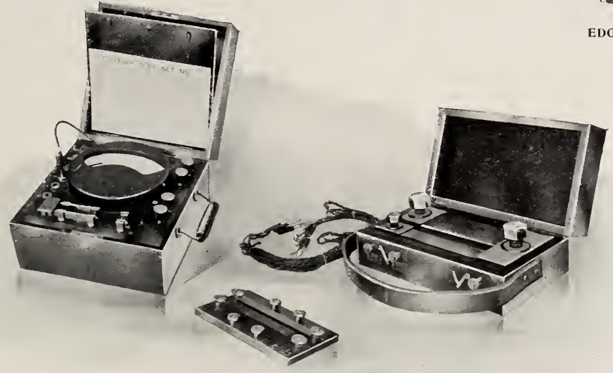

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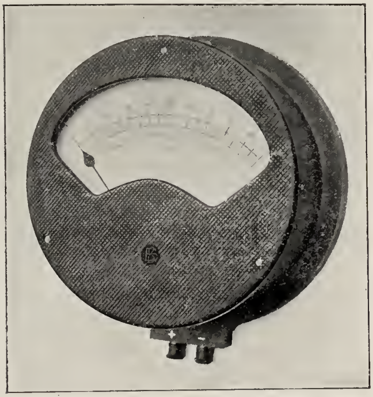

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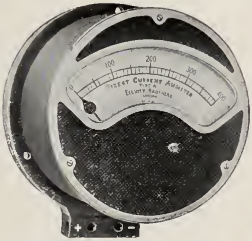

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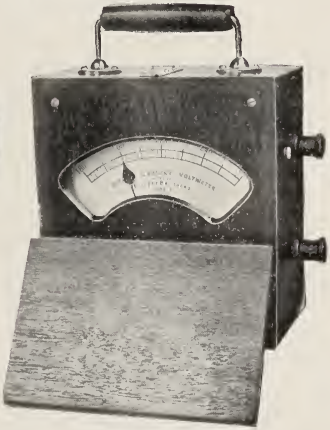

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All communications for the Supplement should be addressed "SUPPLEMENT," 1, 2 and 3, Salisbury Court, Fleet Street, London, E.C.

The SUPPLEMENT will be published on the First Friday in each month.

All copy for text and advertisement pages to reach above address not later than the 22nd of the month.

Manufacturers, Contractors, Generating Station Engineers, and those interested in Electrical Industrial Developments are cordially invited to contribute original matter to the SUPPLEMENT, and when suitable this will be inserted as space permits.

SPECIAL POSITIONS *for display announcements can be allotted in the text pages if early application is made.*

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The Industrial Supplement is holed for filing, and we are distributing cases in which each issue can be retained for ready reference. The cases require a minimum of manipulation, and as they are also corner-holed for hanging, they will be found a serviceable means of conveniently keeping the Supplements at hand.

Each case will hold twelve issues of the Supplement. On request a case will be sent to Consulting, Manufacturing, or Contracting firms; to Chief or Resident Engineers of Electricity Supply, Traction or Power Stations; or to any firm of Merchants or Agents.

Editorial.

WE take this opportunity, in the first issue of the INDUSTRIAL SUPPLEMENT to "THE ELECTRICIAN," to thank the many friends and supporters we have met in connection with this new enterprise. Particularly are we glad to welcome the co-operation of many firms who have opened up new business with us, and we are grateful also for the numerous promises of support which we have received on every hand.

The size and make-up of this number are ample justification for a belief we have long held that such a record of work accomplished was needed—in fact, much needed. Our opinion finds full confirmation in the fact that we had an abundance of material upon which to draw for the initial issue, and we have found it necessary to exceed the limit of thirty-two pages which we had set ourselves as the maximum for our first number. Even after filling this additional space we have crowded out a quantity of valuable material, and we must ask the indulgence of several firms whose announcements and other matter could not, in the circumstances, be included in this number.

It is our intention to introduce in due course special sections into the text of the SUPPLEMENT, to assist our readers in locating articles or notes in which they are mainly interested. In this connection we shall appreciate any suggestions which may be made, and wherever possible we shall willingly act upon them. We hope that manufacturers, in preparing literary matter for the SUPPLEMENT, will assist us in making the same interesting, especially as regards the illustrations. We shall be glad to receive MSS., photographs, drawings, &c., for the SUPPLEMENT in ample time to do full justice to their preparation and reproduction.

This, the first issue of "THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT, may be regarded as an earnest of our future endeavours on behalf of the particular interests which is our principal object to serve.

Electricity Supply and its Leading Exponents. . .

I.—Frank Bailey, M.I.C.E., M.I.E.E.

THE supply station engineer in these days of standardisation knows nothing of the difficulties and trials of designing and erecting plant without the aid of adequate experience. We must turn to the ranks of the older electrical men to find the makers of precedents, the builders of the substructure on which all, or nearly all, subsequent effort has been based. An eminent engineer, a leader among the pioneers of electrical industry, who comes at once to mind, is Mr. Frank Bailey, since the early eighties associated with the first of the public electric supply undertakings of the metropolis (the Whitehall Company), and since 1895 Chief Engineer to the City of London Electric Lighting Co., and a director for many years of the Metropolitan Electric Supply Co., with whose predecessor, the Whitehall Electric Supply Co., Mr. Bailey served, as we have said, in the capacity of resident engineer.

Mr. Bailey graduated in one of the hardest and most bitter schools of electrical experience—a pioneer electric supply station. At this time (1883) he was actually engaged with the Telegraph Construction & Maintenance Co. at their Greenwich works. The station in question was that at the Paddington terminus of the Great Western Railway, where the now historic Gordon two-phase alternators were installed (see *The Electrician* for May 28, 1886, and special supplement therewith for a very full description of this plant). Mr. Bailey was entrusted with the work of completing this unique installation, and that he admirably fulfilled the task is abundantly evident from the fact that the plant has run successfully for more than 20 years. Twenty days was the limit set upon its early career by one whose name was, and is to this day, venerated by the electrical profession. But it has survived, and will only be replaced this year when the Great Western Company's Park Royal station is in service. The original feeder cables comprised a great number of single gutta percha insulated conductors in parallel, as concentric mains were then unknown. The exciters were the largest continuous-current machines then built, and were independently driven by Willans engines. Every step taken in putting down this plant was in effect an experiment.

When the Whitehall Electric Supply Co. (Ltd.) and its successor the Metropolitan Electric Supply Co. (Ltd.) were inaugurated, the experience of Mr. Bailey at Paddington proved of immense value. In fact it may be said to have ensured the successful operation of the enterprise. Serious cable troubles, for instance, were avoided and distribution on a commercial scale became possible. On the engineering side Mr. Bailey successfully steered the undertaking through its early electrical vicissitudes, as he did also the City of London Electric Lighting Co. With this latter undertaking he pioneered a system of low-pressure distribution with the first commercial triple-concentric cable ever made, and out of this successful experiment the original British Insulated Wire Co. eventuated. Until a satisfactory low-tension cable was available house transformers were used, and the high-voltage cable was looped into each building to avoid joints in the streets.

Mr. Bailey's best work finds splendid exemplification in the Willesden station of the Metropolitan Company, and in the Bankside station of the City of London Company. This latter station is now in process of considerable extension, and it is interesting to record that, on the advice of Mr. Bailey, the older one-phase plant has been supplemented with a series of five continuous-current generators of high capacity for supplying the power demand which their installation has directly occasioned. Bankside is one of London's most instructive stations, and will amply repay a visit by those interested in the evolution of electric generating plant. Mr. Bailey is not "infected" with the steam turbine cult, as is

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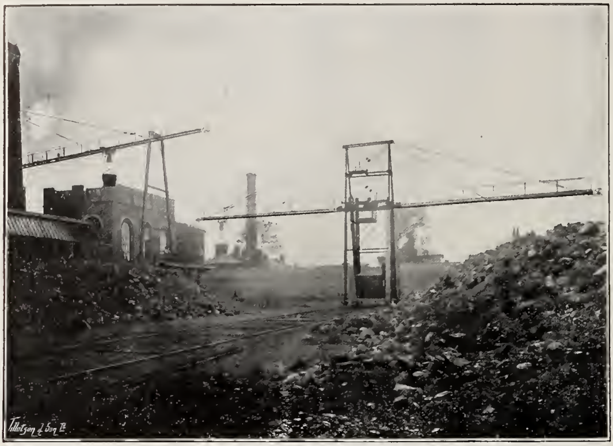

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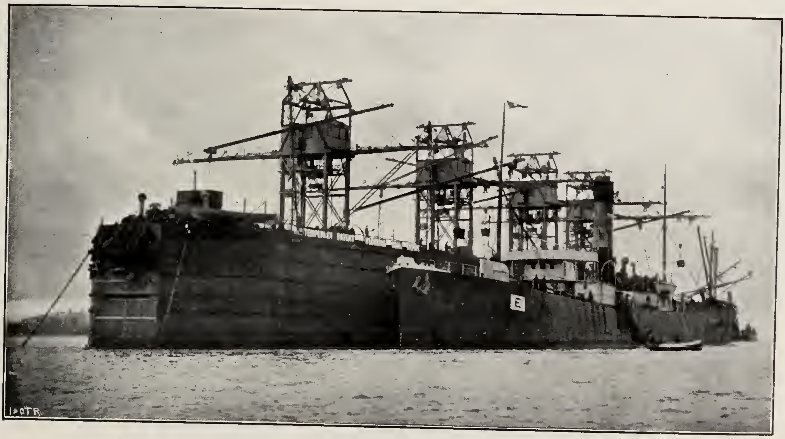

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shown from the pattern of his extension units. These are to be of the medium-speed type of vertical compound engines, the generator being midway between the high and low-pressure cylinders. Under the exigencies of the London service, plant of this pattern has done remarkable work at Bankside, and this in some measure explains its presence in the extension engine room.

Under Mr. Bailey's able generalship an active campaign is being carried on against the gas interest in the City, and from his photometric laboratory we shall yet see emanate lamps which will again wrest the lighting of the City thoroughfares from the hands of the Gas Company. Mr. Bailey has trained many of our best known station engineers, all of whom are proud of their connection with a man whose indomitable pluck and resourcefulness have helped to make the profession of electrical engineering what it is to-day. It is our earnest hope that his present good health may continue, and that he may long remain with us to exercise his great abilities in furthering the advancement of electricity supply.

The Value of Induced Draught.

Natural Draught.

SOME years ago good draught and high chimney stacks were regarded as synonymous terms, but it was universally acknowledged that good chimney draught meant a considerable loss of heat, which might have been usefully employed in the production of steam. To maintain a steady draught without mechanical means, such as will not be affected by climatic conditions, the escaping gases must enter the stack at a high temperature, and if an attempt were made to absorb some of this heat for superheaters or economisers, it would frequently involve defective combustion and a loss of heat out of all proportion to the gain derived from the waste gases.

Mechanical Draught.

The primary object of an induced draught system is to make use of the heat contained in these waste gases, and this it accomplishes with excellent results. Economisers can be added without detrimentally affecting the draught or necessitating an increase in the height of the chimney, such as would be the case with natural draught. But there are a number of additional advantages to be gained by fan draught which are almost equal in importance to the economies attained by the use of the heat in the waste gases. To these this short note will be exclusively devoted.

Flexibility.

From the station engineer's point of view a very valuable feature of fan draught is the fact that it can be varied to suit a fluctuating load, such as is found in an electric lighting station of a large town. It frequently occurs that the demand for steam may at one minute be small, while the next minute a sudden darkness caused by fog or by a thunderstorm may bring the demand up to the maximum. With natural draught there is an additional trouble, for the same cause which increases the demand for light also diminishes the intensity of the draught at the very moment when it is most required. With a boiler plant equipped with an induced draught fan climatic conditions have no effect on the draught, while the intensity of the same can, by speeding up the fan, be immediately increased to meet the extra demand for steam.

Increased Boiler Capacity.

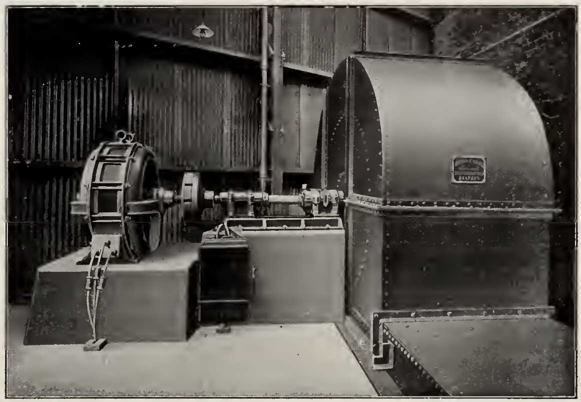
Induced draught increases the capacity of the boilers. It sometimes happens that the boiler plant has been added to until it is entirely beyond the capacity of the existing chimney, so that the draught is poor and sluggish. Not only can the draught be improved and the fires brightened up by the aid of a fan, but it is possible for one or two boilers to be laid off as spares, which must obviously prove of great benefit to the station.

Cheaper Fuel can be Used.

The most important economy to be derived from induced draught is the ability to burn inferior grades of coal. Now the worst coals have three-fourths of the calorific capacity of good coal, while their cost is less than half, consequently they will produce nearly twice as much steam per unit of cost; further, the combustion of the fuel is greatly improved, for with fan draught thicker fires and better combustion with less air are possible, and with every pound of air saved so much less heat is thrown to waste.

Black Smoke Prevented.

Intimately connected with the subject of fuel is the question as to how to prevent black smoke. Local authorities have given this matter a great deal of attention and offenders in this respect have been heavily fined. The improved combustion effected by the induced draught makes the emission of black smoke from the chimneys practically an impossibility; further, the intensity of the draught can be varied to suit different grades of coal.



One of Six "Sirocco" Induced Draught Fans Installed in a Central Station.

Induced Draught for Small Plants.

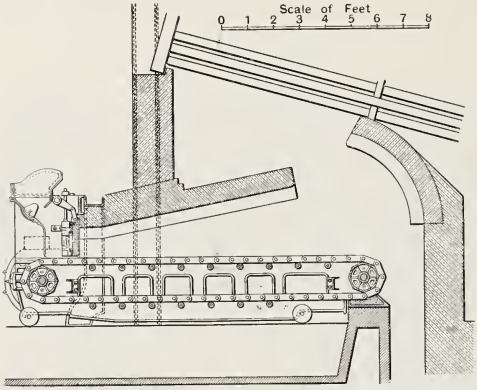
While an induced draught fan shows highly economical results when installed in a large electricity power station, it must not be imagined that it is not suitable for the smaller plants of industrial concerns. As an instance of what a fan can do in a small boiler installation, it may be mentioned that a "Sirocco" induced draught fan was installed in connection with two boilers, each having a grate area of 36 sq. ft. Before the fan was installed, coal costing 8s. 1d. per ton had to be burnt. Since the fan was put into operation, however, coal costing 6s. per ton has been used. The same quantity is consumed for the same duty, but only one boiler is required. There is no black smoke, and the plant is giving satisfaction in every way.

The illustration on this page shows one of six "Siroeco" induced draught fans as installed in a large power station; and three more are now on order, making a total of nine.

"Bennis-Miller-Bennett" Chain Grate.

Hitherto there have been a great many objections connected with the use of chain grate stokers. One of the greatest difficulties has been the dumping bar. The principle of construction in this type of revolving grate is that of a number of short fire bars placed side by side and end to end, and threaded on to metal rods so as to form a continuous chain like a link belt, the number of bars used being adapted to the required length and width of the furnace.

The back end shaft and sprocket wheels act as a guide to the chain grate which is supported at intervals by rollers resting on the framework. At the back end of the grate it is usual to provide what are known as dumping bars. These consist of a number of iron castings, or, in some cases, one continuous bar, resting on the fire bars, for the purpose of preventing partially consumed fuel wasting by passing over the end of the grate. The fuel is kept back by the dumping bars until it is thoroughly burned, and the ashes and clinker collecting at this point heap up over the top of the dumping bars and are pushed forward by the travelling fuel until they fall over into the pit provided to receive them.

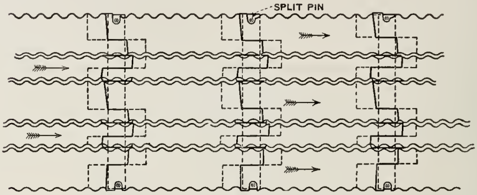


Sectional View of Water-Tube Boiler showing adaptation of "Bennis-Miller-Bennett" Chain Grate.

As we have intimated, considerable difficulty has hitherto been experienced with the dumping bar, owing to the heat from the furnace and hot ashes and clinker resting upon it, and on account of the air coming through the fire bars and impinging on the hot metal and burning it away. If the dumping bars are thickened to resist the heat, then the clinker continually collects in front of them and will not pass over them, thereby choking the fire. If they are made thin they are quickly destroyed.

The last part of the grate surface covered by the dumping bars cannot be used for the combustion of the fuel because as soon as the fire bars commence to turn over the end, a space is left between the ends of the fire bars following each other, into which the clinker would fall, and unless it fell out again during the downward travel of the fire bars, it would be crushed, or stop the grate, when the space between the fire bars closes up again. The same remarks apply to the front end where the fresh fuel has to be fed on to the grate at a point after the fire bars have closed up and reached the horizontal line. The grate has therefore to be made longer than is necessary for the actual fuel combustion area.

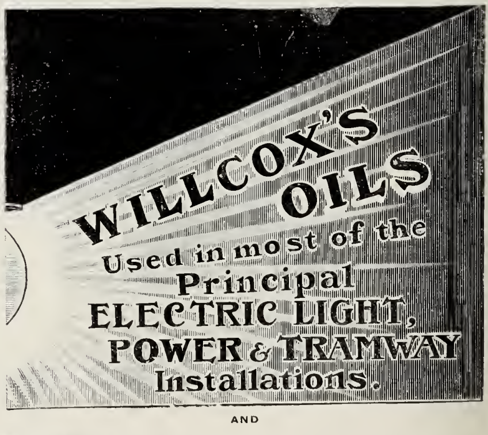
In the new chain grate these main difficulties are overcome, and the dumping bar is done away with. The construction of the links in the new chain grate is worth particular notice Each end of each link is cut away on one side, and terminates on the other side in a projection. These recesses and projections correspond in such a manner that the links fit closely together and can revolve around the terminal supports without forming any projection or aperture between the ends. The upper part of each side of these links is corrugated to admit air to the fuel, and the link is thickened to increase the bearing surface of the chain grate. The coupling of these links is also a matter of importance.



Plan View of Chain Links in "Bennis-Miller-Bennett" Chain Grate.

The effect of this improved link construction is that when the links are put together end to end and secured by pins and bolts, the top surface of the bars remains practically continuous across the junction of each pair of links, and there is no opening into which ashes or clinker can fall, even at the ends where the chain grate passes over the revolving drums. This obviates any danger of clinker or ashes falling down and choking any portion of the moving grate. Moreover, by this improved arrangement of the fire bars the whole of the back end of the furnace can be used as a cooling space for the clinkers.

The special form of chain grate described above must not be regarded in any way as competing with the special type of "Bennis" mechanical stoker.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Ventilating Engineers	
Davidson & Co., Ltd., Sirrocco Engineering Works, 13, Victoria-st., London, S.W., and Belfast, Manchester and Glasgow	40
Wire Covering Machinery	
Johnson & Phillips, 14, Union-ct, Old Broad-st, London; & Charlton. Kent	37
Wire (Covered and Uncovered)	
Henley's (W. T.) Telegraph Works Co., Blomfield-st, London, E.C.; and at North Woolwich and Gravesend	19
Johnson & Phillips, 14, Union-ct, Old Broad-st, London; & Charlton, Kent	37

METALS

J. B. GARNHAM
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ENQUIRIES SOLICITED.

Tramcar Brakes. . .

RECENT unfortunate tramway accidents draw forcible attention to the fact that within the present year far too large a number of disasters of this type have occurred. Four of the most recent accidents in this country have all occurred through a car getting beyond control while descending a grade.

The pressing need of absolutely reliable brakes to control a car descending any gradient is unquestionable. The forms of brakes in general use on tramcars in this country consist of the following:—

1. The ordinary wheel brake, applied by hand power.
2. The rheostatic brake, deriving its power from the momentum of the car driving the motors as generators, the current obtained in this way passing through an external adjustable resistance. This brake is operated by the driver manipulating his controller.
3. The mechanical slipper brake, consisting of some form of a slipper or shoe carried on the car, which is pressed against the track rails by powerful levers or screws. This brake is applied by the driver from the driving platform.
4. The electromagnetic slipper or track brake. This brake consists of a very powerful electromagnet suspended on the cars in close proximity to the track rails. It derives its power from the momentum of the car driving the motors as generators, the current thus generated being passed through the coils of the magnetic brake. Its operation is entirely independent of the line current, and is unaffected by loss of contact between trolley wheel and the wire. This feature alone is of vital importance from the standpoint of safety and reliability.

The tests carried out by Mr. A. L. C Fell, M.I.E.E., of the London County Council Tramways, clearly proved that of all forms of tramway brakes on the market, the electromagnetic was the most powerful, the safest and the most readily applied.

Perhaps the most valuable feature of the electromagnetic track brake is its ability to *control* a car descending a grade. It is possible with this form of brake to allow a car to descend a grade at practically any desired uniform speed. If the speed is either too high or too low it can be immediately changed by moving the controller handle forward or backward the necessary number of notches. As long as the wheels revolve and the car continues to descend the grade, the brake remains in action, and nothing will hinder its uniform retarding effect on the car.

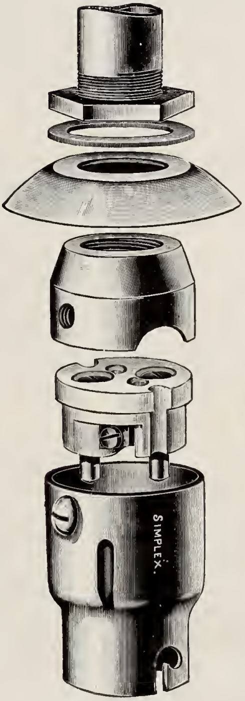
Experience has shown that in a great many cases accidents have been caused through a too strenuous application of the brakes. If through over-anxiety in the control of his car, the driver jambs on his hand brake and locks the wheels, and then finds that the car is still rapidly descending the grade, the presence of an electromagnetic track brake will not assist him, because this brake is inoperative *unless the wheels revolve.* It would seem, therefore, that every effort should be directed toward the development of appliances which will prevent the locking of the wheels, so as to allow the present known powerful forms of brake to operate when they are called upon. To this end it seems necessary and advisable that the hand brake should be designed with such leverage and multiplying power as will render it impossible for the driver to lock the wheels by its means. Further, the electromagnetic track brake itself should be so designed and built that all *direct* action on the car wheels is avoided. There will then be no possibility, either from normal or abnormal operation, of locking the wheels by means of this brake.

The perfection and development of the electromagnetic track brake has unquestionably contributed very largely to increased safety, but even with this brake the human element cannot be entirely disregarded. In the hands of an inexperienced or careless driver the most efficient brake is of little value, because when most needed there is no definite assurance that it will be manipulated properly.

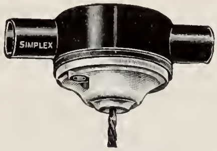
If the electric tramcar is to become a safe and popular vehicle in hilly districts, where indeed electric traction is superior to any other method of transit, the proper use of brakes must be strictly enforced on the part of drivers.

Simplex Specialities. . .

THE use of steel conduit for the running of electric light and power wires is being further encouraged by the makers of this class of electrical material. On grounds of convenience and adaptability the conduit system is now well ahead of wood casing or other protective methods. Simplex Conduits (Ltd.) are constantly introducing specialities which greatly enhance the value of their system and tend to make it more and more indispensable. We illustrate a new pattern watertight lampholder designed for use with bracket arms and pendant drops. The shell is of galvanised steel, which the makers claim is superior to brass for such exposed positions as subways, station yards, lavatories and, in fact, all open work. The holder is shown dissembled in the adjoining view and it is in two parts, only a drain cap and rubber washer being provided to exclude moisture. Another convenient Simplex speciality is a conduit rose fitting, which we also illustrate. It is arranged for direct mounting on socket or screwed conduit and we are informed that by its use the cost of wiring is considerably reduced. The rose is of porcelain and so shaped that the terminals, which are sunk into the material, are easily wired, and particularly on the loop-in system. An efficient cord grip is provided for and after the attachment of the "flex" the rose can be easily secured in position when the terminal screws have been tightened up.



Simplex Galvanised Steel Watertight Lampholder.
(Full size.)



Simplex Conduit Rose Fitting.

Commercial Development of Central Stations. . . . .

General Literature.

The most important matter at the present time engaging the attention of central station engineers is undoubtedly that of wider publicity. The recent annual convention of the Incorporated Municipal Electrical Association gave encouraging signs of a desire on the part of central station engineers to avail themselves of special canvassing literature in their development departments. The companies have already got well established in the field, and one or two monthly periodicals already show signs of encouraging support from the manufacturing element. Up to the present, however, nothing of a particularly specific character seems to have been done. The distribution of a more or less general bulletin is at present evidently regarded as the best method to adopt in approaching prospective customers. Anything in the nature of a monthly bulletin fulfils this purpose admirably, but it can hardly be expected that custom will be directly attracted to the system by this means. In fact, a publication of this kind should be written with the idea of attracting attention and exciting interest rather than of being the means of securing immediate business. It may indeed be well at this juncture if the station engineer looks upon his monthly publication merely as a piece of propagandist literature. It is to him what the electric sign is to the tradesman. It lightly calls attention to the many things which can be accomplished by electrical means, but it does not attempt to compel customers to come on to the mains.

At the present time it is very doubtful if what is known as "direct by mail business" can be successfully carried on in an electricity department. The British public are not yet accustomed to solicitation either by letter or attractive printed matter. If they can be educated up to the American standard in this respect, the station engineer will probably be able to secure most of his customers by this means.

The Training of Canvassers.

It is a common complaint of young and ambitious electrical engineers that the opportunities of securing a good position in the industry are now remarkably few. Whether this is true or not does not at the moment concern us, but we are convinced that there are excellent opportunities in the commercial departments of electricity stations. At the moment there is unquestionably a demand for smart commercial men who can undertake to interview prospective customers with a view to securing their business for the electricity department. The particular field is not yet very clearly defined, so that those taking up this branch immediately may expect to find the duties somewhat varied. Again, the station engineer is still rather cautious in giving substantial encouragement to a man with undoubted abilities for getting business, and this in itself is somewhat of an obstacle. There is, however, no better method of obtaining business than by personal solicitation, and it behoves station engineers to make the path as easy as possible for young aspirants to positions in their commercial departments. It has been said that the head of an electricity department in the future will be more a commercial man than an engineer, but this we should very much question. Divided responsibility at the head of affairs is to be avoided wherever possible, and present tendencies point to the chief combining both the duties of engineer and commercial manager, while acting directly under him would be a staff specialising either on the engineering or commercial sides of the department. There are already indications of this readjustment of the responsible posts, and we hope that station engineers will do all in their power to help those of their assistants whom they perceive better fitted for work on the commercial rather than the engineering side of their undertakings.

A Circulating Library for Station Engineers.

Many electrical books now regularly issued by leading publishing houses are of great value to station engineers, but the aggregate cost of many such publications prohibits their extensive use by those most needing them. The obvious solution of the difficulty is a central circulating library, where not only standard works can be consulted but also the latest books, for the payment of a small annual fee. Engineers interested in a scheme of this nature, but unfamiliar with a suitable centre to which to apply, may perhaps be surprised to know that a good technical circulating library now exists in London. Mr. H. K. Lewis, 136, Gower-street, W.C., is conducting a comprehensive technical library of which engineers can avail themselves by annual subscription. Subscribers may borrow books for any desired period, and we understand that volumes are promptly despatched by mail, the postage being defrayed by the subscriber. Books may be retained by the subscriber at the usual retail prices, and when purchases are made in this way an extra volume for each book bought is allowed with the next exchange. Engineers may also find it convenient to compound their subscriptions, and in such cases special rates can be arranged to meet their requirements.

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FOR
ALL
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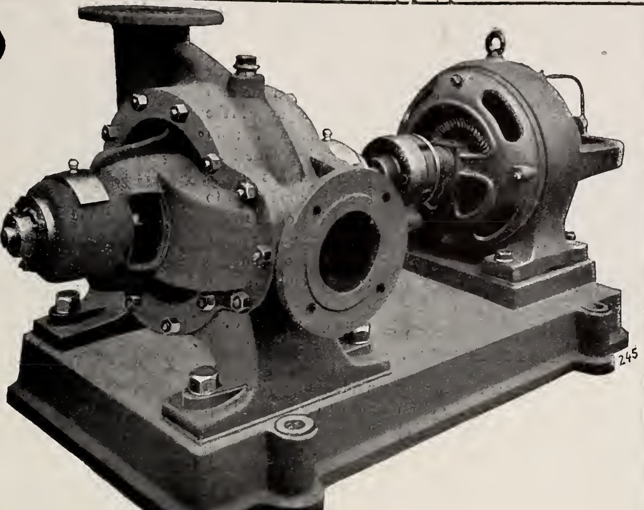
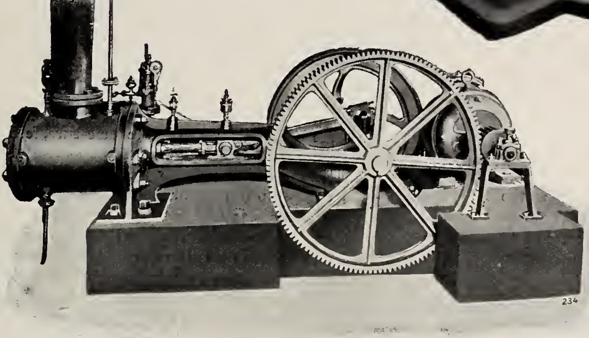
USES.





DURABLE

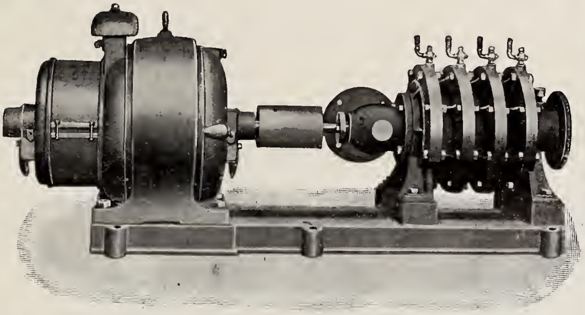
MOTORS

EFFICIENT

ALL SIZES
FOR

MOTORS

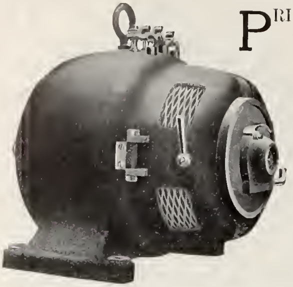
ALL
CIRCUITS.



Union Electric Co. Ltd.

PARK ST., SOUTHWARK, LONDON, S.E.
NEWCASTLE, GLASGOW, LIVERPOOL, BOMBAY.

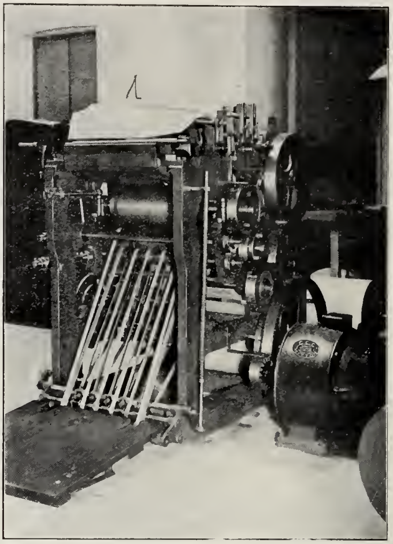
Electric Motors and Printers' Auxiliaries.



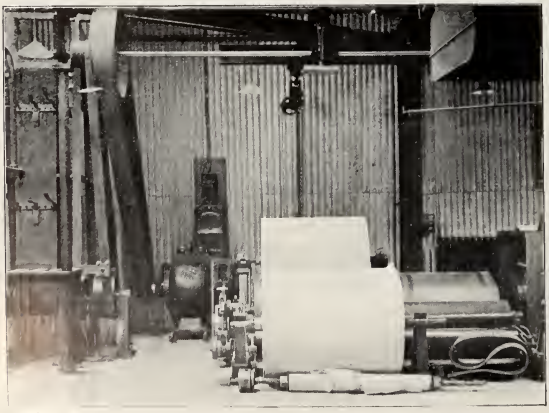
"Witton" Ventilated Enclosed Motor.

PRINTERS have done much to strengthen the case for electric power in the industrial world; in fact, their practical appreciation has given special prominence to the value of the electric drive under conditions arduous enough to commend its use to meet the exigencies of equally trying cases elsewhere. The conquest of the printer—or, rather, the achievement of having convinced him—has been something of a triumph for the electric power engineer. It is, at any rate, sufficient excuse for his proudly regarding it as the beginning of a movement towards the general electrification of industrial machinery. For the purpose he has in view the electric motor is the ideal for the printer, and already he has discovered its real relation to his heavy machinery. There are few "live" printers who do not now make extensive use of electric motors for operating both their large and small presses and power tools. We write with special knowledge of the vast economy and added facility of production which electric driving in printing works affords.

Importance of Auxiliaries. All things considered, the guillotine, the folder, the stitcher, book sewer, the ruler, and the almost innumerable smaller machines requiring power in a printery are equally as important as the rotary, the perfecter, the Wharfedale and other one-siders, the platen, and the other costly plant now generally operated. In fact, all the power machines should be regarded as contributing individually to the collective efficiency of the entire plant, and receive proportionate consideration from the point of view of applied power. Almost naturally the quick-running press comes first when electric driving is under discussion, but the auxiliaries are also valuable units and should be maintained at the same operating standard as the larger plant. In the matter of speed alone it seems incongruous to secure a high average duty from the printing presses and then to rest content with a lower average from the auxiliaries, which, in great measure, feed or supplement them.



"Witton" Motor Driving Direct a Newspaper Folding Machine.



"Witton" Motor Driving Damping Machinery in a Newspaper Office.

The Small Printer. Electric driving is now well established in the larger printing houses of the world, and the tendency is to extend the equipment to the auxiliaries on the lines indicated above. But the appeal for wholesale electrical operation is still unresponded to by the smaller printer. He has put in motors to drive his large presses and heavier plant, but the smaller units are still actuated by hand or find no place on the premises at all. It may even be that an old gas engine still remains to drive the seemingly less pretentious machines in the house. Where the latter is the case, the printer has no reasonable ground for holding out against the small motor. He admits the need for power, but is content to leave in a portion of his steam or gas plant to supply it, regardless of the combined efficiency of his machinery or the effect upon his total output. The initial outlay should afford no excuse for delay if the section already electrically equipped has been and is paying for itself. Here is justification enough for the step, if any were really needed.

General. In a general way we have put the case for the wholesale electrical operation of printing machinery, and the illustrations we present with this brief summary of the situation may be taken as representative of a type of plant which may still be either driven by other than electrical means or be excluded from the establishment on the grounds of operating cost. The installations depicted herewith are equipped with "Witton" motors as manufactured by the General Electric Co., Queen Victoria-street, London, who have placed the views at our disposal for the purpose of this short article.

SEASONS COME and SEASONS GO,
but the

"ROBERTSON" LAMP

still continues to hold its own against all comers for

ALL ROUND GOOD VALUE.

The "ROBERTSON" LAMP enjoys a far greater sale than any other British Lamp on the Market.

THERE MUST BE A REASON.

The GENERAL ELECTRIC CO., Ld.

Head Office:
71, QUEEN VICTORIA STREET,
LONDON, E.C.

REG^D TRADE MARK

Works and Branches:
anchester, Birmingham, Witton, Glasgow, Newcastle. Cardiff, Dublin, elfast, Johannesburg, Paris, Cape Town, &c, &c.

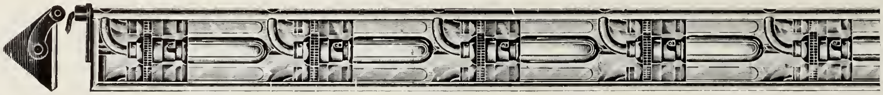
TRADE MARK

Electric Signs and Display Lighting.

ELECTRIC lighting is so commonly adopted in trade and commercial establishments that the particular user is apt to overlook many of its possibilities for attracting business. Unlike gas, electrical energy performs other functions than that of mere illumination, and can be requisitioned for a variety of useful purposes in conjunction with the lighting of a shop, say, or a window. This important fact is not impressed so strongly on users of electric light as it might be, more particularly those who depend largely for business upon attractive windows and brilliant displays. For instance, a cigar merchant may have his windows and shop entrance ablaze with light at night, but, the casual passer by will not know that cigars are to be bought there until he reaches the shop front and inspects the goods. In this case, as in many others, the tradesman has only partially utilised the electric lighting he introduced largely with an eye to business. An electric changing sign could have easily been installed with the shop lights and without much greater expense.

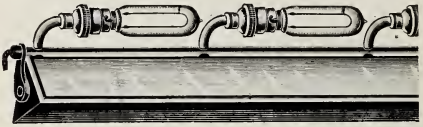
Changing Signs. There is no doubt that the electric light presents exceptional opportunities to tradesmen dependent largely upon quick sales for business, because with it the changing illuminated sign can be adapted for almost any idea in "light attractions." Electrical manufacturers are creating a demand for cheap, yet efficient, signs which, when judiciously used, will considerably improve the conduct of business. At one time complicated motors and clockworks were needed to operate such signs, but improvements have constantly appeared and taken the place of the older devices.

The "Thermo Blink." The Sun Electrical Company, 118 and 120, Charing Cross road, have recently introduced a sign flashing device which is simplicity itself. Unlike some complex arrangements this apparatus, which is appropriately termed the "Thermo-Blink" Motorless Flasher, is contained within space of a few square inches, and can be included in an ordinary electric light circuit by simply cutting one of the wires and coupling the two ends to the terminal provided. The illustration in the advertisement opposite depicts the complete apparatus. It operates under the influence of a rise in temperature created by the current passing through the resistance coil wound on one arm of the triangular metal piece. The heating effect causes the arm to move slightly by expansion and close the lighting circuit, at which moment the resistance arm is cut out. Cooling then takes place, the arm contracts, opens the lamp circuit and puts in the heating coil again when the cycle of operations is repeated. The effect produced in the lamps of an electric sign is that they are regularly lighted and put out, the sign itself of course "flashing" for a moment on the eye and disappearing again. The intervals can be regulated to a nicety, and four sizes of the flasher can be obtained, for circuits of between 2 and 12 lamps. The Sun Electrical Co. inform us that they can also supply a variety of metal cases wired complete with the flashers and necessary lamps. These cases have double glass fronts to admit of the insertion of a suitable stencil between the glass so that the sign "matter" can be constantly and readily changed.



Length of "Sunlite" Reflector with Hinged Lamp Carrier for Concealed Lighting.

Effective Publicity. These flashers should, we think, open up a big field for the lighting of signs, especially those of the small shop-keeper. With practically no fixing to do and low first cost of the flasher, the small shop-keeper for a few shillings can make his sign talk, and in the interests of the electric sign we should like to see a device of this kind more widely used. From the central station engineer's point of view the flasher should materially assist in making the changing sign popular and encourage a certain class of customer on to the mains. In the aggregate these would really constitute more constant load than having one or two customers with large signs which make heavy and intermittent demands on the supply and are not worth encouragement.



"Sunlite" Concealed Reflector showing Lamps Swung Back for Cleaning.

A small sign, which can be flashed intermittently has far more, value from an advertising point of view than many a larger one whose lights are fixed. The small first cost of the flasher described is a point in its favour.

Special lanterns to take theatre play bills afford a striking form of advertisement to which the public is invariably drawn.

"Sunlite" Reflectors. The use of efficient reflectors for electric lighting has been made a speciality of by the Sun Electrical Co. and their application in practice has proved very satisfactory. In the latest pattern the tantalum lamp is employed in conjunction with the company's standard mirror reflector, and the lower illustration in the announcement opposite depicts the arrangement very clearly. The combination gives increased illuminating efficiency by reason of the economy of the new lamp and the special properties of the reflector used. There is, we think, a great need for improvement in the lighting of show cases in shop windows, taking this as a suitable example, and the wider use of trough reflectors and high efficiency lamps should do much to bring this about.

Concealed Lighting. The beautiful effects possible with concealed electric lighting only need to be seen to be appreciated. Now that suitable and efficient lamps and reflectors are available a great deal more can be accomplished in this direction than was at one time possible. The "Sunlite" reflector for this purpose has all the appearances of a device which meets the exigencies of the case. Obviously accessibility to the reflecting surface is an important feature, and in this pattern No. S9) the lamps are so fixed that they can be swung clear of the reflector and all dust and dirt accumulated can be readily swept out.

SUN SPECIALITIES

• *MAKE* •

• *YOUR* •

• *SIGN* •

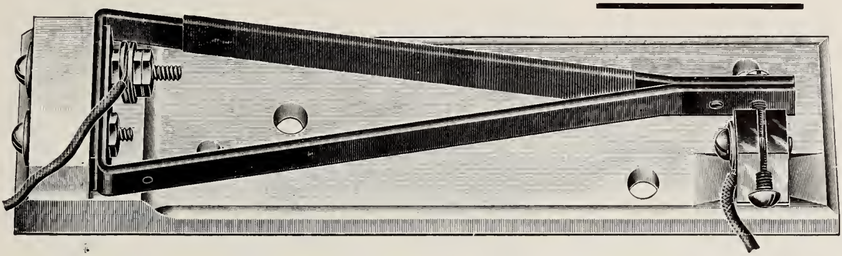
• *TALK* •

BY USING

THE

SUN THERMO-BLINK MOTORLESS FLASHER.

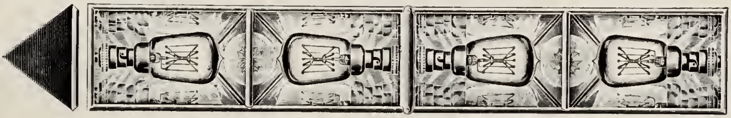
Write for DESCRIPTIVE CIRCULAR which tells you all about it.



CHEAP AND EFFECTIVE. EASILY FIXED TO EXISTING SIGNS.

MORE SUN SPECIALITIES.

SUNLITE REFLECTORS ARE STILL THE BEST!



No. S 5 Sunlite Reflector with TANTALUM Lamps.

A GOOD COMBINATION.

HIGHEST EFFICIENCY REFLECTOR.
HIGHEST EFFICIENCY LAMP.
INCREASED ILLUMINATION IN USEFUL DIRECTION **OVER 250** PER CENT.

See **SECTION "S" SUNLITE SPECIALITIES** for other Patterns and Copy Report re Photometric Test.

THE SUN ELECTRICAL CO., LTD.,

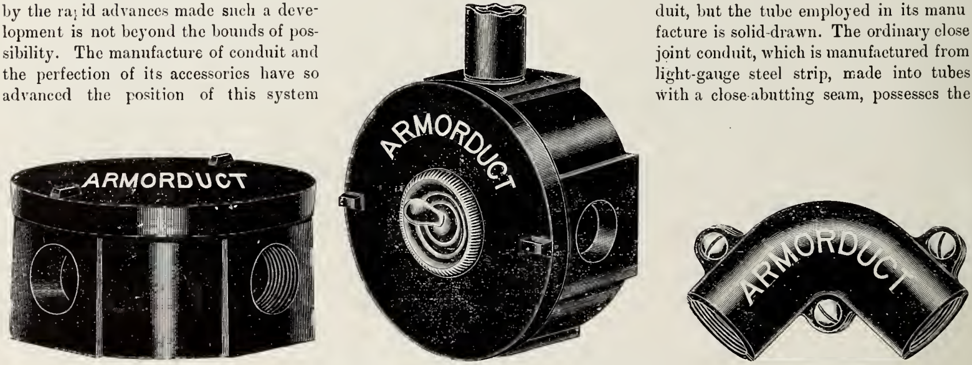
118-120, Charing Cross Road, LONDON, W.C.

Telegrams:—"SECABILIS LONDON." Telephone Nos. 2292 and 2289 GERRARD.

The Armorduct Conduit System.

THE employment of conduits for the protection of electric lighting and power wires has been a matter of considerable controversy for many years past, and while the advocates of the respective methods—conduit and casing—have now cooled their ardour somewhat, the necessity for adequately safeguarding electrical installations against the abnormal risks of service remains an important question. The conduit system has all the elements of simplicity and safety to recommend it, while in addition it affords such immunity from risk of fire as the dictates of experience suggest. Mechanically the system is all that could be desired, and it permits of neater runs being made in difficult situations than could be effected with the most careful disposition of wood casing.

The conduit *v.* casing has not yet arrived at the stage when the former will be universally specified in place of the latter for all permanent installations, but judging by the rapid advances made such a development is not beyond the bounds of possibility. The manufacture of conduit and the perfection of its accessories have so advanced the position of this system that it will now meet successfully the exigencies of the most difficult cases in a wiring installation. In addition, of course, there are special situations in which nothing but conduit could be employed as a protection for insulated wires.



Some Examples of Armorduct Accessories.

The Armorduct System.

The "Armorduct" conduit system is the outcome of many years specialisation on the part of the late Mr. Fred Bathurst, and it has been extensively used since its introduction in installations for both electric lighting and power. It differs from other systems in that it is lined with a special insulating enamel which prevents contact with the steel tube in case the insulation of the wires becomes chafed at any point. It is made up in five grades of conduit, which are designated as follows:—

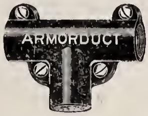
"Armorduct" Standard is the original heavy gauge screwed welded conduit which is made to meet all the requirements for the best work. The tube employed in its manufacture is of carefully selected mild steel of the best quality, and it can be readily screwed and bent. Steel tubes of this class are cleaned by a patented process and subsequently coated inside and out with a superior insulating flexible moisture and acid-proof enamel which preserves the metal from rust and oxidisation, and prevents its corrosion by the acids and alkalies not infrequently found in plasters and cement. The enamel has such tenacity as to be unaffected by the rough handling incident upon installation work, and it will not chip or flake off when the tube is bent. Decorative paint can be applied to it without discolouration and this is a decided advantage in open situations where the bare appearance of the barrel needs a little ornamentation. The interior of a conduit treated under the "Armorduct" process is of gunmetal smoothness, which is an essential feature for the preservation of the conductors in drawing-in.

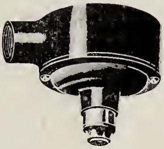
"Armorduct" Extra Heavy is identical with the grade above described with the only exception that the gauge of metal is that of standard gas barrel, namely, 13 to 8 S.W.G. This heavy material is employed almost exclusively for work calling for special protection, such as dock and harbour work, iron works, foundries, chemical works, ice-making and cold-storage plants, breweries, laundries, &c., and for underground connections. The increased thickness of metal affords additional protection from mechanical injury, and the tube, of course, possesses a longer life.

"Armorduct" Seamless is another grade of conduit which is identical in gauge and finish with "Armorduct" standard, but the steel tube employed in its manufacture is solid-drawn. "Armorduct" Seamless, extra heavy, corresponds in gauge and finish to "Armorduct" extra heavy conduit, but the tube employed in its manufacture is solid-drawn. The ordinary close joint conduit, which is manufactured from light-gauge steel strip, made into tubes with a close-abutting seam, possesses the advantage of cheapness as a material and in erection, and its use is satisfactory for all ordinary dry work—in particular, "surface" work. Special attention is paid to the general finish, and, in particular, the enamelling of this material, which is manufactured both circular and oval, the latter class being useful where circular tubes are awkward to instal, owing to their greater depth.

The various fittings and accessories of the system have been designed to meet in detail the requirements of first-class electrical and mechanical construction.

Particular attention is devoted to junction boxes, and we illustrate herewith an improved type knock-out junction box. With this pattern it is unnecessary to use different types of boxes for different positions, as one knock-out box answers equally well for six different applications. It may be used as a terminal, corner, straight, through, tee, intersection or bottom outlet box. The box illustrated is a one-way box, *i.e.*, one hole is supplied ready tapped. As shown in the illustration, thin metal films are cast into the other inlets of the box, which can be readily knocked out and the holes so made may be tapped, or the tube may be led in and secured by lock-nuts. Apart from the great convenience of adaptable boxes of this description they form a ready means for future extension.

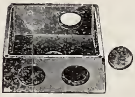


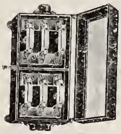


ARMORDUCT

CONDUIT
FOR
ELECTRIC WIRING

THE CONDUIT SYSTEM
"PAR EXCELLENCE."





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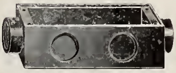

Electric Cable-Making Machinery.

THERE are few branches of industry into which labour and time-saving machinery has not penetrated, and with equal truth it may be said there are few types of such machines which are not constantly undergoing the process of improvement. The new and carefully modified design has hardly given place to the practical example before changes, perhaps drastic changes, suggest themselves, and the stimulus of competition demands their embodiment in the next machine or machines turned out of the shops. With modern manufacturing apparatus the rate of change in design and consequent improvement in finished product has tended to increase of late years, and as a direct result the older forms, serviceable enough in their time as they were, survive now only for short periods compared with those once allotted them.

Increased Output.

The main object in view of the designer of such machinery is increased output as a consequence of both time and labour saved; the reliability of the machine must, of course, remain the same, and in addition it will be an advantage if its selling price can be reduced. The last item is not all-important, as the property of the improved apparatus to economise labour and yet give a greater return is, or should be, one of the strongest inducements to its intending purchaser. There is no need to emphasise the prospects of recovering the capital outlay on the modern type of machine whose output exceeds that of its predecessor three or four times. This must be perfectly obvious at the outset.

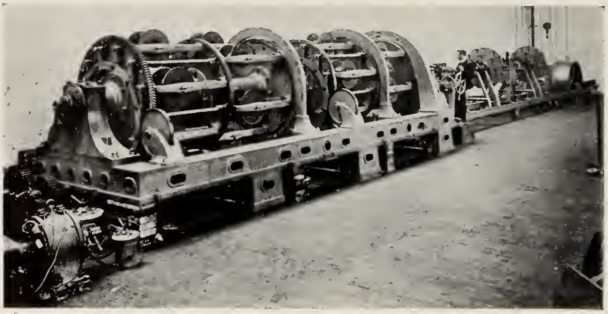

Fig. 1.—Cable Armouring and Braiding Machine built by Johnson & Phillips.

Cable Making.

Into the making of insulated cable the time-saving machine enters largely, and from the user's standpoint the latest and best is essential to efficient production on competitive lines. The cable maker can only hope to keep pace with the times by intelligent co-operation and support of that market which furnishes the most modern means to meet his particular ends. At one time the making and laying of an ocean cable was a leisurely affair conducted with becoming expedition, but without undue haste or too keen an eye to the cost. Nowadays continents may be paralysed for want of inter-communication, and the demand at once arises for the speedy completion of work which formerly forbade "hustle" in its execution. What was once merely expedient has now become a crying need, and to meet the altered conditions corresponding changes have had to be made.

Modern Methods.

The maker of cable-producing machinery to-day has quite a different class of demand to face, and it is the object of this short article to outline briefly the manner in which a typical firm, specialising in this machinery, has adapted its designs to meet the case. Messrs. Johnson & Phillips have been closely identified with cable making since the electrical industry was worthy of the name, and have contributed largely to present knowledge of the efficient production of telegraph, telephone and electric light and power cables. Considerable interest then attaches to their latest types of machines for the speedy manufacture of cables and wires for these particular purposes.

Submarine Cables.

As we have already intimated, contracts for the manufacture of submarine cables now generally contain a time clause, which govern almost entirely the conduct of the work. The maker of the machine which will produce the cable is greatly assisted by this factor and also by reason of the length and uniformity of the cable required. Given the necessary skill in design, he can market a machine to run at very high speeds but still give the necessary quality and finish to the cable. Fig. 1 depicts a machine made by Johnson & Phillips, which they claim to be one of the fastest at present produced for stranding and armouring cable. It will sheath jute-served gutta-percha cores of submarine cables with 24 steel wires and apply protective coverings of two layers of jute yarns and tapes and three coatings of compound. At the normal speed of the machine—120 revs. per min.—it will sheath and protect cable, in the manner described, at the rate of 8 miles per day of 12 hours or nearly 60 ft. per minute run. The machine carries 24 21 in. diameter bobbins, 11 in. wide, for the steel wire, these being arranged in four bays of six each to reduce the diameter of the revolving cage.

Solidity of Construction.

In its construction this pattern of machine is built up to withstand the strains of high speeds. The carriages of the bobbins just referred to, for instance, are of extra heavy section and are supported in gun-metal bushed bearings in the discs. The latter are of steel plate with forged steel rings riveted round the edge and are rigidly attached by stout flanges to the main central shaft, which is hollow, and 15 in. diameter by 1¼ in. thick. The revolving cage is supported at the leading-in end by the central shaft and also by pairs of rollers under each of the three discs. An important feature is that roller bearings are used in each of these supports, a special swivel form being adopted, which has given every satisfaction, under the normal load of 30 tons. The makers claim that by the employment of this class of bearing a motor of one-third the size of that usually adopted with plain bearings is required to operate the machine. To admit of uniform high speeds the jute discs are of small diameter and the bobbins are carried at the side to admit the requisite number of yarns. All risk of slip at the draw-through drum is obviated by making this member 6 ft. in diameter by 18 in. wide, and the smooth running of the machine is expedited by this arrangement.

Cable making Machinery.

We are proud of the high reputation we have established as Makers of this class of Machinery.

We not only construct it, but use it also, and so have been able to take advantage of the experience we have gained in the Manufacture of Cables to make many improvements which have materially decreased labour cost, and which also allow of much speedier output of Cables and Wires, enabling a large turnover to be handled for a comparatively small capital expenditure.

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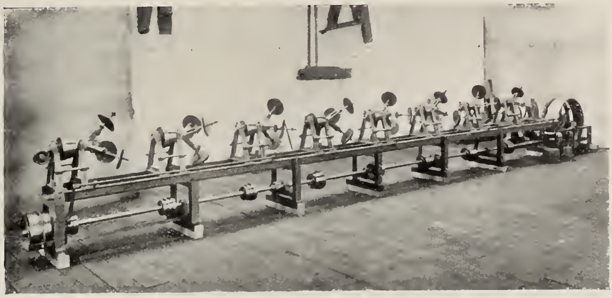

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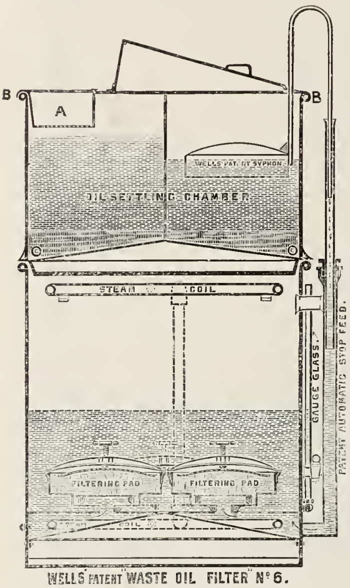
A New Oil Filter. . .

THE oil filter is now a recognised institution in central stations, engine houses and places where oil is used in large quantities. A type of filter which is extensively used is that known as the Wells "sight-feed syphon," a larger pattern of which should become as popular as the smaller sizes. Through the courtesy of the makers we are enabled to present a sectional illustration of this new type, and it will be noticed it possesses several distinctive features. The sight-feed syphon is, of course, retained, but in a modified form. The lower end of the pipe dips several inches into a glass tube, supported in a gland carried by a stout extension tube from the bottom of the filter. The tube is connected to the filtered oil chamber, and as the oil rises it cuts off the supply at the drop feed. When the oil falls again, a syphon again starts, and continues while the oil lasts. The filter, which is known as No. 6, is 54 in. high by 30 in. diameter, and is fitted with two steam coils which increase the rate of filtration. By natural gravitation only 250 gallons of dirty oil can be filtered per week, but by the use of steam the amount can be doubled. The finish of the filter is up to Messrs. Wells' usual standard and the construction is very solid.



WELLS PATENT WASTE OIL FILTER No 6.

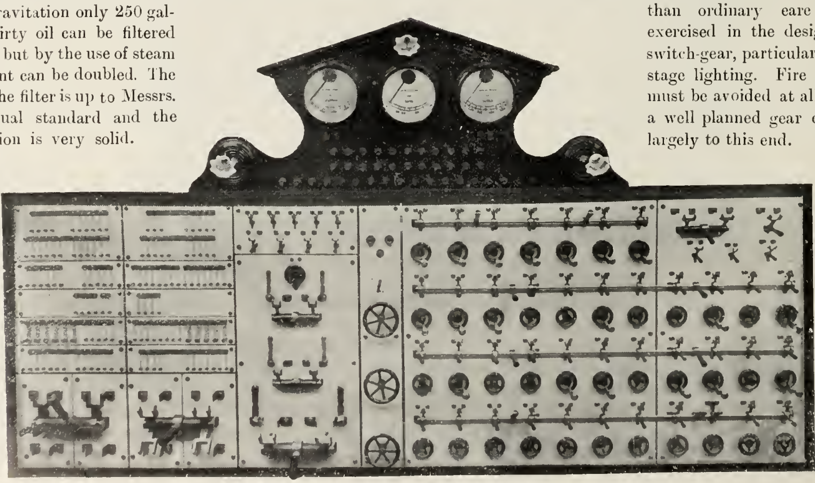
"Ediswan" Products. . .

WE have just received a copy of the Accessories catalogue of the Edison and Swan United Electric Light Co. and are pleased to note that a great advance in catalogues is marked by this issue. It consists of over 100 pages, well illustrated, and full of descriptive and explanatory matter of great interest to contractors and all who have occasion to handle electrical accessories.

The artistic reader will be mostly interested in pages 221 to 226, wherein are listed square base switches, with ornamental covers, and some most artistic switch plates and covers. It is in this direction of art covers and dainty fittings that the contractor must go, if he wishes to keep up his reputation for high-class work and earn the approbation of well-satisfied clients.

Central station engineers will appreciate the many advantages offered in the H.V. house service cut-outs, consisting of terminal type fuses, mounted on porcelain slabs, with binding thumbscrews, suitable for 25, 50 and 100 amperes, at any voltage up to 500. These have a very long break, and we note that, when ordered in quantities, the name of the supply authority can be cast, free of charge, in any convenient position.

We cannot close this brief review without mentioning the elaborate designs for switchboards, which occupy a considerable space. We illustrate one, which is typical of the "Ediswan" well-known style, which was supplied to Sir Charles Wyndham's theatre, for controlling 600 amperes. The supply is from two sources, entering the board at the two change-over switches in the lower left-hand corner. Above these are placed the main circuit fuses, and on the right of the board is arranged the dimmer gearing. The switches are placed above the various handles actuating the dimmers, and can be worked separately or in unison. The dimmers also can be controlled individually, or by a special interlocking gear can be worked all together from the three large hand-wheels on the centre panel. On the top of the board, below the meters, are arranged the signal lights, showing if the dimmers are handled correctly. The other switches are for the lighting of the theatre generally, and the whole board is well finished and of handsome appearance. Theatre installations are of considerable importance and more than ordinary care must be exercised in the design of the switch-gear, particularly for the stage lighting. Fire risks also must be avoided at all costs and a well planned gear contributes largely to this end.



General View of "Ediswan" Switchboard at Sir Charles Wyndham's Theatre.

"The Electrician" Company's Notices.

Engineering and Machinery Exhibition.—"The Electrician" Company will be fully represented at the Engineering and Machinery Exhibition, to be held at Olympia (London) from Sept. 15 to Oct. 17. At Stand 124A in the Central Avenue, near the Great Fountain, will be displayed and open for inspection by visitors to the Exhibition a very large assortment of Books and Publications on all Engineering and Electrical Subjects. Not only will the books forming the well-known "Electrician" Series of Standard Works be available for inspection and purchase, but the books and publications of all the leading British and American publishing houses (including Messrs. Macmillan & Co., Longmans, Green & Co., Harper & Bros., Whittaker & Co., Cassell & Co., and many others).

"The Electrician" Primers.—Occasion will be taken to make bold display of the complete set of 82 "Electrician" Primers, which are now ready for distribution, and of which already many thousands of copies of the separate Primers have been sold. Large orders for these Primers have been received from some of the principal technical educational establishments of the country, including 171 sets for the *Royal Military Academy at Woolwich*. In addition to thousands of the separate Primers, many hundreds of complete sets of volumes have been sold, although these volumes were only available for distribution a few days since.

A complete Prospectus of "The Electrician" Primers is now ready and will be sent post free on request.

New Books.—"The Electrician" Company have issued recently the following:—

"**Electricity Meters: Their Construction and Management.**" By C. H. W. Gerhardi. 220 Illustrations. Price 9s. net.

"**The Steam Engine Indicator, and Indicator Diagrams.**" (New and Enlarged Edition.) By W. Wosby Beaumont. Price 6s. net.

"**Motive Power and Gearing for Electrical Machinery.**" (New and Enlarged Edition.) By E. Tremlett Carter; revised in part by the Author and in part by G. Thomas-Davis. 200 Illustrations and folding plates. Price 12s. 6d. net.

"**A Handbook of the Electrical Laboratory and Testing Room.**" By Prof. J. A. Fleming, D.Sc. Vol. I. 12s. 6d. net. Vol. II. 14s. net.

"**Radio-Activity.**" By Fredk. Soddy. M.A. Fully illustrated. 6s.6d. net.

"**The Localisation of Faults in Electric Light Mains.**" By F. Charles Raphael. Price 7s. 6d. net.

"**A Pocket-Book of Electrical Engineering Formulæ, &c.**" By W. Geipel and H. Kilgour. Price 7s. 6d. net.

"**Secondary Batteries: Their Manufacture and Use.**" By E. J. Wade. Price 10s. 6d. net.

"**Primary Batteries: Their Construction and Use.**" By W. R. Cooper, M.A. Fully illustrated. Price 10s. 6d. net.

"**The Classification of Alternate Current Motors.**" By V. A. Fynn, M.I.E.E. Fully illustrated. Price 3s. net.

"**Æther: A Theory of the Nature of Æther and of its Place in the Universe.**" By Hugh Woods, M.D., M.A.O., B.Ch., B.A. Price 4s. 6d. net.

Forthcoming Books.—Amongst the new books and new editions which "The Electrician" Company will shortly have ready are:—

"**A First-Year Course of Practical Magnetism and Electricity.**" By Dr. P. Egerton Shaw, B.A., Senior Lecturer and Demonstrator in Physics at University College, Nottingham.

This novel elementary book comprises a large number of simple practical experiments which the first-year student will be well able to comprehend. Dr. Shaw's book is fully illustrated, is interleaved with ruled paper for the convenience of the student, whose pocket has also been considered in the published price of the book—3s. net.

The Electrician' Wireman's and Mains Superintendent's Pocket Book" will be ready in September. This is the second edition of this popular work, and Mr. F. C. Raphael, the editor of the Pocket Book, has completely revised and re-written it, adding much new and current matter and a number of new illustrations. It now forms a most complete and handy Pocket Book and Guide for the use of all engaged in electrical installation work.

A new edition of Mr. H. D. Wilkinson's book on "**Laying and Repairing of Submarine Cables**" is well forward, and we hope to publish this important work early in the New Year.

Mr. Oliver Heaviside's third volume of "**Electro-Magnetic Theory**" is making progress. Mr. Heaviside, having recently recovered from a serious illness, which has interfered with his work on the manuscript of the new volume, is now proceeding with the completion of his third volume.

Mr. W. Clark Fisher has nearly ready for the press a new edition of "**The Potentiometer and its Adjuncts,**" and the Company hope to publish this new edition early in the New Year.

Mr. J. Elton Young has in preparation a new edition of his well-known book, "**Electrical Testing for Telegraph Engineers.**" The new edition will include a considerable amplification of the original and the addition of new chapters relating to developments in telegraphic working, &c., which have recently been made.

"The Electrician" Electrical Trades' Directory and Handbook for 1907 (being the 25th annual publication of the **Big Blue Book**) is in preparation, and opportunity will be taken of the holding of the Engineering and Machinery Exhibition at Olympia to collect new names and addresses and corrections to existing entries in the Directory and Handbook, also to receive subscription and advertisement orders for the 1907 edition, which will contain many new features of interest to the engineering and electrical industries.

Further particulars will shortly be published concerning some of the new features of the 1907 Edition.

A complete Digest of the 1906 Edition will be available at the Exhibition, and a copy will be forwarded to any address post free on request.

Publishers and Booksellers.—"The Electrician" Company handle very large quantities of books and publications of all kinds, including, of course, and in particular, Technical Publications. By every mail the Company send out to foreign countries books and publications on all subjects, including Science and Technology, History, Biography, Travel, Fiction, &c., and particular attention is given to orders for regular or irregular consignments of literature, weekly parcels of newspapers, magazines, &c., and no trouble is spared to meet the requirements of the Company's customers at home and abroad.

Literary Bureau.—In this department members of the Company's staff are constantly assisting inquirers on electro-technical matters, particularly in connection with the supply of books on specialist subjects. The Company will be pleased at any time to reply by post, free of charge, to inquiries of this nature.

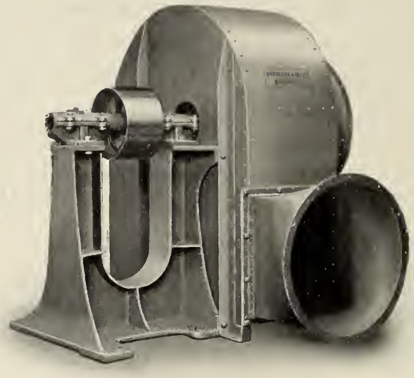
Printing and Publishing.—"The Electrician" Company are laying down further new machinery at their extensive works in Salisbury-court, Fleet-street, London, which are now being operated entirely by electric power. The addition of the new plant will enable the Company to considerably extend its field of operations in the execution of printing orders of any magnitude. Several extensions of premises have been necessary to cope with the expansion of this business in the past, and the Company have under consideration further considerable extensions.

The Company are prepared to tender for printing and stationery contracts of every description, including all kinds of Stationery and Office Sundries and Accessories, Account Books, Works Operating Books and Forms, Catalogues, &c., for the Engineering and Electrical Industries. This is a special section of "The Electrician" Company's business, and for nearly a quarter of a century a large and growing business has been done in this branch. The Company's extensive printing works and offices are especially equipped for Electro-technical work, and the large staff employed is peculiarly well acquainted with the special requirements of electro-technical printing.

Paper Coils of all Kinds.—"The Electrician" Company are open to tender at lowest market prices for all kinds of paper coils for Telegraphs, Recording Instruments, Cash Registers, Toilet Rolls, &c., &c. For many years the Company have supplied these goods to numerous clients in all parts of the world.

"The Electrician" Company's Offices and Works are situated in the heart of the printing and publishing trades in London, and the Company possess exceptional facilities for handling very large quantities of goods for expeditious dispatch to any part of the world. No order is too large or too small to secure the fullest attention in the different departments of the Company's business, which has been carried on at their present address since 1883.

Miscellaneous.—In filling orders for books, stationery, &c., for abroad the Company have for many years undertaken the supply of miscellaneous goods, including typewriters, typewriting sundries and accessories, copying apparatus and all accessories relating thereto, photographic apparatus and materials; in fact, all kinds of miscellaneous goods which can be obtained from manufacturers and dealers in the United Kingdom. These goods are carefully packed and are supplied at lowest market prices.



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NOTES.

As might have been expected, the subject of car brakes formed part of the programme of the Municipal Tramways Association meeting which has just been held at Leeds. The subject is one that is attracting much attention at the present time; but Mr. MOZLEY, whose Paper we give in the present issue, seems to have been rather injudicious in his wholesale condemnation of magnetic brakes as the result of experiments carried ont about three years ago. Magnetic brakes were not as perfect then as they are now, and considering the fact that such brakes have found a great deal of favour elsewhere, it would have been better if Mr. MOZLEY had first of all discovered why other people had found them successful. The burning out of armatures is generally taken as an indication that the motors are unsuitably proportioned for their work, rather than that a magnetic brake should be replaced by a hand brake—a form which has the disadvantage of being dependent on the exertions of the driver.

◆

ON Saturday last the Engineering Exhibition at Olympia was formally opened by Sir ALEXANDER BINNIE. It is surprising that no exhibition of this kind, omitting those restricted to electrical engineering, has been held in London since the day of the Inventions Exhibition, 21 years ago. This may be due, to some extent, to popular fancy, which is less attracted by mechanical appliances that are more or less readily understood than by electrical effects savouring of mystery; and, when all is said and done, the popular taste is an important factor in the success of such a venture. Sir ALEXANDER BINNIE, in his speech at the inaugural luncheon, was emphatic on the advantages of such exhibitions: although they may be regarded as advertisements they are an advertisement of the best class, where the best is shown; they bring together those who are working at the same problems, and, in the case of international exhibitions, they serve to reduce those national prejudices which are too often the result of ignorance.

◆

No doubt the most important point in such a venture is that it should pay—not merely the management, but the exhibitors. The general public are valued for their shillings, but the engineering few are essential for their orders. In this connection, the remarks of Mr. BENNETT BROUGH as to an exhibition of a local character held at Nüremberg are of interest. It appears that the sales for the whole exhibition amounted to £173,150, and that of the 19 groups into which the exhibits were divided the machinery section was the largest. We hope that the exhibitors at Olympia will obtain equally satisfactory results.

◆

AMONG other remarks of interest were those of Prof. SILVANUS THOMPSON, who, in responding for the visitors, put in a plea for a Students' Saturday at the Exhibition. Presumably the price for admission would be reduced, and the attendants at the various stands would undertake instruction without hope of reward; though, as far as that is concerned, such efforts cannot be looked upon as entirely thrown away, for the student soon passes out of student days into a position of more or less responsibility. From the educational point of view, however, it would certainly be well if something of this kind could be arranged, though Saturday is probably the least suitable day of the week, being that on which the Exhibition is likely to be most crowded. If any such arrangement is made we hope that electrical students will take full advantage of it, for, as remarked by Sir WILLIAM WHITE, mechanical engineering is the maid-of-all-work of engineering in general, and the best electrical engineers are those who have had experience of mechanical engineering.

There has been so much development recently in metal filament lamps that it becomes a little difficult to bear in mind exactly how the problem stands. Since the days when osmium was taken up by Auer von Welsbach, and the idea was received with some incredulity, every rare metal of high fusing point has been the subject of investigation, and tantalum, zirconium, tungsten, molybdenum, iridium and osram lamps have followed in quick succession. Under these circumstances it is very useful to have a general summary of the whole question, such as that by Dr. Böhm, of which we give a lengthy abstract elsewhere. The problem is complicated in the most recent form it has taken by chemical, or physico-chemical, methods of attack. Such bodies as colloids, hydrosols and gels are not very familiar to the average electrician, but these are dealt with in a simple way by Prof. Lottermoser in an appendix to this Paper.

◆

Wireless Telephony.—The Paris "Matin" announces that M. Maiche, who has been experimenting on wireless telephony for some time past, has been able to establish communication from Toulon to Ajaccio in Corsica.

Northern Nigeria.—We understand that active preparations for the construction of the telegraph line to Nimule are being made at Entobbe, Uganda, under the direction of Capt. W. T. Wallace, late superintendent of Southern Nigeria telegraphs.

The University of Zurich.—It is reported by the *Chemiker-Zeitung* that the authorities of the University of Zurich intend to make a substantial increase in the fees chargeable to foreigners for the University lecture and laboratory courses, in order to lessen the number of foreign students at the University, who at present form a high percentage of the total number.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Tarifa—Tangier	Jan. 18, 1904 ..	—
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906 ..	—
Môle St. Nicholas—Port au Prince	Aug. 16, 1906 ..	—
Sierra Leone—Conakry......	Sept. 12, 1906 ..	Sept. 14, 1906
Grand Canary—Lanzarote ...	Sept. 18, 1906 ...	—

The Electrical Contractors' Association.—A Paper will be read on Tuesday next, at 8 p.m., at Frascati's Restaurant, Oxford-street, London, W., before the London section of the Electrical Contractors' Association, by Mr. E. L. Berry, on "A New Method of Employing Twin Lead-covered Wire for Electric Light Wiring," when, we are asked to state, consulting engineers and municipal authorities who are interested are invited to attend.

Magnetic Survey of the Pacific.—The sailing vessel "Galilee," which is making the magnetic survey of the North Pacific on behalf of the Carnegie Institute, to which we referred in an article in *The Electrician* of August 3rd, p. 620, is reported to have run into the breakwater at Yokohama during a typhoon on August 24th. According to the *Electrical World* she was considerably damaged, but has been re-floated and docked for repairs.

Foreign Educational Appointments.—Prof. Wilhelm Wien has been offered the professorship of physics at the Berlin University in succession to the late Prof. Drude. Dr. Emile Bose, of Göttingen, has been appointed professor of physical chemistry at the technical college at Danzig, and Dr. Alfred Kalähne, of Heidelberg, is to be professor of physics at the same institution. Dr. Taddäus Godlewski has been appointed extraordinary professor of general and technical physics at the technical college at Lemberg.

Prize Offered for a New Accumulator.—A prize of 8,000 frs. is offered by the Association des Industriels de France contre les Accidents du Travail for an international competition in the design of a new battery or accumulator. The special features to be considered are lightness, facility of examination, simplicity in installing and safety during use. Designs are required to be sent in by the end of this year and competitors must be prepared, if required, to submit actual batteries for testing before April 1907. Inquiries should be addressed to the Director of the Association, 3, Rue de Lutèce, Paris.

Electrical Exhibition at Sheffield.—An exhibition of electrical machinery and appliances is to be held by the Corporation of Sheffield, at the Corn Exchange, from September 27th to October 20th, under the management of Mr. S. E. Fedden, Corporation electrical engineer. A representative display of appliances for industrial and other applications of electricity will be brought together, particular attention being paid to the local metallurgical and engineering industries. The exhibits in this latter section will include a Kjellin steel furnace and an electrical hardening and annealing furnace, both in operation. A portion of the profits of the exhibition will be devoted to local medical charities.

Wireless Control of Torpedo Boats.—A new apparatus for directing the movements of torpedo boats or other vessels from a distance has been brought out in Spain, under the name of the "Telekino," by Señor L. T. Quevedo. According to the *Daily Telegraph* a demonstration of the apparatus was recently given on the royal yacht "Giralda," before the King and Queen of Spain. A feature of the latest form of the apparatus is the provision of an automatic appliance which comes into action when the series of wave impulses ceases from any accidental cause, and stops the boat instead of allowing it to continue in the same course without control. The arrangement can be applied to the control of vehicles on land, in addition to ships and boats of all sizes and descriptions.

The Municipal Tramways Association.—At yesterday's meeting of the Municipal Tramways Association at Leeds Mr. J. M. McElroy (general manager Manchester Corporation tramways), was elected president for the forthcoming year, and Mr. J. Aldworth (general manager, Nottingham Corporation tramways) was elected vice-president. The scheme for amalgamation of the interests of the various tramway associations, which has been considered by a special committee during the past year, came up for consideration at the business meeting yesterday, but a resolution was passed that it was inadvisable to proceed further at present in the matter. A full account of Wednesday's proceedings appears in another part of this issue.

The Muspratt Laboratory at Liverpool.—The new laboratory of physical chemistry and electrochemistry, which has been presented to the University of Liverpool by Mr. E. K. Muspratt, will be opened by Sir William Ramsay, F.R.S., on Octber 13th, when a large number of English and Continental men of science will be present. Addresses will be given by Sir William Ramsay and Prof. Ostwald, of Leipzig. A very complete electrical equipment has been provided, including a 30 kw. motor-alternator, a 30 kw. continuous-current motor-generator, and a 10 kw. set for battery charging. These machines were supplied by Siemens Bros. Dynamo Works. The battery is composed of 36 Tudor cells. The new laboratory, which contains in all 21 rooms, is to be known as the Muspratt Laboratory of Physical and Electrochemistry, and is under the charge of Prof. Donnan.

Water Power in Norway.—It is stated in *Engineering* that the Norwegian Government has decided to introduce a bill regulating the exploitation of waterfalls in Norway. It is proposed to make installations of not less than 3,000 H.P., subject to royal consent first being given. The aggregate of Norway's water power is estimated at some 1,250,000 H.P., and of this total no less than 550,000 H.P. have already, it is asserted, been sold privately, or otherwise, to foreign capitalists and syndicates. The supporters of the Government proposal urge the necessity of keeping the control of the waterfalls, as the State railways are contemplating the introduction of electric traction. But there is some doubt as to the possibility of finding sufficient capital in the country to keep the development of anything more than a small proportion of the remaining power available in Norwegian hands.

Distribution at 4,600 volts at Toledo.—An unusual feature of the Toledo Gas, Electric & Heating Co.'s system at Toledo, Oregon, which is described in a short article in the *Electrical World*, is the use of 4,600 volts as a distributing primary pressure instead of the more usual voltages in the neighbourhood of 2,000. The high-pressure network, which is overhead, is three-phase, with the generator windings star-connected and the neutral point earthed. The transformers are distributed about the town, and the secondary network is at 115-230 volts. The same company also carry on a hot-water heating business. This was formerly supplied by the exhaust steam of the electric light station, but since the establishment of a new generating station equipped with steam turbines, this arrangement is to be abandoned and the heating system will be supplied with hot water direct from the boilers of the old station. Motor-driven centrifugal pumps will be used for circulating the hot water.

A Recording Apparatus for Electric Railway Tests.—An arrangement for obtaining simultaneous records of current, voltage, speed, &c., of electric cars is described in the *Street Railway Journal*. The paper strip is driven by a spring motor of the type employed in phonographs. The records are traced by pencils mounted on travelling carriages and each controlled by a cord passing round a pulley, attached to a disc carrying a pointer, which is caused by hand to follow the movements of the pointer of the voltmeter, ammeter, or other instrument, as the case may be. The disadvantage of the method is the necessity for a number of more or less skilled observers continually watching the instruments. A contact worked by a clock energises an electromagnet every half second, which marks a scale of time on the record, and each revolution of the car wheel is recorded in a similar way. The form of speed indicator employed consists of a small magneto-generator mounted on the truck and belted to one of the axles, in combination with an ordinary Weston voltmeter.

A Device for Stopping Cars on Grades.—The *Street Railway Journal* describes a somewhat novel arrangement which has been tried on a steep grade on one of the lines of the New Jersey and Hudson River Railway in order to avoid any possibility of a car running away down hill. The device consists of a length of track, arranged as a siding to the main line, and with its rails covered with sand to a depth of about 2 in. retained by timbers at the sides of the rails. The points at the beginning of this siding are always open to the main line, so that any car coming down the hill and unable to stop runs on to the sanded track and is pulled up by its resistance. In ordinary working the conductor has to get down and shift a point lever in order to remain on the main track. The rails of the sanded track are placed close alongside the main rails, so that there is no danger of derailing the car at the points. Some tests taken indicate that the sanded track will stop an ordinary passenger car running free at 17 miles an hour without any application of the brakes, within a distance of about 150 ft.

An Installation for the Utilisation of Blast Furnace Gases at Portoferrajo.—An interesting example of the utilisation of blast-furnace gases is to be found in an installation at the iron works at Portoferrajo, in the island of Elba, recently carried out by the Westinghouse Company. At these works, which are described in a recent issue of *L'Eclairage Electrique*, there are two blast furnaces producing respectively 200 and 350 tons of pig per day. Coke is obtained from a battery of 104 coke ovens arranged in two groups. The gases from both the blast furnaces and the coke ovens are utilised for power purposes, partly directly in gas engines and partly by heating boilers supplying steam engines. The engine room, which is 350 ft. long, contains the blowing engines for the blast furnaces, consisting of two steam engines of 1,200 H.P. and three gas engines, one of 1,500 H.P and two of 600 H.P. The generating sets, which produce the current supplying power to the different parts of the works, are situated in the same engine room, and comprise three 100 kw. gas-driven continuous-current sets, one steam-driven 200 kw. set, and an additional set of 350 kw. capacity driven by a gas engine is being installed. The blast-furnace gases which feed the gas engines and are used to heat the boilers pass through three Theisen purifiers driven by two 100 H.P. motors and one of 50 H.P. respectively. The boiler house contains six boilers, arranged so that they can either be heated by the furnace gases or coal fired at times when the furnaces are not working. A five-panel switchboard distributes the current to the lighting and power circuits. Electric motors are employed for driving the furnace-charging machinery and the pumps of various descriptions which are required about the works. A transmission line, about 2½ miles long, takes power to the pump house from which fresh water for the boilers is obtained. A 40 H.P. three-phase motor is used for this purpose supplied at 1,000 volts by an inverted rotary converter and a group of three single-phase transformers. Electric power is further applied to a group of cranes and a cable transporter at the landing stage for the reception of coal and ore, and to a small electric locomotive.

Tests of Electrically-driven Planers.—An article by G. H. Shaeffer and C. E. Butz in the *Electrical World* gives some results of tests of the power required for electrically-driven planing machines. The first test was on a 36 in. by 36 in. by 14 ft. planer driven by a 10 H.P. shunt motor running at 650 revs. per min., mounted on the top of the machine and driving through a Morse silent chain. The weight of planer table was 10,550 lb. The work consisted of a cut on nickel steel, the depth being $\frac{7}{16}$ in. and the length of cut $21\frac{11}{16}$ in. The time of the forward travel of the table was 5·43 seconds, and of return travel, 2·94 seconds. The following table gives the results expressed in watts :—

Table movement.	Total power applied to motor.	Loss in motor & gearing.	Loss in machine.	Power used in cutting.	Time of travel of table in seconds.
Forward to cut ..	6,800	2,650	4,150	..	..
Forward cutting.	9,030	3,400	4,140	1,490	5·7
Reverse	17,515	7,075	10,440	..	0·3
Quick return ..	6,800	2,650	4,150	..	2·4
Reverse to cut ..	8,400	3,140	5,260	..	0·3

By calculation it was found that 1,490 watts were used to cut the metal, out of a total of 9,030 watts supplied. This gives 16·5 per cent. of useful power, the rest being lost in motor, gearing and friction. One tool was used; a second one would have required approximately 16·5 per cent. more power. The total time for a complete cycle was 8·7 seconds, and the actual cutting took place during 4·86 seconds. Thus 56 per cent. of the time of whole stroke was employed in cutting. The overall efficiency of the machine was thus 16·5 × 0·56, or 9·2 per cent. Another test was made on a 48 in. by 48 in. by 12 ft. machine driven by a 20 H.P. compound-wound motor running at 975 revs. per min. The weight of the table in this case was 11,650 lb. The metal under cut was nickel steel. The depth of cut was $\frac{5}{16}$ in.; length of stroke, 4½ ft.; cutting speed, 28 ft. per minute. The time for the table to move forward was 5·64 seconds; to return 3·36 seconds, and 0·36 seconds for each reverse, making the total time for a complete cycle 9·72 seconds. One tool was used. The results are given below in watts :—

Table movement.	Total power supplied to motor.	Loss in motor and gearing.	Loss in machine.	Watts used to cut (net).	Time.
Forward to cut..	4,790	3,045	1,745	..	5·64
Forward cutting	5,360	3,062	1,750	548	..
Reverse	22,600	4,710	17,890	..	0·36
Quick return ..	13,950	3,620	10,330	..	3·36
Reverse to cut...	14,780	3,800	10,980	..	0·36

The friction and windage were taken with the gearing running light, as was also the stray power of the motor. These losses, together with the C^2R losses, were calculated. By subtracting the gearing and motor losses we obtain the net power used by the machine itself, and, by further calculating the difference between power taken in running with and without cutting, we obtain the actual power used to remove the metal. The stray power amounted to 2,700 watts. Thus only 548 watts out of 5,360, or 10·2 per cent. were useful in removing metal. Cutting took place 58 per cent. of the time of a complete cycle, giving an overall efficiency of 0·58 × 10·2, or 5·67 per cent.

SALFORD CORPORATION TRAMWAY ACCOUNTS.

A satisfactory result is again shown by the Tramways Department of the Salford Corporation for the year ended March 31, 1906, there being available, after payment of interest and sinking-fund charges, £13,000 for the relief of rates and £9,302. 1s. 6d. for depreciation and renewals. With the comparatively recent controversy on the question of running powers at Newcastle in mind, and the attitude taken up then by the Corporation there, the Salford undertaking, with its large surplus, affords a striking object-lesson of the beneficial effect of co-operation on the part of tramway authorities, for it has running powers over some 10 miles of line in Manchester, and works, jointly with the Manchester Corporation, some lines in Trafford Park. The total length of tramways worked by the Corporation at March 31st last is as follows :—

Salford	36½ miles.	Owned by Corporation.
Manchester	9½ miles.	Running powers by agreement.
Eccles	8 miles.	Leased to Corporation.
Swinton and Pendlebury	6¾ miles.	,, ,,
Prestwich	7 miles.	,, ,,
Whitefield	4½ miles.	,, ,,
Trafford Park	2½ miles.	Worked jointly with the Manchester Corporation.
Total	74¾ miles.	

The total energy used during the year for haulage, lighting of cars, &c., was as follows :—

	Units.	Units.
Supplied by Salford	6,804,095	
,, Manchester	1,103,798	
		7,907,893
Less recharged to Manchester	30,127	
,, ,, Bury	93,474	
		123,601
Total used by Salford cars		7,784,292

The car mileage run in connection with the above amounted to 5,228,675 miles, giving an average consumption of 1·48 units per car-mile. In this calculation the car mileage run in Trafford Park is not included, as the current is provided by the company and is not included in the operating expenses retained by the Corporation out of the income from the lines.

The gross profit for the year was £79,713. 4s. 11d., to which is added £2,105. 5s. 11d. for interest on investments, &c., making a total available balance of £81,818. 10s. 10d., and this has been dealt with as follows :—

	£	s.	d.
Payment to local authorities for running powers, &c.	£19,557	10	1
Interest and sinking fund charges	39,958	19	3
Contribution in relief of rates	13,000	0	0
Depreciation and renewals fund	9,302	1	6
Total	£81,818	10	10

Two special points of interest in the report may be referred to. The traffic receipts for the year show a satisfactory increase in the gross receipts, but a slight decrease in the earnings per car-mile—viz., 10·18d. as against 10·29d. for the previous year. The total number of passengers carried was 41,807,539 compared with 39,213,560 for the year 1904-5, and the total car-mileage run was 5,257,223 for 1905-6 against 4,884,590 for 1904-5.

In connection with the maintenance of the permanent way, experiments have been made during the year with the welding of the rail joints to overcome, if possible, the trouble arising from time to time, of "hammered" joints. These experiments have proved of a satisfactory character, and it is intended during the ensuing year to carry out this rail-joint welding process on a more extensive basis. Slight rail corrugation having made its appearance on several portions of the track, a rail-grinding machine was purchased and used with good effect. The manager states that special care is to be given to this matter, for it is hoped, by grinding down the rails on the first appearance of the corrugation, to minimise the trouble and inconvenience which is likely to arise therefrom.

An automatic point controller (Turner's patent) has been fixed at the junction of New Bailey-street and Chapel-street, and this having proved satisfactory it has been decided to further equip the system with automatic point controllers from time to time.

Below is given an analysis of the operating expenses in pence per car-mile :—

	Pence per car-mile.
POWER EXPENSES.	
Electric Current	2·217d.
Total power expenses	2·217d.
TRAFFIC EXPENSES.	
Salaries and wages	2·084d.
Cleaning and oiling cars	0·343d.
Cleaning rails and sanding track	0·032d.
Fuel, electricity, water, &c., for depots	0·053d.
Ticket check	0·155d.
Clothing, licence, &c.	0·088d.
Total traffic expenses	2·755d.
GENERAL EXPENSES.	
Salaries and wages	0·110d.
Rents, rates and insurance	0·335d.
Gas, electric current, water and cleaning offices	0·009d.
Accident expenses	0 153d.
Printing, stationery and miscellaneous	0·073d.
Total general expenses	0·680d.
REPAIRS AND MAINTENANCE.	
Cars	0·516d.
Permanent way	0·225d.
Overhead equipment	0·129d.
Buildings, fixtures and miscellaneous	0·060d.
Total repairs and maintenance	0·930d.
TOTAL WORKING EXPENSES (exclusive of capital charges)	6·584d.
CAPITAL EXPENDITURE, &c.	
Interest, &c.	1·030d.
Redemption of loans	0·794d.
Rents of leased lines	0·892d.
Depreciation and renewals fund	0·424d.
Total capital charges	3·140d.
TOTAL EXPENSES (including capital charges)	9·724d.

The traffic revenue amounted to £223,032. 18s. 3d., whilst the total revenue, including interest on investments, was £226,012. 19s. 5d. The working expenses were £144,194. 8s. 7d.; interest on capital (including income tax) £23,250. 9s. 11d.; and sinking fund £16,708. 9s. 4d. Deducting the sum paid for rents to outside authorities given above leaves a net balance of £22,302. 1s. 6d., which was disposed of, as mentioned at the beginning, between a contribution to the relief of rates and the allocation of a sum to the depreciation and renewals fund.

The following further statistical information is of interest :—

	£	s.	d.
Total borrowing powers	£1,172,642	9	3
Borrowing powers exercised	659,733	9	3
Unexhausted borrowing powers	512,909	0	0
Gross capital expenditure	657,564	7	0
Total amount of sinking fund in hand and unapplied	69,521	2	11
Amount of sinking fund applied in reduction of debt	37,477	5	9
Amount of depreciation and renewals fund	30,439	7	3
Percentage of working expenses to receipts	64·6%		
Average total revenue per mile of single track	10·31d.		

The rolling stock of the Corporation was as follows on March 31, 1906 :—

Double-deck single truck cars (two-motor equipment)	84
,, ,, ,, ,, ,, with outer deck covers	31
Double-deck bogie truck cars (four-motor equipment)	50
,, ,, ,, (two-motor equipment)	2
Combination type—bogie truck cars (two-motor equipment)	10
	177

There are, in addition, 14 horses, one watering and snow-sweeping car, two tower waggons, one constructional waggon, one reel waggon, one lorry, and three floats.

Pupin Cables in the United States.—A 90-mile underground telephone cable, provided with Pupin impedance coils every 2 miles, is being laid between Chicago and Milwaukee. The trenches are well advanced and the whole work is expected to be completed during next year by the Chicago Telephone Co

THE TELTOW CANAL AND ITS EQUIPMENT.*

(*Continued from page 846.*)

The Electrical Haulage.

On account of the great weight of the barges that this canal was intended to carry, some method of mechanical haulage was an absolute necessity. After many observations and experiments it was decided that steam tugs could not be employed on account of the damage done to the banks by the waves from the screws of the tugs. Some other method of haulage had therefore to be found which would give the necessary tractive effort and at the same time would be economical. Experiments made on the Finow Canal and on the Douai Canal showed that the actual cost of haulage by electrical "horses," or electric locomotives, was extremely small. The heavy charge, however, for laying a track and for the other necessary establishment charges for such a system made it necessary that the total weight of barges hauled should be very considerable, in order to make such a scheme financially successful; and as a first step to obtaining the maximum traffic possible, before undertaking haulage by electric power, a monopoly was obtained for the haulage of all barges that passed through the canal; no other method of haulage but that installed by the municipality of Teltow is allowed.

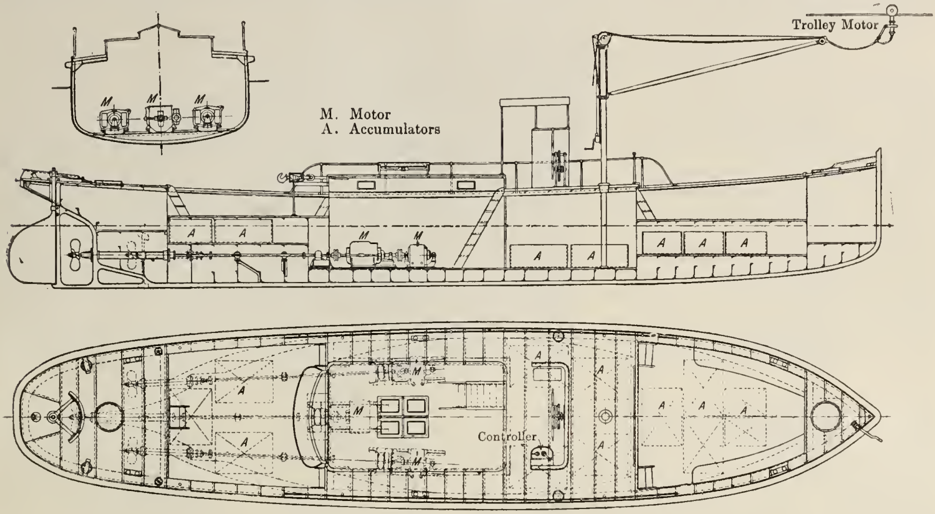

Fig. 9.—Electrically-driven Tug-boat "Teltow."

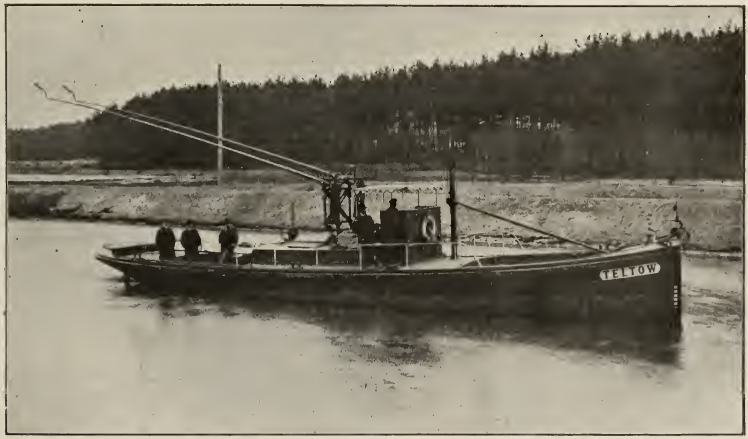

Fig. 10.—Electrically-driven Tug-boat "Teltow."

In a competition on the Finow Canal with a number of different methods of electric haulage, Messrs. Siemens & Halske were successful, and their system, as devised by Herr Köttgen, was adopted. The actual conditions on the Teltow Canal were, however, somewhat different to those at Finow on account of its greater section, and the actual system of haulage is considerably modified from that adopted in the initial trials. The general specification was somewhat as follows: A locomotive was required to run on a track of approximately 1 metre gauge to draw two standard barges of 600 tons capacity at a speed of at least 2½ miles per hour. The locomotive should, moreover, be so designed that, without external aid, the tow-rope could be carried over barges, either full or empty, lying by the canal banks, without stopping; and, lastly, should be so arranged that one man could perform all necessary operations. In the autumn and winter of 1903-4 a number of experiments were therefore made on a completed section of the canal at the Havel end, and locomotives were built. The results of these experiments have been described before,* but may be summarised as follows. At a speed of 2½ miles per hour a resistance of 1·9 lb. per ton of net load was found, an expenditure of 0·014 kw. per ton was required and an energy expenditure of 5 6 watt hours per ton-mile was taken. At 2·8 miles per hour the corresponding figures were 2·29 lb. per ton, 0·021 kw., 6·8 watt-hours per ton-mile; and at 3·1 miles per hour, 2·98 lb. per ton, 0 0284 kw., and 8·4 watt-hours per ton-mile. The working efficiency of the locomotive was 65 per cent. Tests were not made at higher speeds as it was determined that with speeds greatly in excess of 3 miles per hour the damage caused by waves from the barges on the banks would be excessive, although the ratio of canal section to barge section is over five.

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* Based on articles which have appeared in the *Elektrotechnische Zeitschrift*. Blocks for Figs. 10 and 14 have been supplied by Herr Julius Springer, of Berlin.

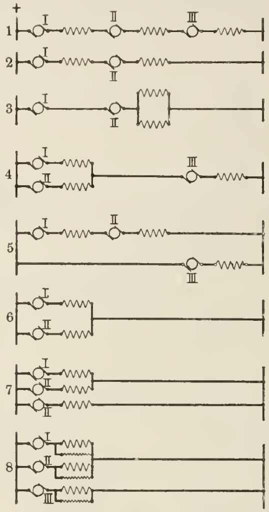

Fig. 11.—Grouping of Motors on Tug-boat "Teltow."

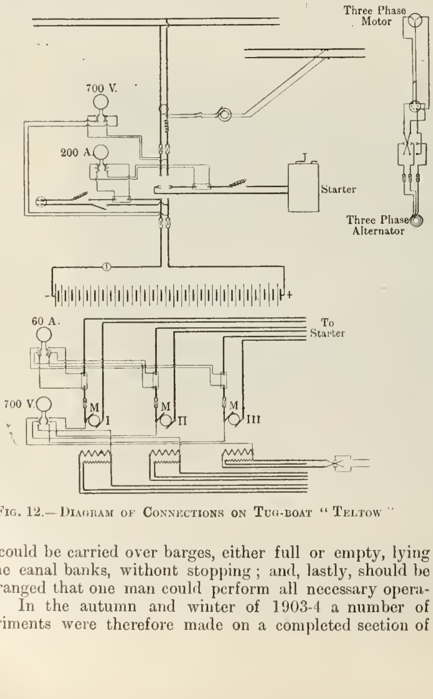

Fig. 12.—Diagram of Connections on Tug-boat "Teltow"

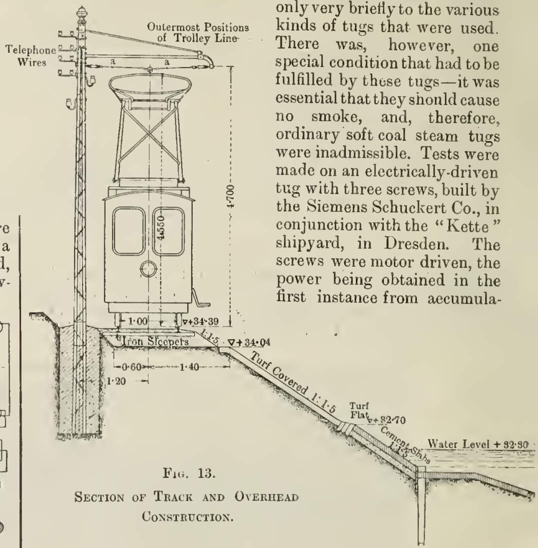

Fig. 13.

Section of Track and Overhead Construction.

Included in the canal are two long stretches of lake, the Griebnitz Zee and the Machnow Zee, through which the barges have to pass. The expense of constructing a tow-path through them was, of course, prohibitive, and, therefore, at the same time that tests on locomotives were carried out, a number of tests were made with tugs having different sources of motive power. These experiments are to be repeated and extended in scope during the next few months, and it will be necessary, therefore, to refer only very briefly to the various kinds of tugs that were used. There was, however, one special condition that had to be fulfilled by these tugs—it was essential that they should cause no smoke, and, therefore, ordinary soft coal steam tugs were inadmissible. Tests were made on an electrically-driven tug with three screws, built by the Siemens Schuckert Co., in conjunction with the "Kette" shipyard, in Dresden. The screws were motor driven, the power being obtained in the first instance from accumulators carried on board the tug; in other experiments an ordinary double overhead trolley was used, and in the third place a special motor-driven collector, according to a design of Lombard-Gerin. In addition, a petrol or spirit motor-boat, containing a 60 h.p. Daimler motor, designed by Herr Georg Apel, of Berlin, and also a suction gas-producer boat built by Messrs. Körting. Fig. 9 shows a plan and Fig. 10 a general view of the tug "Teltow." The boat was divided into six compartments; the two end ones were used for trimming the boat, and the second, third and fifth contained a battery of 220 cells of 244 ampere-hour capacity at a five hours rate of discharge. The total weight of the battery was 11 tons. The charging of it was effected direct from an overhead trolley arranged to connect with the ordinary locomotive trolley line. In the fourth space there were three series-wound motors, the middle one with a capacity of 25 h.p. and the two outer ones of 20 h.p. The drive was direct, without intermediate gearing, and the speed of the screws was therefore high (varying between 202 and 536 revs. per min. for pressures between 120 and 115 volts on the motors), and their diameter is small. By placing the propeller shafts low, the screws lie well under the surface of the water and waves are therefore diminished; also by the use of the two outer screws the boat manœuvres extremely well. The various connections to the motors for varying speed are shown in Fig. 11, and it will be seen that positions 2, 3 and 6 work only the outer screws. The circuits are so arranged (see Fig. 12) that the motors may be driven either from the accumulators or from an overhead line. To the overhead line, connection may be made either through two long trolley poles or by the Lombard-Gerin collector. In the latter arrangement a small induction motor is fitted to the collector and drives it along, as in the well-known trolley omnibus system. This motor is fed from a small three-phase motor-driven dynamo placed on board the tug; the speed of the driving motor is varied by changing the field resistance so as to make the collector run at the same speed as the boat.

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* "Glasers Annalen für Gewerbe und Bauwesen," Berlin, 1904.

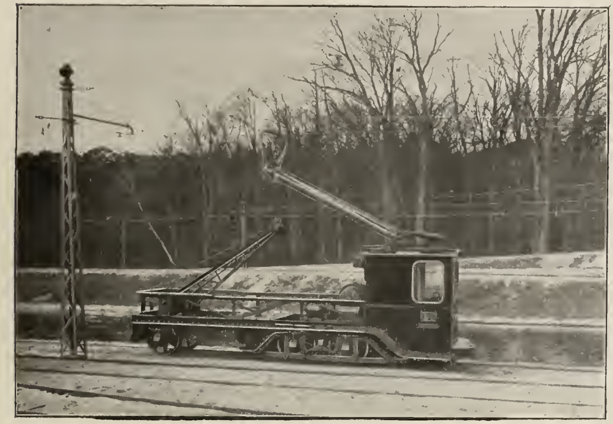

Fig. 14.—General View of Electric Tractor.

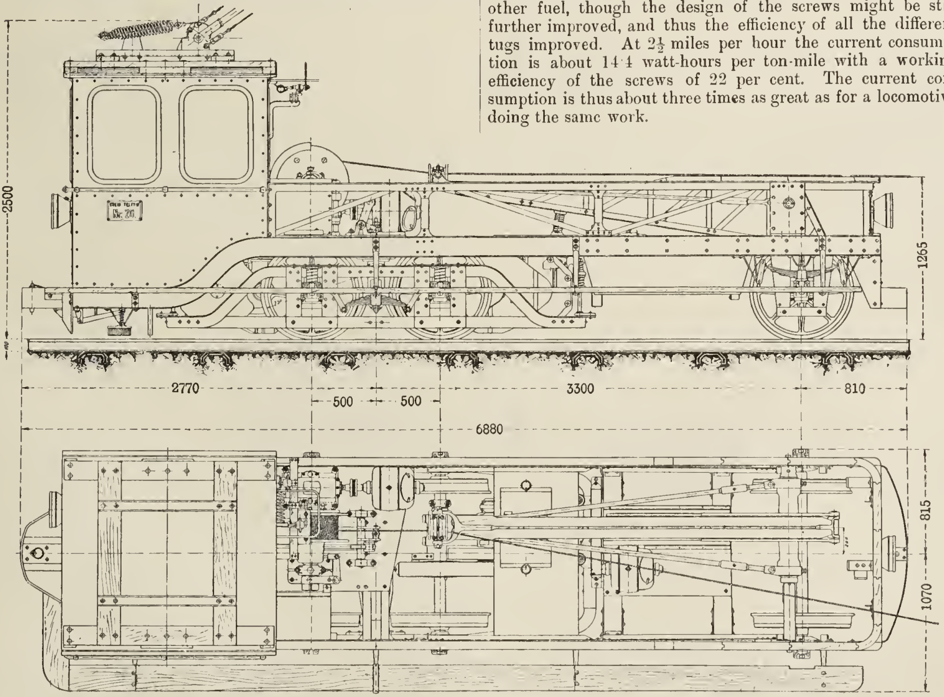

Fig. 15.—Electric Tractor.

The trolley arms for the tug, which collected current direct, were 33 ft. long and were attached to a central mast round which they could pivot, so that the boat could, if necessary, turn round with the trolleys stationary. The poles for supporting the overhead lines used for the direct trolley collectors were placed 164 ft. apart, while those for the Lombard-Gerin system were 98 ft. apart. The experiments showed that accumulator driving was quite satisfactory, as far as technical difficulties were concerned; with the Lombard-Gerin system, considerable trouble was found in efficiently controlling the speed of the collector; while with the direct trolley the risk of the trolley running off the line was too great.

As regards efficiency, the current consumption in the electric tug could not compare with that used by electric locomotive; with cheap current obtained, for example, from water power, the electric boat compared favourably with a steam tug or tug driven by other fuel, though the design of the screws might be still further improved, and thus the efficiency of all the different tugs improved. At 2½ miles per hour the current consumption is about 14·4 watt-hours per ton-mile with a working efficiency of the screws of 22 per cent. The current consumption is thus about three times as great as for a locomotive doing the same work.

In the tests with the tug equipped with a spirit motor, which were continued only for a short time, the consumption of motor spirit was about 0·01 kg. per net ton-kilometre. With spirit costing 2½d. per kilogramme, the cost of fuel exclusive of oil is 0·04d. per ton-mile, and the use of such a method of haulage is, therefore, economically impossible.

With the suction gas-producer tug the tests could not be carried far, as the makers, Messrs. Körting Bros., at an early stage came to the conclusion that the motor fitted to the boat was not well adapted for the purpose. These tests, therefore, are only to be regarded as preparatory. A tug with suction gas-producer plant was tried with a Finow barge (250 tons) and gave a very small consumption of anthracite, but the difficulties met with in connection with the machinery were such that this method of haulage was considered to be hardly possible in practice at present.

The last tests were made with an ordinary steam tug whose boiler was heated with liquid fuel. The well-known Körting method of heating was used, in which the oil is sprayed through a jet. A complete and smokeless burning of the oil, and at the same time great economy, was obtained by the use of a special feed-water heater, and in the last test boat the boiler was also fitted with a special smoke box super-heater. The consumption of fuel was about 0·5 kg. per 48 hours, which, at a price of 3·40m. per 100 kg., costs 1·7pf. With a tug of 100 H.P. capacity the cost of fuel is 1·7m., and this will draw a load of 1,200 tons at $2\frac{1}{2}$ miles per hour, so that the cost of fuel per ton-mile is about 0·008d.

On the greater part of the canal tow-paths are made on each bank, on which a track of 40 lb. rails of 1 metre (3·28 ft.) gauge are laid on iron sleepers made out of rolled plates bent at the ends. The rails are bonded by copper strip under the fishplates. The overhead conductor is similar to that used on an ordinary street tramway; the trolley wire is, however, of 8 section, and is supported on girder poles of varying height. The construction is shown in Fig. 13. On open stretches the average height of the trolley line above the rails is 14 ft. 9 in. At harbours and landing places the conductor is put somewhat lower, so that cranes can the more readily work over the top of the wire; or else the trolley line is put about 18 ft. above the rails, so as to allow the cranes to be operated underneath the trolley line. At bridges the greatest height allowed is 9 ft. 10 in., so that when the necessary wood covers have been fitted the trolley line is only 8 ft. 6 in. above the track. The current collector for the locomotive (shown in Fig. 13) must, therefore, be specially built to allow for these large variations in the height of the trolley line. The collector is built up out of iron gas pipes with cross stays; at the upper end is a bearing, and in these bearings a shaft turns which forms part of the current collector bow. When the trolley line either falls or rises, the bow merely moves backwards or forwards with reference to the locomotive and the supporting shaft falls or rises with it. The electric locomotive is shown in Figs. 13 and 14. The driving of the locomotive

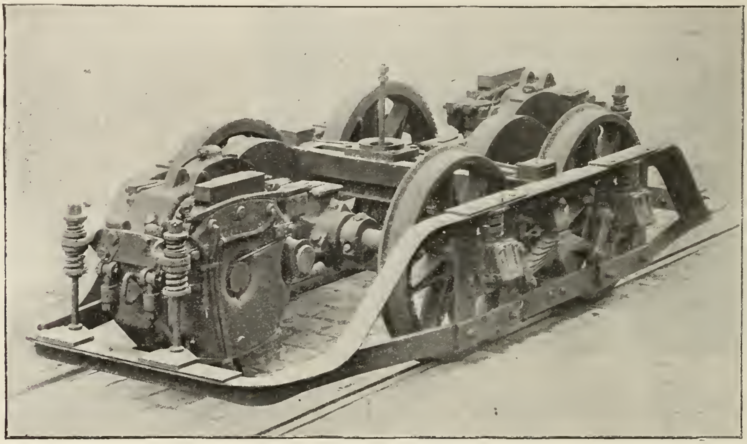
Fig. 16.—Driving Bogie of Tractor.

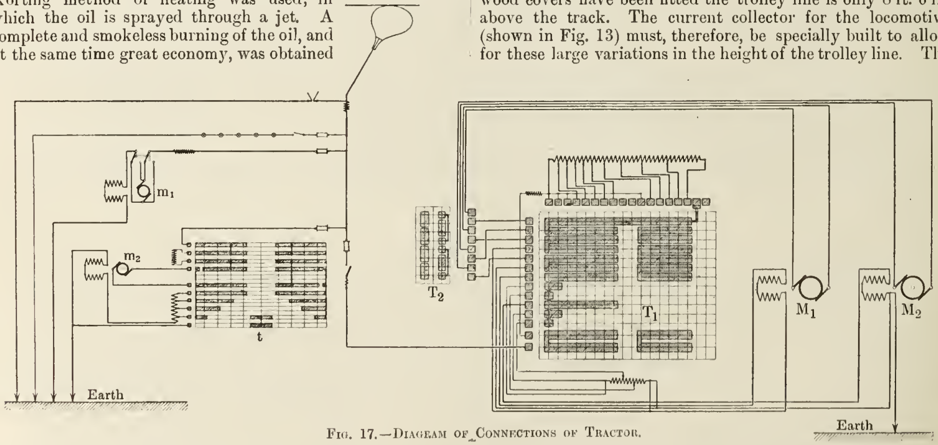

Fig. 17.—Diagram of Connections of Tractor.

is effected by a main driving bogie (see Figs. 15 and 16), both of whose axles are driven through double spur-wheel gearing by an 8 H.P. (continuous load) series-wound motor of 550 volts and running at 800 revs. per min. The frame is built up of iron girders and angle iron, and carries a pair of trailing wheels as well as the driving bogie. The motors are so designed that the locomotive will run for six hours continuously at full load without overheating, the motors, of course, having no time for cooling at stopping places, as with an ordinary street tramway. Across the main truck is a shaft running in bearings bolted to the framework, which supports the lower end of the towing mast. This mast can be raised or lowered by a 3 H.P. motor, working through a screw and pinion; at its upper end is a collar through which the tow-rope—a steel wire rope about 0·4 in. in diameter—passes. The end is wound on to a drum which also may be turned by means of a 3 H.P. motor running at 1,460 revs. per min. The winding drum is not keyed directly to the shaft, but is attached through a friction clutch made up of a number of plates which may be pressed together more or less tightly. The pressure between them is usually such that a pull of 1·2 tons at the drum causes it to turn on the shaft; at starting, when a fully-loaded 600 ton barge may give a pull of about 2 tons, the rope will run out from the drum and the locomotive will be saved all unnecessary shocks. The friction clutch can, if necessary, be entirely freed by hand, so that the locomotive can run forward free of the tow-rope. The towing mast is only raised when it is necessary for the tow-rope to pass over barges or other obstructions which may be lying by the banks of the canal; if it *is* raised, the moment of the force tending to overturn the locomotive is increased, and for this reason the point at which the pull is applied to the tow-rope is normally kept as low as possible. On account of the bridges the highest barge permissible is one the top of whose towing mast, when empty, is less than 13 ft. above the water-level. The length of the towing mast on the locomotive is so chosen, therefore, that the rope can be raised up to 12 ft. 4 in. above the level of the rails, and thus be carried clear of any barges lying by the canal banks. The pull on the tow-rope is oblique, and tends to tilt the locomotive sideways on the rail nearest the canal banks and backwards on the trailing wheels. In order to avoid the second effect as much of the weight of the locomotive as possible is put on the forward wheels, and to prevent a sideways tilt the heavier parts of the equipment are placed on the landward side of the locomotive. Besides this the water-side rail is laid $\frac{7}{8}$ in. above the level of the landward rail. The distribution of the weight is as follows: About 1·9 tons on the landward and 1·35 tons on the water-side pair of driving wheels; 0·55 tons on the landward, 0·39 tons on the water-side trailing wheels. As the view of the locomotive shows, the design differs somewhat from that used on the Finow Canal. All mechanical contrivances for winding up the tow-rope and for raising and lowering it have been got rid of, and electric motors now do all the necessary work. This gives far more effective control, and enables one man to do easily all that is necessary in connection with one machine. Locomotives of smaller weight and higher efficiency have been designed, but when it is remembered that the cost of energy is only about one-fifth part of the total cost of electric haulage, allowing for interest and depreciation, and assuming the normal traffic expected on the canal, it will be seen that this question is one of comparatively little importance.

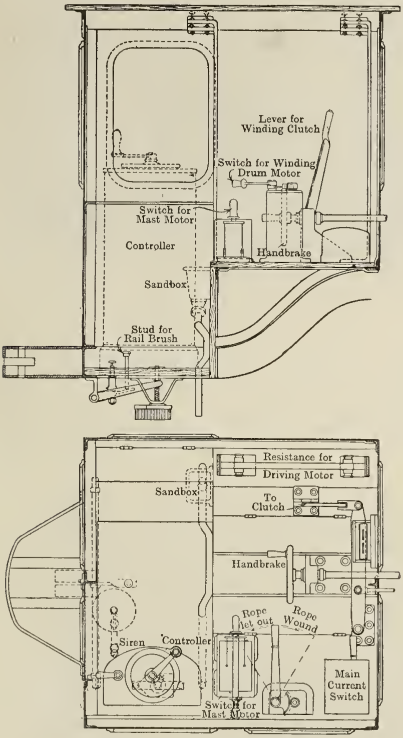

FIG. 18.—ARRANGEMENT OF CONTROL GEAR OF TRACTOR.

At the forward end of the locomotive is the driver's cabin, fitted on all sides with large windows for observing the track, tow-rope and barges. Electric light is also fitted inside the cabin to facilitate examination of the switch gear. The circuits in the locomotive are shown in Fig. 17. They are so divided that the current, after passing through the protective choking coil, passes first to the motor for raising or lowering the towing mast. This motor is switched on direct through a resistance, and is fitted merely with a reversing switch for changing the direction of motion, second to the motor for turning the rope drum. This is arranged in series with a resistance containing a number of steps so that the speed of the drum can be regulated according to the speed of the locomotive and the barge, and the speed of the barge may be gradually changed as desired. Thirdly, connection is made to five 16 c.p. lamps for 110 volts, arranged in series; and lastly, through a fuse and automatic cut-out, to the controller for the two driving motors. These are arranged as in the ordinary tramcar with series parallel control. There are six series steps and three parallel steps; the last is the running position for very light barges; there are also three other steps in which resistance is placed in parallel with the field magnets—the first position for light barges, the second for heavy barges and the third for running unloaded. By this means the speed of running with barges is between 2·5 and 2·8 miles per hour, giving an average of 2·6 miles per hour. Without some arrangement giving a variable running speed, the differences in speed for barges carrying different loads would have been far too large with the series-wound motors employed; to keep the speed more constant shunt-wound motors were originally suggested, but other reasons militated against their adoption. Each circuit is protected with fuses, an automatic cut-out being placed only in the main motor-circuit.

The locomotive is also fitted with a siren, rail cleaner, sand box and hand brake. A mechanical brake is not required for the low speeds at which the locomotive runs.

The arrangement of the driver's cabin is shown in Fig. 18, and it will be seen that ample space has been allowed. The normal load for the locomotive is two standard barges, each of 600 tons capacity, and these are towed at a speed of 2·5 miles per hour, the tractive effort exerted being approximately 1 ton. Four Finow barges with a net total load of 800 tons are towed at a speed of about 2·8 miles per hour.

(To be continued.)

OSCILLOGRAPHS AND SOME OF THEIR RECENT APPLICATIONS.

BY DAVID A. RAMSAY.

The recent developments in the use of alternating currents, and especially of high-tension and extra-high-tension currents for the transmission of power over long distances, has rendered necessary a study of the phenomena which occur in such cases.

Many of the methods which are applicable in the case of continuous currents, and have rendered measurements in connection with them capable of such a high degree of precision, fail completely when alternating-current measurements are in question. It is also true that many factors, such as capacity and inductance, which are of small importance in the case of continuous currents, are of the greatest importance in dealing with alternating or rapidly-fluctuating currents.

It is the purpose of the following notes to point out several such problems which the Duddell oscillograph is particularly well adapted to investigate, and to give one or two examples of some results that have been obtained. This instrument is manufactured by the Cambridge Scientific Instrument Co. in various forms with a very complete range of accessories, and an attempt will be made to show the form of instrument best suited to the several different classes of research or demonstration in which it may be profitably employed.

An oscillograph may be described as a moving-coil galvanometer of very short period, the deflection of which at any instant is practically proportional to the current flowing through it at that instant, in spite of the fact that the current may be varying very rapidly in strength and in direction. It must be critically damped, as any tendency to overshoot would distort the wave form from its true shape.

The original idea of the instrument is due to M. Blondel, who pointed out in 1893 the principles on which such an instrument should be designed, but to Mr. Duddell is due the credit of developing the instrument into its present form as a practical commercial instrument.

The moving or vibrating part of the instrument consists practically of a single pair of fine phosphor-bronze strips kept under considerable tension in a strong magnetic field. Across these strips a very small and light mirror is fixed. A beam of light from an arc lantern, or other source of intense light, is thrown on to this mirror and reflected from it on to a suitable screen. Thus when a current is sent through the strips the deflection of the mirror causes the spot of light reflected from it to move; the displacement from the zero position being a measure of the current. If the screen is also moved in a direction at right angles to the motion of the reflected spot of light, a curve is traced out by the spot of light which shows the instantaneous value of the current of any instant. In this way the P.D. and current curves of an alternating supply are obtained.

In all large schemes where power is distributed over a considerable area one of the largest items in the capital cost, as well as in the cost of upkeep, is that of the distributing cables. This is especially the case in this country, where overhead transmission is rarely employed. A knowledge, therefore, of the strains to which the insulation of the cables may be subjected is of great importance. This information is most readily obtained by studying the shape of the P.D. wave by means of the oscillograph. It will be obvious that it is only when the actual shape of the wave form is known that the relation between the root mean square value of the voltage and the maximum value (which is the important point in so far as the insulation of the cables is concerned) can be found. This is important on high-tension systems and it is equally important that the experiments should be carried out on the primary or high-tension circuit. Transformers frequently alter the shape of the wave and fail altogether to reproduce higher harmonics which may be of great importance.

With this point in view, a special oscillograph set has been designed for use on high-tension circuits, a view of which is given in Fig. 1. In this oscillograph the magnetic field is produced by means of a strong permanent magnet, so that the only connections to the oscillograph are those from the vibrating systems to the circuit to be investigated. It is thus easy to effectively insulate the instrument.

In the outfit illustrated this insulation is provided by placing the oscillograph on a tall corrugated porcelain insulator. It has also a porcelain cover while the possibility of brush discharge to the case is further provided against by having a large porcelain plate between the instrument and the case. Behind the oscillograph there is a large high-tension insulator for the purpose of supporting the leads to the oscillograph. With this outfit circuits of high potential up to 30,000 volts may be safely studied. Fig. 2 shows the instrument with cover on ready for work. As the oscillograph itself presents some new features it is shown more in detail in Figs. 3 and 3A. All the working parts are enclosed in a strong metal case, which has iron pole-pieces let into the sides to concentrate the magnetic field. This case is filled with the damping oil and is provided with an oil-tight lid. The two vibrating systems are also quite distinct from each other and can be removed independently for repair. One of these with one side removed is shown in the figure. As each vibrating system is made as simple as possible no special skill is required to repair it, any reasonably skilled experimenter being able to re-suspend it complete in about a couple of hours. Anyone who has endeavoured to re-suspend vibrators of the double high-frequency type will realise what a great improvement Mr. Duddell has introduced in this new simple vibrator.

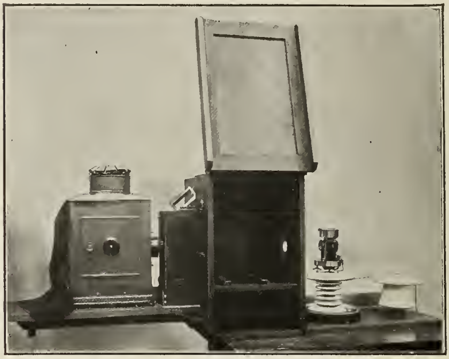

Fig. 1.—Oscillograph for High-tension Work, with Cover of Instrument removed and Cinematograph Film Camera in position.

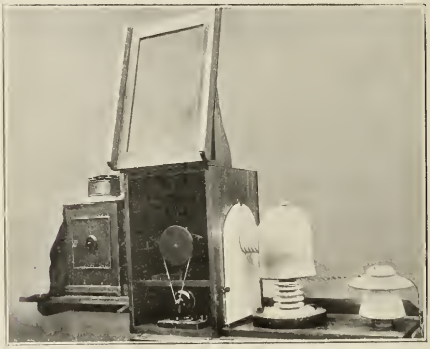

Fig. 2.—Oscillograph for High-tension Work, with Cover of Instrument in position.

By means of a screw the spots may be adjusted in azimuth, and by a second adjustment the whole vibrator can be tilted through a small angle, so as to bring the spots into the same horizontal plane.

When such high tensions as those mentioned above are used it is, of course, necessary to provide a large non-inductive resistance to put in series with one pair of strips to obtain the P.D. wave. For this a special type of resistance, patented by Messrs. Duddell & Mather, is made. This consists of fine silk-covered wire woven with silk in the form of cloth and immersed in insulating oil, thus providing a large resistance in a compact form and free from inductive or capacity effects. To obtain instantaneous photographic records, such as the wave form of an alternator, with this apparatus a plate allowed to fall down a slide under the action of gravity is employed, the height through which the plate falls being suitably adjusted to the frequency. The instrument is also provided with a set of revolving mirrors driven by a small motor (see Fig. 2) in which the curves may be visually examined, even while the photograph is being taken.

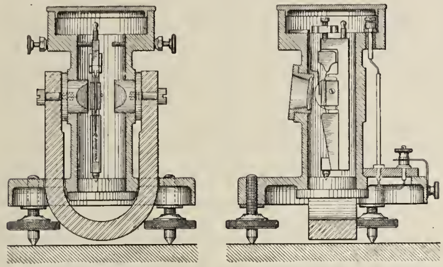

Fig. 3.—Permanent Magnet Oil Bath Oscillograph for High-tension Work.

As an example of the practical value of such a study of the wave form the following actual case is of interest. An investigation by means of the oscillograph being made on the alternators of a well-known supply company revealed the fact that one of the 5,000 volt generators had rather an abnormal wave form, which is shown in Fig. 4. When connected to lightly-loaded cables the irregularities were greatly magnified by the capacity of cables, and the result was the curve shown in Fig. 5, which shows that in proportion to the power conveyed by the cables the strain on their insulation was very high.

As a result of this investigation the shape of the pole-pieces of the generator was re-designed and the wave-form made almost completely sinusoidal.

In some cases, however, such as at the moment of switching on or off a high-tension cable, quite abnormal conditions are produced,* which it may be even more important to study than the shape of the waves under ordinary conditions. For this purpose a simple form of cinematograph film camera is provided.

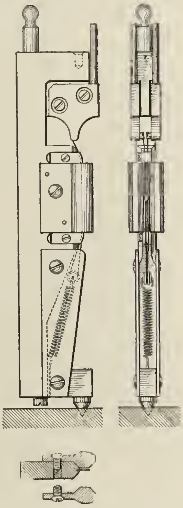

Fig. 3a.—Vibrator of Oscillograph.

The case of the falling-plate instrument is provided with an aperture, into which the cinematograph camera (Fig. 1) slides up to a shoulder, and in this position the plane of the film occupies the position previously occupied by the falling plate. The latter can thus be replaced by the film camera very quickly without interfering with any other of the instrument adjustments. The camera can be used with films or negative paper, the latter rendering the photographs comparatively inexpensive. With it any length of film up to 200 ft. may be exposed, thus enabling transitory phenomena, such as that mentioned above, to be investigated. As an example of a record of this kind Fig. 6 is interesting as showing the great rise of potential on switching off a high-tension feeder. This arrangement is also particularly suitable for the study of the important question of the performance of air-break and oil-break switches. By this means Mr. Duddell has shown that switching off the same cable as in Fig. 6 under the same conditions, with the exception that the contacts were under oil, no rise of potential at all was obtained, thus proving in this case the great superiority of oil-break switches.

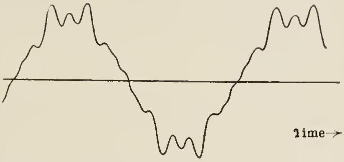

Fig. 4.—P.D. Curve of 5,000 Volt Three phase Generator.

Another cause likely to lead to the breakdown of high-tension cables is the presence of resonance. This is most likely to occur with generators whose E.M.F. waves contain higher harmonics. Should such conditions cause the breakdown of a cable at one point, oscillations are likely to be set up in the rest of the circuit of a very dangerous character, and may easily cause the breakdown of much valuable plant and a total interruption of supply. This point has been discussed to some extent by Mr. Field,* who emphasised the importance of every engineer becoming acquainted with the conditions under which resonance is likely to occur in the system under his charge, so that such conditions may be carefully avoided.

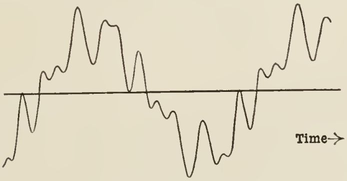

Fig. 5.—P.D. Curve of 5,000 Volt Three-phase Generator.

The reactions between alternators running in parallel is another case in which the wave form is of great practical importance, and can be best elucidated by means of the oscillograph. To run satisfactorily in parallel, the wave forms of the different alternators should not differ greatly in shape, and, in cases where machines run badly, the cause may usually be found by means of oscillograph tests and the necessary remedy indicated.

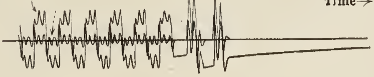

Fig. 6.—P.D. and Current Curves of Alternator, showing Effect of Switching off High-tension Feeder.

There are many other problems of a similar kind in which the oscillograph may throw light, such as the effect of different kinds of load on the wave form, &c. Messrs. Constable and

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* See Paper by W. H. Patchell, *Proceedings* of Institute of Electrical Engineers, Vol. XXXVI., and discussion thereon, and *The Electrician*, Vol. LVI., pp. 341, 382, 420, 459, 539.

* See Paper by Mr. M. B. Field, read before the Glasgow Local Section of the Institution of Electrical Engineers, Feb. 10, 1903, and *The Electrician*, Vol. L., pp. 979, 1,031, 1,068.

Fawsett* remark in the course of a Paper read by them before the Institution of Electrical Engineers that "the curves obtained serve to emphasise what is often not fully realised—namely, that the wave form obtained from any given alternator is almost as largely dependent on the kind of load it is called upon to carry as upon the design of the alternator."

Figs. 7 and 8 are the curves of P.D. and current of an open-type hand-feed alternating arc lamp, in the first case in series with a non-inductive resistance, and in the second with a choking coil.

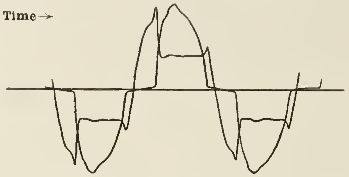

Fig. 7.—Alternating Arc in Series with a Non-inductive Resistance.

It has been found † that the luminous efficiency of the alternating-current arc is about 40 per cent. higher when supplied from an alternator with a flat-topped E.M F. curve than from a machine with a peaked curve. Where arc lighting forms a considerable proportion of the load it is therefore important to select an alternator having a suitable wave form. On the other hand, transformers give a better efficiency with a peaked wave form.

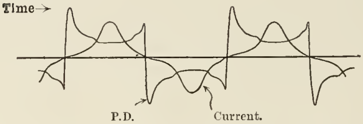

Fig. 8.—Alternating Arc in Series with a Choking Coil.

Another direction in which the oscillograph has lately been successfully employed is in connection with telephonic research.

In this case the pattern usually employed is what is called the high-frequency type. In this instrument, the vibrating system of which is now completely immersed in oil, the free period of the vibrating system is only $\frac{1}{100000}$th of a second, and it is rendered accurately dead-beat by means of the damping oil, so that it is well adapted for investigating the very rapid fluctuations of the current caused by speaking into a telephone. The recording apparatus usually consists of a falling-plate photographic camera. For such records the falling-plate camera is usually fitted with a special slow-speed slide in which the speed, with which the plate falls, can be varied within wide limits by means of a counterpoise.

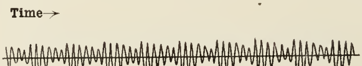

Fig. 9.—The Sound of "A."

As an example of the performance of this type of instrument Figs. 9 and 10 are of interest. In each case the time scale is about 160 cm. per second. Fig. 9 shows the current produced in a telephone on making the vowel sound of long "a" as in mā. Fig. 10 is the sound of "o" as in no.

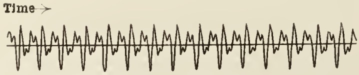

Fig. 10.—The Sound of "O."

For further examples of such diagrams the reader is referred to the inaugural address to the Institution of Electrical Engineers in 1905 by John Gavey, C.B.,* Engineer-in-chief to the G.P.O , where there will be found many diagrams of different letters as well as the effect on the curve of 1 mile and also of 20 miles of standard telephone cable.†

This application of the oscillograph is only of very recent date, but it offers a promising field for research, and may reasonably be expected to result in the extension of the distance over which the telephone can be employed.

Amongst the many other uses to which the high-frequency type of oscillograph has been put, one or two will be briefly referred to. One is that of investigating the characteristic curves of medical induction coils.‡ By its means Drs. Head and Lewis Jones have shown that the duration of the wave is the chief factor in determining the painful or painless character of the current, and that the presence of iron in the coil produces a marked effect in increasing the length of time which these momentary currents last.

This type of oscillograph has also been successfully employed by Mr. W. R. Cooper§ to investigate the phenomena occurring during electrolysis by alternating current. In a Paper read before the Faraday Society on October 31, 1905, he showed a number of extremely interesting curves showing what happens under varying conditions as to applied E.M.F. and current density. He has kindly permitted the writer to reproduce one of these, which is shown in Fig. 11. This shows the P.D. and current during the electrolysis of a dilute solution of sulphuric acid of specific gravity 1·130 when the applied P.D. is 1·8 volts, the electrodes being platinum wires 0·18 mm. diameter and 2 cm. long. The extremely rapid oscillations shown are probably due to the smallness of the electrodes.

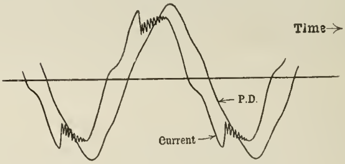

Fig. 11.—Phase Difference in Electrolysis

Dr. D. K. Morris || has used the oscillograph to record the magnetisation curves of transformers during working, and has in the same Paper given interesting curves showing the currents in a shunt-wound direct-current motor and in a rotary converter under varying conditions of load. Mr. Catterson Smith¶ has made a novel application of the oscillograph by studying the curves of P.D. and current during the commutation of a four-pole direct-current motor.

To turn, now, from purely research work, the oscillograph has been very largely employed and been found very valuable in technical colleges for teaching purposes and lecture demonstration. To the average electrical student, who has often only a bowing acquaintance with the differential calculus and Fourier's theorem, even the more elementary problems connected with alternating currents are not by any means easy. When, however, their working can be clearly shown on the screen by the oscillograph the necessary explanation is much simplified and more readily understood by the student.

For this purpose the projection type of instrument has been designed. It is altogether on a larger scale than either of the instruments mentioned, the mirrors being sufficiently large to enable the curves to be thrown on to a screen and exhibited to a large number of people at one time. This apparatus gives waves on the screen having an amplitude of over ½ metre,

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* See Constable and Fawsett, *Proceedings* Institution of Electrical Engineers, 1903; and *The Electrician*, Vol. L., pp. 862, 903, 935, 1,069.

† Rosling and Wedding, *The Electrician*, 1894, Vol. XXIII.

* See *Proceedings* of Institution of Electrical Engineers. No. 176 Vol. XXXVIII., 1906; and *The Electrician*, Vol. LVI., pp. 151 and 172.

† See also "How to Improve Telephony." W. Duddell, Royal Institution, March, 1906.

‡ See *British Medical Journal*, October 8, 1904.

§ See *Transactions* of the Faraday Society. Vol. I., February, 1906.

|| See *Electrician*, February 19, 1904.

¶ See *Proceedings* of the Institution of Electrical Engineers, part 174, Vol. XXXV., 1905.

about $1\frac{1}{2}$ metres long, showing in this length $1\frac{1}{2}$ wave-lengths. Fig. 12 shows the complete instrument arranged for projection work. As in this case the screen is stationary it is necessary to introduce a movement of the beam of light, proportional to time, in a direction at right angles to the motion it already possesses due to reflection from the vibrating mirrors. This is produced by a mirror mounted on a synchronous alternating motor. This mirror is vibrated in synchronism with the curves under observation. During the greater part of each revolution of the motor the mirror is rotated with a constant angular velocity so that the spot of light, combining the two motions, traces out the curve on the screen. When it arrives at the full extent of its motion, the mirror is suddenly caused to return to its initial position, the light meanwhile being intercepted by a shutter fixed to the motor shaft. The mirror then starts on a second journey and draws a second wave form on the top of the first, the successive curves appearing by persistence of vision as a single bright line.

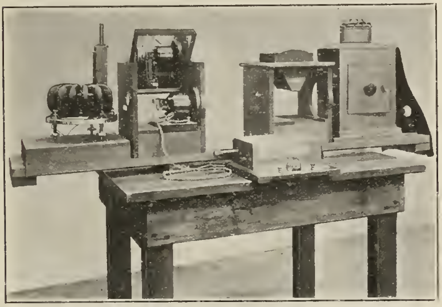

Fig. 12.—Oscillograph for Projection.

By placing the synchronous motor under the tracing desk the wave form is thrown on to a piece of tracing paper fixed down by clips and may readily be traced. A suitable dark slide is also made for photographing the wave on the tracing desk.

A new type of synchronous motor has recently been introduced which is much more robust than that formerly provided. It is a small induction motor with short-circuited rotor in the iron core of which four slots are cut. It has a two-phase winding on the stator and by means of a phase-splitting arrangement, shown in Fig. 12, these are supplied with two currents with a phase difference of about 55 deg. Thus it starts and runs up to within 2 or 3 per cent. of synchronous speed as an induction motor. It is then pulled into phase and runs in phase as an attracted iron motor.

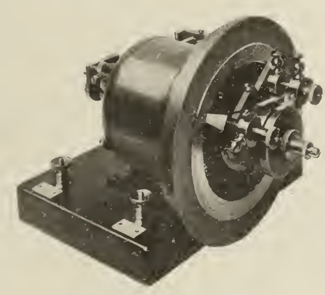

Fig. 13.—Synchronous Motor with Contact Maker for use with Oscillograph.

This motor can also be fitted with a contact maker for tracing the wave by the Joubert point-to-point method. This contact maker consists of three insulated rings electrically connected to each other and with a brush bearing on each. The rings are respectively a complete ring, three-quarters of a complete ring and an instantaneous contact 1 mm. wide. The two brush holders, one carrying one brush and the other two brushes, are also capable of being moved independently, a divided circle showing their respective positions. Thus points by the Joubert method can be obtained very conveniently with either an electrometer or a condenser and galvanometer. Fig. 13 shows this motor with the contact maker. This arrangement is also very useful for showing other phenomena not strictly connected with alternating currents, such as the unidirectional or oscillatory charge and discharge of condensers, &c. Fig. 14 represents the oscillatory discharge of a condenser through a low-resistance inductive circuit. By means of this motor, such curves may be projected on to a screen or shown on the tracing desk. The time scale is about 200 cm. per second.

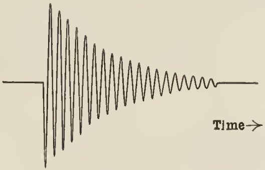

Fig. 14.

The motor can also be fitted with other attachments, such as a revolution counter, a speed or frequency indicator which enables the speed of a distant alternator to be observed.

The above are a few of the uses of the oscillograph; others, no doubt, will occur to the reader. In conclusion, Mr. Patchell's remarks may be quoted that "he takes this opportunity of placing on record his high appreciation of the debt that engineers owe to Mr. Duddell for the invention and perfection of the instrument that renders the carrying out of such tests possible."

A SUB-STATION FOR LIGHTING ON A TRACTION SYSTEM AT WHITTINGTON, CHESTERFIELD.

Electric light was introduced into the borough of Chesterfield as far back as 1881, and more recently a well-equipped tramway system has been introduced. The line extends from the western borough boundary through the town into the urban district of Whittington on the north. This district, lying outside the borough boundary, did not, until recently, possess an electric light supply. The inhabitants, however, were likely to use a considerable amount, provided it were possible to secure a supply from the Chesterfield Corporation mains. Mr. R. C. Acland, the borough electrical engineer and tramways manager, realising that a considerable source of revenue lay near at hand, and that it would not be necessary to

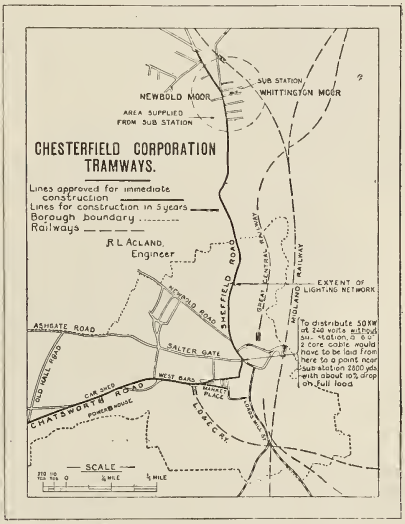
SUB STATION
WHITTINGTON MOOR
NEWBOLD MOOR
AREA SUPPLIED FROM SUB STATION
CHESTERFIELD CORPORATION TRAMWAYS.
Lines approved for immediate construction
Lines for construction in 5 years
Borough boundary
Railways
R L ACLAND. Engineer
SHEFFIELD ROAD
GREAT CENTRAL RAILWAY
MIDLAND RAILWAY
EXTENT OF LIGHTING NETWORK
NEWBOLD ROAD
ASHGATE ROAD
OLD HALL ROAD
SALTER GATE
WEST BARS
MARKET PLACE
CAR SHED
CHATSWORTH ROAD
POWER HOUSE
L.D.&E.C.RY.
LORDS MILL ST
To distribute 50 KW at 240 volts without sub-station, a 6 0" 2 core cable would have to be laid from here to a point near sub station 2800 yds. with about 10% drop on full load
SCALE
220 YDS 110 YDS 0 ¼ MILE ½ MILE

Fig. 1.—Map of Chesterfield Tramway System

increase the capacity of the generators to supply this demand, drew up various plans to accomplish the desired result.

The tramway line, as shown in Fig. 1, extends as far as Whittington. The lighting mains, however, end at approximately 1½ miles from Whittington, so that if new feeders to supply this district with current were to be installed it would necessitate laying them from the generating station. The amount of expenditure for cable, troughing, breaking up the streets and laying the cable for this length, Mr. Acland estimated would come to at least £2,500, a sum too large to be considered, as the income from the sale of current would not cover the outlay. Against this scheme was one of installing a sub-station near the end of the tramway line and putting in a motor-generator which is fed direct from the tramway 'bus bars, the supply to the overhead line being tapped off this feeder through circuit-breakers placed in a special feeder pillar, shown in Fig. 2.

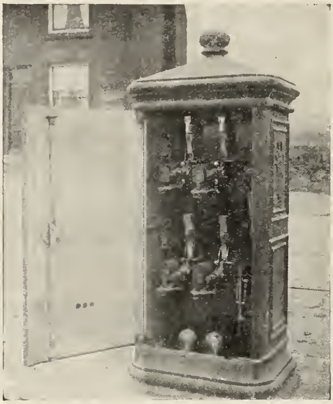

Fig. 2.—Special Feeder Pillar

As the voltage at this end of the line varies from 480 to 520 volts, some method of keeping the voltage of the motor-generator constant had to be determined upon. This difficulty was entirely and most satisfactorily overcome by installing in the sub-station a voltage regulator supplied by the British Thomson-Houston Co.

This is believed to be the first instance in the United Kingdom where it was proposed to tap a tramway line and regulate the voltage for efficient lighting by means of an automatic voltage regulator, and the results have fully justified the venture.

To demonstrate the reliability of this regulator (to regulate the voltage within 1 per cent.) the engineer recently, when showing the sub-station to a visitor, moved the shunt rheostat controlling the speed of the motor from the point with all resistance out to all resistance in, thereby speeding up the motor from 720 to 800 revs. per min., at the same time putting on the full load on to the generator, then reducing the speed and finally operating the load switch, thus throwing on and off the full load of the generator. The pointer of the voltmeter was seen to scarcely tremble owing to the rapid operation of the voltage regulator. With the regulator cut-out, however, and the above performance repeated, the pointer of the voltmeter rapidly oscillated from 220 to 260 volts.

The electrical equipment of the sub-station consists of a B.T.-H. 75 h.p. motor which operates direct from the tramlines (the voltage of which varies from 480 to 520 volts), coupled direct to a 50 kw. generator compound wound for 240 volts. The rated speed of this set is 790 revs. per min. Additional space, with cable ducts, &c., under the floor, is provided for another set. The switchboard (which is illustrated in Fig. 3) at present consists of three panels. The first, for controlling the motor end, contains a circuit breaker, ammeter, single-pole switch, starting rheostat and wattmeter. The second is the generator panel, and carries an ammeter, double-pole switch and fuse, voltage regulator and shunt rheostat for the dynamo. The shunt rheostat for the motor end is also placed on this panel.

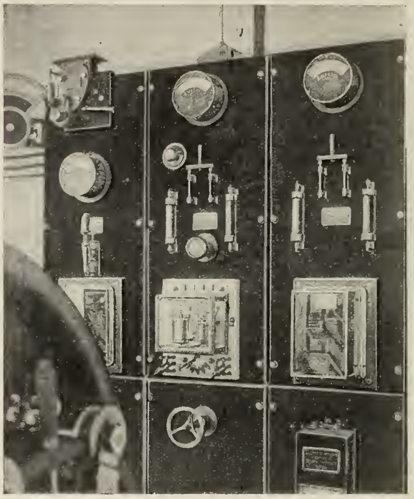

Fig. 3.—Switchboard in Whittington Sub-station.

The third panel controls the feeder, and is provided with ammeter, double-pole switch and fuse, B.T.-H. wattmeter and Elliott recording voltmeter, which is connected across the dynamo terminals.

The entire cost for construction of building, electrical apparatus, &c., did not exceed £500, against the first scheme of feeders from the Chesterfield generating station of £2,500, and a far better service has been secured with less voltage variation than could have been secured with the latter scheme.

There are cases of seaside towns depending mainly on the summer traffic to keep their tramlines going, and where the traffic is but light in the winter, which could, by installing similar sub-stations, at comparatively little expense, supply current for lighting purposes in the winter months (when the lighting load would be the greatest) and thereby induce a load on their stations and operate their generators at a better load factor.

There are numerous cases where tramways extending out some miles into the country and passing various smaller villages en route could make use of these sub-stations by supplying current, benefit the towns so passed through to the extent of enabling them to have the advantages of an electric supply, and as the current so supplied in the majority of cases would not necessarily mean an increase in the generating capacity, the demand coming as it would at the slackest time of the year, the current could be supplied to these outlying districts at a very small increase above the cost.

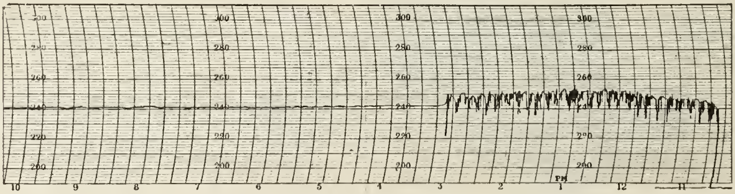

Fig. 4.—Voltage Record With and Without Automatic Regulator.

In Chesterfield an increasing day load is being secured by supplying current for power purposes at a very low price per unit, and prospects are exceedingly good that this load will constantly increase.

Mr. Acland is most satisfied at the successful operation of his sub-station, made possible by the introduction of the B.T.-H. voltage regulator, the curve at the sub-station being far better than that at the generating station.

Curves taken recently at the sub-station showing the voltages with the regulator in and out of circuit are given in Fig. 4.

The whole of the apparatus was supplied by the British Thomson-Houston Co., to the specification of Mr. R. L. Acland, and was erected by the Corporation staff under the direct supervision of Mr. H. L. Percy, the late chief assistant engineer.

THE ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(First Notice.)

The exhibition which was opened on Saturday last at Olympia (London) by Sir Alexander Binnie, and which is to remain open until October 17th, covers so large a field of engineering practice that it is an obvious impossibility that any one branch should have been treated in anything like a fully representative manner. Following, too, so closely on the electrical exhibition of last autumn, we should hardly expect to see a very great number of the leading electrical engineering firms represented. The possibilities opened up by the employment of electrical methods are, however, so far-reaching that a glance round the stands shows many interesting examples of the influence which electricity has had on other branches of engineering in so many directions, although, perhaps, few electrical novelties are shown.

Machine tools of all descriptions form a prominent feature of the exhibition. These are, almost without exception, arranged for electrical driving, and in many cases are shown in actual operation. No very new methods of driving or of controlling the motors are shown, and the motors themselves are mostly examples of the standard work of the group of British motor manufacturing firms whose names and productions are already familiar to engineers. A more detailed inspection shows the increasing use that is being made of variable-speed motors controlled by shunt regulation, the application of which often enables the mechanical speed changing devices to be considerably simplified. Of the application of alternating-current motors there are comparatively few examples. The principal source of electric supply to the exhibition is the special main from the Hammersmith station, but the majority of the electrically-driven exhibits are supplied with continuous current from a generating set on the stand of the Thames Ironworks, Shipbuilding & Engineering Co. The generator consists of one of the company's standard 220 kw. multipolar machines capable of a normal output of 1,000 amperes at 220 volts at a speed of 385 revs. per min., but we understand that at times it is called upon to give a very considerable overload. It is direct-coupled to and driven by a Scott's patent three-crank compound vertical enclosed engine by Messrs. Reavell & Co. and works with a steam pressure of 160 lb. per square inch supplied by a Davies patent water-tube boiler. Another set which supplies a certain amount of power to the rest of the exhibition is a dynamo driven by a 42 B.H.P. gas engine by Messrs. Crossley Bros. running at 180 revs. per min. and supplied from a self-contained suction gas plant on the firm's adjoining stand, which also works a 39 B.H.P. engine running at 220 revs. per min. direct-coupled to a four-pole dynamo supplying some arc and incandescent lamps on the stand. Both these engines are of the ordinary single-cylinder horizontal type and a particularly simple form of low-tension magneto-ignition is employed in which the inductor is periodically rotated through a small angle by a pin at the back end of the half-time shaft, and suddenly released and restored to its normal position by a pair of powerful springs.

In addition to the engines supplying power to the exhibition, one or two prominent builders of electric light engines are exhibiting. Conspicuous among these is the stand of Messrs. W. H. Allen, Son & Co., who show a three-crank three-cylinder compound vertical enclosed high-speed engine, fitted throughout with their usual system of forced lubrication. This engine is capable of developing 450 B.H.P. at 400 revolutions, and is suitable for a steam pressure of from 100 lb. to 200 lb. per square inch, condensing or non-condensing. A two-crank 220 B.H.P. engine is also shown, and a number of centrifugal and other pumps. An interesting object on this stand is the crank shaft of a three crank 500 B.H.P. engine which has been in actual daily service in a generating station for seven years. A table of accurate measurements at various points as compared with the original dimensions shows how remarkably slight the wear has been.

Another stand, mainly devoted to engines, is that of Messrs. Easton & Bessemer, on which are two vertical high-speed engines for direct coupling to dynamos, one enclosed and one open, and a horizontal engine specially designed for use with superheated steam.

Messrs. Willans & Robinson do not show any large work, but devote their stand to a display of samples of castings of alloys for bearings, &c., cast by their special method of treatment, which is claimed to get over the troubles often experienced of the segregation of the different constituents, and to result in a very homogeneous internal structure particularly suited for bearings.

Other stands of interest to the central-station engineer are those of Messrs. E. Green & Sons, who show models of their well-known economisers; of the Stirling Boiler Co., whose glass model of their water-tube boiler, showing the circulation through the tubes, is a familiar object at exhibitions; and of the Temperley Transporter Co., who exhibit working models of several forms of coal-handling plant.

Of the numerous exhibits of electrically-driven machine tools, one of the most prominent is that of Messrs. Armstrong, Whitworth & Co., the centre of whose stand is occupied by a large lathe with 18 in. centre of very substantial construction for work up to 10 ft. in length. This lathe is driven by a 60 H.P. ventilated enclosed four-pole motor designed for a three to one speed variation, and is shown at work with tools of special "high-speed" steel, taking a ¼ in. cut 1½ in. wide in a large steel ingot at a rate of 50 ft. per minute. Several other machine tools are shown, and there is a representative display of hand-screwing apparatus, surface plates, tools and gauges.

A stand which shows an interesting development in the electrical driving of machine tools is that of Messrs. John Stirk & Sons, of Halifax, who exhibit several machines in which the field frame of the driving motor forms an integral part of the construction of the machine itself. An example of this is shown in Fig. 1, which illustrates a 6 in. slotting machine with the motor, so to speak, embedded in the upright portion of the frame. The commutator end cover with perforated shields can be seen on the right. This motor is rated at 1½ H.P. at any speed from 500 to 1,500 revs. per min. The first transmission is by a chain inside the hollow upright to the pinion shaft, further reduction being by the usual gearing at the back of the machine. The same principle of self-contained motor drive is exemplified in an 8 in. high-speed lathe in which the motor is contained in the box end of the lathe under the headstock, a construction giving exceptional rigidity and accomplishing a great saving in floor space. This motor is of 7½ B.H.P. and is also designed for a three to one speed variation by shunt regulation alone, which, we are informed, is easily obtained, without sparking troubles, without having recourse to auxiliary commutation poles. The control gear is mounted on a panel close to the lathe and an arrangement of rods is provided so that the speed regulating switch can be operated by a hand wheel carried on the slide rest itself during working.

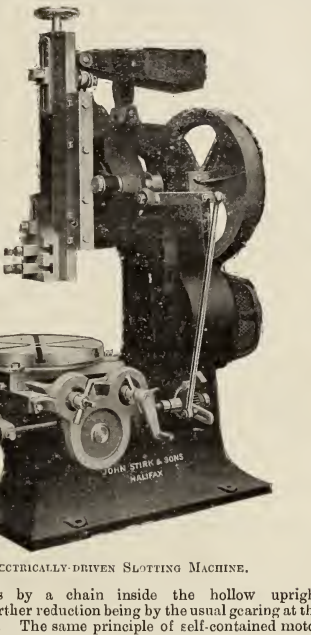

Fig. 1.—Electrically-driven Slotting Machine.

Large displays of machine tools of very varied descriptions are given on a number of stands, an interesting example of which is that of Messrs. Schuchardt & Schutte; practically all these tools are shown in operation and driven by electric motors. Amongst them is an automatic gear hobbing machine for cutting spur, worm or spiral gears, of a type rapidly finding favour on account of its simplicity and rapidity of turning out work. A special crank shaft lathe is also shown, and several examples of electrically driven milling, grinding and drilling machines of various descriptions.

American machine tools are well represented on the stands of Messrs. Buck & Hickman and Charles Churchill & Co., the latter of whom also exhibit the Biernatzki form of hob gear cutting machine.

The smaller types of electrical driven tools, such as portable drills, &c., are shown on several stands, including those of the Consolidated Pneumatic Tool Co. and Messrs. Kramos, whose portable drills have already been described in our columns in connection with the recent colliery exhibition. In this connection the flexible shafts and drills shown by Messrs. C. Wicksteed & Co. are also of interest.

A prominent object in the centre of the exhibition is the "Electric Water and Air Circulator," erected near their stand by the James Keith & Blackman Co., taking the form of a handsome illuminated fountain 33 ft. in height, in which some 1,500 gallons of water are circulated per minute by electrically-driven pumps, and a system of fans which cause the air to be drawn through the falling water and be thereby cleansed and purified. All the motors and the coloured lamps which illuminate the fountain from the interior are controlled from a switchboard on the adjoining stand. Messrs. Keith & Blackman also show a number of their well-known electrically-driven fans and blowers of every description, including a new pattern now exhibited for the first time, for blowing against moderate pressures, and occupying an intermediate position between their ordinary open fans and high-pressure blowers. A good show of electrically-driven fans is also to be found on the Sturtevant Engineering Co.'s stand. Another application of electrical driving is exemplified by a portable electric haulage plant for mining and similar purposes driven by a 15 H.P. motor shown by the Sheepbridge Coal & Iron Co., who also exhibit a compact form of liquid type controller for a three-motor crane. Each motor is controlled by a separate lever which actuates a circular drum pattern reversing switch, and also raises and lowers the curved electrode, dipping into the liquid, through the medium of a quadrant and pinion and a crank and connecting rod, so that in the central position of the handle the blade is raised, but is lowered into the liquid by movements either in the forward or backward direction.

Further examples of the universal applications to which electromotors can be put are found in an electrically-driven refrigerating plant shown by Messrs. G. J. Worssam & Sons and the air compressors on the stands of Messrs. George Richards & Co. and Tilghman's Patent Sand Blast Co., which are all motor-driven through spur gearing.

A portable electric generating plant mounted on a 5 ton steam waggon, which should prove of considerable use for a variety of purposes, is exhibited by Messrs. Savage Bros. The set consists of a vertical enclosed 20 H.P. engine running at 500 revs. per min. and taking steam from the boiler of the waggon at 200 lb. per square inch direct-coupled to a four-pole compound-wound dynamo giving an output of 135 amperes at 70 volts. The set is placed across the car behind the driver's seat.

Installation material is also represented by the stand of Simplex Conduits (Ltd.), who have a good display of the various parts of their well-known steel conduit system and some water-tight switchboards and fittings for factories, mills and collieries. Messrs. Simmonds Bros., exhibit material for temporary installations on the "Niphan" system, which consists of wiring enclosed in flexible metallic tubing in conjunction with specially arranged couplings.

Attention should be drawn to a remarkably simple device exhibited by Mr. W. G. Walker & Co., for testing motors of small and moderate size. The apparatus, which acts as an absorption dynamometer, consists simply of a pair of vanes mounted on arms, which can readily be attached to the shaft of the motor to be tested. The vanes are adjustable as to their distance from the centre, and from the speed, position and size of the vanes the horse-power that is being absorbed by the resistance of the air can be determined.

THE CADMIUM STANDARD CELL.[*]

BY GEORGE A. HULETT.

(Concluded from page 864.)

An adjustable cadmium cell was made as represented by Fig. 1; the leg A contained the cadmium amalgam and the cadmium sulphate of the anode, and it will be seen from the cut that the side tube B of this leg bends down and passes through the neck of the tube C. This tube C contained the mercury, paste and cadmium sulphate of the cathode leg of the cell. This cell was used in a water-bath and it was found necessary to attend to the insulation. This was done by sealing on the little tubes *e* and *f* as indicated in the cut, the contact wires passed up through these tubes and there was then no further trouble on this point This cell had the value 1·01837 and has remained perfectly constant, although it has many times been taken apart and the anode leg used to test other systems. The cell is now six months old and a new anode leg has lately been made, but it shows exactly the same value as the older ones.

A large tube, 5 cm. by 24 cm. (Fig. 2), contained the materials of the cathode system of the cadmium cell. The neck of this tube was made to admit the side tube B of the adjustable anode A, Fig. 1, thus forming a cadmium cell. Contact with the mercury in this large tube was made through a platinum wire which was fused through the closed end of the tube and passed up on the outside. The wire was covered with shellac, a thin strip of cloth was placed over the wire, and then it was thoroughly shellaced and finally covered with a coat of collodium (the use of collodium was suggested by Dr. E. H. Loomis, and is a very admirable device for protecting anything which is to be in contact with water for any length of time). This large tube contained 140 grammes of mercury, 50 grammes of coarse-grained electrolytic mercurous sulphate which had been washed with alcohol and dried, with 50 grammes of cadmium sulphate crystals and about 400 cubic cm. of a saturated solution of cadmium sulphate. In order to bring this system to equilibrium, the neck of the tube was securely closed with a cork and rubber covering, the tube was brought to a horizontal position in the 25 deg. bath and rotated about its longer axis as follows: Above the bath was a shaft which was run at any desired speed by a worm gear, and from this shaft two little belts extended down into the bath. The tube was suspended in the loops of these belts. The belts were kept in place by rubber rings on the shaft and on the tube. In this way it was possible to rotate the tube about its longer axis at any desired speed; the solid contents of the tube were spread out in a long layer and slowly "rolled down hill" as the tube rotated. This method insured a thorough mixing of the contents of the system and was sufficiently gentle to avoid grinding the solids. A fine powder has an abnormal solubility and this error is very considerable when the solubility is small. Also it was found desirable to avoid breaking up the mercury into small globules, because these globules formed larger ones when the rotation was stopped, and this change caused very decided variations in the E.M.F. readings. It was found that by rotating the tube at the rate of 1 revolution in about six seconds that the mercury generally remained in one globule, and that this rate, with the above method, still insured a perfect mixing of the contents of the tube. From time to time the tube was brought to an upright position in the bath and the E.M.F. measured with the aid of the adjustable anode leg. The large 100 litre thermostat maintained the temperature constantly within 0·02 deg. of 25°C. Since the rotating would unduly expose the mercurous sulphate to the light, it was decided to avoid this possible source of error by covering the tube with asphalt paint and then with collodium.

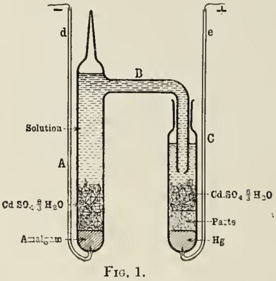

Fig. 1.
(one third natural size.)

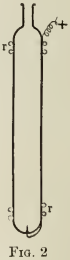

Fig. 2
(one-sixth natural size.)

The first rotation was for 12 hours, when the system was tested with the anode leg, the first reading

3 minutes after stopping the rotation was 1·0190 volts.
9 ,, ,, ,, 1·0184 ,,
35 ,, ,, ,, 1·0178 ,,
3 hours ,, ,, 1·0177 ,,

The system was now rotated three days and

5 minutes after stopping the rotation the E.M.F. was 1·01938 volts.
20 ,, ,, ,, ,, 1·01942 ,,
1 hour ,, ,, ,, 1·01941 ,,
5 hours ,, ,, ,, 1·01941 ,,

The tube was closed and rotated 7½ days, making a total of 11 days.

3 minutes after stopping the rotation the E.M.F. was 1·01820 volts.
9 ,, ,, ,, ,, 1·01860 ,,
30 ,, ,, ,, ,, 1·01910 ,,
3 hours ,, ,, ,, 1·01971 ,,
24 ,, ,, ,, ,, 1·01971 ,,

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[*] From the *Physical Review*.

The preliminary low values observed here were regarded as due to the mercury being in small globules and as they united to form larger ones the E.M.F. increased to a maximum. That the constant value obtained was reliable is shown by the following test: Some of the clear solution was removed and brought into a tube like the tube C of Fig. 1. Some mercury was put in to serve as an electrode and then the solution tested with the anode leg. The value obtained was 1·01983.

The system was now rotated 6½ days, making a total of 17½ days.

3 minutes after stopping the rotation the E.M.F. was 1 01920 volts.
5 ,, ,, ,, ,, 85 ,,
30 ,, ,, ,, ,, 91 ,,
1 hour ,, ,, ,, 89 ,,
5 hours ,, ,, ,, 90 ,,
24 ,, ,, ,, ,, 79 ,,
72 ,, ,, ,, ,, 74 ,,

The clear solution was tested as previously described and gave 1·01992 volts. Evidently a change begins to take place in the layer next to the mercury as soon as the solids settle down on the electrode and this is possibly the "drift" of the cadmium cell at its maximum rate.

The tube was again closed and rotated 8½ days, making a total of 26 days. The following readings were then obtained:—

3 minutes after stopping the rotation the E.M.F. was 1·0120 volts.
6 ,, ,, ,, ,, 1·0155 ,,
18 ,, ,, ,, ,, 1·0166 ,,
1 hour ,, ,, ,, 1·01910 ,,
3 hours ,, ,, ,, 1·01976 ,,
7 ,, ,, ,, ,, 1·01977 ,,
24 ,, ,, ,, ,, 1·01973 ,,
48 ,, ,, ,, ,, 1·01967 ,,
170 ,, ,, ,, ,, 1·01948 ,,

Here the preliminary low value, which has been attributed to changes in the mercury electrode, was more persistent and the maximum value observed was consequently lower. After the tube had stood quietly for a week, the lower end was given a rotary motion in order to break up the mercury into smaller globules but without mixing the entire contents of the tube.

2 minutes after the shaking just mentioned the E.M.F. was 1·0135 volts.
7 ,, ,, ,, ,, 1·0161 ,,
12 ,, ,, ,, ,, 1·0177 ,,
45 ,, ,, ,, ,, 1·0196 ,,
1 hour ,, ,, ,, 1·01985 ,,
2 hours ,, ,, ,, 85 ,,
6 ,, ,, ,, ,, 85 ,,

These results indicate that the preliminary low values observed in the preceding experiments were due to the mercury changing from small to large globules, as had been assumed. It was possible to still further test this point as follows. The tube was rotated as before for 3½ days at the rate of one revolution in six seconds and then the rate was decreased to one revolution in 70 seconds and this rate of rotation was continued for one day in order to allow the mercury to collect in one globule. The tube was then carefully brought to an upright position and the anode leg adjusted.

2 minutes after stopping the rotation the reading was 1·01977 volts.
4 ,, ,, ,, ,, 77 ,,
10 ,, ,, ,, ,, 78 ,,
40 ,, ,, ,, ,, 76 ,,
1½ hours ,, ,, ,, 75 ,,
5 ,, ,, ,, ,, 71 ,,
9 ,, ,, ,, ,, 68 ,,
24 ,, ,, ,, ,, 64 ,,

The clear solution gave 1·01985. It is evident from the preceding experiments that if the system in the cathode leg of the cadmium cell is stirred until no further change takes place that, at 25 deg., the cell has the value 1·0198 volts, or 0·0014 volts higher than the cadmium cell. If this system, after it has been rotated until no further change takes place, be allowed to rest, the E.M.F. begins to drop, but the clear solution, from which the solids have settled, continues to retain its high E.M.F. against a mercury electrode. It seems reasonable to conclude that there is some interaction between the cadmium sulphate solution and the mercurous sulphate which produces an increase in the mercury concentration of the solution, but when the solids settle down on the mercury, another change takes place at the boundary between the mercury and the paste which causes a decrease in the mercury concentration of solution next to the mercury. The possibility that the oxygen of the air dissolved in the solution produces some mercuric mercury has been considered. This would explain the results obtained if we assume that the mean rate of oxidation is rapid compared to the subsequent rate of reduction by the mercury. However, I have not been able to get experimental proof of this view, while the following results with the cathode system of the Clark cell show that under similar conditions, oxidation by dissolved air does not play a measurable rôle in the case of a zinc sulphate solution. It seems more probable that the interaction between the cadmium sulphate solution and mercurous sulphate is of the nature of an hydrolysis accompanied by the slow formation of a new, slightly soluble solid phase. The evidence for this view will be given when the present experiments are completed.

In order to test the method that has been employed in the preceding experiments, and also to confirm many of the conclusions, it was decided to subject the cathode system of the Clark cell to the same processes. An adjustable Clark cell was made similar to the above adjustable cadmium cell. This Clark cell has shown a constant value of 1·42045 volts at 25 deg. A large rotating tube was charged with mercury, mercurous sulphate (electrolytic, washed with alcohol and dried), recrystallised zinc sulphate, and the saturated solution. This system was rotated as previously described, and after 12 hours the contents were tested with the adjustable anode of the Clark cell, with the following results:—

3 minutes after stopping the rotation the E.M.F. was 1·42052 volts.
45 ,, ,, ,, ,, 1·42048 ,,
3 hours ,, ,, ,, 1·42048 ,,
6 ,, ,, ,, ,, 1·42049 ,,

The system was now rotated 24 hours and then showed 1·42050 volts, and after the solids had settled, some of the clear liquid was tested against a mercury electrode with the adjustable anode and the value obtained was 1·42051 volts.

The system was now rotated for six days.

3 minutes after stopping the rotation the E.M.F. was 1·42055 volts.
6 hours ,, ,, ,, 1·42050 ,,
27 ,, ,, ,, ,, 1·42054 ,,

The tube was again closed and rotated for 10 days, making a total of 17½ days, and then gave the value of 1·42052 volts and was constant. This experiment shows that the cathode system of the Clark cell comes to equilibrium in less than 12 hours and remains constant from then on. The slight variations observed may readily be accounted for as due to slight temperature variations to which the E.M.F. of the Clark cell is very sensitive, besides, no special precautions were taken to exclude the effect of light, so the test was a very severe one.

These results, obtained by rotating the cathode systems of the cadmium and Clark cells, seem to confirm in a most decisive manner the validity of the observations of the last two years on the Clark and cadmium cells. The assumption that the "drift" of the E.M.F. of the cadmium cell is due to changes in the cathode system seems justified, but the possibility that some of the observed decrease in E.M.F. might be at the amalgam of the anode has not been overlooked. This was tested as follows: Some of the old cadmium cells, which are now distinctly lower than when they were first observed, were opened, and the side tube B of the anode leg A of Fig. 1 was brought into contact with the liquid of the cell, and the E.M.F. of the cathode leg measured with the new anode as well as with the old. Any difference in the E.M.F. would be due to differences between the old and the new anode.

Cell.	With the old anode.	With the new anode.
F1	1·01832	1·01829
F2	1·01830	1·01830
F4	1·01833	1·01830
C2	1·01832	1·01827
N9	1·01616	1·01617

Cell C2 was made on November 21, 1903, with commercial mercurous sulphate, and was originally 1·01866. Cell N9 was one of the cells made in November, 1904, with only a little paste and is still decreasing. With the new anode the cells are about 0·00003 volt *lower*, so the change at the cathode has been even greater than indicated by the direct comparisons of the cells.

The foregoing experiments justify the conclusion that the cathode system of the cadmium cell, as at present constructed, is not a system in equilibrium and that the E.M.F. of the cell decreases with time. The rate of this "drift" depends on a number of factors, but if the paste in the cathode leg is about 2 cm. deep, the change is very slow. The cadmium cell, when properly constructed with electrolytic mercurous sulphate, which has been prepared and washed as previously described, has a value of 1·01843 volts at 25°C. and seems to be reproducible to about two parts in 100,000. Cells should be made from time to time to detect the presence and magnitude of the drift. For all ordinary purposes this cell is entirely satisfactory, but if there are no serious errors in the experiments recorded in this article, the cadmium cell as at present constructed can hardly supplant the Clark cell as a primary standard of E.M.F.

The Clark cell made with recrystallised zinc sulphate and electrolytic mercurous sulphate which has been prepared and washed as described in this journal* has the value 1·43300 volts at 15°C. as determined by Dr. K. E. Guthe.† This value is also the average of all the best previous determinations of the value of the Clark cell in absolute units. The experiments described in this article have severely tested the Clark cell and with most favourable results. Several improvements and simplifications of this cell have been suggested by the work done and are now being tested.

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* *Phys. Rev.*, XXII., 334, 1906.

† *Ibid.*, 117, 1906.

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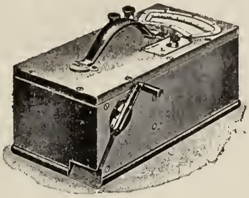

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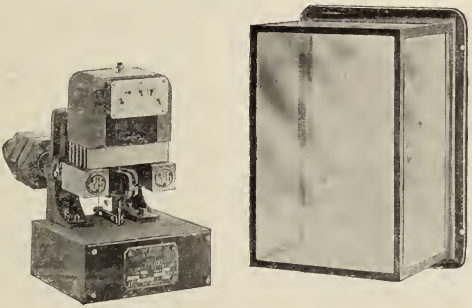

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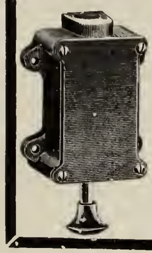

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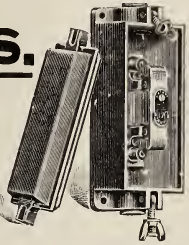

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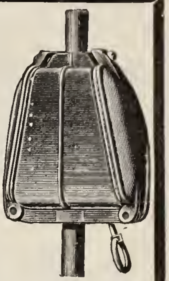

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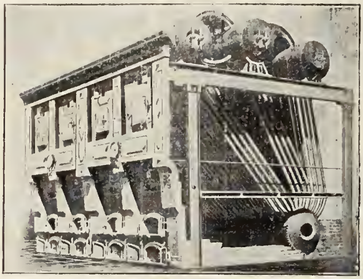

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British Westinghouse Electric and Mfg. Co, Westinghouse Building, Norfolk-street, Strand, London, W.C. —
Gilbert Gilkes & Co, Kendal 29
Gordon (James) & Co, 81 and 83, Knightrider-street, London, E.C. —

Underground Mains
Callender's Cable and Construction Co, Hamilton House, Victoria Embankment; and Belvedere, Kent 2
Johnson and Phillips, 14, Union-ct, Old Broad-st, London; & Charlton, Kent 1

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Varnish
Indestructible Paint Co, 31, Cannon-street, London, E.C 31
Paege (B) & Co, 14, Kaiserin Augusta-Allée, Berlin, N.W. 87 4
Santoni (D) & Co, 15-17, Beauchamp st, Brooke-st, Holborn, London, E.C. ... 29

Ventilating Engineers
James Keith and Blackman Co, 27, Farringdon-avenue, London, E.C. 23

Voltmeters
Crompton & Co Salisbury House, London Wall, E.C.; and Chelmsford 6
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Everett, Edgcumbe & Co, 87, Victoria-street, Westminster, S.W., and Collindale Works, Hendon, N.W... 12
Evershed & Vignoles, Acton Lane Works, Chiswick, London, W. 15
Geipel and Lange, 72a, St Thomas-street, London, S.E. 28
Johnson and Phillips, 14, Union-ct, Old Broad-st, London; & Charlton, Kent 1
Nalder Bros. and Thompson, 34, Queen-street, Cheapside, London, E.C. ... 21
Pitkin (J) & Co, 56, Red Lion-street, Clerkenwell, London, E.C. 14
Richard (Jules), Paris. Agent: Levi (J) & Co, 95, Hatton-gdn, London, E.C. 2

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Water Softeners
Doulton & Co, Royal Doulton Potteries, Lambeth, London, S E. 13
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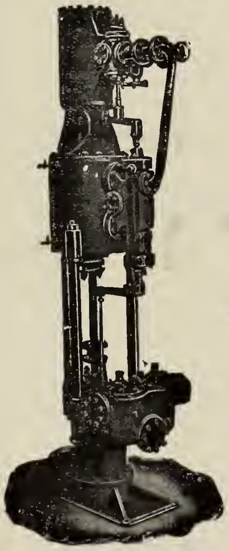

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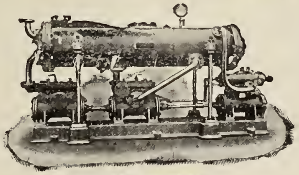

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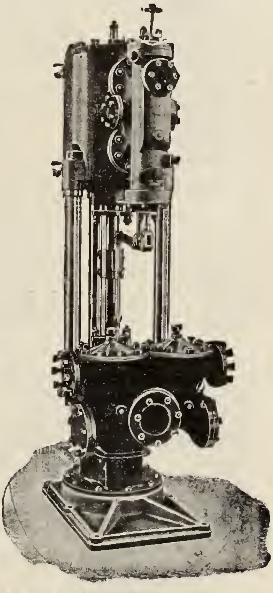

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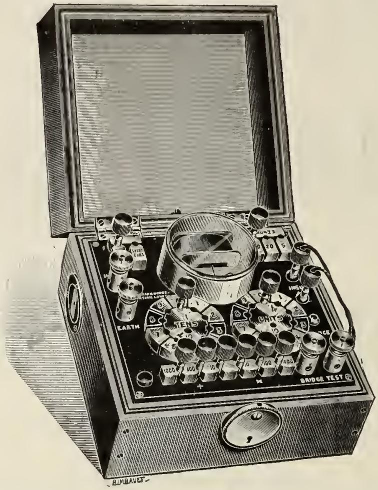

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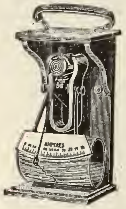

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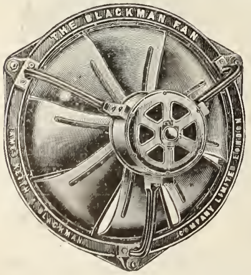

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cannot follow on the same lines it is likely to suffer in competition. The average user of the motor omnibus cannot afford to be clad in motoring attire, even from the point of view of convenience if not of cost, and he will, therefore, prefer the protection of the tramcar to the risk of a chill on the motor omnibus.

As to advertisements, most people will be pleased to see them curtailed, for on the ordinary horse omnibus the destination is much more difficult to find out than the latest opera; and even motor omnibus proprietors seem to think that a name, such as the Vanguard or the Pioneer, is much more important than the destination. But for the proprietors, the advertisements are a valuable asset. For example, during the last half-year the net profit of the London General Omnibus Co. amounted to but little more than its revenue from advertisements, so that the half-yearly dividend of 6 per cent. would have been seriously affected if this source of revenue had been materially curtailed.

Some light is thrown on the important question of repairs by the half-yearly accounts of the London Road Car Co. At the time of the report this company owned 435 two-horse omnibuses and 94 motor omnibuses. Before the advent of the motor omnibus the cost of repairs for the half-year was about £11,000, or probably about 0·45d. per car-mile. During the last half-year, however, this item has risen to £30,843, or probably to about 1·3d. per car-mile. Against this may be set a certain proportion of the cost of horse renewals, which in the corresponding half-year of 1904 amounted to over £12,000, together with certain smaller items. It would not be fair, of course, to attach very great weight to such figures at the present time, as this report embraces what must be considered as the experimental stage; but they serve to draw attention to the very great importance of this part of the subject. To some extent heavier expenses may legitimately be incurred, because the motor omnibus can carry a larger number of passengers than a horse omnibus; and not only so, but it can deal with more traffic in a given time owing to greater speed. But, so far, the earning capacity of the motor omnibus has probably had a fictitious value attached to it, because competition has been mostly with the horse omnibus. When the older style of vehicle is replaced by the newer, there will no longer be the same rush on the part of the public for the motor omnibus, and therefore it is desirable to keep down the costs to a figure which will be suitable to the normal revenue. Apart from the question of repairs, there is depreciation, which will be considerably higher than for horse omnibuses, and there will be a larger capital on which dividends will have to be paid. Possibly with careful handling this may turn out all right in the end; but when it is remembered that a halfpenny per car-mile may mean all the difference between success and failure of an omnibus company, it will be realised that the problem is one requiring the most careful attention, and that the recent boom in motor omnibuses may lead to unfortunate results.

REVIEW.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Plant Response as a Means of Physiological Investigation. By Jagadis Chunder Bose, M.A., D.Sc. 1906, pp. i.–xxxviii. and 1–781. (London: Longmans, Green & Co.) 21s.

This book is noteworthy as proceeding from the pen of one known hitherto to the scientific world as a physicist whose lectures on electrical oscillations attracted a great deal of attention in England. Prof. Bose now comes forward as a plant-physiologist.

There is no reason why a man should not change his hunting ground when he has exhausted one research, provided he observes certain conventions analogous to the game laws and does not mind venturing upon new territory more familiar to others than to himself. A broad track of experimental work leads across the frontier between electrical science and physiology, and it is along this path that Prof. Bose has elected to proceed.

Some 30 years ago, Charles Darwin, discussing one summer morning with Burdon Sanderson the relation of plant life to animal life, suggested the possibility of detecting electric currents like those produced when a muscle contracts, in the case of plants which exhibit sudden movements, such as the Venus' Fly-trap or the Sensitive Plant.

In the series of Papers which resulted from this suggestion Burdon Sanderson showed how close was the resemblance—how heat and cold, fatigue and rest, and electric currents affect the plant as they affect the animal—how the plant could be put under chloroform, wholly or locally, and recover or be killed. Also, how certain phenomena could be ascribed to the mere movement of water in the tissues, while others indicated an irritability of plant protoplasm akin to that of muscle, and proved the continuity of the living substance from cell to cell.

Prof. Bose by no means confines himself to electrical phenomena, but plunges boldly into the realms of plant physiology. A large part of the book is therefore beyond the scope of *The Electrician*. It consists of a long series of experiments, clearly described, with no more technicalities than are necessary, and very well illustrated, so arranged as to set forth step by step the facts on which the author rests his theory. The reader is never left for a moment in doubt as to the interpretation of the phenomena, and the book has the peculiar interest associated with the works of one who knows exactly what he thinks and wants others to think the same.

It must, however, be regarded as an error of judgment that so very little reference has been made to the work of previous and contemporary physiologists. To anyone not specially acquainted with the subject it would seem that Prof. Bose has discovered all the phenomena he describes, and even to the physiologist it is difficult to find out which of the experiments he claims as original. Many of them are familiar friends and many others seem new. Yet they are all alike described as having been performed by Prof. Bose.

It is right that a man should repeat for himself every experiment on which he proposes to rest his theory, but he should describe it as a repetition. A mere general reference in the preface to a list of text-books is apt to make the reader place all the experiments in the same category as those he recognises.

The author's theory is that all substances, vegetable, animal or mineral, give out electrical currents in response to a "stimulus." The majority of the experiments in the present book are designed to show that all plants respond also by movements.

Much that Prof. Bose ignores has been written to prove the similarity of the phenomena of life in plant and animal, but few physiologists would allow that the so-called "response" of inorganic matter bears anything more than an accidental resemblance to the response of living matter. When an electric shock, so small as to be almost imperceptible, is sent through living matter, animal or plant, it is followed almost immediately by a sudden current through the living substance, called by Waller the "blaze current." If the direction of the shock is reversed, the blaze current still appears with its direction unchanged, because it is not generated by the shock, but is a function of the living material set in action by the shock, as a loaded gun is fired by pulling the trigger. It is, as Waller has shown, the test and token of vitality. In muscle the tissue is so arranged that the excitation of one part sets all the rest in action, as a train of powder is fired by applying a match to any part of it. In plants there is a less close connection between cell and cell, and the cell wall is so bad a conductor as practically to insulate when the E.M.F. is low. The conditions are eminently favourable to the production of small currents due to polarisation, or local changes in the concentration of the cell-contents, or to the wrinkling or cracking of a film of oxide at one of the interfaces. Such currents of purely physical origin are constantly observed, but they are easily distinguished from the true "response" by the different time-relations of their photographed curves.

Prof. Bose does not seem to have discriminated between them. He does not seem to be aware that the production of small movements in ordinary plants by electric shocks was an old experiment in 1892, when the present writer demonstrated it in a public lecture. One wire of an ordinary shocking coil was placed in the water in which a cut branch was standing and the other in a beaker in which the tip of one of the leaves was dipped. Almost any plant will answer, but some show the change quicker than others. Shocks not stronger than a man could stand were passed for five minutes. Half an hour later the leaves were wilted along the track of the current.

Plants like the acacia, which go to sleep at night, folded their leaves while the audience watched. But it was the sleep of death—the current had electrocuted them.

George J. Burch.

MODERN FORMS OF ELECTRIC INCANDESCENT LAMPS.*

BY DR. C. R. BÖHM.

The Nernst lamp, and the various attempts that have been made with osmium, iridium, zirconium, tantalum and tungsten are to be regarded as improvements aiming at the displacement of the carbon filament. The original Edison lamps took 4·5 and 5 watts per candle-power, and for the past 20 years lamps have been made taking 3·5 watts per candle-power. This has been still further reduced to about 2·5 watts per candle-power, such lamps having a fairly long life; but beyond this point it has been found impossible to go, and all attempts to add more refractory substances to the carbon filament have hitherto failed. Carbon is infusible, but slightly volatile at high temperatures, especially in a vacuum; this has the effect of blackening the bulb, and altering the structure of the filament. Consequently, seeing that the light emitted is proportional to the fifth power of the absolute temperature of the filament, and that an increase of temperature is the obvious method of producing a greater economy, it is natural that inventors should have looked for some substance that can replace carbon, which appears unstable at high temperatures.

Nernst assumed that no metallic bodies could replace carbon; and therefore turned his attention to electrolytic conductors. He discovered that magnesia, zirconia, thoria, yttria and other rare earths became good conductors when heated; and by the choice of suitable oxides in the shape of a mixture of zirconia and yttria, he was successful in overcoming the electrolytic effects produced by a direct current. But an insuperable objection will always remain to this form of lamp, in that it is necessary to provide means for heating the filament before it begins to conduct. All sorts of attempts have been made to deal with the matter of preliminary heating, but the fact remains that the time required for heating and lighting the filament, together with its sensibility to variations of current, are likely to militate against its general adoption. Auer von Welsbach suggested osmium, which cannot be drawn out into a wire owing to its brittleness, but can be made into a filament by mixing the finely divided metal with an organic binding substance. The binding material is carbonised in the usual way, and the filaments are then electrically heated to a white heat in a reducing atmosphere. This removes the whole of the carbon, and the osmium particles frit together to a coherent mass. Quite apart from the fact that these lamps are only suitable for low voltages, there is the further question of obtaining the necessary amount of osmium. Till lately, there was very little demand for osmium; and the amount that was obtained in purifying platinum was sufficient to meet the demand. But the amount that would be needed to manufacture these lamps on a commercial scale led Auer von Welsbach to buy up all the known sources of osmium before publishing his invention. Consequently the price of osmium, for which there had been no commercial demand, rose at once to £250 a kilogramme. The Welsbach Gas Co. assert that they are in a position to turn out millions of lamps, and hope to recover a great part of their raw material in the shape of old lamps, which they offer to buy back at the rate of 9d. apiece. Any deficiency in the supply of osmium from this source is to be met by the output of their mines.

The Cooper-Hewitt mercury lamp is also well known. Mercury lamps had been known since 1860; but Cooper-Hewitt discovered that an economical result can only be obtained by a careful regulation of the temperature and of the density of the mercury vapour. The colour of the light is a mixture of blue and green; there are no red rays. Therefore the colouring of all objects, excepting those which are black or white, is changed by it. Ultra-violet rays have been much studied during the last ten years, and are found to be beneficial in the treatment of certain forms of disease. The Cooper-Hewitt lamp could be applied in such cases, were it not for the fact that ordinary glass absorbs the ultra-violet rays. The firm of Heraeus, in Hanau, prepared a form of quartz glass which was suitable, and lamps composed of this glass communicated an unmistakable smell of ozone to the room in which they were burnt. The spectroscope showed that the spectrum of this light extended to 220 $\mu\mu$; the only obstacle was the high price of the glass, for the matter of expense was a serious objection from the medical point of view. Lately, Dr Zschimmer, working for Schott & Co., of Jena, has made further improvements in the manufacture of glass for this purpose. This glass, which is called uviol (*i.e.*, ultra-violet), allows the spectrum to extend to 253 $\mu\mu$. Consequently, the chemically-active spectrum is two-thirds of the length of the visible spectrum, which reaches from 579 $\mu\mu$ to 405 $\mu\mu$. These lamps, made of glass by Heraeus or Schott, are therefore successful attempts to transform electrical energy into radiation of very short wave-length; and besides their application to medicine, much photographic work has been done by them, especially at times when the daylight is either short or defective. Under the influence of this light, hydrogen and chlorine can be caused to combine. The stability of dyes can also be tested by the use of this lamp. The bleaching action of the sun's rays is due to ultra-violet radiation. Hitherto the stability of dyes has been mostly tested in southern countries, where the light of the sun is more powerful. The arc lamp does not produce the same result as the sun in so far as its bleaching effect is concerned. But experiments with the form of the Cooper-Hewitt lamp, made of uviol glass, have been so successful that it seems probable that the question of the permanence of any dye will be able to be settled in a few days, whereas up to the present time it has occupied several months. The lamp also seems likely to replace the Finsen arc in the treatment of lupus. The light itself is better, cheaper, and more easily applied, and in skin diseases of various kinds there seems to be large scope for Cooper-Hewitt lamps, particularly of the Schott or Heraeus types.

At the conference which has just been held at Meran, Dr. Schott exhibited his so-called fluoresence lamp, which is merely an ordinary uviol lamp having a great part of the long-waved radiation suppressed. This gives, therefore, less light, but causes fluorescence in a great variety of substances. This is the case with rhodamine, fluorescine, and uranium glass, which appear brighter than the lamp itself. With vaseline, lanoline, soap, and the human skin, a peculiar colour effect is produced. This lamp is also likely to have a sphere of usefulness in medical work. In all work with ultra-violet rays it is necessary to protect the eyes with suitable glasses. Fifty years ago Regnault and Foucault expressed the view that the violet and ultra-violet rays might be harmful to the eyes, because they caused fluorescence in the eye with corresponding exhaustion of the nerves and alteration of the transparent network. This is particularly the case with the mercury light, and the nervous organism of the eye is liable to be sooner exhausted by it than by one giving a larger amount of yellow and red rays. Many attempts have been made to replace mercury by some other metal; but the difficulty consists in volatilising and then restoring the negative electrode. Various gases have been used, while preserving the feature of the mercury electrodes; but no success has been achieved in this direction.

Bolton followed in the footsteps of Auer von Welsbach, and discovered the peculiarities of tantalum, the melting point of which is between 2,250°C. and 2,300°C. Its resistance increases with a rise of temperature, exactly as in the case of osmium. At ordinary temperatures the resistance of a wire 1 metre long and 1 sq. mm. in section is 0·165 ohm; at the temperature of the lamp it becomes 0·85 ohm. The breaking strength of tantalum, when cold, is very great, being 93 kg. per square millimetre, as compared with 70 kg. to 80 kg. per square millimetre, in the case of good steel, according to Kohlrausch's figures. But when heated it becomes soft like osmium, and after burning for 200 or 300 hours it is easily broken. The diameter of the filament is 0·05 mm. to 0·035 mm.; with a diameter of 0·05 mm., a 25 c.p. lamp for 110 volts requires a filament 650 mm. long, weighing 0·022 gramme, so that 1 kg. of tantalum would make 45,000 lamps. It is impossible to wind such a length in a horseshoe form; and the great advantage of tantalum lies in the fact that it can be wound on a framework, so that the required length of filament can be kept in shape. The patents taken out by Siemens & Halske, together with Scholvien's patent, seem to cover the entire ground of the application of great lengths of filament to incandescent lamps (see German Patents 153,328 and 159,096, together with application numbered 21,671, made on September 29, 1905). Siemens & Halske have also protected a process for making tantalum filaments out of the amorphous powder, and the use of various metals that can be drawn out into a wire—*e.g.*, tantalum, zirconium, thorium, yttrium and erbium (see German Patent No. 165,057 of October 14, 1904, granted November 24, 1905; and also No. 169,565 of May 3, 1903, and granted April 5, 1906). The possibility of the formation of carbides, which would lead to the early destruction of the filament, is prevented by using no organic binding substance in the construction of the filament. A piece of tantalum heated to a red heat can be beaten out into a sheet under the steam hammer, and gradually, after much hammering, becomes as hard as **a** diamond. An attempt was made to bore through a sheet of tantalum 1 mm. thick with a diamond boring-machine. After boring uninterruptedly for three days and three nights at the rate of 5,000 revs. per min. the only mark on the tantalum was a small cavity ¼ mm. deep, and the borer was found to be much worn. Siemens & Halske intend to make tools of tantalum, and have taken out a patent (No. 167,217) for a tantalum nib which is said to resist chemicals and to possess the required elasticity to a remarkable degree.

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* Abstracted from the *Elektrotechnischer Anzeiger*, August 16, 23 and 30, and September 6, 1906.

Several forms of zirconium lamp have been made, zirconium carbide being stable in the presence of water. Three patents were taken out by Sander (see Nos. 133,701, 137,568 and 137,569). The hydrides or nitrides of zirconium are used in combination with an organic binding material. The hydride is obtained by reducing zirconia by means of magnesium in a current of hydrogen, according to Winkler's method, and if an excess of magnesium is used the product is said to be ZrH_4. The magnesia and the excess of magnesium is removed by treating with dilute hydrochloric acid, and, after drying, the hydride is made into a paste by mixing with the organic binding material. After pressing the filaments through a die, they are dried in an atmosphere of hydrogen at a temperature of about 300°C. In order to make them conduct, they must be heated after being mounted, or a high but not abnormal voltage may be applied. They can then be taken to a state of incandescence, when the formation of the carbide takes place. Hydrogen is passed into the bulb, and the filament becomes hard and metallic. The filaments tested by Wedding took 2 watts per candle-power, but were intended for low voltages.

Another form consists of the so-called zirconium-carbon lamp. This is made by heating an ordinary carbon filament in an atmosphere of some volatile zirconium compound (see German patents 140,323 and 141,353) though these have a very slightly improved efficiency as compared with a carbon filament. Hollefreund, of Berlin, who has been manufacturing these zirconium filaments, has lately brought out other carbide lamps, which contain also tungsten and ruthenium, and have a fusing point much higher than that of zirconium carbide. These lamps are said to burn for 1,000 hours at 1 watt per candle-power, and have a steady value for the first 500 hours, but take low voltages. For instance, a filament 0·6 mm. in diameter and 5 mm. long requires 1 volt (see patents Nos. 140,378, 146,555, 147,233 and 147,316).

The zirconium lamp was followed by another with a filament of iridium, which, like osmium, belongs to the platinum group. Iridium cannot be drawn out into a wire, but can be rolled into a sheet about 0·8 mm. thick. Gülcher's process for the making of iridium filaments is explained in patents Nos. 145,456 and 145,457. It is very similar to other processes already mentioned, and consists in mixing iridium in the form of a powder with a binding medium, squirting it into filaments, heating it in the air till the binding material has been completely eliminated, and continuing the heating until the iridium particles frit together. The lamp is for low voltages only, and can hardly be regarded as likely to be a serious rival of the carbon filament, especially seeing that the sources from which iridium can be obtained are not very numerous. It seems more likely that Gülcher has taken up the manufacture of these lamps in the interests of his accumulator works. The osmium filaments have been used extensively in connection with many plants which have batteries. But the osmium lamps are expensive, and the Gülcher Accumulator works considered that it might be good policy to have a filament which they could manufacture on their own account, and quite independently of the Auer Company. This probably gave rise to the ideas which have culminated in the development of the iridium lamp.

The group of highly infusible metals includes also tungsten and molybdenum. The idea of using them is by no means new, and many processes exist by which lamps are made by coating platinum or carbon filaments with tungsten or molybdenum. Lately Dr. Alexander Just and Dr. Franz Hanaman have patented methods of preparing lamps from tungsten and molybdenum (see German patent 154,262 of April 15, 1903, and granted September 8, 1904). It is known that the oxychlorides of these metals are reduced by hydrogen at a red heat with the formation of the metal, hydrochloric acid and water. If, therefore, a hot metallic or carbon filament is brought into an atmosphere consisting of the vapour of tungsten oxychloride, mixed with an excess of hydrogen, the reduced tungsten would be deposited on the filament, which would then consist of a carbon core with a coating of tungsten or molybdenum. But experiments have shown that under certain circumstances the reaction takes quite a different course. Suppose that there is very little hydrogen present, instead of an excess as was assumed in the above case. The carbon filament, on heating, will be found to be gradually changed into one of pure tungsten in a manner very similar to that by which Dr. Blau obtains osmium filaments by running carbon filaments in a vapour of osmium tetroxide. The reaction may be explained in the following way. The carbon combines with the oxygen of the oxychloride, forming carbon monoxide, while the chlorine is reduced by the hydrogen to the state of hydrochloric acid, and tungsten deposits itself in the place of the carbon. The following equations explain the reaction :—

$$WO_2Cl_2 + C_2 + 2H = 2HCl + 2CO + W$$

or

$$WOCl_4 + C + 2H_2 = 4HCl + CO + W$$

If the carbon is completely replaced by the tungsten the amount of hydrogen may be increased, and more tungsten is then deposited on the filament already formed. This takes place in accordance with the equations,

$$WO_2Cl_2 + 3H_2 = 2H_2O + 2HCl + W$$

or

$$WOCl_4 + 3H_2 = 4HCl + H_2O + W$$

The condition which must be fulfilled before the carbon is thoroughly replaced by tungsten is that there should be an excess of oxychloride vapour, together with very little hydrogen and a high temperature ; at a lower temperature and in the presence of an excess of hydrogen, the carbon takes no part in the reaction. Molybdenum and tungsten act similarly in so far as these reactions are concerned. The similarity between this process and that by which Dr. Blau obtained his osmium filament is very striking. In the case of osmium, the presence of reducing gases is expressly excluded, and the carbon is gradually oxidised to the gaseous condition by the osmium tetroxide, or, in other words, the osmium tetroxide is reduced to the metallic condition by the action of the carbon, which is itself volatilised in the course of the reaction. It may, however, be pointed out that osmium lamps are not made by this process at the present moment. It is believed that there were some practical difficulties that could not be overcome, and the same seems also to be true of the tungsten filaments. Dr. Just has made further applications for patents relating to the same idea, in one of which he proposes to mix a reducible combination of the metal, such as the oxide or chloride or sulphide, with an inorganic binding medium, such as water, and to squirt the paste into the form of a filament, which is then reduced to the metallic condition by exposure to a current of hydrogen at a suitable temperature. On the other hand, it seems that the original ideas of Just are still likely to lead to practical results, and it is stated that by the substitution process it is possible to obtain tungsten filaments of such a diameter that 32 c.p. lamps can be run on 110 volts. Of course, filaments of this diameter cannot be obtained by the paste process by which Auer von Welsbach makes osmium filaments.

Dr. H. Kuzel, of Vienna, has lately described a method by which he makes filaments from amorphous powders without the help of an organic binding material. The firm of Pintsch Brothers, of Berlin, is undertaking the manufacture in Germany, and work is also being done in Austria. Up to the present only one patent has been published, and this is the English patent 28,154 of the year 1904.* The Kuzel process employs the refractory metals in their colloidal condition, either as hydrosol, organosol, gel, or as a colloidal suspension. These metals include chromium, manganese, molybdenum, uranium, tungsten, vanadium, tantalum, niobium, titanium, thorium, zirconium, platinum, osmium and iridium. The metals are obtained in the colloidal form—*i.e.*, in a more or less fluid or gelatinous condition ; they can also be obtained in the solid condition by carefully drying the precipitated sols, gels, or colloidal suspensions. In the first instance the solvent is removed as far as possible from the sol, or gel, by means of gentle drying, pressing, or filtering, until a paste remains; or if the metal is precipitated, small quantities of water or other fluid are added—*e g.*, alcohol, glycerine, chloroform, or xylol, until the colloidal metal swells up and forms a pasty mass. This pasty mass is worked in the usual way, by squirting it into filaments, which are then dried, and heated by passing a current through them. When heated to a white heat, the metal is changed from the colloidal into the crystalline state, with consequent changes in the diameter and specific resistance. Colloidal metals have hitherto received their only practical application in the medical world, but if the figures which have been published relating to the results obtained are accurate, it seems possible that they may play a part in the improvement of electric lighting. The words "sol," "gel," &c , are familiar enough in the modern field of physical chemistry, but they may possibly wear a strange aspect to those who are unfamiliar with work in this direction. Prof. Lottermoser, who has made a special study of the subject of colloids, has therefore written a note, appended to this paper, in which the main facts are clearly stated.

The Auer Gas Co., who are working on the osmium lamps, have lately turned their attention to other metals, especially tungsten and molybdenum. Their main object is to obtain a paste without the use of an organic binding medium. In the case of tungsten and molybdenum, they propose to mix the trioxide, or one of the acid hydrates of these metals, with an excess, of ammonia, until a tough mass is obtained which can be squirted. These tungsten lamps are now made under the name of osmin or osram lamps. Osmin filaments are said to give 40 c.p. at 120 volts, or 80 c.p. at 220 volts, and in these cases a diameter of 0·03 mm. is necessary. An ordinary hair has a diameter of about 0·06 mm., and it will therefore be seen that it is not likely that for the ordinary voltages it will be possible to make lamps of less than 35 c.p. or 40 c.p. But this may prove no serious disadvantage, seeing that these lamps, burning at 1 watt per candle-power, would only take as much current as a 10 c.p. carbon filament. The osram lamp consists of a mixture of osmium and tungsten. It has been supposed that alloys tend to lower the fusing point, and that they were consequently unsuitable for electric lamps. Kuzel suggests that the high efficiency of the new metallic filaments does not entirely depend on their high fusing point, but rather on the fact that alloys are used, particularly in the form of their eutectic metallic combinations, which are well known to possess different physical properties from their components.

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* *The Electrician*, Vol. LVI., pp. 655, 679, 829, 954.

The General Electric Co., of America, has also invented a new form of carbon filament. It is known that a carbon filament can be heated to a very high temperature without undergoing any favourable change. But if a treated filament is heated in an electric furnace it undergoes a very decided change. The furnace employed is of the resistance type, and takes 1,900 amperes, raising the temperature to 3,000°C or 3,700°C. Under this treatment the filaments shrink very much, their surface looks as though it had been fused, and their specific resistance has a positive temperature coefficient, so that the filaments appear to be of a metallic nature. Chemically considered, they appear to be made of graphite, but their efficiency is said to be only 2·5 watts per candle-power.

The following notes refer to the economy likely to be obtained from the different forms of lamp which have been mentioned above. The osmium lamp labours under the double disadvantage of high initial cost and low voltage. The maximum voltage up to the present is 47; consequently, on an ordinary network, they require to be run in series with all the consequent complication. The efficiency is 1·5 watts per candle-power, which is about half of that of the carbon filament, and its life seems to be as long, if not longer. As compared with the Nernst lamp, it has the disadvantage of requiring to be hung in a vertical position, as osmium becomes soft on heating.

The tantalum lamp has about the same efficiency as the osmium lamp, but its filament can be made in a suitable length to take 110 volts, and it can be suspended in any position. It seems, indeed, probable that tantalum lamps will be made for higher voltages. Its useful life is about 400 or 600 hours, and its total life is more than 1,000 hours. It is very necessary to protect the lamp from any vibration, more particularly after it has been burnt for some time. It is true that a breakage will often cure itself automatically, as a slight shake is sufficient to cause the broken ends to make a chance contact and consequently to fuse together again. The lamp is not sensitive to voltage variations, having a positive temperature coefficient. According to Ambler, a rise of 4 per cent. in voltage increases the light of a carbon filament by 24 per cent.; the same change only alters the light of a tantalum lamp by 9 per cent. This is probably due to the positive temperature coefficient of tantalum, while in the case of carbon it is negative. The lamp is sold at a price of 2s. 6d., and would seem to have a great future if its economy were not eclipsed by the latest types of zirconium and tungsten lamps. According to the manufacturer, the zirconium lamps are said to take 1 watt per candle-power, and to have an average life of 500 hours. These lamps are being sold at the rate of 3s. for a 40 volt lamp, 3s. 6d. for one taking 75 volts and 4s. for 120 volts.

The iridium lamps of Gülcher take only 24 volts, and are sold at the price of 3s. 6d. each; they are said to take from 1 to 1·5 watts per candle-power. But very little information can be obtained about them.

The latest novelty is certainly the tungsten lamp, which is being made according to four different processes. The first is due to the patents of Just and Hanaman. It is intended to make a lamp for 110 volts, giving from 30 c.p. to 40 c.p., and taking 1·1 watt per candle-power. Indeed, it is said to be probable that the efficiency will be as low as 0·8 watt per candle power. In any case, lamps have been tested by the Munich Electric Supply Co., and it was found that a 40 c.p. lamp took about 1·1 watts per candle-power. The Kuzel tungsten lamps are being made by Kremenecky, in Vienna. They were tested by the manufacturer, and it was found that they took between 19 and 32 volts, and had a useful life of 1,000 hours at 1 to 1·25 watts per candle-power, with a total loss of light of 10 to 15 per cent. The lamps mend any fracture automatically, as in the case of the tantalum lamps. Other independent tests have been made, giving results similar to those quoted above, and it is said to be likely that lamps of this type will be made capable of burning on 110 volts. In any case, the cost of manufacture is likely to be small, and it is intended to put the lamp on the market as soon as possible.

The efficiency of the 3-ampere Cooper-Hewitt lamps is between 0·33 and 0·15 watt per candle-power, which is about the same as the result obtained with flame arc lamps. It burns very steadily, and considerable variations of voltage produce no noticeable effect. It requires no attention, its light appears almost constant, and it has a very long life with proper handling. Lamps, which are still in good condition, have already burnt 7,000 hours. The cost of a mercury lamp in America, 75 cm. long, giving 500 c.p. to 600 c.p., is £6; the quartz lamp by Heraeus, prepared for ultra-violet rays, costs £15; while the uviol lamp by Schott, 25 cm. long, together with the holder, costs £6. 5s.

Another type of tungsten lamp, made under the name of the osmin lamp, when tested in Munich gave 55 c.p. at 110 volts, and took 1·02 watts per candle-power. Another test, carried out in Vienna, showed an efficiency of 1·03 watts per candle-power, and after burning 1,776 hours the efficiency was still 1·09 watts per candle-power. It is intended to manufacture osmin lamps of 40, 50 and 60 c.p. for 105 and 110 volts. The fourth kind of tungsten lamp, consisting actually of a mixture of osmium and tungsten, and sold under the name of the osram lamp, has been tested by the Reichsanstalt. After burning 500 hours, 25 c.p. lamps took 1·12 watts per candle-power, and the 32 c.p. lamps took 1·08 watts per candle-power. After burning 1,000 hours the conditions remained much the same as before. The Auer Gas Co. intend to make osram lamps for 220 volts; those giving 40 c.p. to 50 c.p. will take about 1·2 watts per candle-power, and higher candle-powers will take as little as 1 watt per candle-power.

Whether these tungsten lamps will fulfil the expectations that have been made remains to be seen. At present they are largely in the laboratory stage, though some are actually being manufactured. In any case they are mostly in that state in which a certain amount of privacy seems not only desirable but necessary. There are many proposed methods for making tungsten lamps; but it may be pointed out that in those countries in which an examination for novelty takes place before a patent is granted, as, for instance, in Germany and Austria, no patent has yet been granted for any of these processes, except in the case of the first application made by Just and Hanaman. So that at present it is impossible to say which method will be protected by patent, and equally impossible to say which method will lead to any definite practical result. Optimists assert that a lamp taking 0·5 watt per candle-power is certain to come; and though the daily press announces its advent from time to time, the technical world knows well enough that a commercial lamp taking 1 watt per candle-power would be quite sufficient for the present.

Notes on Colloids.

An Appendix by Prof. Alfred Lottermoser.—The essence of a solution is that the dissolved substance should be evenly distributed throughout the entire volume of the solvent. The dissolved substance exerts a pressure, in consequence of which it diffuses itself throughout the solvent in opposition to the force of gravity; consequently, the dissolved substance behaves like a gas, which also fills any space quite evenly, but the rate of diffusion of a gas is immensely greater than that of a dissolved substance. Consequently, the laws which relate to the behaviour of gases, which have been chiefly discovered by the work of van't Hoff, apply equally to dissolved substances. But soluble substances are known which possess a very small, and, indeed, almost negligible, power of diffusion; and for these substances the laws relating to gases would seem to be no longer valid. Graham first studied this matter, and he called substances of the first kind "crystalloids," since on removal of the solvent they remain behind in the crystalline state; whereas he called the substances with small power of diffusion "colloids," since glue may be considered to be a typical instance of this class Substances of this latter class remain behind in the amorphous condition after removal of the solvent, and consequently the words "colloidal" and "amorphous" are to some extent identical. Still, a sharp line of distinction cannot be drawn between colloidal and crystalloid substances, seeing that multitudinous substances are on the border line.

Assuming that the laws for gases hold good, it is possible from the diffusion-capacity, or osmotic pressure, to determine the molecular weight. According to this, the molecular weight in the case of colloids would be of the order of 10^4, and even much greater than this. Supposing that the laws for gases are assumed to hold good, we must suppose that we are dealing not with single but with complex molecules. The only other alternative is to give up the idea of solution and to introduce a new conception, as Graham did—viz., that of the "hydrosol," according to which the colloid is evenly distributed throughout the solvent in an extremely fine state of division. Then the question arises as to whether it is possible to see these small particles. This question may be regarded as settled, and answered in the affirmative. It is, however, impossible to see the slightest sign of any want of homogeneity in hydrosols, even under the most powerful microscope; but Tyndall's experiment provides us with another optical method. If a beam of light, after being concentrated by a lens, is allowed to pass into a fluid and is then observed by the eye in a direction at right angles to the direction of the light, the beam will only appear to be invisible in that case in which the fluid is homogeneous—*i.e.*, when nothing is present which is capable of diverting the rays in any way from their path. Most solutions are of this nature, and are optically "empty." In hydrosols, however, the path of the rays is at once visible in a more or less brightly illuminated streak. This shows that small particles are present which reflect or divert a part of the rays, or, in other words, rays are diverted from their path and directed into the eye, which is looking in a direction at right angles to the path of the beam. If dust is sprinkled in a fluid, it is at once noticeable in the shape of bright particles, but these particles are a million times greater than those of a hydrosol, and consequently the latter cannot be recognised in this way as separate entities. But if the above experiment is repeated under the microscope, in the way that Zsigmondy and Siedentopf suggested, it is possible to see separate particles, though it is not possible to define their shape. The metal hydrosols, which are interesting to us at the moment, were examined with great care under the ultra microscope, as the instrument constructed by Zsigmondy was called. In most cases the particles can be seen to be in a state of lively motion, and form a picture of the greatest beauty. It is possible to determine the size of the particles, which can be seen in the brightest sunlight down to linear dimensions of $5\mu\mu$ ($1\mu\mu = 0{\cdot}000001$ mm.). And obviously it is possible to see particles which are below this limit, seeing that Nature makes no leaps; such particles are no longer visible in the ultra-microscope as separate particles but give the impression of an evenly but weakly illuminated field of vision. On the other hand, solutions are known which are not optically "empty," and show the Tyndall phenomenon; and this shows, as I have already said, that no sharp distinction can be drawn between hydrosols and true solutions. Similarly it is not possible to define hydrosols in a purely mechanical way and to limit them to oozes, or suspended particles, which can be distinguished under the microscope. It is true that these oozes of clay or ultramarine possess none of the properties of true solutions; they do not possess the property of diffusing themselves, but then it is possible gradually to increase the size of the particles of a hydrosol until we can microscopically perceive their magnitude, in which case this hydrosol has completely lost all the properties of solutions.

It can, therefore, cause no surprise when we find that hydrosols and suspensions have many properties in common. If an electric current is passed through a suspension or a hydrosol, and even if the resistance is very great, the particles will be seen to be displaced with regard to the fluid; they are electrically opposed to the solution carrying a charge, and the direction of their displacement depends in general on the chemical nature of the particles. Therefore it is natural that the direction of their migration should be influenced by the addition of various substances, and in this respect electrolytes produce a very marked effect. (According to the electrolytic dissociation theory of Arrhenius, electrolytes are understood to be substances which cause the solution to conduct by splitting up into electrically charged particles, called ions—*i.e.*, the wanderers—which give up their charges at the anode and kathode.) The effect on the direction of migration of the ions is most clearly seen in the case of very dilute solutions; but it is not possible to go minutely into this aspect of the problem. In more concentrated solutions the electrolytes produce such an effect on suspensions and hydrosols that the minute particles coagulate together and form more complex structures. The most important point to be noticed is that the effect of an electrolyte is made up of those of the two classes of ions: that ion which has an opposite charge to that of the particle in suspension, or to that of the hydrosol, exerts a precipitating influence, the extent of which depends on the nature of the ion; whereas the ion which has a similar charge tends to prevent the precipitation partially or entirely. Although the effect of electrolytes on hydrosols, and their connection with the direction of migration of the hydrosol particles, is of the greatest importance in the examination of the nature of hydrosols, it is not possible to enter further into the discussion of these phenomena dealing with the nature of hydrosols, especially seeing that we are at present far from completely understanding this difficult subject.

It is possible, in a purely mechanical way, to produce finely divided suspensions by subdividing matter; but for the production of such a state of division as exists in hydrosols we must have recourse to other means, and in this matter chemical and electrical methods are useful auxiliaries. By both of these methods it is possible to obtain metallic hydrosols. If chemical means are employed, care must be taken to exclude an electrolyte which possesses marked precipitating power; for instance, one in which there is an ion having a high valency and having an opposite charge to that of the hydrosol. The chemical reaction always takes the form of a reducing process, and a dilute solution should be used. In more concentrated solutions such electrolytes should be used as tend to produce reversible gels, which are immediately changed into the hydrosol by the further addition of the solvent. By this latter method Carey Lea has produced a silver hydrosol; in a very dilute solution Zsigmondy has obtained the hydrosol of gold; and the author has also obtained some hydrosols of the platinum group. Another reduction process which has been employed by Paal, the author and others, consists in the employment of very stable colloids, which are mostly organic, and prevent the precipitating action of the electrolyte on the metallic hydrosol, even in fairly concentrated solutions. In this way also metallic colloids can be obtained which, however, contain notable traces of the added or protecting colloid.

The second method of obtaining metallic hydrosols is an electrical process. Bredig has succeeded, by volatilising the kathode in an electric arc under water, in producing a great number of metals in the form of hydrosols. Billitzer has also applied this method. Lately, Svedberg has succeeded in reducing all metals to sols in a similar manner. Of course, those metals which decompose water are not obtained in the form of hydrosols, but are collected as sols or organosols in various organic fluids. Finally, it is possible to convert both metallic and non-metallic elements into hydrosols by a kind of electrolytic process, which consists of a volatilisation of the kathode at ordinary temperatures.

Although, indeed, the particles move with the electric current, as has been already mentioned, yet the hydrosols, and more particularly the metals, show only a very slight power of conductivity. This is probably due to the presence of ions. A precipated gel, which has been obtained by drying or by electrolytic action, is a non-conductor, or at any rate a very poor conductor, as Barus and Schneider have found in the case of silver. This is not surprising, seeing that they consist of small disconnected particles, even although they are immensely larger than hydrosols. Kuzel has found this to be the case with his filaments. They only become conductors on being raised to a high temperature, which causes a change from the colloidal to the crystalline state, and produces a continuous metallic conductor of very small diameter.

FIFTH ANNUAL CONFERENCE OF THE MUNICIPAL TRAMWAYS ASSOCIATION.

At Leeds, yesterday, the Fifth Annual Conference of the Municipal Tramways Association was opened by the Lord Mayor of Leeds (Mr. Edwin Woodhouse), who officially welcomed the Association to the city. Some 100 members were present and the morning proceedings opened with the Presidential Address, delivered by Mr. J. B. Hamilton (general manager, Leeds Corporation Tramways).

MR. J. B. HAMILTON'S PRESIDENTIAL ADDRESS.

As president of this association, an honour which I appreciate very highly, it is now my duty after fully a year of office to deliver what is termed the Presidential Address. In many associations the first duty of the president on his election is to deliver an address. In our case, however, the Presidential Address is given at what is practically the end of the term of office, and has this great advantage in that it affords an opportunity, amongst other things, to review some of the work the association has been engaged in, and the principal events which have occurred during the period of my occupation of this most honourable office. Before passing on to consider the year's work, I must refer to the great loss which this association and all the members of it have sustained by the sudden death last Christmas of Charles Revill Bellamy, who was general manager of the Liverpool Corporation Tramways, and the second president of the association in the year 1903-4. Mr. Bellamy was one of the principal founders of this association, and throughout his all too brief connection with it was to the front in everything which made for its growth and greater usefulness. His invaluable assistance to the association, the magnificent organising ability which he showed in the formation of the Liverpool Corporation Tramways Department—which marked him as a great captain of industry—his invariable and painstaking courtesy, and withal his warm-hearted kindliness, make his loss to his friends and to this Association an almost irreparable one. Indeed, the last conversation I had with him a day or two before the suddenly fatal termination of his illness was mainly upon our affairs, particularly as to the amalgamation of all tramway interests in one powerful association, a consummation which he had very closely at heart. In company with your secretary, and several other members of the Executive committee, I attended the funeral service as representing the Association. At the first Executive committee meeting which was held after his untimely end a resolution of condolence from your Executive committee was forwarded to Mrs. Bellamy and family; but I should propose that we formally instruct the secretary, on behalf of all the members, to forward a suitable letter of sympathy from this association to his wife and family in their bereavement.

This is the Fifth Annual Conference of the association, and I have had the pleasure of being present at all of them. It will be remembered that the first meeting was in London, at the Tramways Exhibition in 1902, when Mr. John Young, then General Manager of the Glasgow Corporation Tramways, was our president. The second meeting was held in Glasgow, and Mr. Young retained office throughout that most successful conference. In the following year the venue was in Liverpool, with Mr. Bellamy as president; and last year our conference was again in London, with Mr. Baker, general manager of the Birmingham Corporation Tramways, as president. Throughout these four years, the main objects of the association, which are for the furtherance and diffusion of information relating to the working of tramways and for the protection of your interests, have been kept steadily in view, and the various papers which have been read and the discussions which have taken place upon them have proved to the undoubted advantage of the members generally. To enable the growing work of the association to be properly dealt with, various modifications of our original constitution have been introduced. The discussion of highly technical papers and purely executive matters led to the formation of a subsection, composed entirely of those actually engaged in the operation of tramways, and termed the managers' section. This also meets yearly, the last being in May in Sheffield, where a most interesting meeting took place. Then, two years ago the membership was increased, and our sphere of influence widened by the addition of another representative from each committee.

At the present moment we are looking forward to a very instructive series of Papers, which, I trust, will keep the members fully interested during the Conference. The Paper which Mr. Mozley, of Burnley, proposes to read upon the subject of "Brakes" is one which at the present juncture cannot fail to be interesting to every member of the association. The subject selected by Mr. Holford, of Salford—viz., "Renewals and Depreciation," is one which in the past has given rise to much discussion, and still leaves many matters to be settled. Mr. Bullough's Paper on "Track Maintenance" touches a very important subject; whilst the various points raised by Mr. R. A. Smithson—for many years chairman of the Tramways committee here—are, I think, sure to engage the interest of everyone who has the welfare of municipally-operated tramways undertakings at heart. I feel that in these four gentlemen we have a quartette who will sustain the high reputation of the association for dealing with the practical operation of tramways in a practical way.

Many important matters dealing with Parliamentary legislation and Board of Trade and other Government Departmental regulations have been dealt with by your Executive committee during the year. Amongst others, the regulation proposed by the Home Office in regard to locomotives in factories required a considerable amount of attention. Under this proposal it seemed as if by their definitions every tramway car would become a locomotive, and be subject to many harassing and quite unnecessary restrictions as to space, signals, &c. Your Executive committee took this matter up on behalf of this association as well as the Light Railways Association. Evidence was given before the Commissioner, a number of interviews afterwards took place, and latterly, by the kind assistance of Mr. R. E. Fox, Town Clerk of Leeds, a clause was inserted which gives immunity to tramway depots. Numerous interviews have from time to time, through the courtesy of the Secretary of the Board of Trade, been permitted with the officers of that department. At these interviews your committee have been enabled to lay before the Board their views upon details of construction and equipment of new lines, clearance between tracks and between bridges, top deck covers, centre posts and brackets, permanent way—weight of rail, width of grooves, &c.; cars—reversed staircases to be avoided, type of lifeguard recommended, desirable that folding steps should be adopted, top covers not to be used on gauge 3 ft. 6 in. or less, arrangements for sanding at both ends, height of railings, &c., earthing of trolley standard, detachable trolley heads, &c. Your committee have also been able to come to an agreement with the Post Office Department as to cost of guard wires in cases where telegraph or telephone wires are put up in proximity to previously existing tramway wires. In such cases the Post Office Department will pay half cost of construction. In all these matters the association has had the active co-operation of the Tramways and Light Railways Association and the Tramways and Light Railway Officials' Association, whose interests being identical have acted in conjunction with us.

The tramways industry is growing very rapidly, and unceasing vigilance ought to be exercised to guard against repressive or harassing legislation or regulations. During the Parliamentary Committee sessions, clauses are continually being sought to be introduced into tramway orders and bills which are not in our best interests, and these, when established, are quoted as precedents. To enable us to effectually protect ourselves from such attacks, I think the time has come when we ought to concentrate the whole of the tramway interest into one Tramways Association of Great Britain and Ireland, so that we might stand with a united front to all opponents. The effect of such a union when presenting their case would be incalculably greater than in coming before them as three different associations representing presumably three different interests, and after all, gentlemen, our interests for all practical purposes are identical. As the question of broadening the basis of our association so that we may include representatives from every kind of tramways undertaking in the kingdom will come up for discussion to-morrow, I do not wish to refer further to this matter at the present time.

The statistics of the year show that a continual development of tramway lines is going forward, although for reasons which will readily occur to you it is not at the same rate of speed as in several years at the beginning of the century. For the last year the Board of Trade returns show that, roughly, 33 million pounds has been expended by local authorities in tramway undertakings. This shows an increase of about five millions for the year. The number of miles open is 1,395, and the number of undertakings is 174. Of this number, 115 are municipally operated, the capital expenditure being about 28½ millions. The gross receipts for the whole of the municipally-operated undertakings is about six millions, whilst the number of passengers carried at about 1d. per head is 1,355 millions, an increase for the year of 160½ millions. Combining municipally-owned and operated tramways and company tramways, I find there is a total capital outlay of 52¾ millions, that the miles of line in operation are 2,116, the total gross receipts amount to 10 millions, and the passengers carried reach the huge total of 2,068 millions.

We hear from time to time—although rather less just lately—of the magnificent future of the motor omnibus in city transportation, and a few of us have had some experience in connection with them. In my opinion the petrol omnibus is yet far from being a sure and reliable conveyance—which is the first requisite of such a service—or comparable in point of operating cost with an electric car. I had an opportunity a short time ago of looking over the returns showing the percentage of omnibuses in operation to those in stock of one of the largest companies in London. Not only was the percentage given of their own vehicles, but from daily observations taken I saw the percentage in operation of all the vehicles owned by a considerable number of the larger companies in London. These showed that the most fortunate companies had a maximum of about 70 per cent. of their total stock on the road at any time, whilst many of them had only between 50 and 60 per cent. This is in line with my own experience. Apart from the traffic-destroying vagaries of the omnibus, there is the cost of running to be considered. I am quite sure that on the most level and easily-worked routes, when thorough normal maintenance is carried out and sufficient depreciation allowed, the expenses per 'bus mile are but little under 1s. It is almost impossible to compare these results with that of an electric tramway, which costs, including sinking fund, depreciation and renewals, practically about 7½d. per mile to run, because, in addition to the saving per mile run, there is the much greater attraction for traffic owing to being more reliable, the greater carrying power of each vehicle—56 as against 36 or 38—and the fact that an immense saving occurs in other departments of the Corporation as a result of the maintenance of a large proportion of the highway in the principal streets by the tramways department. In making these remarks, I do not in the slightest degree deprecate the work which is being done by motor omnibuses and motor omnibus companies, particularly in London, where, as a competitor with the horse omnibus, they are really making great headway. Unless, however, a very great improvement in reliability and economical operation takes place, I do not think they will long retard, even in London, the extension of tramway enterprise.

During the last few months there has seemed to be quite an epidemic of serious accidents through tramway cars running away down-hill, and this has caused renewed attention to be given to the question of efficient braking powers. Curiously enough, the two principal accidents which have occurred—viz., the one at Highgate, London, and the other at Halifax—are under quite dissimilar conditions; in one case the gradient was 1 in 22, and in the other a very acute one of 1 in 11. On both cars were brakes acting on the rails in addition to the ordinary hand brake acting on the wheels. The evidence at the Board of Trade inquiry elicited the fact that both accidents were due to an error of judgment and to over confidence on the part of the motorman, who allowed too high a speed to be attained before applying the track brake. These disasters have produced the usual crop of ingenious inventors, who each and all have a perfect panacea for such conditions. Generally, those which I have seen would undoubedly, if brought into operation, stop the car from running away, but in such a violent and objectionable manner as to make the cure worse than the disease. A perfect brake must be prompt and certain in its action, simple and strong in its mechanism, and yet not too sudden in its retarding effect. Whatever brake may be in operation must depend for its use on the judgment of the motorman in charge, and it is in just this variable human quantity where the greatest likelihood of failure lies. Whilst I have referred to the cases in which want of judgment has been shown, I cannot in fairness but say that the general operation of the cars in the crowded streets of our great cities, where great nerve and readiness is required, shows the high efficiency and trustworthiness of the average motorman. That operation of tramways is being conducted with every regard for the safety of their passengers and the public generally is gradually being recognised by the Board of Trade, who during the past year have granted to many tramway undertakings increased maximum rates of speed. I think this fact speaks for itself.

The conveyance of heavy goods traffic upon tramways has scarcely yet engaged the serious attention of many of our municipal undertakings. I believe that as soon as the undertakings have settled down after their rapid development and conversion from horse lines that goods haulage between railway termini and factories and warehouses, and in other directions, offers a great field for development. In our own undertaking in Leeds we have lately contracted in connection with another Corporation department to carry some 100,000 tons of material during two years for about 3 or 4 miles on our track. It is estimated that a saving of from £2,500 to £3,000 to the city will ensue. Should this be successful, and I see no reason to expect it otherwise, I am certain we will be able to consider and carry out a lot of other work in a manner satisfactory to the public and to ourselves. As goods carriers to and from stations, in co-operation with railways, we should be able to handle the traffic quicker and at less cost in many cases than by horse traction, and such business should prove of considerable advantage to traders, to railway companies, and ourselves. I must congratulate the Corporations of Bradford and Manchester upon their courage in commencing very extensive parcel services. In the case of Manchester particularly, they have been successful in the High Court in establishing their right to handle parcels within their own municipal area. This is a decision of the utmost importance to every tramway undertaking, and our thanks are due to them for so ably fighting their and our battle. Preparations have been made to carry out the work on a very large scale; although in their case the financial results have been adverse so far, still it is a business which I trust will grow and become in time self-supporting, if not profit-earning. The convenience and saving to the citizens throughout the city from such a cheap and rapid transit for light goods and parcels is too obvious to require comment.

I should like to refer, before I conclude, in a few words to the labour question. During the past year I regret to note several cases have occurred in which the employés have thought it necessary to withdraw their labour so as to get redress for their grievances or compliance with their requests as to wages, &c. I do not in the slightest degree express any opinion as to whether such demands or complaints were just or otherwise. The fact remains that the labour was withdrawn, and great loss and inconvenience resulted to all classes of the community in the district. Surely such obsolete and drastic remedies can be avoided by fair and impartial arbitration. Tramway committees composed of men elected by the ratepayers, and freed from the incentive of personal pecuniary advantage, are unlikely to place onerous conditions or improper regulations on the staffs of their departments, and therefore shouldhave no hesitation in offering to submit the matter in dispute to any competent and independent arbiters mutually chosen by both parties to the dispute. It is gratifying to observe that this most sensible course was actually adopted successfully by one of our large corporations this year. I think the great weight and influence of an association such as this should be readily given towards facilitating arbitration being accepted in all cases where questions arise which require settlement.

In these remarks I have purposely avoided taking up any special technical subject, but have rather contented myself with briefly running over and reviewing some of the principal matters affecting our industry generally throughout the year. I will now close by expressing the pleasure which my term of office as your President has given me, and the hope that our conference in Leeds will maintain the high level of former years. So far as the Papers and matters to be specifically brought before you are concerned, I am sure the gentlemen who do so will give you opportunity for much interesting discussion; and if we are favoured with sunshine and good weather, I hope in other respects your brief sojourn in Leeds will be a pleasure to all.

A cordial vote of thanks, proposed by Mr. A. Baker (Birmingham), to Mr. Hamilton for his address was unanimously carried, after which Councillor R. A. Smithson, of Leeds Corporation tramways, read a Paper on "Municipal Operation of Tramways: Some Points of a Committee's Policy," which we shall publish in our next issue.

The next Paper to be read was on :—

CAR BRAKES.*

BY HENRY MOZLEY.

(General Manager, Burnley Corporation Tramways.)

In view of the large number of accidents on tramways recently owing to failure of brakes, and the anxiety of the Executive committee to have the question considered in all its bearings, I had no hesitation in complying with the request to give the Association the benefit of our experience with brakes at Burnley, and my committee instructed me to furnish you with any information you required. Municipal authorities, having only one interest to serve, can approach the subject without suspicion of bias, and makers of brakes may be assured that it is the public interest and safety alone which the Association has in view; moreover, this very disinterestedness enables local authorities to freely communicate to each other their common experiences and information without let or hindrance.

The Burnley Corporation Tramways consist of a trunk line 7 miles 12 chains in length, and three branch lines a little more than 1 mile each. The trunk line was worked with steam power for 20 years, the locomotives weighing 10 tons 10 cwt. in working order; bogie cars weighing 4 tons, and having a seating capacity of 64 passengers, so that loads of 20 tons were frequent. The brakes were actuated by steam power upon all the 12 wheels simultaneously, and on no occasion during the period did an accident occur caused by a failure of brakes.

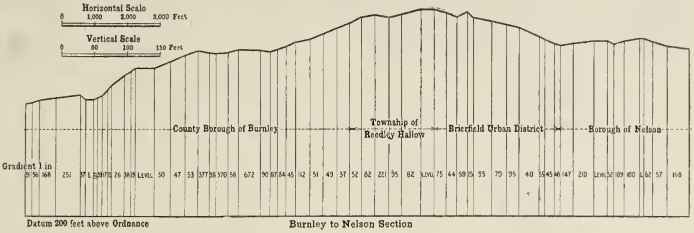
Horizontal Scale
0 1,000 2,000 3,000 Feet
Vertical Scale
0 50 100 150 Feet
County Borough of Burnley
Township of Reedley Hallow
Brierfield Urban District
Borough of Nelson
Gradient 1 in
Datum 200 feet above Ordnance
Burnley to Nelson Section

FIG. 1.

Fig. 1 shows the nature of the route. The Padiham section is 3 miles 19 chains in length, having very little level in it, the characteristic of the route being a steady rise to Park-lane from both directions—the exact rise Padiham to Park-lane being 257 ft., and the distance 2 miles 3 chains; and Calder Vale to Park-lane 155 ft., the distance 75 chains; thus showing that we had long been accustomed to controlling heavy weights on severe gradients, and made us very much alive to the importance of brakes when the time came for the introduction of electric traction. A section of this portion of the line is given in Fig. 2.

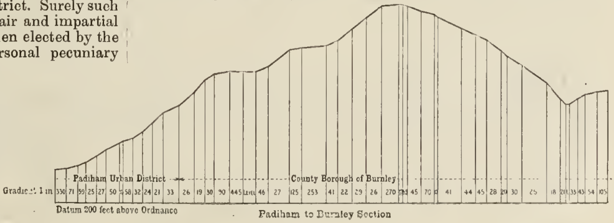
Padiham Urban District
County Borough of Burnley
Gradient 1 in
Datum 200 feet above Ordnance
Padiham to Burnley Section

FIG. 2.

The trunk line has been worked electrically from March, 1902. The cars are double-decked bogies, equipped with Brill maximum traction trucks and B.T.-H. motors, their weight being 12 tons 10 cwt. and seating capacity 70, the weight, fully loaded, 17 tons 10 cwt., with occasional heavier loads. There have been no accidents connected with brakes, which are the simple hand-brake improved by ourselves, and the rheostatic brake. Track brakes are not required or used on this route.

After the trunk line had been in operation 12 months and the result being satisfactory, my committee began the construction of the three branch lines. One of these, the Manchester-road branch, is of an exceptionally dangerous character, having a continuous gradient averaging 1 in 18 for the full distance and 1 in 9·8, 11 and 12 in parts near the junction with the trunk line, the actual rise being 340 ft. in 1 mile 13 chains.

Fig. 3 will illustrate the nature of the gradient very clearly.

The car for this and the Towneley route (worked as one line, horse-shoe shaped, and touching the trunk line in Burnley centre) is of special design, having a large inside seating capacity (44), the Towneley branch having a low culvert under the Leeds and Liverpool Canal. This necessitated four motors, thus bringing up the weight of the car to 14 tons 12 cwt. 1 qr. 26 lb. empty, and 17 tons 10 cwt. 3 qrs. 26 lb. fully loaded.

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* Paper read before the Leeds meeting of the Municipal Tramways Association on Wednesday last. (Slightly abstracted.)

You will readily understand that to control this weight on such heavy gradients the best brakes obtainable were necessary, and my committee appointed a special sub-committee to deal with the question, and it is from this point the subject will be the most interesting and instructive. We had come to the conclusion that only mechanical track brakes were suitable, and made full inquiries into all types of track brakes known to tramway men, including the Hewitt & Rhodes' air brake erected on cars at Oldham (this brake was used for emergencies only and appeared to be too unreliable in the matter of maintenance), and found not one would answer our requirements. We were, therefore, driven to the necessity of designing one.

This brake was erected on a locomotive we were building at the time, and its performances were so satisfactory that it was resolved to adopt it for the Manchester-road cars, and here I may say that during the trials it was found that it would be unsafe to use wood for the slippers, and that soft grey cast iron was the only suitable and safe material. Before this point was reached we had obtained some reliable information and experience of magnetic brakes, which, by this time, had begun to interest tramway men. I propose to go into a little more detail to make clear to you the causes which proved to us the unsuitableness of the magnetic and the adoption of the mechanical track brakes with cast-iron slippers in place of wood—the general practice where mechanical track brakes are used. We had been accustomed for 20 years to the use of the mechanical brakes, and it was a considerable shock to go back to hand brakes when electricity was put into operation, and we naturally kept a look-out for a remedy for this backward step, and the magnetic brake appeared to fulfil the requirements. We therefore obtained permission to try two rival magnetic brakes for the purpose of ascertaining their suitability for service brakes, and at the same time ascertain whether the brake could be used on the Manchester-road cars.

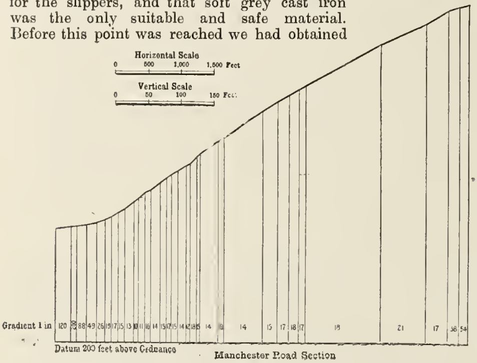


FIG. 3.

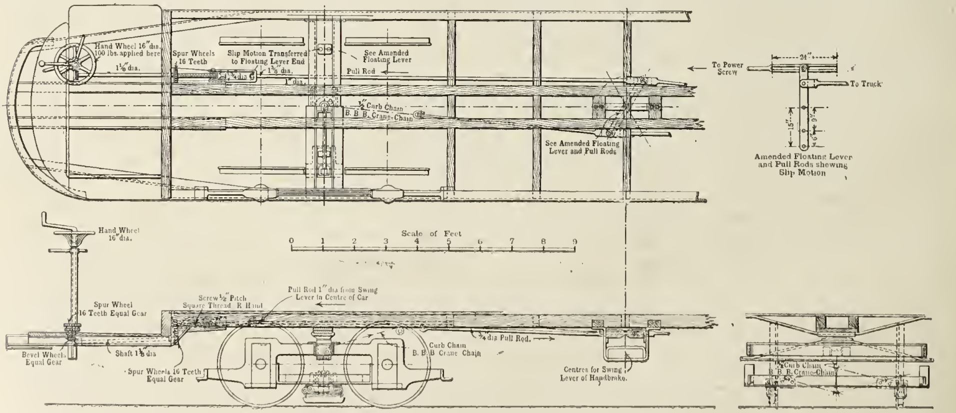

Hand Wheel 16" dia. 100 lbs. applied here
1⅛" dia.
Spur Wheels 16 Teeth
Slip Motion Transferred to Floating Lever End
¾ dia.
1⅜" dia.
1" dia.
See Amended Floating Lever
Pull Rod
½" Curb Chain
B. B. B. Crane-Chain
See Amended Floating Lever and Pull Rods
To Power Screw
24"
To Truck
15"
9"
6"
Amended Floating Lever and Pull Rods shewing Slip Motion
Hand Wheel 16" dia.
Scale of Feet
0 1 2 3 4 5 6 7 8 9
Spur Wheel 16 Teeth Equal Gear
Screw ½" Pitch Square Thread R Hand
Pull Rod 1" dia from Swing Lever in Centre of Car
Bevel Wheels Equal Gear
Shaft 1⅛ dia
Spur Wheels 16 Teeth Equal Gear
Curb Chain
B. B. B Crane Chain
¾ dia Pull Rod.
Centres for Swing Lever of Handbrake.
Curb Chain
B. B. B. Crane-Chain

FIG. 4.—ARRANGEMENT OF HAND-OPERATED SLIPPER BRAKE.

By this time we had gained considerable experience of the rheostatic brake, and found that it was highly destructive to the motors and could only be used for emergencies. The magnetic brake being actuated by the same means, we took the precaution of requiring the makers to satisfy us by actual measurements as to the voltage and amperes generated by the motors. Both makers entered into an agreement to do this, and the brakes were erected on Nos. 6 and 7 cars, the cars being precisely alike.

The Newell brake was fixed to No. 6 car, but we could not use it as a service brake owing to the high current generated causing the resistances to overheat, its tendency to skid the wheels and other causes, and it was removed and returned to the makers.

The British Thomson-Houston Co.'s brake was kept in service five months, and during that time three armatures were burnt out, and the brake had to be abandoned. After the second armature failed the makers made important alterations in the magnets, which lessened the pressure on the motors, but notwithstanding this improvement one more armature burnt out, and we were then convinced the magnetic brake was unsuitable for service purposes.

The makers took measurements as required by the agreement, and Table I. gives the statement supplied by the British Thomson-Houston's Co.'s engineer.

Table I.—*Tests of B.T.-H. Magnetic Brakes.—July 22, 1903.*

From pole No.	To pole No.	Distance ft.	Times, sec.	Speed.	Reading in amps.	Volts.
101	84	1,856	102	12·4	35 to 17	400 to 200*a*
73	65	857	43	13·6	35 to 15	400 to 200*b*
49	46	328	14	16·0	47 to 34	550 to 300*c*
..	..	..	..	..	90 to 25	800 to 250*d*
37	34	351	15	16·0	48 to 28	590 to 350*e*
..	..	..	21	11·4	90 to 25	800 to 300*d*
49	46	328	20	11·2	29 to 24	250 to 210*f*
..	..	..	20	11·2	32 to 29	300 to 200*g*
37	34	351	..	..	Momentarily. Continuously. 50 25	Momentarily. Continuously, 400 to 220*h*
..	..	..	21	11·4	25	250*i*

a 1st notch.—Grades 1 in 26, 1 in 28, 1 in 22, 1 in 40, 1 in 253. No flashing or sparking of motors.

b 1st notch.—Grade 1 in 26. No flashing or sparking of motors.

c 1st notch.—Grade 1 in 18.

d 1st notch.—High ampere and volt readings due to high initial speed of car, which had not come to an even speed when readings taken. No flashing or sparking of motors.

e 1st notch.—Grade 1 in 21.

f 2nd notch.—Grade 1 in 18.

g 2nd notch.—Speed of car fairly constant when readings taken. No flashing or sparking of motors.

h 2nd notch.—Grade 1 in 21.

i 2nd notch.—Car had come to even speed when readings taken. No flashing or sparking of motors.

The Westinghouse Company's representative failed to supply the readings which were taken by them, but I append, in Table II., readings taken by ourselves at a later date, and after the British Thomson-Houston Co. had altered the magnets of their brake.

The data are placed side by side for convenience.

The tests were carried out on certain down grades on the tramway route, as indicated by pole numbers in table below.

During the tests these grades were approached at a fairly high rate of speed, and shortly before reaching the first pole marking the prescribed course the track brakes were applied. The time required to cover the distance was noted, and concurrent readings were taken of amperes and volts at intervals of four or five seconds. From these observations was determined the average speed of car when descending the grade under the action of the brake, also the average total amperes generated by motors and the voltage across the motor armature. The results are shown below. Rails were very greasy :—

Table II.—*Tests Made December 22, 1903.*

Pole No.	Distance ft.	Grade.	Brake.	Time m. s.	Speed.	Average amps.	Average volts.
101–84	1,856	1 in 26	B.T.-H.	1 47½	11·75	13 4	135*
		1 in 28	..	..	..	..	..
		1 in 22	..	..	..	..	..
		1 in 40	W.	1 47	11·80	19·2	198
		1 in 253	..	..	..	..	..
73–65	857	1 in 26	B.T.-H.	0 46·4	12·6	16·0	204†
			W.	0 49	11·9	16·0	146
49–46	328	1 in 18	B.T.-H.	0 17	13·1	28·0	326‡
			B.T.-H.	0 12·8	17·4	47·0	584
			W.	0 11·8	18·9	51·5	710
37–34	351	1 in 21	B.T.-H.	0 15·5	15·45	35·0	453§
			B.T.-H.	0 16·6	14·4	30·0	386
			W.	0 16·0	14 95	40·0	532

* Car brought to a stop with B.T.-H. brake, 82 amperes maximum current.

† Dead stop made with 85 amperes maximum B.T.-H. brake and 100 amperes + Westinghouse.

‡ Westinghouse resistance smoking, stop made with 100 amperes + B.T.-H. brake and 100 amperes + Westinghouse brake. Westinghouse wheels skid ; B.T.-H. very slightly.

§ Dead stop, no skid, 100 amperes B.T.-H. and Westingheuse.

In the above table the average values of amperes and volts are computed from the readings taken when running between poles indicated in first column. The momentary high values observed when bringing car to a stop have *not* been considered in computing the average.

Several emergency stops were made on slight down grade with following results :—

Whose Brake.	Distance to stop.	Time.	Volts.	Remarks.
	feet.	seconds.		
B.T.-H.	67	5	640	With West. brake moters flash and wheels skidded slightly. No flashing or skidding withB.T.-H.brake.
B.T.-H.	54	4	320	
W.	130	7	1,160	

The second emergency stop with B.T.-H. brake was an entirely satisfactory stop, the retardation being practically constant, and at a very high rate. The above figures show the rate to have been 4·6 m.p.h. per second, and the initial speed about 18·5 m.p.h.

A further series of tests was made with the same cars on the Manchester road route. The cars were allowed to descend the grade with the track brakes in operation. Five stops were made during the run, using track brakes only, and the time from start to finish of test was noted in each case, as well as approximate speeds and total amperes taken by the brakes :—

——	B.T.-H. brake.	West. brake.
Average speed approximate	7½ m.p.h.	7½ m.p.h.
Total time, including stops	14 min.	12 min. 7 sec.
Total time, exclusive of stops	11 min.	10 min. 42 sec.
Average current, exclusive of momentary stopping currents over 50 amperes....	16·68 amps.	19·29 amps.
Average current inc. of stopping currents	23·22 amps.	29·28 amps.

Although the B.T.-H. readings were more favourable than in the first test, the voltage and amperes were still high.

Now compare the ordinary braking currents with the driving currents on the same hills :—

Brakes .... 10 to 68 amperes.
Driving .... 51 to 90 „

Remembering that motors are designed for driving only, it is no mystery why armatures burnt out with the almost double work put upon them. But this is not the only reason why magnetic brakes could not be used for service purposes—they are uncertain in their action, and the tendency to skid a source of danger. With every desire to obtain a service brake, we were obliged to give up the magnetic brake, and we are still on the look-out for a suitable form of mechanical brake to relieve the driver from hand braking.

The magnetic brake had not been used anywhere under the circumstances of the Manchester-road tramway, and with our experience of it on the trunk line it was quite clear an unsuitable brake for the conditions obtaining there. A simple matter of figures will show you how this is. By experiment it has been found that at saturation point the Newell brake magnet can be lifted from the rail at 15 cwt. Now compare this with the weight required to hold 18 tons on 1 in 9·8—the car must run away if nothing else to depend on.

I now proceed to describe the mechanical track brake, and the way it operates upon the cars which have been working the Manchester-road route for a period of 2½ years with an entire absence of accident.

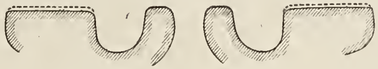
Fig. 4 is from a drawing supplied to the Board of Trade, together with a description of the brake arrangement and power.

The hand wheel of the track brake has a diameter of 16 in.—reckoning 15 in. centre of rim gives a circumference of 47 in. This wheel operates a screw of ½ in. pitch (which is provided with a ball thrust to reduce friction), which is connected by pull rods direct to the swing lever in the centre of the car. The gear ratio between the hand wheel and the nut on the screw is 94 to 1. The floating lever in the centre of the car has a leverage of 5 to 3. The connection between this lever and the levers on the trucks is by rod and chain, and is not affected by the radial movements of the trucks on curves. The power is imparted to the track shoes by means of levers having a ratio of 3 to 1. Total leverage, 468 to 1.

The brackets (which are of cast steel) carrying the track shoes and the fulcrums of the levers are attached to the truck frames by means of steel angle and tee bars, which are bolted to the truck frames. The wearing parts of the shoes are of cast iron, and are easily renewed.

The brake is used as follows: On leaving the terminus at the summit the brake is screwed down sufficient to allow the car to run the proper speed with the hand brakes off; the car is then controlled by the hand brake, which has about the same leverage as the track brake. When the car is stopped the track brake is eased off to allow the car to start, and then screwed down again as before.

For an emergency stop the rheostatic brake is used, and its effect is very efficient and will stop the car at 6 miles per hour on 1 in 9·8 in 3 yds. or 4 yds.



Up grade 1 in 9 8. Down grade 1 in 9·8.

FIG. 5.—SECTION OF WORN RAILS, MANCHESTER-ROAD, STANLEY-STREET.

Each shoe and lever to the shoe is independent, therefore the failure of one shoe or lever does not affect the remainder. Two shoes only will safely control the car. The track brake alone will bring the car down safely and make service stops, thus being a perfectly independent brake and additional to the ordinary equipment of the car. The shoes are easily changed, and last from 10 to 21 days according to the weather. The dimensions of the shoes are 15 in. long by 3 in. wide, and the wearing depth is 1⅜ in. When cast-iron slippers were adopted there were no data available as to the wearing effect upon the rail, but the accompanying section of the rails on the heaviest portion of the gradient clearly show that the wear on the down or braking side is less than the up or driving side.

Fig. 5 illustrates the wear on the rail after 2½ years' service, and the passage of 81,655 cars.

Practically no sand is used on the down rail, even in greasy weather, and I may here state the meteorological conditions of Burnley are bad, the rainfall being greater than any other part of Lancashire except the Lake District ; moreover, the subsoil is clay, which accounts for Burnley being such a favourable district for weaving. The brake has recently been adapted to maximum traction trucks under the double-deck cars with equally satisfactory results.

Finally, I submit the following conclusions from our experience: Bogie cars are easier to control on steep inclines than four-wheel cars, whatever the character of the brakes. Magnetic brakes, particularly those which affect the wheel brakes, are unsuitable for tramways either for service or safety purposes. That they can only be considered as auxiliary to the rheostatic brake, and not as independent track brakes. That they are highly destructive to the motors. They are treacherous and uncertain in their action.

The only form of brakes which will safely control a car on gradients greater than 1 in 14 or 15 are : (*a*) Hand brake with adequate leverage actuating cast-iron blocks on the wheels ; (*b*) mechanical track brake with adequate leverage provided with cast-iron slippers ; (*c*) rheostatic brake for emergencies only.

DISCUSSION.

Mr. A. L. C. FELL (chief officer London County Council tramways) regretted that the author, reading a Paper on brakes in 1906 based on experiments made in December, 1903, should ignore all of the improvements in magnetic brakes since the date of his test, and said that his final conclusions as to the respective values of brakes were not, therefore, in accord with those of other engineers who have experimented on the more recent and perfected type of magnetic brake. The author's experiments and his conclusions drawn therefrom refer particularly to the Burnley tramways, but several of the statements were put in such general terms that they might be interpreted as covering not only the circumstances at Burnley but all other electric tramways of the country, and because of these sweeping statements he considered it necessary to bring to the author's attention some of the results which other engineers have reached, as the opinions based upon these results were diametrically opposed to those of the author. For example, it was a fact, in spite of the author's statement of its impossibility, that the new types of magnetic track brake were used as regular service brakes on cars nearly as heavy as the Burnley cars, and on grades nearly if not quite as great, and also that the service braking under these conditions does not necessarily burn out amatures; and finally, so far as his own experience with magnetic brakes was concerned, they were not uncertain in their action, and could not skid the wheels to a dangerous extent. He admitted the necessity of distinguishing between the conditions of Burnley with those of the L.C.C. tramways. His own object when choosing a brake had been to find the best brake for the L.C.C. conditions, and the three qualifications kept constantly in view when making their choice were: (1) Safety to the general public and the rolling stock of the L.C.C. (2) Higher average speeds without increasing the maximum running speed beyond a fixed limit. (3) That the brake chosen should at all times be under perfect control. The necessity of the requirements under point (1) are, of course, self-evident. To fulfil the requirements of (2) quick application and quick release were a necessity, and the magnetic brake combined these qualities in a way which probably no other brake would ever more than equal. As regards point (3) he had found that with seven brake notches on the controller they were able to obtain extremely satisfactory results. The author of the Paper made the statement that the magnets of the Newall magnetic brake will not hold a car on a 1 in 9·8 grade. This statement in itself was misleading though probably true, but he failed to understand why the author should assume that because the magnets in themselves would not hold a car on the grade mentioned, he should omit to state the fact that the retarding action of the magnets on the rail are only a part of the total, inasmuch as it is impossible to use the Newall brake without applying the brake blocks to the wheels. For instance, on a grade of 1 in 9·8, if a retarding force of 4,113 lb. is applied through any type of brake, an 18 ton car, neglecting friction, would be in a state of running equilibrium. Any additional retarding force would eventually bring the car to rest. The magnetic brake shoes with which his own experiments were made last year in London—and which his committee adopted for their heavier types of cars—each had a pull on the rail when about saturated of 4,500 lb. There were four magnets under the car, therefore, the united pull on the rails in the vertical direction was 18,000 lb. The friction between the rails and the track shoes might safely be taken at 15 per cent., therefore, the maximum retarding effect of the magnets alone is 2,700 lb. But the track magnets brought the wheel brakes into action, and the leverage between the magnets and the wheel brake blocks could easily be made in the proportion of 4 or even 5 to 1. Assuming 5 as the figure, then $2{,}700 \times 5 \times 0{\cdot}15 = 2{,}025$ lb., which added to 2,700 from magnets alone gave 4,725 lb. Therefore, without car friction and without any torque of the armatures, the magnetic brake with which thep experimented, would stop a car weighing 18 tons although it was only designed for a car of a maximum weight of 15 to 16 tons. If there is sufficient space between the brake wheels in the 18 tons cars, a still more powerful magnet could be utilised and the lever ratio also increased, thus increasing the retarding effect. The conditions existing at Burnley, owing to the great length of the grade, were severe, and would require an extra output from the motors for a fairly long period of time, but his experiments had indicated exactly what this extra work on the motors would amount to in a day's run, the selection of larger motors could be made accordingly. It was, of course, understood that for service stops on level tracks the slipper brake described by the author was impossible, as it would be much inferior to the ordinary hand brake, which, in his opinion at least, was equally inferior to the magnetic brake. He thought that the author had overlooked the fact that in all cases where the mechanical track is in use the retarding effect is limited by the weight of the car multiplied by the coefficient of friction between the rail and the track shoes. This maximum possible retarding effect was practically the same whether it were all effected by the track brake, or divided in any proportion between the track brake, wheel brake and rheostatic brake. The author described a method of operating his cars down the grade which was most practical, but he spoke of the retardation produced by the brake blocks, hand-wheel brake and rheostatic brake, as though they were in no way dependent upon each other and as though they could all be exerted to their respective full powers at the same instant, which was manifestly impossible. The speaker submitted that, no matter what value might be put upon the united braking effect of the three types of brakes, with the magnetic brake an additional braking effect of over 40 per cent. would be obtained. Assuming the same values as before—viz., weight of car = 40,320 lb. and coefficient of friction 15 per cent.—then the maximum possible braking effect with the slipper, or combined slipper, wheel and rheostatic brake in retarding effect was 6,048 lb. With the magnetic brake this maximum retarding effect could be increased by 2,700 lb., which is 44 per cent. The following was also submitted for the author's consideration: As previously shown, to bring the car to rest on the grade stated, and neglecting car friction, a retarding effect greater than 4,113 lb. must be applied. The author stated that two shoes only would safely control the car, but if we adhered to the figure for the coefficient of friction of 15 per cent., it is readily seen that unless more than one-half of the weight of the car could be applied to two of the track shoes, the car would continue to accelerate by a force equivalent to 2,097 lb. He admitted that 15 per cent. was a low coefficient to take, but even if a much higher one were used it was readily seen with only two of the shoes available there would be very little margin if any. It must also be borne in mind that the maximum braking effect under those conditions could be obtained only by taking the entire weight of one-half of the car on the shoes, and this was a bad condition to place a car in which had a curve to negotiate at the foot of the grade. He could not reconcile the author's statement: "For an emergency stop the rheostatic brake is used, and its effect is very efficient and will stop a car at 6 miles per hour on 1 in 9·8 in 3 yds. or 4 yds." With his general assumption that you make the whole arrangement useless if, instead of wasting the energy generated by the motor as in the rheostatic brake, it is used for magnetising supplementary track-brake shoes, tramway engineers had given this question most careful consideration, and the fact that the magnetic track brake is in operation on over 3,000 cars at the present moment showed that although a few antiquated sets failed in Burnley some years ago, a large number of engineers were prepared to pin their faith on the efficiency of the latest developments.

Mr. A. NANCE (Belfast) said that the mechanical slipper brake had been adopted at Belfast as meeting the requirements of the service better than any other brake available; the fact that it could be applied by the conductor was a point in its favour. With the slipper brake a car could be allowed to descend a gradient at a given speed, and then controlled by the hand brake, the rheostatic brake being used as an emergency brake. On a 1½ mile gradient in Belfast, 1 in 19 and 1 in 24, with two curves and a crossing, the cars were controlled in this way, and there were three compulsory stops on the descent. It was most important that the sand be kept dry, but this was not always attended to.

Mr. J. A. ALDWORTH (Nottingham) said the mechanical slipper was used with wood blocks in Nottingham on a gradient of 1 in 11 without any trouble, but magnetic brakes were also used on double deck bogie cars over same route with satisfactory results.

Mr. H. E. YERBURY (Sheffield) asked for experiences of energising the magnetic brake from the trolley wire direct.

Mr. W. CLOUGH (Bury) strongly upheld the magnetic brake, and said that the figures in the Paper were based on an obsolete pattern of magnetic brake. Tests were valueless, in his opinion, without *recording* instruments, as readings of indicating instruments could not be taken correctly. He had had three years' experience of magnetic brakes on grades of 1 in 18 and 1 in 15 and had never burnt out armatures or had the least trouble. He considered that the author, in advocating the rheostatic brake, had admitted the use and value of the magnetic pattern, and further, he could not see how skidding was possible, as directly this happened (with the Newall brake), the breaking action automatically ceased and the wheels were again permitted to revolve.

Mr. F. SPENCER (Halifax) said the magnetic brake was ideal in theory but the fact that it was, like all power brakes, more liable to break down told against it. A car must attain a certain speed before it was possible to ascertain if anything was wrong, and this was another objectionable feature as motormen were liable to allow a car to attain an excessive speed before trying the brake. Wood blocks tended to greater rail wear because the under surface of the block was always coated with grit which acted like coarse emery powder on the rail. For this reason cast-iron blocks were preferable as causing less wear. Six years use of the slipper brake in Bradford had been unattended by accident. He questioned the transmission loss of 15 per cent. given by the author in his paper as that of the system of levers and chains used to operate the slipper brake described.

Mr. MOZLEY, in reply, preferred not to enter into "technicalities," as he termed them, and practically disregarded Mr. Fell's criticisms as premature. In another 12 months he inferred that Mr. Fell's wholesale approval of the magnetic brake would be either greatly qualified or changed for an entirely opposite opinion. In Burnley the magnetic brake had been definitely abandoned at the time, because armatures were constantly burnt out, and it was considered unsatisfactory to adopt the form of brake available at the time.

CORRESPONDENCE.

THE SUDDEN SHORT-CIRCUITING OF ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Punga's interesting article on "The Sudden Short-circuiting of Alternators," in your issue of August 31st, may I point out that in a letter to your issue of December 6, 1901, I gave a short account of some of the effects mentioned by Mr. Punga in his article. The observations I referred to were made in 1900 upon the newly-installed three-phase generators at the Central London Railway generating station.

It is interesting to note that the same effect takes place in the throwing on of a more or less inductive load—*i.e.*, the generator voltage takes time to adjust itself. Also a generator having an "amortisseur" winding would show this effect to a greater degree as the flux would be held in the poles for a greater length of time. In the case of a rotary converter transforming continuous to alternating current, the effect is beneficial, as, if a short-circuit occurs, the flux can only change gradually, with the result that the speed does not increase so rapidly as it otherwise would, and more time is given for cut-outs to act.—Yours, &c.,

Rugby, Sept. 13. R. C. CLINKER.

GLOW-LAMP STANDARDS AND GLOW-LAMP PHOTOMETRY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am much interested in the article on Photometry by Mr. J. S. Dow in your last issue. Mr. Dow points out that the running of lamps in parallel is not a perfect substitute for accurately adjusted and measured voltage, and that in the case of one pair of lamps, which he cites as an example, a change of 1 per cent. in the voltage applied to both lamps altered their candle-power ratio by about 0·25 per cent. Changes of this order I can confirm from my own experience. I believe, however, that no change in the candle-power can be detected over quite a wide range of voltage regulation so long as both lamps are working at the same temperature, or in other words, the same watts per candle power.

Mr. Dow also refers to the change taking place in the candle-power ratio of two lamps when the distance between them is varied. This is a common experience, and is doubtless due in a great measure to focussing effects. I find that this effect is entirely absent when standard lamps with bulbs designed to scatter the reflected light are employed. The effect can be shown on an exaggerated scale, if a parabolic reflector is placed just behind one lamp.

I quite agree with Mr. Dow that standard glow lamps are better regulated by measuring the amperes passing through them rather than the voltage at their terminals, as this gets over all uncertainty as to bad contacts, which may exist even inside the lamp itself between the filament and the platinum. In fact I have known this to occur.

The part of Mr. Dow's article which particularly interests me is his reference to the after effects of overrunning for short periods. Mr. Dow finds that, after overrunning, lamps increase in candle-power and decrease in resistance when brought back to their normal voltage. He also finds that the lamps afterwards tend to return to their original condition. I have sometimes obtained the same result and sometimes, also, the exact opposite—namely, that after overrunning the lamps fall in candle-power and rise in resistance. Whether overrunning causes the lamps to increase or decrease in candle-power, however, in every case that I have investigated as yet I have always found that they tend ultimately to return to their original condition. I will not, however, suggest that this is an established law, as I have not up to the present had an opportunity of making a sufficiently thorough investigation of the phenomena.

The moral of this sort of hysteresis effect is that standard lamps must be aged on their running voltage and that any overrunning to hasten the process of ageing is highly detrimental to their constancy afterwards as standards.

In conclusion, our thanks are due to Mr. Dow for a very interesting article and for drawing attention to several causes of error in photometry which are not, I fear, sufficiently appreciated.—Yours, &c.,

Westminster, Sept. 14. Lancelot W. Wild.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A manager will be wanted next year for asphalte factories. Knowledge of French language and of electrical and steam machinery essential. Salary £350 and furnished house. See an advertisement.

A good electrical draughtsman (with experience in cable work and overhead tramway construction) and an assistant electrical engineer (for correspondence and estimating) are required for a large tramway undertaking. See advertisements.

A second assistant electrical engineer is wanted in the electric light branch of the Public Works Department of Southern Nigeria. Salary £300. Single furnished quarters provided for small annual rent and first class passages out and home. Applications to the Crown Agents for the Colonies, 4, Whitehall-gardens, London, S.W., until Sept. 24.

An assistant inspector of scientific supplies is required for the India Store Depot. Salary £200, rising to £350. Further particulars from the Director-General of Stores, India Office, Whitehall, S.W., until Sept. 29

An assistant lecturer is required in department of engineering drawing at the Glasgow and West of Scotland Technical College. Salary about £100. Applications to Mr. J. H. A. McIntyre.

Mr. Lawrence Birks, who has been engineer to the New Zealand Electrical Construction Co. since 1904, and was previously superintending engineer at Christchurch, assistant engineer at Sydney, and assistant professor of engineering at Heriot-Watt College, Edinburgh, has been appointed engineer-in-charge at Rotorua (N.Z.) under the Tourist and Industries Department. There were 51 applicants for the position.

Mr. G. R. Abel, late of the Durham power station, has been appointed electrician-in-charge at the Coronet-street works of Shoreditch (London) electricity department.

Mr. Wm. Allen, A.M.I.E.E., of Gloucester, has been appointed assistant electrical engineer at Mansfield.

EDUCATIONAL NOTICES.

King's College, London.—The 1906-7 session commences on Wednesday, Oct. 3. In addition to the ordinary day courses in engineering and applied science there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Courses of instruction are arranged (in connection with the evening classes at the college) for the intermediate and final examinations for the B.A. and the B.Sc. degrees of the University of London. There are also classes in engineering and architectural subjects. Full information and prospectuses from the Dean (Mr. R. W. K. Edwards), or the Secretary.

University College, Bristol.—The 1906-7 session begins on Oct. 2. There are courses of instruction in electrical, civil, and mechanical engineering at this college, and special facilities are offered in connection with college and engineering works scholarships. Favourable arrangements have been made with firms in or near Bristol for practical training to be obtained concurrently with the college course. Applications for vacancies should be made as early as possible to the registrar and secretary, Mr. Jas. Rafter.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Electrical Standardizing, Testing and Training Institution. The new session opened on Monday last. This institution affords a complete theoretical and practical training in electrical engineering, including workshop practice in well-known works.

Finsbury Technical College.—The session for the evening departments in electrical and mechanical engineering, chemistry and applied art begins on Oct. 1. Programmes containing particulars of courses of instruction may be obtained from the Registrar at the college Leonard-street, Finsbury, E.C.

An introductory course of six lectures on the Calculus for engineers will be given by Prof. Coker, commencing Tuesday, Oct. 2, at 8 p.m. These courses will serve as an introduction to the advanced course of lectures and laboratory work on steam and other heat engines, and will occupy the remainder of the session.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering will commence on Oct. 1; entrance examination Sept. 26 and 27. These courses, which include periods occupied in commercial workshops, extend over four years, and also prepare for the degrees of B.Sc. in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Evening technical courses in all branches of electrical and mechanical engineering will commence on Sept. 24. The laboratories are well equipped for both alternate (single and polyphase) and continuous-current work and for all kinds of electrical testing.

In view of the increasing work of the institute and the inefficiency of the accommodation, notwithstanding the large size of the building, the governing body have for the coming session taken the rooms of the British Horological Institute, in Northampton-square adjoining. This extension has made it possible to free rooms occupied last session by the optics department. In the rooms thus vacated there has been equipped during the vacation an intermediate electrical engineering laboratory, intended for those students who, having passed through the junior laboratory, are not yet sufficiently trained in handling machines and instruments to be trusted with the expensive equipment of the senior laboratory. At present both d.c. and a.c. work are taken in the same room, but it is intended later to have large rooms for each division of work. Another of the rooms vacated is to be devoted to an extension of the junior laboratory, which has been overcrowded during the last few sessions, although it has been utilised five nights a week. Another room has been devoted to a much-needed extension of the senior electrical testing laboratory. Yet another room will be devoted to an extension of the instrument workshop, which has also suffered from overcrowding. In the two last cases this want of accommodation has led to refusal to enrol late-coming students in the past. No such refusals will, it is hoped, be necessary during the coming session.

The chief extension in the mechanical engineering department consists of an additional room devoted to the power laboratory, which has enabled the classes for automobile engineers to be considerably developed. Six special courses, giving to an earnest evening student four years continuous work, are now devoted to this subject. An addition to the equipment of this department takes the form of a 75-ton testing machine, by Buckton, of Leeds.

Birkbeck College.—The 84th session commences on Wednesday, 26th inst., when Sir E. H. Busk, Vice-Chancellor of the University of London, will give the opening address, at 7:30 p.m. Day and evening courses of study prepare for the examinations of the University in the faculties of arts, science, commerce and law. During the past year 77 students passed some University examination, while a large number gained successes at various public examinations. The college has added considerably to its appliances in recent years, and the physical, chemical, biological and metallurgical laboratories are thoroughly equipped. Courses in mining, metallurgy and assaying are given both in the day and evening. The calendar issued by the college supplies detailed information respecting the courses of study, examinations, studentships, &c.

Borough Polytechnic Institute.—A four year course of instruction in electrotechnics (comprising lectures and laboratory work) for evening students commences at this Institute on the 24th inst. Particulars of these courses, and also of the chemical, electrochemical and engineering courses, may be obtained on application to the principal (Mr. F. C. Millis), 103, Borough-road, London, S.E.

South Western Polytechnic (London, S.W.)—A complete three years' course in electrical engineering is given in the day classes and a four years' course in the evening classes at this polytechnic. Courses of lectures and practical work are also given in electrical engineering (elementary, intermediate and advanced) and electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting and calculus for engineers. These lectures may be taken separately or as part of a course. Particulars from the Secretary, Manresa-road, Chelsea, London, S.W.

Sir John Cass Technical Institute, London—The new session begins on Sept. 24. There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the electrical, metallurgical and chemical industries and in trades associated therewith. Every facility is afforded for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. Courses of instruction in glass blowing will also be given during the session by Mr. A. C. Cossor. Details of the classes can be obtained at the Institute, Jewry-street, Aldgate, E.C.

Hackney Technical Institute.—The session commences on Sept. 24. There are evening courses in electrical engineering subjects, including alternating currents, dynamo design, wireless telegraphy, &c. Prospectuses from the secretary of the institute, Dalston-lane, London, N.E.

L.C.C. School of Photo-Engraving and Lithography (6, Bolt-court, Fleet-street, E.C.).—This school is open to those who are genuinely engaged in business in any branch of the photo-mechanical, photographic, designing, illustrative, lithographic, engraving and printing crafts. The school is well equipped with the necessary appliances for study and practical work. It contains a large studio for life and elementary drawing, design rooms, lithographic studio, lithographic press room, photographic studio with electric light installation, dark room, collotype preparation and printing room (with three presses), etching rooms, lecture room, &c. Only those engaged in the trade are admitted. The inclusive fees are 10s. per session (of from 30 to 40 weeks), and 4s. 6d. for those in receipt of less than 30s. per week. Trade apprentices, learners and improvers (under 21) are admitted free. The 12th session commences on Sept. 24.

Calendar.—The calendar of the evening classes at the Wigan and District Mining and Technical College contains details of the courses of instruction, fees, &c. There are classes in mechanical and mining engineering (with a special course in the application of electricity to mining), practical mechanics and mathematics, drawing, elementary science, &c. Copies of the calendar from T. Wall & Sons, Wigan, price 6d. ; post free 9d.

Aberdeen.—The Council have decided to apply for a provisional order to extend their area for supply of electric energy to correspond with their gas supply area.

Annfield Plain.—The Council have engaged Messrs. D. Balfour & Son to prepare a report on electricity supply.

Argentina.—The "Review of the River Plate" says Messrs L. & S. Monteverde, owners of the Tranvia Nacional in La Plata, have applied to the Government for permission to electrify and extend the line.

The Empresa Canal Zabala has applied to Montevideo Municipal Council for a concession for an electric tramway from Capilla de Toledo and Carrasco through Artigas, along the south coast of Montevideo, &c., and over Pantanosa bridge to the Zabala.

Australasia.—The "Australian Mining Standard" says :—

Sydney Council have quoted 2d. per unit (plus 5 per cent.) for current to be supplied for lighting, for working lifts and other purposes at the G.P.O.

The net profit on the first half-year's working of *Fremantle and East Fremantle* (W. Australia) tramways and electricity supply works (to June 30) was £2,713, and as the supply to the railways, N. Fremantle Municipality and the Harbour Trust had only just commenced, it is expected that the revenue will be greatly increased during the current half-year.

The District Councils of *Prospect*, *Nailsworth* and *Walkerville* are urging the Premier of South Australia (Hon. T. Price) to include the tramways in their districts amongst the systems dealt with in the bill which Mr. Price intends to introduce for the acquisition and electrification of the tramways in the Adelaide district.

Echuca (Victoria) Shire Council have decided to raise a loan for the equipment of electricity works.

Bangor.—An inquiry was held here last week into the application of the Council to borrow £2,700 for electricity supply extensions.

Bermondsey (London).—There are now 68,890 8 c.p. lamps (including 64,228 for private consumers) connected with the mains. Loans of £2,635 and £2,000 for condensing plant and mains extensions respectively are to be taken up. The Council are proceeding with their application for a provisional electric lighting order.

Bonnyrigg (N.B).—The Lighting committee have been asked to report upon the following offer of the Lothians Electric Power Co. for supply of electricity for public lighting :—

The company propose to erect 94 lamps (or more if desired) and keep them alight from beginning of September till beginning of April, between one hour after sunset and 10:30 p.m. (approximately 1,000 lighting hours) for 25s. per lamp per annum, on condition that permission be given to erect poles and overhead wires for lighting and power. The scheme will entail a slightly greater annual expenditure to the Council than the system of gas lighting at present in vogue, but the illumination will be increased by over 500 per cent.

Buckhaven (N.B.)—The Council have asked Wemyss & District Tramways Co. to submit terms for the public electric lighting of Denbeath.

Camberwell (London)—On Wednesday the Mayor ruled out of order the report of the Works committee recommending application for a provisional electric order.

When giving permission to the County of London Electric Supply Co. to lay mains in the borough, the Council put in a proviso that the mains should be laid solely for the supply of electricity.

The company appealed to the Board of Trade, who now reply that pending the consideration of the question of the introduction of general legislation, it is desirable to postpone giving a decision, it being understood that the company are allowed to continue their work without prejudice to any decision the Board may ultimately give on the matter.

Cardiff.—The Tramways committee discussed on Friday a proposal to have the watering and sanding of the streets in which the tramways run done by one department instead of by the tramways and health departments.

The borough electrical engineer and tramways manager (Mr. A. ELLIS) said the sanding of the tramways track cost between £600 and £700 a year. In other towns the work was done by the public works or health departments.

The chairman and deputy-chairman are to meet the Health committee and discuss the matter.

Chester-le Street.—The Council have approved the County of Durham Electrical Power Distribution Co's scheme for the supply of electricity in the district by overhead cables.

Dublin.—Kingstown Council have conditionally approved the scheme of the Irish Electrical Agency (Ltd.) for supply of electricity for lighting and power in Kingstown, Dalkey and Killiney.

Dunfermline.—The question of electricity supply has been before the Council for a long time. Members have been divided into two parties, one favouring an agreement with the Fife Electric Power Co. for a supply of electricity in bulk, the other advocating municipal works. The leaders of the two parties were invited to report upon the question and, as might be expected, these reports are only the reflection of the views of the parties.

Provost Macbeth thinks it would be a risky experiment for the Corporation to attempt an installation of suction gas plant of the size which they would require, as the factories in the district practically all generate their own electricity. Bailie Stewart thinks, however, that the Corporation should generate electricity on the lines suggested by Crossley Bros., *i.e.*, by suction gas plant.

Ealing.—The Electricity Supply committee announce a reduction of 5 per cent. in the charges for electric current.

Electric Power and Lighting in British Dockyards.—The new generating station at *Portsmouth* Dockyard, which is to supply electrical energy to the whole of the dockyard and eventually to Whale Island and the Naval Barracks, was formally opened by Rear-Admiral Sir H. D. Barry on Saturday last.

The generating plant consists of six Belliss-Dick Kerr direct-coupled sets, five of 600 kw. and one of 300 kw. Each engine is coupled with a separate Allen condenser which runs independently. The condensed water is discharged into a hot well and is pumped by electrically-operated Worthington pumps to the top of the boiler house, where it is discharged into the main feed tanks, after passing through filters. The steam-raising plant consists of 10 boilers fitted with Bennis mechanical stokers. There are also two McPhail & Simpson superheaters. The main coal bunkers are at the top of the boiler house, and the coal after being crushed to a size, is carried by conveyers right over the building and discharged into the separate bunkers, from which the coal is supplied automatically into the hoppers when the boilers are under steam. The feed water is taken from the town's supply and, after going through a softening process, is pumped through the main feed tanks by Weir pumps to the boilers. The main switchboard was manufactured by Dick, Kerr & Co., and consists of six generator panels, 12 lighting feeder panels and 20 power feeder panels, besides two balancing panels, and one third-wire earthing panel. In addition there are six panels for supplying current to the various power and lighting circuits in the generating station. There is also a large overhead crane in the station, electrically-driven, and capable of lifting 25 tons. By means of an electrically operated plunger which fits under the axle of the coal truck, the rear of the waggon is tilted, and the coal is tipped out.

Work in connection with the electric power and lighting installation at the Naval Ordnance Depot, Bull Point, *Devonport*, is also approaching completion.

The installation is stated to be the first in which electricity has been utilised to supply lighting and power for the handling of high explosives by night. The generating station is near the eastern end of the depot. The boiler room contains four Babcock & Wilcox boilers, all fitted with the revolving type of grate, and with appliances for regulating the height of the fires with automatic fuel supply. At present an ordinary auxiliary engine works the belting for actuating the shafting governing the movement of the grates, but it is proposed to replace this by a small electric motor. The three dynamos employed were manufactured by the Lancashire Dynamo & Motor Co., and give an output of 310 to 340 amperes at 220 to 240 volts. The engines are by Willans & Robinson. The switchboard consists of 11 panels. There is a battery of 120 cells of the Tudor nine-plate type. The main circuits are enclosed in glazed earthenware pipes. The road lighting is a combination of arcs and incandescents, a pair of incandescent lamps being attached to each standard, and can be brought into circuit on special occasions or as police lamps. For lighting the buildings containing explosives and the main magazines special circuits have been arranged, as in no case could the wires be allowed to pass inside the buildings. The wiring has been effected by leading piping along outside the walls and by joining in short lengths of the same immediately over each window or entrance door, to which safety water-tight lamps are attached. The reflected light from these will sufficiently illuminate the buildings, to enable the explosives to be handled with safety. Near the entrance to each building is placed a small locked switch supply box and a cutout box for controlling the lamps.

The contract in connection with the generating plant has been executed by the Lancashire Dynamo & Motor Co. W. T. Henley's Telegraph Works Co. made and laid all cables, &c., and provided the equipment for the supply chambers and pillars, and W. J. Corse & Co., Plymouth, executed all wiring and fitting work, &c.

Mr. F. Thursfield, representing Messrs. Preece & Cardew, consulting engineers to the Admiralty, supervised the progress of the undertaking.

Engineering and Machinery Exhibition.—We learn that all the meters for measuring power at the exhibition now being held at Olympia, some 50 in number, are Hookham meters.

Fatality.—A fatal accident occurred on the system of the Sunderland & District Tramways (Ltd.) on Wednesday at Houghton-le-Spring. A tramcar left the metals at a sharp curve at the bottom of an incline and, running across the roadway, jammed a man, named Paton, against the wall. Paton was badly injured, death ensuing 15 minutes after the accident.

Ferry Hill (Durham).—The Council are negotiating with Bolekow, Vaughan & Co. for a supply of electric current to the 48 public lamps.

Fraud.—At the Central Criminal Court, London, on Wednesday, Chas. J. Dudley, described as an electrician, aged 30, pleaded guilty to a charge of obtaining money by false pretences, and was sentenced by Sir Forrest Fulton to 12 months' imprisonment with hard labour.

It was stated that prisoner, who had traded as an electrical and surgical appliance maker, had advertised for canvassers. Applicants were required to deposit money as security for samples which they never received. Prisoner had been convicted previously.

It was stated on prisoner's behalf that although he had not a patent he was the inventor of a portable electric lamp for medical purposes. He had the monopoly of the sale of the lamp. The advertisements spoke of his being the "sole patentee" and as having "the world's rights," but those statements were not accurate, and he therefore pleaded guilty. He was desirous of repaying the persons who had deposited money with him, and if judgment was postponed and prisoner was allowed to go out he could, by the end of the month, earn £40 which would go towards repaying them. The Recorder would not agree to this suggestion.

Halifax.—The Tramways committee are now running a full service on all the routes. 27 of the old employés resumed work on Monday, and applications have been received from 19 others. The bulk of the men are, however, still holding out.

Hospital Lighting.—As announced elsewhere, the Governors of St. Bartholomew's Hospital have now let the contract for the wiring, &c., of the new out-patients' block of the hospital. The installation is being carried out to the specification of the consulting engineer, Mr. F. Charles Raphael.

India.—Messrs. Crompton & Co., who are erecting and equipping a generating station for supplying current for lighting, power, &c., and are also constructing electric tramways in Cawnpore, expect to have the full tramway service working by the end of the year. Meanwhile, the superintendent (Lt.-Col. Walker) has submitted proposals for an independent plant for supplying power for the Government harness and saddlery factory.

London County Council Tramways.—St. Pancras Council on Wednesday adopted the recommendation of the Parliamentary and General Purposes committee that approval be given to the County Council's proposed Bill authorising the construction of electric tramways (see p. 686 of our issue of Aug. 17) so far as the routes lie within this borough.

With reference to the proposal that the conduit system be adopted in the conversion to electric traction of the tramways in Hampstead-road to Camden-road, and that the overhead system be used on the routes from High-street, Camden Town, to Finsbury Park and from Camden-road to Hampstead terminus, the Council decided to adhere to its former resolution that only one system of electrification should be adopted, and to request the County Council to reconstruct the whole of the lines in St. Pancras on the conduit system.

Manchester.—Two reports have been prepared by the city electrical engineer (Mr. S. L. Pearce) on the extension of the generating plant and on the future policy of the Electricity committee for the more economic working of the electricity stations.

Estimates of the probable increased demand for current, calculated on recent progress and prospects for the future, indicate that the maximum supply of the present plant will be called for in the winter of 1907-8, and that further provision will have to be made to meet the demand for the winter of 1908-9.

With regard to the working of the stations, the Dickinson-street station, as the oldest establishment of its kind in the city, is worked less economically than the Bloom-street or the Stuart-street stations, the latter being the most economically worked of the three. It is suggested that in the summer months Dickinson-street station shall be closed and the whole of the demand be met from the other two stations. At present the normal capacity of the plant at the three stations is 32,800 kw. The maximum load last winter was 21,928 kw., compared with 20,023 kw. in the previous year, 17,290 kw. in 1904, 12,775 kw. in 1903 and 9,140 kw. in 1902.

Mansfield.—The Mayor announced on Saturday that the strike on the local tramway had ended.

The company offered to reinstate the men on the old terms and consider a scheme for giving them a bonus. The men declined to accept the terms unless the drivers received ½d. per hour advance and the conductors 5d. per hour. On Saturday the company agreed to pay the motormen 5½d, and the conductors 5d. per hour, promising to reconsider the whole question in six months. The men agreed to accept a ¼d. per hour at once and a similar advance in January, the motormen to receive a similar advance at the end of six months.

Newtownards (Co. Down).—The Council has discussed a proposal of the British Electric Traction Co. to construct an electric tramway between Newtownards and Dundonald.

The company, it was stated, were at present hardly prepared to undertake the task of constructing the line, inasmuch as there was not a regular flow of traffic between the proposed termini. The company would, however, test the possibilities of the place, by starting a service of motor omnibuses, giving, say, half-hour services.

A committee has been appointed to investigate the matter and report.

Obituary.—Dr. D. H. Goodsall, a director of the Western Telegraph Co., of the Pacific & European Telegraph Co., and of the London Platino-Brazilian Telegraph Co., died suddenly on Friday last after a cardiac attack.

Oxford.—At Tuesday's meeting of the Council two tenders were received (from the National Electric Construction Co. and the Oxford Tramways Co.) for the conversion of the local tramways to electric traction, and were referred to the Tramways committee for report and analysis.

Poplar (London).—Application is to be made to the L.C.C. for a loan of £500 for wiring consumers' premises.

Presentation.—Mr. R. H. Wilson, third engineer at Chesterfield electricity works, was on Friday last presented by the staff with a silver cigarette case and a pipe, with amber mouthpiece, on the occasion of his leaving to take up the duties of chief assistant to Lewes & District Electric Supply Co.

The borough electrical engineer (Mr. R. L. Acland) made the presentation, and recalled the fact that this was the fourth occasion during the past 12 months on which a member of his staff had obtained the post of chief assistant engineer to an electric supply undertaking. In three of these lighting and tramways were combined.

Ravensthorpe.—The L.G. Board have asked the Council to supply further evidence of a demand for electricity in the district, before sanctioning a loan.

It will be remembered that the Council have provisionally agreed with the Yorkshire Electric Power Co. for a supply of electricity in bulk, and the loan was required for distributing cables, &c. At the recent inquiry only 27 persons guaranteed to take current, but it is well-known that only when electricity supply is available in a district can the demand be properly gauged.

Ship Lighting.—As might be expected, the new Cunarder, the ss. "Mauretania," which was launched yesterday (Thursday), has a very complete electric lighting and power installation. There will be electric lifts for conveying passengers from one deck to another, electric baggage and other lifts, and a complete telephone system giving communication between the state-rooms and the purser's office. Electric ventilating fans in the engine rooms and passengers' quarters will be provided. Nearly 5,000 electric lights will be fitted throughout the ship.

South Wales.—A special meeting of consumers and prospective consumers of the South Wales Electrical Power Distribution Co. was held at Cardiff on Friday, when the results of the representations made to the various collieries in the coalfield were submitted. The directors had issued a circular to their customers, giving amended terms on which they would be prepared to supply power. After discussion a committee was appointed of representative consumers to confer with a committee of debenture holders of the company with a view to discussing the terms.

Stoke Newington (London).—The electricity supply cables are to be extended in Green-lanes from Lordship-park to Seven Sisters-road at an estimated cost of £410.

Walsall.—The Corporation have decided to reconstruct the old tramway track in the borough, employing workmen of the tramways department under the supervision of Corporation officials.

Mr. Pearman Smith asked for an explanation why an entirely new method of procedure was to be adopted with regard to tramways construction. Seeing that an expenditure of nearly £40,000 was involved, he thought it would have been in the public interest that the work should have been done by contract, as otherwise it was quite possible the Corporation might incur considerable loss.

Mr. Millerchip said experience had convinced the Tramways committee that they could do the work more efficiently and more economically than if it was let to a contractor.

Warsaw.—Works have recently been established here for the manufacture of incandescent electric lamps.

West Ham.—An adjourned inquiry was held on Tuesday into the application of the Council to borrow £75,651 for extensions of their electrical undertaking.

In May the inquiry was opened, and in looking through the various items the inspector (Mr. H. R. Hooper) pointed out that the Council were asking to borrow several thousand pounds for plant and material for which a loan had already been obtained.

The borough electrical engineer (Mr. A. H. Seabrook) could not explain the matter as he had then only recently been appointed.

Mr. Hooper now said that he had thoroughly gone into the question, and found that out of the total of £75,651 for which the Council asked sanction to loan, £17,634 was for excess expenditure and the remainder for new work.

Mr. Seabrook gave evidence to the effect that the new plant was required because of the greatly increased demand for electrical energy for power and light. In regard to the excess expenditure, he said that at the inquiry in 1902, when sanction was granted to borrow £210,226, it was estimated that the completion of the Abbey Mills power station would cost £1,988, but the expenditure was £12,295, the excess being made up by work that was found necessary but not anticipated. It was estimated at that time that for the Canning Town power station and mains £228,445 would be required. Up to March 31, 1906, £210,226 had been sanctioned and £223,798 had been expended, including expenditure on works and variations of works outside the original estimates, but found necessary as the scheme proceeded. The Abbey Mills station had been superseded by the Canning Town station, and the building, so far as the electric light undertaking was concerned, was of no value.

The Inspector: There is still a debt of £4,307 on Abbey Mills station, of which only a portion can be properly asked for, because you have nothing to show for it except the machinery, which was removed to Canning Town. He must say an unfortunate mistake had been made in not applying for the loan before. Machinery was purchased in 1898, and not until now was application for sanction to the expense made. Moreover, no payment had been made to the sinking fund with regard to the machinery, which by now had much depreciated. In some instances the Council were applying for sanction to borrow money to purchase articles for which they had already had the money. The cost of the buildings at Abbey Mills should have been written off as a dead loss four years ago.

In answer to the Inspector, Mr. Seabrook said that on public lighting the Council had spent £2,947, and had not received sanction to borrow the money.

The Inspector: There has been no provision made for a sinking fund?—No.

It is very sad to find all this expenditure has been incurred and not one single penny has been put by to the sinking fund to meet the debt that has been incurred. The position is extremely unsatisfactory, and the returns which have been made year by year are not strictly correct.

Mr. Withers (for ratepayers) asked the inspector to recommend that the sanction be not granted. He did not consider the Council were fit to be entrusted with public money. Other ratepayers said that they would only agree to the loan being granted on condition that the Council consented to have a Local Government Board auditor to go through their accounts.

Worksop.—The salary of the electrical engineer (Mr. J. P. Crowther) has been increased to £200 per annum, rising by increments of £25 a year to £300.

P. & O. Batti-Wallahs' Society.—On Thursday last the P. & O. Batti-Wallahs' Society, with the kind consent of the managing directors of the P. & O. Co., visited one of their latest ships (the ss. "Mooltan") at Tilbury Docks.

The members were met by Capt. Harris' representative, and were received by the chief engineer. A tour of the engine room was made under the guidance of the electrician attached to the ship, and all were much struck to see the great advancement that the P. & O. Co. had made in their electrical equipments. The generating plant installed consisted of five two-crank Belliss-Morcom engines coupled up to four-pole Siemens dynamos, and one smaller set placed on the upper deck, with a small donkey boiler for emergency use. The wiring for the upper decks is connected to the main board through a branch board in the emergency engine room, thus arranging for lights on the upper decks should the main engine room be flooded through mishap. The five main sets are each 350 amperes at 105 volts, the low voltage being the only unchanged feature since the days when the older members were at sea. The sets feed the motor circuits, two the lighting circuits, and one is spare. The ammeters, starting switches and speed regulators for the many motor circuits was the first means of bringing home to the members the fact that a great change had taken place. The five forced draught fans were driven by electric motors, as were two large fans ventilating the engine room, and many applications of electricity were seen over the ship. A large number of cabins were provided with small electric fans, and in the pantry and galleys very interesting examples were seen, such as an electric motor for turning the spit in the roasting ovens, and also electric plate and dish-washing machines. In the saloon were a large number of electric punkahs fitted, no doubt much appreciated in the tropics, and preferred to the old hand-pulled punkahs of the earlier days. Members noted with interest that a telephone system had been introduced enabling the officer on the bridge to speak to the engineer of the watch, the look out forward, or the officer on the poop (while mooring). Before leaving the Society was entertained to tea in the saloon, and all expressed great satisfaction at the admirable arrangements made by the P. & O. Co. for them.

Electro-Harmonic Society.—It is announced that arrangements have now been completed to hold the ensuing season of the Electro-Harmonic Society's concerts in the King's Hall, Holborn Restaurant. Members of the society are reminded that the annual subscription of 10s. 6d. is due prior to the first concert, to be given on Oct. 5. Mr. W. E. Lane, the hon. sec., Finsbury-pavement House, London, E.C., will be pleased to receive subscriptions and nominations for membership of the society.

Scott's Old Boys.—The second annual re-union dinner will be held at Manchester Hotel, Aldersgate-street, London, E.C., on Oct. 6, at 6:30 for 7 o'clock. The scheme of an annual re-union has been taken up with enthusiasm and a large number will be present. All who were trained or engaged in Scott's works at Hammersmith or Acton are cordially invited. Anyone not having received a notice should communicate with the hon. secretary, Mr. H. Marryat, 28, Hatton-garden, E.C.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The accounts of the electricity department for the year ended July 31 show net outstanding capital expended of £237,462, an increase of £16,704 over the previous year.

The revenue was £41,656, including £9,948 for current for Corporation tramways, £1,557 from the Aberdeen Suburban Tramways Co. and £985 motor hire. Working expenses were £17,016. The gross profit was £24,640. Interest required £7,780, depreciation £7,572 and sinking fund £5,448. The surplus (£3,899) has been carried to reserve. 4,945,198 units were generated (compared with 4,899,050), of which 1,864,328 (1,709,012) were supplied to private consumers, 249,681 (255,540) used for public lighting, 2,000,143 (1,960,448) used on Corporation tramways and 166,096 (144,831) supplied to Aberdeen Suburban Tramways Co. Works costs were 0·51d. per unit (against 0·62d.) and total costs 0·86d. (against 0·90d). In our issue of the 7th inst. we gave an abstract of the report of the city electrical and tramways engineer, Mr. J. Alex. Bell.

Darwen.—The accounts of the Tramways Fund for the year ended March 31 show capital expenditure £79,599 (increase £496), of which £11,480 has been repaid.

The total receipts in connection with the Darwen section were £11,820. Traffic expenses were £2,457, general expenses £631, repairs and maintenance £1,628, and power expenses £2,272 (2·6072d. per car-mile). £900 was allowed for depreciation, leaving £3,932 gross profit (4·5116d. per car-mile). After payment of interest and instalments of loans and sinking fund, the net profit on the section was £376 (0·4309 per car-mile). On the Hoddlesden section the year's income was £1,687, and gross profit £108 (0·8506d. per car-mile), after allowing £150 for depreciation and meeting operating expenses, of which power (at 1¾d. per unit) cost £580 (4·5637d. per car-mile). Interest required £459 and sinking fund £293, and the deficiency for the year was £640 (5·034d. per car-mile).

East Ham.—The Council have adopted the tramways accounts for the year ended March 31st, and £1,192. 11s. 4d. has been carried to depreciation and renewals account.

Councillor Oakley said their greatest consideration was the permanent way, as, in the opinion of experts, the life of their rails would be only from 10 to 12 years. That being so it followed that in less than the next seven years they would have to re-lay the greater portion of their system, and he estimated that that would cost the ratepayers about £38,000. If they did not build up a reserve to meet that expenditure, they would have to fall back on the rates.

Hammersmith (London).—The report of the borough electrical engineer (Mr. G. Gilbert Bell) for the year ended March 31 states that the period has been the most eventful in the history of the undertaking, owing to the capacity of the plant having been more than doubled, the price of current reduced to a low flat rate, and several important new contracts for supply of current entered into.

The installations connected increased by 241, making the total 1,818, representing 112,122 8 c.p. lamps. 3,644,146 units were sold, an increase of 695,513. 48 per cent. of the current was used for private lighting, 38 per cent. for power and 14 per cent. for public lighting. A satisfactory feature was the large increase in the quantity sold for power. The average price per unit sold was 2·32d. per unit, against 2·94d. There are 229 motors of 1,420 H.P. connected, against 180 motors of 1,208 H.P. In a number of factories electric driving has superseded gas and steam engines and not a single complaint has been received in connection with the change. The experiment in converting a circuit of rectified arcs to alternating current having proved satisfactory, the work of converting the whole of the lamps was proceeded with, and this has now been completed and the lamps give a better light. Works costs have been reduced during the 12 months to 0·792d. per unit (11·2 per cent.) and the total costs to 1·096d. per unit. A comparison between the two years' costs per unit in detail showed a reduction in practically every department over which the staff has any control. In conclusion, Mr. Bell states that the year under review has been the most successful since the commencement of the undertaking. The total revenue expenditure was £21,002, an increase of £2,089 over the previous year, while the revenue (notwithstanding the fact that the greater portion of the current was sold at reduced rates) actually shows an increase over the previous year of £179.

Manchester Tramways Parcels Service.—The general manager of the tramways department (Mr. J. M. McElroy) has prepared his special report on the working of the tramways parcels department.

The total operating expenses amounted last year to £17,366, and interest, &c., to £400. The income from the carriage of parcels was £11,996, leaving a deficit of £5,770. The Tramways committee have had (it is explained) to undertake large expenditure in providing vans, horses, &c. New stock has been purchased at large expense and parcel depots have had to be rented. Litigation has also increased expenses. The work of the department has been handicapped through the fact that incoming parcels for delivery have not been received in such large numbers as parcels for dispatch to different parts of the city or out of Manchester. Mr. McElroy also states that no branch of municipal work has ever had so many difficulties to contend with as the parcels department. From the start it was obvious that the facilities provided were altogether inadequate. The central depot was quite unsuitable for the business to be carried on. What was wanted was a large central depot with tramway sidings into it and all proper facilities for unloading from the collecting vans and loading into freight vans for transit over the lines. At each of the suburban depots similar facilities were necessary on a smaller scale. Then in the Salford area the department has had no depots, and this has necessitated delivery in Salford by vans from one of the Manchester depots. The judgment in the action brought against the Corporation by Sutton & Co. established their right to employ horses and vans for collection and delivery, subject to the restriction that every parcel in some portion of its journey from the consignor to the consignee must be carried on the tramways. Experience had taught them that compliance with that restriction had entailed greater expense on the department than was at first contemplated. Boycotting was also alleged, but the most serious difficulty they had had to contend with had been that of competition. Before the Corporation entered the field the local parcel carrying business was almost entirely in the hands of one firm of carriers, but when the Corporation entered into the business their opponents were in a better position than they were. Whilst the Corporation were, to all intents and purposes, simply local carriers, the company were general carriers, and had offices and agents in all the large towns in the country. It was true that the department advertised that they conveyed parcels to all parts of the United Kingdom, but all their "rail" parcels—*i.e.*, parcels for towns outside their local delivery area—were handed over to the railway company, who paid them 1d. per parcel for collection. On the other hand, the rail traffic was the backbone of the business of their opponents, and by far the most profitable. It might be argued that with their tramway system they possessed such advantages over their opponents as should have outweighed any of the disadvantages mentioned. Parcels and goods had, however, to be conveyed to the cars, and this conveyance must in the main be by means of motor or horse vans, and in considering as to how far tramways might with advantage be used in the transit of parcels and goods, the extent to which the use of collecting and delivery vans and facilities for loading and unloading were necessary must be an important—indeed the determining factor. Where the tramways gave them a decided advantage was in the delivery of light parcels by messenger boys from the various cash offices along the lines of route. They had tramcars running in all directions every few minutes, and by utilising the cars for the conveyance of parcels they were able to give prompt delivery, which was of great advantage to the public. If the committee decided to continue the business on the present lines, they would be called upon to provide a large and properly-equipped depot in the centre of the city, and also to provide suitable suburban depots. That would necessitate a considerable capital cutlay. As to the working of the department during the present financial year. the income still fell considerably below the expenditure, and there appeared to be no immediate prospect of any improvement. The position was, therefore, serious, and called for immediate consideration by the committee.

The Parcels sub-committee met on Tuesday and decided to advise a policy of contraction and consolidation. The old company (the Manchester Carriage & Tramways Co.) used to collect and deliver parcels within their own area, and it is with such work that the committee must in future be content. It is said that as matters now stand the greatest loss is sustained on parcels which are collected in Manchester for delivery outside the tramway area.

Newcastle-on-Tyne.—The accounts of the electric tramway department to March 31 show capital expenditure £1,144,099, an increase of £23,232 on the year.

Revenue was £196,996 (compared with £197,493 in previous year), including traffic receipts £192,655 (£193,305), street lighting £3,207 (£3,030) and public building, lighting, &c., £635 (£645). Traffic expenses were £58,319 (£68,736), general expenses £15,630 (£17,330), general repairs and maintenance £18,552 (£22,533), power expenses £9,433 (£10,628), maintenance and repairs at power and sub-stations £12,394 (£14,855) and street lighting £1,038 (£884). The gross profit was £91,063 (£73,155). Interest required £33,652 (£33,944), special rents £3,755 (£2,000) and depreciation (rolling stock, &c.) £1,093, leaving a balance of £52,554 (£36,012). Sinking fund absorbed £33,209 (£29,718), £640 was applied to defraying cost of raising loans and obtaining provisional order and £18,704 (£6,294) has been placed to reserve and renewals fund. 4,053,722 (4,326,152) car-miles were run. 8,254,841 (8,581,301) units were generated, 6,878,822 (7,192,791) used for traction and 1,376,019 (1,388,510) for lighting, &c. The current consumed per car-mile was 1·697 (1·66) units, and the coal consumed during the year was 15,915 (18,322) tons, or 4·32 lb. (4·8 lb.) per unit generated. There are 191 cars in stock, of which 99 are double-decked and 23 have roof covers. 4,284,333 (4,306,993) passengers were carried, being 10·56 (9·95) per car-mile, and the average receipts per car-mile were 11·67d. (10·84d.), the average fare per passenger being 1·10d. (1·07d.) Total operating costs per car-mile were 6·27d. (6·89d.), of which power costs were 0·36d. (0·41d.). The system comprises 57¼ miles of single track, of which 52½ miles are owned by the Corporation, who also operate over 4¾ miles of the Tyneside Tramways Co.'s lines.

An important report by the auditor on depreciation accompanies the accounts, in which it is contended that the present reserve fund is inadequate. The engineer and general manager of the tramways department (Mr. E. Hatton), in commenting upon this report, says: "I trust the Tramways committee will adopt a firm attitude on this subject and set aside annually the whole of the gross surplus available until the deficiency pointed out in the auditor's report is made up, and then, after providing the proper annual sum (£19,500) for reserve and renewals, any surplus could be devoted to such purposes as the committee may decide. The friends of municipal trading who argue that the whole of the net surplus should be devoted to relief of rates or the reduction of fares, &c., and that no reserve is necessary (seeing that the capital is being redeemed) are really placing the undertaking in a false position, and it is only a question of years before this fact will be demonstrated. The statement that no reserve or renewals fund is necessary would be correct if the life of the various parts of the undertaking coincided with the terms of borrowing, but since the life of those various parts is shorter than the periods of the loans, and as the Corporation cannot re-borrow without first redeeming the outstanding loans, then, when those parts are worn out and require renewing it will be necessary to levy a rate for that purpose, and, therefore, it is only by accumulating a reserve fund during the early life of the undertaking that the necessary provision can be made. Therefore, the true friends of municipal trading are those who, in addition to paying interest and redemption, are endeavouring to build up a reserve and renewals fund for the time that will all too surely arrive, and by thus putting the undertaking on a sound businesslike footing at present they will prevent what will otherwise undoubtedly be a blow to municipalisation.

St. Pancras (London).—The estimated expenditure of the Electricity department for the half-year ending March 31 next is £37,270, income £45,100. Main extensions, to cost £407, are to be carried out.

The revenue for current supplied to the tenants of the Goldington municipal buildings during the year was only £50. 6s. 10d., while the Housing committee paid the electricity department £163. 2s. 6d. For a portion of the year the tenants paid an average sum for current consumed, and presumably consumed more than the average quantity. It is now proposed to replace the slot meters by ordinary meters, and the Electricity committee will undertake the collection of the charges for current in future.

The annual report of the chairman of the Electricity committee states that the number of additional consumers connected during the past year was 268, making a total of 2,763, representing a demand of 97,329 16 c.p. lamps. There are 1,197 arc lamps and 545 motors, besides cooking and heating apparatus and other current-consuming devices. The total units sold was (exclusive of public lighting) 5,047,974, realising £59,997, equal to an average of 2·85d. per unit. The profit was £9,441, against £13,098 and £20,583 in 1905 and 1904. The net profit of the undertaking since it was started in 1892 amounts to £86,742. 37 additional arc lamps were erected during the year (making 792 public arcs and 43 Nernsts).

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

The demand for the first issue of "The Electrician" Industrial Supplement (published gratis with *The Electrician* for Sept. 14) has necessitated an additional printing. We have now a further supply of copies available.

In answer to numerous requests for filing cases for the Supplement, the Publisher begs to announce that these will be ready in a few days, and will be distributed next week. The filing cases are made to hold twelve copies of the Supplement.

TENDERS INVITED.

Army Contracts.—An advertisement elsewhere states that manufacturers who may wish to be invited to tender for army requirements should address the Secretary of the War Office by letter, stating the articles they manufacture and the names of at least two well known firms or public bodies who have purchased from them and are in a position to certify to the quality of their productions. The articles purchased include cables, chemicals, clocks, electrical stores, fuses, india-rubber goods, ironmongery, lamps and lanterns, scientific instruments, tools, traction plant, vehicles, wires, &c. Firms whose names are on the War Office list need not apply.

The directors of the *Metropolitan Railway Co.* invite tenders for supply of general stores during the 12 months ended Oct. 31, 1907, including electric lamps, carbons, fuses, ebonite, &c., electric wires and cables, telegraph fittings, battery jars, zinc, insulators, &c. Forms of tender, &c., from the secretary, Mr. R. H. Selbie, 32, Westbourne-terrace, London, W. Samples and patterns may be seen at the office of the company's storekeeper, adjoining Neasden station, N.W., from Oct. 1 to 6 inclusive. Tenders to the Secretary not later than 10 a.m. Oct. 8. See also an advertisement.

Blackpool Electricity and Tramways committee invite tenders for supply and erection of (1) one 800 to 1,000 kw. turbine, direct-coupled to one 800 kw. single-phase alternator; (2) one 500 kw. d.c. tramway generator and (3) surface-condensing plant. Specifications, &c., may be obtained at the office of the borough electrical and tramways engineer, Mr. Charles Furness. Tenders (addressed to the chairman of the committee, West Caroline-street, Blackpool) by 29th inst. See also an advertisement.

The *Bombay, Baroda & Central India Railway Co.* (2, 3 and 4, Bishopsgate-street Without, London, E.C.) want tenders by noon Sept. 25 for various stores, including accumulator cells.

Umtata (Cape Colony) municipality require tenders by Oct. 31 for electric or acetylene gas lighting. Particulars from the town clerk, Mr. E. J. Ramsay.

Limerick Electric Lighting committee invite tenders for gas plant, gas engine and dynamo, switchboard extensions and cables. Tenders, to the town clerk (Mr. W. M. Nolan), before 2 p.m., Oct. 2.

Wimbledon Council want tenders by noon Oct. 13 for supply and erection of circular saw bench, band sawing machine and 12 H.P. electric motor.

Pontypridd Council want tenders by 24th inst. for supply and erection of tramcar sheds.

Gillingham Corporation want tenders by noon Sept. 24 for coal for the electricity station.

Johannesburg Town Council invite tenders for supply and delivery f.o.b. (at a port suitable for shipment to South Africa) of one-phase alternate-current motors with accessories. General conditions, specification and forms of tender from the consulting engineers, Messrs. Mordey & Dawbarn, 82, Victoria-street, London, S.W. Tenders to the town clerk, Municipal Offices, Johannesburg, by Oct. 15.

The Magistrates of the City of *Utrecht* (Holland) invite tenders for (1) supply of 12 complete electric motor cars for the city tramways, and (2) supply and erection of the complete overhead line work, consisting of standards, trolley wire, span wire and other accessories. Tenders (which must be delivered to the magistrates) must be at the Town Hall, Utrecht, by 2:30 p.m. Sept. 29.

TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Council have received the following tenders for one 2,000 kw. steam turbo-generator, with switchboard, condensing plant, &c.:—

Willans & Robinson (*prov. accepted*)	**£8,857**
Electrical Co.	13,500
Brown, Boveri & Co. (Richardson-Westgarth turbine)	11,084
Brush Co. (Brush turbine)	11,075
British Westinghouse Co. (Westinghouse turbine)	10,281
British Thomson-Houston & Co. (Curtis turbine)	10,240
C. A. Parsons & Co.	10,210
Mather & Platt (Zoelly turbine)	9,940
Electric Construction Co. (Parsons turbine)	9,875
Ditto (Richardson-Westgarth turbine)	9,780
Ditto (Willans turbine)	9,725
Richardsons, Westgarth & Co. (Dick Kerr alternator)	9,870
Ditto (Siemens alternator)	10,145
Siemens Bros. & Co. (Parsons turbine)	9,778
Ditto (Willans turbine)	9,769
Ditto (Richardson-Westgarth turbine)	9,888
General Electric Co. (Richardson-Westgarth turbine)	9,445
Ditto (Willans turbine)	9,518

The Electricity committee reported that, in regard to the majority of the tenders, it was necessary to add a provisional sum of £800 for foundations, but in any case the tender of Willans & Robinson was the lowest, and the chief engineer (Mr. S. W. Baynes) had reported that he had every confidence, after inspecting a plant of nearly the same capacity supplied by the firm, in recommending the acceptance of their tender. Messrs. Willans & Robinson had also undertaken to supply in the shortest time of any of the firms quoting. The condition under which the Council accepted this tender at £8,857, with the additional of a provisional £800 for foundations, was subject to their agreeing to Mr. Baynes acting as sole arbitrator, and, in the event of his being unable so act, to the substitution of the usual arbitration clause.

The following tenders were received by St. Pancras Council for two three-phase high pressure 500 kw. motors for sub-stations, and one 1,000 kw. motor for King's road station, with switchboard, &c.:—

Bruce Peebles & Co. (*prov. accepted*)	£6,840 and **£6,180**	British Westinghouse Co.	£7,234
Brown, Boveri & Co.	9,912	Vickers, Sons & Maxim	7,200
Crompton & Co.	8,965	Electric Construction Co.	6,184
Brush Co.	8,710	Mather & Platt	5,739
Electrical Co.	7,760	British Thomson-Houston Co.	5,723
Dick, Kerr & Co.	7,726	Siemens Bros. & Co.	5,689
British Electric Plant Co.	7,450	General Electric Co.	4,764

Mr. Baynes reported that a number of the firms had not included the cost of foundations (estimated at £450), and had omitted to provide for the cables connecting the machinery to the switchboards (estimated at £200). He had, therefore, adjusted the six lowest tenders accordingly with the following results:—

Vickers, Sons & Maxim	£7,850	Siemens Bros. & Co.	£6,339
Electric Construction Co.	6,834	Bruce Peebles & Co.	6,180
Mather & Platt	6,389	General Electric Co.	5,414
Brit. Thomson-Houston Co.	6,373		

After going carefully into the question of the efficiencies offered by the various firms, Mr. Baynes considered the tender of Bruce Peebles & Co. at £6,180 the most economical, and in that view the Electricity committee concurred. The condition under which the tender was accepted was that a clause should be inserted enabling the Council to take a proportionate amount from the contract for every cent. or fraction per cent. of efficiency below that specified in the tender, and also empowering the Council to reject the plant wholly if the percentage should fall below the following rates of efficiencies: Combined efficiency of 1,000 kw. motor, full load, 90 per cent; three-quarter load, 87 per cent.; half-load, 85 per cent.; 500 kw. motors, full load, 89 per cent.; three-quarter load, 87·5 per cent.; half-load, 84 per cent.

Salford Council have accepted the following tenders:—

British Westinghouse Co., special car accessories; Meters (Ltd.) station meter; W. T. Glover & Co., paper insulated cables; Liverpool Electric Cable Co., cables; Howard Asphalt Troughing Co., troughing and bridges; Rowland Carr & Co., bitumen and bitumen compound; Berry, Skinner & Co., switches and motor starters; Everett, Edgcumbe & Co., gravity type ammeters; Simplified Underground Conductor Co., asphalt concrete; Ferranti (Ltd.) house meters; Adams Mfg. Co., motor starters; Johnson & Phillips, cables; Electromotors (Ltd.) and Royce (Ltd.), high and low speed motors; General Electric Co., steel insulated screwed tubing; British Insulated & Helsby Cables, house fuse boxes and mica sheets; Lancashire Dynamo & Motor Co., electric motors.

The contract for the electrical installation in the new out-patients' block of St. Bartholomew's Hospital, which is in course of erection, has been awarded to Thompson, Ritchie & Co. The accepted tender is in accordance with the specification of the consulting engineer (Mr. F. Charles Raphael), and includes the lighting of the block (about 900 lamps), wiring to the lift and fan motors, and provision of the motor-generator and circuits for the medical applications of electricity.

Stalybridge, Hyde, &c., Joint Tramway Electricity Board have decided to instal a 2,000 kw. turbine set in their generating station, and have placed the complete contract (including turbine generator and condensing plant) with Willans & Robinson, Rugby. The alternator is to be of the three-phase type, and will be built by Bruce Peebles & Co., Edinburgh & London.

Hove Council have accepted the offer of the Reason Mfg. Co. to supply (on sale or return) 12 tantalum lamps and fittings. The cost of lantern fittings and wiring is £2. 4s. 6d. per post, or, if fitted into existing lanterns £1. 7s. per post.

Hammersmith (London) Council have placed an order with the British Electric Transformer Co. for 10 controlling boards of Berry series gear at £35 per set. The three sets purchased in February as an experiment have given every satisfaction.

Heckmondwike Council have accepted the tender of the Heywood Air-tight Damper Co. for supply of dampers for the boilers at the electricity works.

An order has been placed by Bermondsey (London) Council with Duke & Ockenden (at £34. 2s.) for repairing the artesian well pump at the generating station.

British Insulated and Helsby Cables have recently secured a contract for about £9,500 worth of cables for Sydney (N.S.W.) Corporation.

Colwyn Bay Council have accepted the tender of J. O. Davies for engine and boiler foundations at the electricity works.

The City of London Corporation have placed an order with the British Thomson-Houston Co. for 1,000 incandescent lamps at £40.

Smethwick Education committee have accepted the tender of the Brush Co. for a motor-generator at £35 for the technical workshops.

Boiler Contracts.—Among other important orders for boilers recently obtained by the Stirling Boiler Co. (Motherwell, N.B., and Edinburgh, London, &c.) are the following:—

Colwyn Bay District Council, one boiler of 2,760 sq. ft. heating surface; Walsall Corporation electricity department, one boiler of 3,450 sq. ft. heating surface; London Electric Supply Corpn., one Stirling independently-fired superheater capable of superheating 80,000 lb. of steam per hour, fired by chain-grate stoker (for Deptford power station); Sydney (N.S.W.) Municipal Council, four boilers, each of 5,750 sq. ft. heating, surface, with superheaters, chain-grate stokers, ladders, gangways, piping, &c., all to be delivered and completely erected on site at Sydney.

BUSINESS NOTICES.

Their factory accommodation having been recently enlarged, E. P. Allam & Co., of Red Lion-street, Clerkenwell, E.C., are able to increase their output of "Premier" open and enclosed types of starting switches, speed regulators, lift controllers, &c. They hope in future to be able to give immediate delivery from stock of all standard apparatus.

Thos. Barnes and Chas. Rupert Barnes, electricians, 81½, Great Hampton-row, Birmingham, and Six Ways, Erdington, have dissolved partnership. Debts by Mr. C. R. Barnes, who continues.

The Sydney (N.S.W.) address of the Edison & Swan United Electric Light Co. (Ltd.) has been changed from 16, Carrington-street, to 58, Clarence-street.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the creditors of Ernest Rosenberg, patent broker, Birkbeck Bank-chambers, Holborn, London, W.C., was held yesterday. Debtor formerly carried on business as an electrical engineer, but lost £20,000 (he says) in connection with the concern, which was formed into a company. He had since dealt in patents and held various agencies. He attributed his failure to inability to realise share interests and the failure of another person to carry out a contract. Estimated liabilities, £8,000; value of assets unascertained. A trustee was appointed.

Albert E. Butterfield, electrical engineer, 4, Saltaire-road, Shipley, has been adjudicated bankrupt. The first meeting of creditors will take place on Sept. 26 at 29, Tyrrel-street, and the public examination on Oct. 24 at the County Court, Bradford.

The trustee (Mr. C. H. King, Trinity House-lane, Hull), in the bankruptcy of Fred. Shaw, electrical contractor, 258, Hessle-road, Hull, has been released.

The trustee (Mr. W. F. J. Hunt, Cambridge Junction, Portsmouth) in the bankruptcy of John Weston Martin and John Primmer Poor, electricians, 154, New-road, Buckland, Portsmouth, has been released.

Claims against the Cooper Patent "Anchor" Rail Joint Co. (Ltd.) by Nov. 6 to Mr. W. Crosland, 43, Albion-street, Leeds.

Claims against Wm. H. L. Watson and Geo. Huntington, electricians, 83, Battersea-rise, S.W., and Dering-street, Bond-street, W., London, as partners, and also against the separate estate of Geo. Huntington, by Oct. 3 to Mr. F. S. Salaman, 1, Oxford-court, London, E.C.

A supplementary dividend of ½d. will be payable on 26th inst. at 58, Coleman-street, London, E.C., in the liquidation of the McGuire Mfg. Co. (Ltd.), 2, Queen Anne's-gate, London, S.W.

A meeting will be held on Oct. 15 at 333, Dashwood House, London, E.C., to receive an account of the winding up of the British Electric Signs Co., Ltd.

A meeting will be held on Oct. 19 at 520, Salisbury House, London Wall, E.C., to receive an account of the winding up of the Consolidated Telephone Construction & Mfg. Co., Ltd.

The British Electrical Tool Co., Ltd., is being wound up voluntarily and Mr. C. S. Holliday, Greek-street, Park-row, Leeds, is liquidator.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. have received instructions from the liquidator of Christian & Phipps (Ltd.) to sell by public auction on the works premises, 23 and 24, High-street, Hampton Wick, on Sept. 25, at 10:30 for 11 a.m., the whole of the modern plant (including dynamos, motor, switchboards, battery of chloride cells, tools, &c.) and the finished and unfinished electrical stock and materials (consisting of manufactured switches, fuse boards, fuse boxes and fuses, electric light fittings and lamps, &c.). Further particulars and catalogues from the liquidator (Mr. F. Beddow), 41, Finsbury-pavement, E.C., or the auctioneers, 46, Watling-street, London, E.C., and Albert square, Manchester. See also an advertisement.

Plant, &c., for Sale.—J. Stone & Co. (Ltd.), Deptford, London, S.E., have for disposal three Crossley gas engines, two G.E. shunt-wound dynamos, sixteen electric motors, &c. See an advertisement.

Barber & Coleman (Ltd.), 38, King-street West, Manchester, advertise for sale two electric motors (2½ H.P. and ½ H.P.).

The Forth Shipbreaking Co., Bo'ness, N.B., advertise for sale some copper armoured cable.

Exports of Electrical Goods and Apparatus.—According to official returns for the month of August, 1906, the value of electrical goods and apparatus (other than machinery and telegraph and telephone wire) exported from the United Kingdom was £586,580, compared with £505,343 in the corresponding month of 1905 and with £105,897 for August, 1904, an increase of £81,237 over 1905 and of £480,683 over 1904. For the eight months of 1906 ended Aug. 31 the total value of these goods was £1,814,680, compared with £1,675,001 for the same period in 1905 and with £1,060,503 in 1904, showing increases respectively of £139,679 and £754,177.

The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Sept. 12 to 18 with the ports of destination:—

Aden, £9. *Africa*—Alexandria, £218 (including £12 telegraph material); Cape Town, £734 (including £472 telegraph material); Chinde, £15 (telegraph material); Delagoa Bay, £34; Durban, £1,192 (including £465 telegraph material); East London, £64; Port Elizabeth, £9; Port Said, £186 (telegraph material). *Australasia*—Adelaide, £60; Auckland, £200; Brisbane, £76 (including £6 telegraph material); Broome, £11; Christchurch, £50; Lyttelton. £88; Melbourne, £2,349 (including £1,600 telegraph cable); Otago, £445; Perth, £657 (including £549 telegraph material); Sydney, £1,249; Townsville, £200; Wellington, £1,016 (including £836 telegraph material). *Belgium*—Antwerp, £50; Brussels, 17; Ghent, £10; Ostend, £181. *Brazil*—Bahia, £30; Rio Janeiro, £120; Santos, £173. *Burma*—Rangoon, £64. *Canada*—Halifax, £29; Montreal, £16. *Ceylon*—Colombo, £333 (including £18 telegraph material). *China*—Shanghai, £10. *Denmark*—Copenhagen, £11. *France*—Boulogne, £589; Le Treport, £26; Paris, £23. *Germany*—Hamburg, £14. *Gibraltar*, £320. *Holland*—Amsterdam, £130 (including £65 telegraph material). *Hong Kong*, £57 (including £35 telegraph material). *India*—Bombay, £2,777; Calcutta, £3,412 (including £550 telegraph material); Karachi, £76; Madras, £311. *Italy*—Genoa, £100. *Japan*—Nagasaki, £945; Tokyo, £850 (telegraph material). *Malta*, £270. *Mauritius*, £40 (telegraph material). *North Atlantic*, £22,000 (telegraph cable). *Portugal*—Lisbon, £160. *Russia*—Batoum, £145; Odessa, £152. *Seychelles*, £20 (telegraph material). *Siam*—Bangkok, £270. *Spain*—Grenada, £8; Malaga, £16; Santander, £29. *Straits Settlements*—Penang, £29; Singapore, £183 (including £49 telegraph material). *Sweden*—Stockholm, £40. *U.S.A.*—New Plymouth, £44; New York, £175. *West Indies*—Domincia, £55; Jamaica, £8. Total £43,180, against £28,467 in the corresponding week last year (Sept. 13 to 19.)

CATALOGUES, &c.

"*W. J. Davy*" *Arc Lamps.*—For many years the arc lamps manufactured by Arc Lamps Limited, St. Paul's-crescent, Camden Town, London, N.W., have been on the market, and many thousands are in use both for indoor and outdoor illumination. Cardiff, for instance, has been supplied with no less than 840 of these lamps, London County Council with 235, and the list set out on pp. 8 and 9 of a new catalogue of "Davy" lamps contains the names of very many other large users, including several Government departments at home and oversea. Full particulars are given in the new catalogue of the Davy "Sunræ" flame arc lamp, which will work on a.c. or d.c. circuits, gives a white or coloured flame as desired, and is made for from 1,500 c.p. to 5,000 c.p. It is claimed that the carbons for these lamps are as cheap as ordinary carbons. The particulars given regarding this new flame lamp are very complete, a remark which applies to the information concerning all kinds of arc lamps and their accessories by Arc Lamps Limited. Copies of the catalogue will be furnished to the trade, we are informed, on receipt of trade card.

Babcock-Wilcox Plant.—Messrs. Babcock & Wilcox (Ltd.), 30, Farringdon-street, London, E.C., are issuing several useful leaflets and pamphlets relating to accessories required for steam plants and kindred work. Besides superheaters, chain grate mechanical stokers, feed water heaters, water purifiers, steam feed and exhaust piping, the company have extended their mechanical conveyor department dealing with the conveying of all kinds of material, such as coal, iron ore, chalk, cement, &c., and this department now undertakes structural steel work. A new department, recently added, is engaged in the manufacture of electric cranes from up-to-date designs and according to the latest and best known methods. The new lists of which we acknowledge receipt deal with automatic exhaust relief valves, and with numerous machines of the company's manufacture. Some good illustrations accompany the lists.

Feeder Pillars.—Price list J, just issued by Johnson & Phillips, describes and illustrates standard feeder and switch pillars and junction boxes. A speciality is made of below-ground distributing and fuse boxes, and various types of these are depicted in the list. The pamphlet also contains particulars of house service fuses, and boxes for single and double service.

Technical Thermometry.—A new catalogue on technical thermometry has recently been published by the Cambridge Scientific Instrument Co., dealing with the many applications of electrical thermometers, the electric resistance thermometers, thermo-electric thermometers and the Fery radiation pyrometer.

The list is divided into three sections:—1. The more particular commercial applications of pyrometers. 2. Scientific or research work. 3. An appendix explaining the theoretical considerations of the instruments, and giving tables of general interest. The matter fills some 60 pages of the list, and will be found generally interesting.

Drawing Instruments.—J. Davis & Son, in sending us their complete list (No. 062A), ask us to remind our readers that they are exhibiting at stand No. 229 at Olympia, where Mr. R. H. Haylock will be pleased to show their specialities in drawing instruments, slide rules, premium calculators, &c.

Single and Polyphase Motors.—We are in receipt of lists Nos. 19 and 20 from Hodgson Wright & Wood, of Halifax, dealing with small one, two and three-phase motors. These machines are made up to 10 H.P. and for pressures of 200 and 400 volts, 50 periods.

Nernst Lamps.—A new Nernst lamp list is issued by the A.E.G. English Mfg. Co., New Compton-street, London, W.C. Copies of this list may be obtained on request.

Lampholder Fans.—Marples, Leach & Co have been appointed sole agents for the United Kingdom for an ingenious electric fan which can be fitted into any lampholder without plug or cord. The fan is suitable for continuous or alternating-current circuits, and the table or desk form can be adjusted to any angle.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The directors' report for the 12 months ended March 31 states that the buildings and machinery at Rugby have been maintained in first-class condition, and the directors have followed their usual practice in providing for depreciation thereof, as well as for depreciation of patents and stock in hand, besides making resrves sufficient in their opinion to cover risks in connection with bad debts, depreciation of shares held by the company and other contingencies. The number of hands employed (excluding office staff) at March 31 was 1,877, and has since increased.

Heavy Traction Work.—The company to date has sold in the United Kingdom heavy traction railway motors having a capacity of over 25,000 H.P. During the period under review the company has sold to the G.W. and Metropolitan Railway companies all the motors and train control equipments for the electrification of the Hammersmith line, operated by them jointly. It also has sold to the Metropolitan Company a large number of motors and control equipments for its general service and all the trains, which have been equipped to date, have operated with the greatest success. Although the contract was closed after March 31 the company has also electrically equipped some of the old type of cars for the Metropolitan Company and these are giving every satisfaction. At the recent meeting of shareholders of the Metropolitan District Railway Co. the chairman announced that all the motors and control apparatus, furnished by the B.T.-H. Co. had operated most satisfactorily.

Single-phase a.-c. Railway Equipments.—During the year the company has acquired from the Allgemeine Elektricitats Gesellschaft the British patents covering the Winter-Eichberg system for single-phase railway work, and with the consent of the company the A.E.G. has entered into a contract for single-phase equipments with the L.B. & S.C. Railway Co., the first railway in Great Britain to be equipped with single-phase plant. The company also owns for the United Kingdom the Latour patents, and the patents covering the single-phase system developed by the General Electric Co. of New York.

Patents Generally.—During the year the company has also acquired from the General Electric Co. (N.Y.) and the Cie Française pour l'Exploitation des Procédés Thomson-Houston all their British patents on very satisfactory terms and, prior to March 31, 1905, a similar contract was made with the A.E.G.

Contracts, &c.—During the year the company entered into a number of contracts for furnishing high-tension switch gear, Curtis steam turbines and other apparatus and supplies. The company has sold to date Curtis turbines having a total capacity of 32,000 kw.

The directors believe the company has good value in the enterprises in which it has investments. The trading profit for the year, after deducting general and technical expenses, discounts, debenture and other interest, amounts to £31,549. 6s. 2d., which, with amount forward (£1,696. 10s. 9d.), makes £33,244. 16s. 11d. The whole of this profit (with the exception of £4,121. 17s. 10d. carried forward) has been applied to various depreciations, which the directors believe to be ample. The balance of the excess cost of manufacturing, incident to the establishment of the manufacturing business of the company amounted to £39,261. 6s. 5d. (£28,000 having been previously written off). The amount added during the year was £446. 11s. 3d., making a total in this account of £39,707. 17s. 8d. From this there is written off £8,000 further, leaving a balance of £31,707. 17s. 8d., from which further amounts will be written off from time to time until finally disposed of. The directors regret the loss by death of one of their colleagues (Mr. S. Kocherthaler) and of their works manager, Mr. Charles W. Phipps.

DICK, KERR & CO. (LTD.)—The directors' report for the year ended June 30 states that the profits were £86,354. After paying debenture and loan interest and trustees' fees and providing for the premium payable on the redemption of the debenture stock (£13,365), leaving £72,989, added to £42,388 from last year, making £115,377. The directors propose to carry to special reserve for extensions of manufactories or replacements of machinery, &c., or special depreciation of same £15,000; to pay a dividend of 10 per cent. on the ordinary shares, and to carry forward £56,077. During the year the company has been fully employed on important contracts, both at home and abroad, and the manufacturing departments have been kept busy. Last year attention was drawn to the severe competition existing in all branches of the business, and the directors regret to say there is no improvement in this direction. In the last balance-sheet there was shown a special reserve of £40,000 to be set aside for extensions of manufactories, replacements of machinery, &c., or special depreciation of same. The directors now propose to make a net addition of £10,000 to this reserve, bringing the total to £50,000, in addition to which £5,000 has been written off tools, &c.

LLANDUDNO & DISTRICT ELECTRIC TRAMWAY CONSTRUCTION CO. (LTD.)—At the statutory meeting on Monday Mr. C. H. Rigg gave particulars of the progress made since the incorporation work of the value of £20,000 had already been executed at the date of the prospectus, and since the money was subscribed for the present company all materials (rails, poles, &c.) have bad to be ordered, and the directors are informed by the contractors that no appreciable progress can be made until the beginning of next month, when the material will be on the spot. They were advised that the line would be finished and running by next Easter. The contractors (Messrs. Bruce Peebles & Co.) had undertaken to pay a dividend at the rate of 6 per cent. per annum up to June 30, 1907, on the subscribed shares, after allowing for any profits of the company for the period antecedent to that date available for dividend on such shares. Mr. Stephen Sellon, who had probably had more experience of tramway enterprises than any other engineer in this country, estimated that the profits of the company would be £12,300 per annum, which would give a large sum available for dividend.

CITY NOTES.

MEMORANDA (Sept. 20).—**Bank rate** 4 per cent. (since Sept. 13, 1906). **Price of silver** $31\frac{9}{16}$d. per oz. **Consols** 86¼—86⅜ for money, 86⅜—86½ for account; 2½ per cent. annuities 84¾—85¼. **Consols Pay Day**, Oct. 3; **Stocks and Shares Continuation Day**, Sept. 25; **Ticket Day**, Sept. 26; **Pay Day**, Sept. 27; **Mining Share Carry-over Day**, Sept. 24.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The board have decided to pay, in addition to the dividend at the rate of 10 per cent. on the preference shares, an interim dividend at the rate of 4 per cent. (tax free) on the ordinary shares, for the half-year ended June 30, payable 1st prox.

DIRECT WEST INDIA CABLE CO. (LTD.)—The directors recommend a further dividend of 3 per cent., making 6 per cent. for the year to June 30, leaving £1,313 to be carried forward.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on Oct. 15 of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending Sept. 30 and the usual interim dividend of 1¼ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended June 30. The transfer books of the ordinary stock will be closed from Oct. 6 to 13 inclusive.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO.—The directors have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share (tax free), payable 15th prox. The share register will be closed from 6th to 13th prox. inclusive.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—In their report the directors recommend a further dividend of 2½ per cent., making 5 per cent. for the year ended June 30, leaving £774 to be carried forward.

HAMBURGISCHE ELECTRICITATS-WERKE (HAMBURG).—A dividend of 8 per cent. has been declared for 1905-6, compared with 7½ per cent. for the previous year.

MUNCHENER TRAMBAHN AKT. GES.—For the past year a dividend of 11 per cent. has been declared, the same rate as in 1904-5.

PRIMITIVA GAS & ELECTRIC LIGHTING CO. OF BUENOS AYRES (LTD.) An interim dividend on the ordinary shares at the rate of 5 per cent. (2s. 6d. per share) has been declared for the half-year to June 30.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 2 per cent. has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of £15,000 4½ per cent. first debenture stock of the *Folkestone Electricity Supply Co. (Ltd.)* to be quoted. The committee have been asked to appoint special settling days in and grant quotations to a further issue of 12,500 £5 ordinary shares (issued at £2 premium, £2 capital and 16s. premium paid), and 12,500 £5 preference shares (issued at 10s. premium, £2 capital and 4s. premium paid), of the *Newcastle-upon-Tyne Electric Supply Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 12	1,729	+ 267	15	23,869	+ 429
Airdrie	,, 7	255	+ 1	36	7,940	+ 662
Anglo-Argentine	,, 16	15,410	+ 2,327	37	548,907	+ 60,809
Ashton-under-Lyne Corp.	,, 15	363	+ 55	25	9,069	+ 1,109
Ayr Corporation	,, 15	329	+ 29	18	7,230	+ 26
Baker St. & Waterloo Ry.	,, 15	1,510	...	11	14,690	...
Barnsley	,, 7	166	+ 16	36	5,900	+ 68
Barrow	,, 7	339	+ 68	36	9,427	+ 599
Bath Electric Trams, Ltd	,, 12	1,070	+ 308	37	31,043	+ 5,746
Birkenhead Corporation	...	...	...	...	...	...
*Birmingham Corporation	,, 15	1,441	+ 1,080	24	23,035	+ 14,469
Birmingham & Mid.	,, 7	10,403	– 105	36	366 802	+ 17,708
Blackburn Corporation	,, 12	1,189	+ 219	¶24	26,574	+ 1,818
Blackpool Corporation	,, 13	2,099	+ 285	23	39,117	+ 2,465
Blackpool and Fleetwood	,, 15	1,257	+ 107	...	...	...
Blackp'l, St. Anne's & Lytham	...	..	...	...	...	...
Bolton Corporation	,, 16	2,096	+ 52	24	53,024	+ 3,771
Bournemonth Corporation.	,, 12	2,234	+ 408	†24	43 375	+ 9,043
Bradford Corporation	,, 15	4,519	– 21	24	114,014	+ 4,821
Brighton Corporation	,, 16	1,140	– 76	24	27,183	– 903
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 14	5,580	+ 620	5	11,188	+ 1,580
Buenos Ayres & Belgrano	...	...	...	...	...	...
Buenos Ayres Elec. Trms.	Aug. 18	1,369	+ 31	34	44,831	+ 7,432
Burnley Corporation	Sept. 15	1,195	+ 51	24	28,786	+ 1,097
Burton Corporation	,, 17	289	– 26	§24	7,597	– 460
Bury Corporation	,, 9	1,044	...	24	24,567	...
	,, 16	969	...			
Calcutta Tramways Co.	,, 15	R46,278	+ R2,047	11	R484,677	+ R12,044
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 8	2,267	+ 248	23	50,062	– 138
Cavehill	,, 7	144	+ 102	36	3,353	+ 1,431
Central London Railway	,, 15	5,871	– 110	11	59,876	– 2,721
Chatham & Dist. Lt. Rys.	,, 13	930	+ 216	†37	25,061	+ 153
City & South London Rly.	,, 16	2,992	+ 682	11	27,036	+ 1,805
Colchester Corporation	,, 13	266	+ 40	...	...	...
Cork Electric Trams Co.	,, 13	566	+ 52	37	18,056	– 218
Croydon Corporation	...	...	...	...	...	...
Devonport & Dist. Trams.	,, 7	553	+ 55	36	16,597	– 203
Dover Corporation	,, 15	298	+ 48	24	6,999	+ 1,028
Dublin & Lucan Railway	,, 14	143	+ 6	§11	1,609	– 52
Dublin United	,, 14	5,367	+ 457	‡11	64,356	+ 3,588
Dundee Corporation	,, 12	1,164	+ 154	§17	19,488	+ 4,128
East Ham Council	,, 15	928	+ 67	24	23,067	+ 2,149
Exeter Corporation	,, 14	330	+ 32	24	7,503	– 303
Falkirk and District	,, 12	545	...	...	...	...
Gateshead & Dist. Trams	,, 7	1 049	+ 88	36	34,853	+ 1 924
Glasgow Corporation	,, 15	17,728	+ 2,003	16	260,085	+ 22,892
Glossop	...	...	...	...	...	...
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 7	305	+ 26	36	8,841	+ 375
Gt. Northern & City Rly.	,, 15	1,670	+ 134	11	17,150	+ 2 256
Greenock & Port Glasgow	,, 7	861	+ 205	36	24,393	+ 1,266
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 7	400	+ 94	36	11,072	+ 1,423
Hastings Elec. Trams Co.	,, 13	1,279	...	11	12,963	...
Huddersfield	,, 15	1,505	+ 111	24	37,535	+ 3,498
Hull Corporation	,, 15	2,279	+ 113	24	54,827	+ 1,245
Ilford Dist. Coun.	,, 15	607	+ 6	24	12,522	+ 211
Ilkeston Dist. Council	,, 12	147	+ 27	24	3,356	+ 352
Ipswich Corporation	,, 15	503	+ 6	24	11,625	– 106
Isle of Thanet Co.	,, 15	1,292	+ 226	49	30,646	– 59
Keighley Corporation	,, 13	163	+ 26	11	1,762	+ 88
Kidderminster & District	,, 7	156	+ 11	36	4,531	– 3
Kilmarnock Corporation	,, 15	162	+ 5	18	2,964	– 63
Kirkcaldy Corporation	,, 12	302	+ 77	11	2,985	+ 358
Lanarkshire Trams Co.	,, 13	935	+ 60	†37	32,426	+ 5,841
Leamington	,, 7	194	– 7	36	6,491	+ 2,683
Leeds Corporation	,, 15	6,495	+ 412	24	155,067	+ 9,142
Leicester Corporation	,, 15	2,213	+ 85	37	81,927	+ 5,022
Leith Corporation	,, 15	542	+ 142	...	...	...
Lincoln Corporation	,, 15	110	..	24	2,903	...
Liverpool Overhead Rly.	,, 18	1,433	– 76	11	17,259	– 587
Liverpool Corporation	,, 8	11,348	+ 527	36	387,896	+ 6,596
*London County Council	,, 8	26,574	+ 11,544	23	610,997	+ 260,359
London United	,, 14	7,242	+ 1,235	†37	234,745	+ 16,551
Lowestoft	,, 15	323	+ 6	51	9,334	– 538
Maidstone Corporation	,, 15	142	...	24	3,171	– 287
Manchester Corporation	,, 15	14,250	+ 1,380	24	336,104	+ 21,050
Mersey Railway	,, 15	1,713	+ 107	11	18,012	+ 1,318
Merthyr	,, 7	217	+ 25	36	7,069	+ 177
Metropolitan Dist. Railway	,, 16	7,294	+ 503	11	79,053	+ 8,221
*Metropolitan Elec. Trams.	,, 7	4,316	+ 836	36	123,966	+ 29,222
Middleton	,, 7	394	+ 103	36	13,011	+ 469
Nelson Corporation	,, 15	147	+ 11	25	3,692	+ 327
Newcastle-on-Tyne Corp.	,, 15	4,021	+ 258	24	98,803	+ 6,121
Newport (Mon.)	,, 15	690	+ 82	24	15,822	+ 907
Northampton Corporation.	,, 13	473	+ 39	24	11,358	+ 193
Oldham, Ashton & Hyde	,, 7	614	+ 62	36	20,600	+ 600
Oldham Corporation	,, 16	1,826	+ 99	25	46,127	+ 4,398
Perth (N.B.) Corporation	,, 12	182	...	17	2,967	...
Perth (W. A.) Elec. Trams	,, 14	1,344	+ 68	37	54,120	+ 3,321
Peterborough	,, 7	167	+ 13	36	4,788	– 300
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	,, 15	2,386	+ 73	24	55,006	– 715
Potteries	,, 7	1,821	+ 3	36	63,643	+ 3,055
Preston Corporation	,, 5	890	+ 225	...	...	...
	,, 12	775	+ 142			
Reading Corporation	,, 13	711	+ 59	...	...	...
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 13	521	+ 34	24	12,204	+ 1,243
Rothesay	,, 7	307	+ 52	36	9,383	+ 1,450
Salford Corporation	,, 17	4,406	+ 52	24	111,494	+ 2,517
Sheerness	,, 5	84	– 7	36	2,189	– 442
Sheffield Corporation	,, 16	5,243	+ 205	25	133,454	+ 8,530
Singapore Trams	,, 15	$9,432	...	12	$87,309	...
Southampton Corporation.	...	...	...	...	...	...
Southend Corporation	,, 12	596	+ 100	24	11,649	+ 568

(a) These comparisons are with the corresponding period last year. ¶ Plus 3 days. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	Sept. 7	422	+ 70	36	12,074	+ 290
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	,, 16	1,386	+ 19	24	35,762	+ 1,904
Sunderland & District	,, 12	469	...	37	14,865	...
Swansea Trams	,, 7	965	+ 71	36	30,242	+ 4,873
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 7	55	– 2	36	1,679	– 169
Tynemouth and District	,, 7	425	+ 121	36	9,955	– 21
Tyneside Trams Co.	,, 12	479	+ 74	37	17,009	+ 1 363
Wallasey District Council	,, 15	853	+ 49	24	21,025	+ 930
Walsall Corporation	,, 15	514	+ 6	37	19,128	+ 1,018
Warrington Corporation	,, 13	365	+ 20	24	8,962	+ 676
West Ham Corporation	,, 13	2,339	+ 262	24	55,989	+ 14,022
Weston-super-Mare	,, 5	397	+ 100	36	6,159	+ 424
Wolverhampton Corpn.	,, 12	830	...	11	9,824	...
*Worcester	,, 7	362	+ 9	36	10,422	– 745
Wrexham	,, 7	123	+ 13	36	3,747	+ 69
Yorkshire W.R. Trams	,, 16	842	– 35	37	31,008	...
Yorkshire Woollen District	,, 7	1,041	+ 331	36	32,674	+ 9,418

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Sept. 19.	Rate per Cent. Yielded.			Dividend Due.	Business, Week to Sept. 19.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£	s.	d.		Highest.	Lowest.
5	5/0	Anglo-Argentine Ord. Shs.	$7\frac{5}{16}$–$7\frac{9}{16}$	5	5	0	Ap, Oct	$7\frac{7}{16}$	7⅜
5	2/9	Do. 5½% Cum. Pref.	5¾–6	4	11	8	–	$5\frac{15}{16}$	$5\frac{13}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	139–141	4	7	0	–	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	108–105	4	15	0	–	..	..
5	–	Brisbane Electric Trams. Invest. Ord.	1½–1¾		..		..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½–4¾	5	5	0	–	$4\frac{11}{16}$	4⅝
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99–104	4	6	6	–	100½	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	117–120	5	0	0	–	118½	..
St.	5%	Do. Pref. Ord. Stk	110–118	4	8	6	–	..	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107–110	4	11	0	–	108½	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	104½–105½%	4	5	3	–	–	..
100	4½%	Do. Vancouver Power Debs.	101–104	4	6	0	–	..	..
5	8/0	Buenos Ayres and Belgrano Ord.	3⅜–3⅝	4	16	6	–	$3\frac{7}{16}$	..
5	8/0	Do. 6 per Cent. "A" Cm. Pref.	5½–5¾	5	4	0	–	..	..
5	8/0	Do. "B"	5–5½	5	0	0	–	..	..
St.	5%	Do. 5 per Cent. Debs.	104–106	4	14	4	–	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102–105	4	15	0	–	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93–101	4	19	0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101–105	5	4	9	..	..	–
100	6%	Do. 6% 1st Deb. Bonds	102–107	5	12	0	..	..	–
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8⅜–8⅞	4	10	6	–	..	..
5	2/6	Do. Nos. 105,001 to 137,610	8–8½	4	14	0	–	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103–106	4	5	0	–	..	..
1	0/6	Cape Electric Tram Shares	½–¾	3	6	6	–	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100–103	4	18	0	–	..	–
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	95–97%	5	3	0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92–93	5	7	0	..	..	..
St.	6%	Do. 6% "B" Ditto	83–87	6	18	0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	1⅜–$1\frac{9}{16}$	3	4	0	..	$2\frac{13}{32}$	..
1	0/7½	Do. 6% Cum. Pref.	1⅛–1⅜	4	7	4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100–103	4	17	0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100–103	4	7	6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	108–105	4	5	6	–	..	–
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104–106	4	14	8	..	..	..
–	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	141–143	5	12	6	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%–100%	5	0	0	–	99¾	99⅝
		ELECTRICITY SUPPLY.							
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5¼–5¾	4	17	0	..	5½	..
5	5/3	Calcutta Elec. (1-50,000)	8⅜–8⅞	4	10	0	..	–	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48–50	5	0	0	..	..	..
–	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92–94	5	6	4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½–3		..		..	..	–
St.	5%	Do. 5% Debs.	88–92	5	8	6	–	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108–111	5	8	0	–	110	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$–$\frac{27}{32}$	7	8	6	–	..	..
1	1/6	Rand Electric	1–1⅛		–		–	–	..
1	..	River Plate Electricity Co. Ord.	½–⅝		..		..	$\frac{9}{16}$	..
1	1/2½	Do. 6% Non. Cum. Pref	⅞–1	6	0	0	–	..	..
St.	5%	Do. 5% Deb. Stock	99–102	4	18	1	..	..	..
5	8/0	Rosario Elec. Co. 6% Pref. (1-20,000)	5⅛–5⅝	5	8	6	–	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99–102	4	8	0	Ap, Oct	–	–
–	5%	Shawinigan Water and Power 5% Bds., Scrip	99–101%	4	19	0	..	100⅜	100

* In calculating the yield, allowance has been made for accrued interest but for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Sept. 19.	Rate % Yielded.	Dividend Due.	Business, Week to Sept. 19.	
		ELECTRICITY SUPPLY.		£ s. d		Highest.	Lowest
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	10 –11	6 7 0	..	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾–10½	4 8 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾–11¾	5 2 0	..	..	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	..
5	6/6	Bromley (Kent) El. Lt. & Power Shares	6½–6⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	8½– 9	5 11 0	–	8⅞	..
5	6/6	Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	101 –104	3 17 0	–	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4½– 5	5 0 0	Feb, Aug	4⅝	..
5	2/6	Do. 4½ per Cent. Pref.	4½–5	4 10 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 0	–	..	..
5	2/6	Do. City Undertaking 4½% Cm. Pref.	4 – 4½	5 0 0	–	..	..
5	2/6	†Chelsea Electric Supply Ord.	5⅜– 5⅞	5 2 2	March ..	5¾	5⅝
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10 –11	5 9 0	Feb, Aug	10⅞	10⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾–12¾	4 14 0	Jan, July	12 1/16	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	124	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	101 –104	4 0 6	..	102½	101½
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞–3	4 0 0	April, Oct	..	–
5	5%	Do. Do. 5% non cum. pref.	5 7/16–5⅝	4 13 11	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	7⅞–8⅛	5 5 0	–	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾–12¼	4 18 0	Mar, Sept	12⅛	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	..	..
5	6/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	–	..
5	5/0	Hove Electric Lighting Ord.	7⅞–8⅜	5 8 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	–	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 –102	3 18 6	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
2	2/4½	London Electric Supply Ord.	1⅞–2⅜	4 4 0	–	–	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	..	..
5	4/0	Metropolitan Electric Sup. Ord.	8 –8½	5 6 0	April, Oct	8 7/16	8 3/16
5	2/6	Do. 4½ per Cent. Cum. Pref.	5¼–5½	4 1 9	Jan. July	5¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	–	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11 –11½	3 18 3	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102½–103½	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7½–7⅞	5 5 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾– 6	4 6 11	Feb, Aug	..	–
100	4%	Do. 4% Mort. Deb. red. 1907	98 –100	4 0 10	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1 7/32–1 9/32	2 8 0	Mar, Aug	..	–
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	2/6	†Oxford Electric Ord.	6¼– 6¾	4 19 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	10 –11	5 14 0	Feb, Aug	10¼	..
5	6/6	Do. 7 per Cent. Pref.	7 – 8	4 7 0	Feb, Aug	..	–
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	–
5	4/0	Smithfield Markets Electric Sup. Ord.	2 – 2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	6 – 6½	5 14 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16– ⅞	..	..	..	–
1	0/8⅖	† Do. 7% Cum. Pref.	1 3/16–1 5/16	5 5 0	..	1¼	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3½– 4	6 10 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	4⅞	4 11/16
St.	4½%	Do. 4½% 1st Mort. Deb.	99 –102	4 8 0	..	..	–
5	5/6	Westminster Elec. Sup. Ord.	9¾–10¾	6 6 0	Mar, Sept	10 1/16	9⅞
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 13/32	5 5/16
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	..	88	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	1 1/32	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	100 –104	4 6 6	–	–	..
St.	4½%	B'hm & Midland Trams 4½ 1st Db. Stk.	98 – 100	4 10 0	..	99¾	..
10	9½%	Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –106	3 17 6	Feb, Aug	..	–
10	6/0	British Electric Traction Ord.	5½– 6	5 0 0	–	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	9¼–9¾	6 3 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perpetual Debs	115 –118	4 4 8	..	116¾	116½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92½–95½	4 14 0	..	94¾	94⅜
St.	4%	Central London Ordinary Stock	84 –86	4 13 0	June, Dec	86	..
St.	4%	Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	98¾	97½
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	74¾	..
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	84 –89	4 10 0	..	84	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 – 5¼	4 15 0	..	..	–
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	43 –45	4 9 0	Feb, Aug	44½	43½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 –122	4 2 0	Feb, Aug	120½	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	115	116
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½– 4	10 0 0	..	3⅞	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	..	..
10	9%	‡ Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	102½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 – 2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8¼–8⅝	3 16 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 6	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾–9¼	5 8 0	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 0	–	94	93¼
St.	..	Mersey Con. Ord. Stock	5 –7	–	–	..	..
St.	..	Do. 6 per Cent. Perp. Pref.	7 –10	–	–	..	..
1	–	Metropolitan Elec. Trams Def.	⅛– 3/16	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	13/16–15/16	5 9 0	–	–	..
St.	4½%	Do. 4½% Deb. Stock	98½–100½	4 9 6	–	..	–
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾– 7¼	5 10 0	..	6 1/16	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾–8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	89 –92	5 8 8	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	89 – 91	5 10 0	–	90¾	89¾
St.	3%	Waterloo and City Ord.	103 – 106	2 16 6	June, Dec	..	–
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	8 –8½	..	–	–	..
St.	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	–	..	–

Shre.	Last Dividend	Name.	Price Wed., Sept. 19.	Rate % Yielded.	Dividend Due.	Business, Week to Sept. 19.	
		ELECTRIC MANUFACTURING, &c.		£ s. d.		Highest.	Lowest.
1	10½d.	Aron El. Met. 6% Cm. Pf.	½– ⅝	..	–	..	..
1	2/4½	Babcock & Wilcox Ord	4⅛–4⅜	4 10 0	..	4 5/16	4 3/16
1	7½d.	Do. Pref	1⅛–1⅜	3 14 0	..	..	–
5	4/0	†British Insulated & Helsby Cables Ord.	6¼–6¾	5 10 0	July, Feb	..	..
5	6/0	Do. 6 per Cent. Pref.	5⅝–6⅛	4 18 0	Jan, July	6	5¾
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	–
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94 –98	4 12 8	..	..	..
5	..	British Westinghouse 6% Pref.	1½–1¾	..	..	1⅝	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	80	79
2	1/0	Brush Electrical Engineering	1⅜–1 7/16	..	March ..	..	..
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1⅜–1⅞	6 8 0	Mar, Sept	1 11/16	–
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –98	4 11 9	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	83¾	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	11	10⅝
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	110	..
1	9⅜d.	Castner-Kellner Alkali Co.	1 1/32–1 5/32	5 4 6	..	..	–
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	–	..	–
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	–	1 11/32	–
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	–
5	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅝–1⅞	3 13 6	Jan, July	..	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%– 97%	5 2 0	Jan, July	..	..
5	10/0	Dick, Kerr & Co. Ord.	7⅝– 7⅞	5 11 0	Sept	..	..
5	3/0	Do. 6% Cum. Pref.	6⅞–7⅛	4 5 0	Sept	..	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½–1¾	4 5 6	Feb, Aug	1 11/16	1 17/32
5	2/6	Do. (£5 paid)	2½– 2¾	4 11 0	Feb, Aug	2⅝	2 13/32
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	..
5	1/6	Edmundson's Elec. Corp. Ord.	3⅝–3⅞	9 6 0	H'lf-yearly	..	..
5	6/0	Do. 6 per Cent. Cum. Pref.	5⅛–5⅝	5 11 6	..	5⅛	5
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	102	101½
2	1/7½	Electric Construction Co.	¼– ½	14 0 0	July	..	..
2	2/9⅗	Do. 7 per Cent. Cum. Pref	1¾– 2¼	6 4 0	July	2	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	85 – 88	4 11 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 – 9½	5 5 8	..	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 – 97	4 2 6	–	..	–
5	5/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	12⅝	..
5	2/3	Do. 4½ per Cent. Pref.	5¼– 5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½–109½	4 2 0	..	..	..
St.	22/6	Do. Do. Scrip (all paid)	107½–109½	4 2 6	..	108½	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	17¼	–
100	..	Do. 4% Debs. Red.	100 –102	3 19 6	..	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	–
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	15/16–1	6 0 0	..	1	31/32
1	7½d.	Do. 6% Cum. Pref.	1 –1⅛	5 7 0	–	1 1/16	15/16
St.	4½%	Do. 4½% Perp. Deb. Stock	93 –101	4 9 0	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	83½–85½	5 12 6	Mar, July	84¾	83¾
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	–
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2½– 2⅝	5 16 6	..	2 9/16	2 17/32
1	6d.	Do. 5% Non-Cum. Preference	1 5/32–1 7/32	4 4 6	..	1 3/16	..
St.	5%	Do. 5% Non-Cum. Preferred	113 – 116	4 6 0	–	..	–
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	..	..
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	104 –106	4 5 0	–	..	..
5	–	Willans and Robinson Ord.	¾–1¼	..	Apr, Oct	–	..
5	–	Do. 6 per Cent. Cum. Pref.	2¾– 3¼	..	Apr. Oct	–	..
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	–
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½– 4	–	Jn, Dec ..	..	..
100	5%	Do. 5% Debs. (red.)	87 –92	5 8 8	..	..	..
St.	15/0	Anglo-American	66½–68½	4 15 0	F, My, Ag, N	..	..
St.	30/0	Do. Preferred	113½–114½	5 6 0	F, My, Ag, N	114½	113⅞
St.	10/0	Do. Deferred	23⅞–24⅛	2 2 6	F, My Ag, N	24 1/16	23⅞
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97½–98½	4 0 6	Jn Ap, Jy, O	98⅛	97¾
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	2⅞–3⅜	5 11 9	April, Oct	..	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	8 19 0	Jan, July	..	..
20	6/6	Direct United States Cable	15½–16	5 6 0	Ja, Ap, Jy, O	15¾	15½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..	..
St.	65/0	Eastern Ordinary	144 –147	4 15 0	Ja, Ap, Jy, O	145½	145
St.	17/6	Do. 6½ per Cent. Pref. Stock	90 –92	8 17 9	Ja, Ap, Jy, O	92	90¾
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108¼	..
10	2/6	Eastern Extension	14⅜–14⅞	4 12 6	Ja, Ap, Jy, O	14½	14⅜
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 8	Feb, Aug	..	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	97 –101	3 19 0	Feb, Aug	99¾	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–106%	3 17 6	May, Nov	101¼	..
10	5/0	G. N. (of Copenhagen) with coupon 68	37½–38½	6 0 0	Jan, July	38¾	38⅜
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	..
25	52/6	Indo-European	60 – 62	5 5 0	May, Nov	..	..
100	4%	Mackay Companies Common	74 15/16–75 15/16	5 0 0	Jan, July	–	..
100	4%	Do. Preference	72 11/16–73 5/16	5 9 6	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 0	..	..	–
2½	–	West Coast of America	¾– ⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 8	Jan, July	..	..
10	–	West India and Panama	⅜– ½	–	May, Nov	⅜	..
10	4/0	Do. 6% 1st Pref.	6¼– 6¾	8 18 0	May, Nov	..	..
10	–	Do. 6 per Cent. 2nd Pref.	4½– 5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Jn, O, D	14 21/32	14½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	–
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	–	..	..
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 8 4	..	–	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	..
5	5/0	Chili Telephone (fully paid)	6¾– 7¼	5 11 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	6 15 3	–	–	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109 –111	5 8 0	–	110¾	109¾
St.	6%	Do. Def. Stock	109 –111	4 10 0	–	110¾	109¾
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	11 9/16	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 18 0	Feb, Aug	10⅝	10 17/32
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 9/16–5 13/16	4 7 6	Feb, Aug	5 11/16	5⅝
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	99¼	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½–104½	3 16 6	–	..	..
1	0/9⅜	Oriental	1 1/16–1 3/16	4 3 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16–1 5/16	4 11 0	–	..	–
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	..	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 0	..	..	–
5	5/0	United River Plate	7 –7½	5 6 8	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 9 6	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½– 5½	5 10 0	–	..	–
10	2/0	Globe Telegraph and Trust	10⅞–11⅜	4 19 0	Ja Ap, Jy O	11⅛	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅜–14⅞	4 0 0	Ja Ap, Jy, O	14¾	14⅝
10	6%	Submarine Cables Trust (Cert.)	130 –132	4 11 0	April, Oct	..	–

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex dividend ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Some attempts are being made to set public opinion against the extension and development of electrical and other railways in Switzerland on the ground that they spoil the country as a beautiful playground by bringing tourists there. We have often heard this outcry. For instance, the Jungfrau railway is stigmatised as an atrocity of the deepest dye. But if there are no facilities for travel, how are the holiday people to get there? A most curious development of human petty vanity leads each tourist to imagine he appreciates scenery in a superior and special way, and that it is only the other people who are tourists. The superior person is always raising an outcry against any progress which interferes with scenery, or even opens it up. The man who writes to the papers about some industry using a Scotch waterfall really feels that he has some higher and meritorious appreciation of scenery which is denied to the sordid people who want to make money. He gets his little self-advertisement, and, after all, he does not keep industry back very seriously. Electrical tramways were kept back by the opposition to trolley wires, on æsthetic grounds, but that was not really the higher appreciation of beauty of superior persons: it was only a useful stone to throw, and was adopted by men with a deep-rooted objection to all novelty.

The electrical working of the traffic through the Simplon Tunnel, the details of which are described on another page, is hardly open to these criticisms as its primary object is to form a link in the main line system connecting Italy with the rest of Europe. Technically it presents several points of interest, apart from the interest attaching to the tunnel itself, although, perhaps, no startling novelty of method is embodied. Several, so to speak, local conditions weighed largely in the choice of system, so that it is not fair to unduly generalise and regard the engineers responsible for the scheme as necessarily champions of three-phase locomotives against all other systems. Considerations of traffic practically compelled the use of locomotives, and the adoption of three-phase working is partly explained by the fact that some locomotives on this system were available for almost immediate use. Switzerland and nothern Italy, however, can be regarded as the home of three-phase traction, as witness the pioneering mountain lines of Gornergrat, the Jungfrau and other places, the Stanstad–Engelberg and Burgdorf–Thun Railways, and in Italy the historic Valtellina line. A point of difference from some of this earlier practice is, however, found in the method of speed control. Instead of the cascade system of the earlier Valtellina motors, a change-over to a different number of poles is employed for the lower speed, with the result that a substantial reduction in weight of the equipment was obtained without increase in complication of the switch gear. Another point to which we think more attention might advantageously be directed than has been hitherto is the method of transmission employed from the motors to the wheels. The side coupling rod system, of which these locomotives are examples, has, so far, only been seen in the productions of a certain small group of Continental firms. In addition to its obvious superiority over gearing as regards efficiency and quietness, especially at high speeds, it has the undoubted advantage of considerably reducing the "unsprung" or partly sprung weight, which in anything larger than a tramcar plays such havoc with the track.

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We have called attention on more than one occasion to the desirability of the full period of 42 years for the repayment of electric lighting loans for extensions of plant to London Borough Councils being reduced to a shorter term, as the probable life of the plant in question is considerably shorter than this figure. The London County Council, thanks mainly to the exertions of Lord Welby, has been considering the matter for some time, but the first actual example of such a reduction of time being made is found in the case of the loan granted this week to the Fulham Borough Council for extensions of plant, the period for the repayment of which has been fixed at 30 years. In the case of provincial loans, under the sanction of the Local Government Board, the tendency has been for a long time to shorten the period of loans for extensions, sometimes even to a still greater extent, although there are widely divergent views as to the periods which should be allowed for different kinds of plant of different lengths of life.

One of the greatest factors which imposes limitations on the work of the designer of continuous-current machinery is, of course, the question of commutation, and, indeed, there are few subjects connected with electrical machine design about which so much has been written. In the earlier days, after a host of experimental data had been collected and conclusions had been arrived at as to which of the many variables really influenced the result, the main aim of the designer was to so proportion his machines as to keep certain constants, determined by more or less elaborate formulæ, within those values determined by experience, and abide by the result, even if the machines so produced were from other points of view absurdly large for their work. The advent of the so-called "interpole," however, wrought a great change in the way the problem was approached. It was no longer the designer's sole object to keep his commutation constants low; they could be allowed to reach relatively enormous values and the commutation forced to be satisfactory by external means. As a result, in many cases, machines some 30 to 40 per cent. smaller in size can now be employed than could be the done with "natural commutation," and, indeed, conditions can be fulfilled in the directions of high speeds and high voltages which would otherwise be practically impossible. The recent developments of this subject are treated at some length in an article in the present issue, which summarises some of the conclusions arrived at by prominent workers on the subject. The application of auxiliary poles must not, of course, be regarded as a panacea for all sparking troubles. The fact must not be lost sight of that there are cases where the saving in size of the carcase of the machine is not sufficient to counterbalance the increase of cost introduced by the commutation poles and the slight, though appreciable, loss of efficiency which is entailed.

Another case, parallel to that of "forced commutation," is found in the tendency which exists to allow not only commutation constants but also thermal constants to reach high values and employ external means whereby the temperature is kept within bounds. In the design of enclosed motors of large size, the use of a fan to draw a current of air through the case is becoming increasingly common, and a similar feature is familiar in the construction of modern turbo-alternators, especially on the Continent. Fans, as in the case of the Simplon Tunnel locomotives, are commonly used for cooling resistances, and an extreme case is found in the suggestion of Messrs. Siemens Bros., noticed in another column, to even force a circulation of air through ducts in the commutator bars of a continuous-current turbo-generator. In the case of "forced ventilation," as in the case of "forced commutation," the matter must be looked at from both sides. There is an undoubted gain in the size of the apparatus but only at the cost of increased complication and lower efficiency. Cases, however, do sometimes arise in alternating-current working in which some such arrangement is of great advantage in enabling higher limits of induction to be utilised in the iron than would be otherwise possible without rendering prohibitive the temperature rise due to the no-load losses alone.

There is something amusing after all in the outcry against the District Railway fares. It shows, rather, what fools we all are, taken collectively. We have a steam railway which does not pay. The railway adopts electric traction and reduced fares and queer coaches, and there is not standing room. The passengers then complain, and think somebody, such as Mr. Keir Hardie or Mr. Lloyd-George, should compel the company to run more trains for an hour in the morning and evening. The company, finding even over-full trains do not pay, especially when carrying workmen at a loss, raises the fares. This is just what the passenger should want—more room at a trifle more cost. Not a bit of it: he thinks that because he chooses to ride he has a prescriptive right to a seat whenever he happens to want it at a fare which is unremunerative to the company. The idea that a railway is a money-making concern, with shareholders who want dividends, never seems to enter the head of the average man. We sometimes wish the District would sulk, and shut down altogether for a month, just to show the public what a benefit it really is. The notion that any concern working under an Act of Parliament is a privileged body whose duty is to serve the public at a loss is a fallacy that is very deeply seated in Parliamentary circles. It is in deference to this idea that railways are hampered in every way possible, that tramways have to carry workmen cheaply, and that many enterprises that would be of great public benefit as a whole are vetoed by ignorant and irresponsible committees. This is a large subject, though, and cannot have any justice done to it in short notes.

Considerable attention has been focussed of late on the subject of tramcar brakes, partly on account of some regrettable occurrences a few months back, and the matter was again brought into prominence at last week's meeting of the Municipal Tramways Association. As a few misconceptions seem to exist in some quarters as to the exact functions and, on the other hand, the limitations of the various types of brake in common use, we hope that the short series of articles on the subject from the pen of Mr. H. M. Sayers, which we commence in this issue, will contribute to a clearer understanding of the principles which govern the design of tramcar brakes of different varieties.

Some publicity has been given in the press recently to the statement that Scotland Yard is not connected to a telephone exchange, and our esteemed contemporary the *Globe* is particularly indignant that every subscriber to the telephone system of the Metropolis has not the opportunity of indulging in the luxury of a few minutes' occasional conversation with the Criminal Investigation Department whenever he feels inclined, or ringing up the lost property office to inquire if the umbrella he left in a cab has reached headquarters. We understand, however, that whatever may be the reasons of the authorities for wishing to communicate with the public by other methods, the private telephone system between the various police stations in London is very complete. There is, however, some point in our contemporary's comparison of the call boxes to be found in every street in Vienna, by which policemen on duty can communicate with any police station in the town with the "primitive whistle with which it is impossible to summon help without giving the alarm to thieves and burglars."

A GREAT deal has been talked of late on business-getting methods for electric supply concerns, and it is interesting to note the points of view from which different municipal authorities view the question. The opposition last week, finally, however, unsuccessful, at Brighton against the establishment of a small show-room to demonstrate the possibilities of electricity to the public, comes as somewhat of a contrast to the opening yesterday, as the outcome of the labours of Mr. S. E. FEDDEN, of the most complete municipal electrical exhibition which has yet been seen, by the Lord Mayor of Sheffield.

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Personal.—Dr. L. A. Bauer, whose resignation from the United States Coast and Geodetic Survey took effect on September 1st, has accepted the directorship of the Department of Terrestrial Magnetism of the Carnegie Institute at Washington, under whose auspices the magnetic survey of the North Pacific, to which we referred last week, is being carried out.

The Civil and Mechanical Engineers' Society.—The first meeting of the forthcoming session of the Civil and Mechanical Engineers' Society will be held on Thursday next, at Caxton Hall, Westminster, when Mr. W. B. Esson will deliver his Presidential Address at 8 p.m. The regular meetings of the Society will be held at the same place on the first Thursday in each month throughout the session.

The Junior Institution of Engineers.—A large party of members of this Institution visited the Northfleet Works of the Associated Portland Cement Manufacturers (Ltd.) on Saturday last, and were given the opportunity of inspecting the various processes and methods of cement manufacture. Electrical power is largely employed at the works, and considerable extensions are in progress.

Electrical Flour Bleaching in America.—Flour bleaching by electrical methods has increased to such an extent in the larger establishments in the United States that a special set of regulations for the installation of such apparatus under the rules of the National Electrical Code has been established. These regulations, which are published in the *Western Electrician*, are mainly directed towards lessening the risk of fire, and cover a considerable range of detail.

Continental Telephone Systems.—Some notes on the progress of telephone engineering on the Continent have been sent us by Mr. H. Laws Webb, who has just returned from a telephone inspection trip, having visited Denmark, Germany, Bavaria, Austria, Switzerland and France. In Copenhagen the telephone system is being converted to common battery working. Both in Germany and in Austria experiments are being made with automatic exchanges, but so far no automatic exchanges of any size have been equipped. In the meantime the conversion of the Berlin system to common battery working is proceeding, and two large exchanges are now equipped with the new plant. It is the intention of the French Administration to adopt the central battery in Paris.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma..	July 12, 1906
Môle St. Nicholas—Port au Prince	Aug. 16, 1906
Grand Canary—Lanzarote	Sept. 18, 1906

British Weights and Measures.—We have received a copy of the second annual report of the British Weights and Measures Association, which is a body with the avowed object of opposing the introduction of the metre or any of its derivatives into the British Empire. The publication consists chiefly of a series of short articles looking at the matter from various points of view and recapitulating those objections, real and imaginary, which have been advanced at various times against the C.G.S. system, and enlarging upon some of the conveniences of the units at present in more universal use in this country. Various compromises are also considered, such as the suggestion emanating from Canada to adopt a new "metre" exactly 40 in. in length. The committee of control of the Association comprises several well-known men, whose names would have led us to expect a higher average level of literary merit in the contributions to the report.

The Engineering and Machinery Exhibition at Olympia.—A number of illustrated lectures have been arranged for during the progress of the exhibition. The first of the series was given yesterday by Mr. Bailey Denton on "Sewage Disposal." Amongst the remaining lectures on the programme are the following: "Development of the Steam Turbine," by Hon. C. A. Parsons, M.A., C.B., and Mr. R. J. Walker, Saturday, September 29th; "Science as Applied to Marine Engineering," by Mr. A. E. Battle, Saturday, September 29th; "Master Strokes of the Great Engineers," by Mr. J. G. W. Haldane, Monday, October 1st; "Japan and the Far East," by Mr. George A. Goodwin, Tuesday, October 2nd; "The Connection and Disconnection of the Power from the Work," by Dr. H. S. Hele-Shaw, F.R.S., Tuesday, October 9th; "Gas Engines," by Mr. H. A. Humphrey, Thursday, October 4th, and Thursday, October 11th; "Steam Pipes and their Explosions," by Mr. C. E. Stromeyer, Monday, October 15th.

A Voltage Regulator for both Alternating and Continuous-current Systems.—A new form of automatic voltage regulator, suitable either for continuous or alternating currents, designed by Mr. W. H. Chapman, is described in a recent number of the *Electrical Review* of New York. A relay is employed for detecting small changes of voltage and applying the corrective force. This consists of a coil within which is a thin iron disc pivoted at opposite ends of a diameter. Due to the magnetic force set up by current passing through the coil, this disc tends to turn so that its plane will be along the axis of the coil, but is opposed in its motion by a spring. The latter is under tension, and is controlled by means of a thumb-screw and lock-nut. This device enables a close adjustment of the voltage to be made, as to produce a change of 1 volt requires that the thumb-screw be given nearly a turn. Attached to this rotating disc is a spring having platinum contacts at the end. This, due to the motion of the disc one way or the other, makes contact at one or the other of two adjustable fixed contact points, which close the circuit through the controlling solenoids. These points are also tipped with platinum, and are protected from dust by means of a metal cover with a glass top. Two resistance lamps are placed in series with the relay coil for cutting down the current and for compensating for temperature changes. The temperature coefficient of resistance of the lamps is positive, while that of the coil is negative. In this way errors due to changes in temperature are avoided. The resistance switch itself is worked by a pair of solenoids, whose plungers are attached to the ends of a rocking arm. These solenoids carry current only when the circuit is completed by means of the coil, so that they are in operation only a small part of the time. They have two windings—a primary, which carries the operating current, and a secondary, wound in the same direction. The latter is short-circuited upon itself, and its function is to prevent arcing at the relay contacts, this being done by the reaction of the secondary current induced when the circuit is broken. There is, in addition, a pair of high-resistance lamps connected up so as to absorb any little discharge remaining after this action.

Wireless Telegraph Notes.—Some successful experiments in long-distance overland wireless telegraphy carried out last week by the Russian Military Engineering Department are reported in the *Daily Telegraph*. Messages were dispatched from Nauen, near Bergen, to Volkovo Polye, in the neighbourhood of St. Petersburg, a distance of about 825 miles, and distinctly received without difficulty. The station at Volkovo at present only contains sending apparatus designed for a range of about 100 miles, so that an interchange of messages was not practicable.

A Reuter's telegram states that Mr. Marconi will attend the international conference on wireless telegraphy which will meet at the Reichstag Building, Berlin, on Wednesday next, as the representative of Montenegro. Thirty-one countries in all will be represented, only China and Peru of those invited having declined to send representatives.

The following articles were adopted, according to a Reuter's telegram, at the meeting of the Institute of International Law held at Ghent this week, when (among other subjects) the regulations to be applied to aeronautics and wireless telegraphy were considered :—

1. The air is free. The only rights that States have in it, in peace or war time, are such as are necessary to their preservation.
2. In the absence of special circumstances, the rules applicable to correspondence by ordinary telegraphy shall be applicable to wireless telegraphy.
3. Each State shall have liberty, so far as is necessary for its safety, to oppose the passage of Hertzian waves over its territory and territorial waters, whether such waves emanate from State apparatus or private apparatus, placed on land, in a ship or in a balloon.
4. In the event of correspondence by wireless telegraphy being prohibited, the Government shall at once warn other Governments of the fact.
5. The regulations in force in time of peace are not applicable in time of war.
6. On the high sea, in the zone covered by the sphere of action of their military operations, belligerents may prevent the despatch of Hertzian waves by a neutral State.
7. Individuals who, in spite of the prohibition of the belligerents, engage in the transmission of messages by wireless telegraphy between different sections of a belligerent army or territory are, if captured, to be considered as prisoners of war and treated as such. Ships and balloons belonging to neutrals which by movements in concert with the enemy may be considered as being engaged in his service may be confiscated, as well as the despatches and wireless telegraphic apparatus found on them.
8. A neutral State is not obliged to prevent the passage over its territory of Hertzian waves destined for a belligerent State.
9. A neutral State is obliged to close, or take under its own administration, any radiographic establishment belonging to a belligerent State which it had authorised to operate within its territory.
10. Every prohibition of communication by wireless telegraphy issued by belligerents must be immediately notified by them to neutral Governments.

The Canello Incandescent Lamp.—Another new lamp filament has been patented in the United States under the name of the Canello incandescent lamp filament. The claims cover a filament having a rare oxide core, a continuous conducting coating of metal and an outer coating of oxide. The coating is referred to especially as of ruthenium, and the outer coating of thorium oxide. The method claimed consists in impregnating a combustible thread with a compound of rare earth metals, incinerating the thread thus impregnated to produce a filament composed of the oxides of these metals, rendering the filament conducting by applying thereto a metal deposit, passing an electric current through the conducting filament to heat it, and while so heated subjecting the filament to a reducing gas and a volatile metallic compound, and then to the vapours of a thorium compound of acetylacetone. One variation is to apply to the impregnated thread a metallic compound which is soluble, reducing the compound to metal to render it conducting and depositing on it an oxide of a rare earth. Still another consists in applying, after the incineration of the thread, a refractory metal, rendering the filament of uniform conductivity by depositing a metal thereon where the resistance of the filament is greatest, and then coating with an oxide. In the specifications osmium is mentioned as a substitute for ruthenium. In the first stage of the process cotton threads are impregnated with a soluble salt of thorium, zirconium or cerium, and after being allowed to dry are calcined in an oxyhydrogen blow-pipe flame. They are then dipped in a solution of peroxide of ruthenium or osmium and subjected to a current of sulphuretted hydrogen, which converts the peroxide into sulphide. Or a current of hydrogen may be supplied which carries with it vapours of ruthenium or osmium, a hydrocarbon such as formic aldehyde being used to reduce the metallic vapours. In this state the filament has a resistance of several thousand ohms. To reduce the resistance and render the section uniform a current at several hundred volts is passed through the filament while in a receptacle through which is passed hydrogen carrying with it vapours of ruthenium or osmium acting together with vapour of formic aldehyde. The filaments are then attached to the leading-in wires by a solution of a suitable metallic salt, such as chloride of osmium, which is applied by means of a reducing gas. The last operation consists in the depositing on the filament a uniform coat of oxide, which may be done by means of a vapour of a thorium compound of acetylacetone. The carbon deposit from the latter is made to disappear by heating the filament in thoroughly dried carbonic acid gas. Instead of this method, a bath may be prepared of nitrate of thorium diluted with water, and with the filament as the negative pole and a carbon pencil as positive pole, an electric circuit closed. When the deposit of thorium oxide is completed, the filament is dried and heated in vacuo. Red phosphorus can be used to absorb the gases liberated.

Board of Trade Railway Returns for 1905.—The annual return by the Board of Trade, giving statistics relating to the capital, traffics, receipts and working expenditure of the railway companies of the United Kingdom for the year ended December 31, 1905, contains considerable information concerning electric lines. An independent record, however, cannot be compiled, owing to certain railways being only partly electrically operated, and the figures for which are contained in the total result applying to the particular company. The returns show that at the end of 1905 the length of line, in equivalent of single track, which was worked solely by electricity was 140¼ miles, while that worked partly by electricity was 170½ miles. The returns further show that the number of miles run by electrical trains in 1905 amounted to 9,667,429, including 9,640,921 miles by passenger trains, 2,870 miles by goods trains and 23,638 miles by mixed trains, the total quantity of electrical energy used in the same period for electrical train running and other purposes being 100,977,467 B.T.U. The following figures give an indication of the capital invested in electric railway enterprise in Great Britain, the figures representing paid-up capital, including loans and debenture stock to December 31, 1905.

Baker Street & Waterloo	£2,397,140
Central London	3,871,536
Charing Cross, Euston & Hampstead	2,762,442
City & South London	2,615,572
Great Northern & City	2,079,016
Great Northern, Piccadilly & Brompton	3,457,070
Liverpool Overhead	549,956
Underground Electric Railways Co. of London	10,200,000

It will be seen that the above list includes only those lines which have been promoted as electric railways and were either running or under construction on December 31, 1905. The returns for the Metropolitan, Metropolitan District, North Eastern, Lancashire & Yorkshire and the Mersey Railway Companies do not give separate figures for the capital expended upon the conversion of such lines as are now operated electrically. The capital of £10,200,000 given above for the Underground Electric Railways Co. of London includes £8,255,000 invested in other companies, but to what extent this will modify the figures for the Baker Street & Waterloo, the Charing Cross, Euston & Hampstead and the Great Northern, Piccadilly & Brompton Railways, which are in the Yerkes "group," is not made clear. In the same way the capital of the Waterloo & City Railway is included in that of the London & South-Western Railway Co. Without giving in detail all the information regarding working expenses of electric railways tabulated in the return, there are one or two special items worthy of mention. For instance, the burden of rates and taxes is an ever-present grievance, and the figures below show how this item affected electric railways in 1905, the second column showing the total working expenditure of the companies in question.

	Rates and taxes.	*Total working expenditure.*
Central London	£29,686	£190,042
City & South London	5,611	72,184
Great Northern & City	3,484	47,871
Liverpool Overhead	4,267	63,936
Mersey	3,181	69,036
Waterloo & City	2,302	17,045

The proportion of expenditure to total receipts were :—Central London, 53 per cent.; City & South London, 48 per cent.; Great Northern & City, 52 per cent.; Liverpool Overhead, 80 per cent.; Mersey, 79 per cent.; and Waterloo & City, 48 per cent.

THE DESIGN OF CONTINUOUS-CURRENT DYNAMO ELECTRIC MACHINERY WITH INTERPOLES.

Considerable attention has been given in the columns of one of our Continental contemporaries during the last year or more, to the various questions arising in connection with the design of continuous-current machinery with interpoles. While, in our opinion, a considerable part of the matter which has been written on this subject is of distinctly minor interest, and deals with points possessing but slight practical importance, nevertheless there constantly recur in a number of these articles, and in the correspondence to which they have given rise, allusions to certain aspects of the question which possess considerable interest and importance. A brief bibliography of certain amongst these recent articles is given below, arranged in chronological order.

BIBLIOGRAPHY.

I. "Gleichstrommaschinen mit Hülfspolen. Versuche und Dimensionerung." Dr. Max Breslauer (*E.T.Z.*, July 13, 1905, p. 640).

II. "Gleichstrommaschinen mit Hülfspolen." Contributions to Correspondence columns. R. Pohl, Max Breslauer (*E.T.Z.*, August 17, 1905, p. 786; September 14, 1905, p. 873; October 12, 1905, p. 959).

III. "Beeinflussung des Gleichstrommaschinenbaues durch Einführung der Wendepole." G. Dettmar (*E.T.Z.*, January 11, 1906, p. 23).

IV. "Beeinflussung des Gleichstrommaschinenbaues." Contributions to Correspondence columns. W. Oelschläger, Max Déri, G. Dettmar, R. Pohl (*E.T.Z.*, February 22, 1906, pp. 209-210; April 12, 1906, p. 375; May 31, 1906, p. 535).

V. "Verteilung des Kraftflusses in einer Maschine mit Wendepolen." E. Arnold (*E.T.Z.*, March 15, 1906, pp. 261-263).

VI. "Verteilung des Kraftflusses in einer Maschine mit Wendepolen." Contributions to Correspondence columns. R. Pohl, E. Arnold (*E.T.Z.*, July 26, 1906, pp. 713-714).

VII. "Einiges über Wendepolmaschinen und Kompensierte Maschinen; Zahl der Wendepole." E. Arnold (*E.T.Z.*, August 2, 1906, p. 717).

VIII. "Betrachtungen über den Einfluss des Wendepoles auf den Entwurf normaler Gleichstrommaschinen." Wilhelm Oelschläger (*E.T.Z.*, August 23, 1906, p. 783).

I. CONTINUOUS-CURRENT MACHINES WITH INTERPOLES: *Breslauer.*—Breslauer's article is of very great interest and importance. It is chiefly devoted to a clear account of some tests made upon an 8 H.P. four-pole 500 volt interpole motor. The tests were of a very exhaustive character, and comprised results on the alternative forms of interpoles employed in the course of the investigations. Up to loads and speeds corresponding to a reactance voltage of over eight, the commutation was excellent. As the author points out, had interpoles not been used, one-fifth of this voltage would have constituted the limit of satisfactory commutation. In one notable particular the author's conclusions are at variance with those arrived at by the authors of some of the other articles to which we shall allude. This relates to the width of the interpole's pole arc. The best results were obtained with a very narrow pole arc. It is stated that the "tests showed, further, that a pole thickness as small as 40 per cent. of the slot pitch, even with five segments per slot, still gave good results; the axial length of the interpole in this case amounting to some two thirds of the gross core length." Dr. Breslauer's explanation for the superiority of a small pole arc is that the inevitably high magnetic leakage associated with interpole designs must be reduced to the minimum practically attainable. Thus, in a test in which a considerably increased pole arc was employed, the motor ran far less satisfactorily, and it was necessary to adjust the brushes for each load. Dr. Breslauer concluded that this very unsatisfactory result was a consequence of the increased magnetic leakage.

It will also be of interest to set forth some of the other general conclusions arrived at by Dr. Breslauer: "As necessary exitation for the interpole, values were obtained which varied from 1·2 to 1·4 times the armature ampere turns. . . . As to the economic side of the question, it is not likely that the necessary copper for the interpoles can be reduced to less than two-thirds of the armature copper, so that according to my experience, and including the extra labour, an increase of the cost up to 12 per cent. per machine is involved. This increased cost is, however, offset by considerable savings which may be made in the copper on the main poles, since the air-gap can be reduced to the mechanically permissible minimum, and since, furthermore, from the standpoint of good commutation, and with a view to decreasing field distortion, it is no longer necessary to resort to high tooth density, since a slight increase in gross core length will in most cases involve less outlay than the additional copper which is necessary to overcome the magnetic reluctance of the teeth at high saturation."

Dr. Breslauer also lays great stress on the circumstance that in ordinary motors a great deal of commutator heating arises from imperfect commutation, and that when, as in the case of a good interpole design, the commutation is practically perfect, it becomes feasible to considerably reduce the size of the commutator so far as relates to the heating standpoint, since with the decreased commutation losses a decreased radiating surface becomes sufficient. Dr. Breslauer finds that with ideal commutation, as it may be obtained at any load and overload by the assistance of interpoles, it becomes practicable to employ a much higher current density at the brush surface, and thus a further saving is effected in the size of the commutator, since decreased brush surface is accompanied by decreased brush-friction loss.

II. CORRESPONDENCE ON BRESLAUER'S ARTICLE.—The correspondence coming under these headings opens with a futile, or at any rate purely academic, discussion as to the correct method of representing the lines of magnetic force in the case of magnetic circuits with interpoles. But little of practical importance is disclosed by this discussion. Nevertheless, it brings to mind the fact that more than one manufacturing company has actually gone to the expense, in constructions with interpoles, of employing absolutely independent magnetic circuits for the interpoles. This has apparently been due to some confusion of ideas as regards interference of the main and auxiliary flux. One design of this character has been described at page 1,004 of *The Electrician* for April 6, 1906. A reversion to the type with a single magnetic yoke is, however, now fairly general.

In the discussion, further allusion is made to the difficulties arising through the increased magnetic leakage occasioned by the presence of the interpoles. While this increased magnetic leakage acts as a disadvantage in increasing the speed of the motor, through the weakening of the magnetic flux from the main poles, this, although it is too considerable to be by any means overlooked, is a comparatively minor effect. The gravest disadvantage associated with the leakage flux relates to the very high percentage which this flux bears to the flux in the auxiliary poles. This may, if the design is at all crowded, rise to a very high percentage indeed. Now, in order that the interpole may correctly play its part at all loads, it is necessary that the flux entering the armature from the interpole shall be closely proportional to the armature current. Thus in such designs the interpole must be proportioned for very low saturation. The saturation will obviously, for an interpole of given dimensions, be lower the lower the percentage which the leakage flux bears to the flux in the interpole. Dr. Breslauer's observation that the brushes had to be set at a different position for each load, in the experiment in which he used a relatively large pole arc for the interpole, may thus be explained as due to the occurrence of increasing saturation values in the interpole as the load increased, and these increasing saturation values were, in turn, due to the very considerable magnetic leakage consequent upon the wide pole arc of the interpole, which, of course, entailed a very short distance between the tips of the interpole and the tips of the main pole.

Another interesting point mentioned in the correspondence is the intimation by Pohl that interpole designs of at all unsatisfactory proportions are sensitive as regards brush position. Pohl extends this bad feature to embrace machines of the Déri type, in which type, as is well known, not only is a reversing field provided, but the armature reaction is completely neutralised at all points by a so-called compensating winding which is arranged opposite the armature surface and distributed over the entire air gap. Pohl takes a most decided stand to the effect that the interpole construction is sufficient, and that the further provision of a compensating winding as employed in the Déri system, brings with it no further advantages whatsoever. Breslauer takes up this matter and points out that the compensation of the armature reaction which is accomplished in the Déri system, and which is not accomplished by the ordinary interpole system, results in a decreased core loss, owing to the uniform distribution of the magnetic flux over the entire pole face as contrasted with the distortion in the distribution which still occurs with increasing loads in designs of the interpole type. Pohl writes that this slight advantage of decreased core loss is dearly purchased by the considerable outlay for copper for the compensating winding, and by the C^2R losses therein. One further point, to which considerable attention is given in the discussion, relates to the relative merits of various forms of pole face for the interpole. The importance of such details would appear to be unduly emphasised by Pohl.

III. The Influence of the Use of Interpoles on the Design of Continuous-current Dynamo-electric Machinery: *Dettmar*.—We now come to an interesting article by Dettmar. The author begins by stating that the good commutating results obtainable by means of interpoles are clearly established, and he proceeds to investigate the effects which this new principle will have upon the general proportions of machines in which it is employed. He first points out that, with a view to obtaining good commutation with the ordinary type of machine, designers have employed very strong magnetic fields and high magnetic densities, especially in the armature teeth. All this has led to a large expenditure for spool copper. The employment of interpoles will tend to change this plan of procedure. Smaller magnetic fluxes and a greater number of armature turns per pole will be employed. Lower magnetic densities will also be chosen. Field distortion will not entail such objectionable consequences as would be the case without the interpoles. Consequently, machines of the interpole type will be characterised by much stronger armatures, somewhat larger diameters of armature, and shorter magnet cores, and less weight of main field spool copper per magnet core. The decreased weight of main spool copper will be sufficient to largely or entirely offset the additional weight of the copper employed for the excitation of the interpole. It will no longer be necessary to resort to so great a number of commutator segments as has been necessary with a view to obtaining good commutation without the use of interpoles. It has heretofore been necessary to resort to exceedingly thin segments, so thin, in fact, that the thickness of the insulation as compared with the thickness of the copper segment has sometimes led to undesirable mechanical conditions. The most significant conclusion to which Dettmar arrives is contained in the following paragraph: "The choice of the number of poles has heretofore been materially influenced through consideration of the conditions favourable to good commutation. With the use of the interpole, one has a much freer choice in this respect, and can be guided to a greater extent by economic considerations. For those firms having a large annual turnover this is of the most far-reaching importance, as the weight of a machine may be greatly decreased by the use of an increased number of poles. It will, therefore, in many cases be possible to materially decrease the expenses for freight and for customs duties." The author also looks forward to a slight improvement in the efficiency at the rated load, and to a great improvement in the efficiency at light loads. This, however, he points out, is not the case at the present stage of development, where we frequently find designs of the old type being altered into interpole designs. In such cases the efficiency at the rated load is decreased to the extent of the losses in the auxiliary windings. The author states that field distortion, while it still takes place in interpole designs (and, in fact, to an increasing extent, owing to the greater armature strength employed per pole), no longer has objectionable consequences, except so far as relates to a slight increase in core loss with increasing load, for the core loss is a function of the field strength at the points of maximum density. The author believes that with the increasing use of the interpole type, carbon brushes of much higher conductivity will come to be used, and this will be accompanied by a decrease in the size of the commutator, with the attendant decrease in cost. Electrolytic machines will be far more practicable when designed in accordance with the interpole system, as will also boosters and other machines which have to be operated under varying conditions of voltage and speed. The way is also clear for continuous-current designs for far higher voltages than have heretofore come into general use, and the author looks forward to machines with normal pressures considerably exceeding 2,000 volts. The article concludes with an expression of opinion that the costs of such machines will, on the whole, not be materially greater than machines of the ordinary type, and may even, in the course of time, be slightly lower.

IV. Correspondence on Dettmar's Article.—Dettmar's article gave rise to considerable correspondence in the *Elektrotechnische Zeitschrift.* Messrs. Oelschläger, Déri, Pohl and Dettmar contribute to this discussion. Oelschläger indulges in speculations as to the reason that the interpole type, which had been invented some 20 years ago, should not have been satisfactorily developed until within the last couple of years. He ascribes this to the fact that it is only comparatively recently that our knowledge of the reactance voltage in the coils short-circuited under the brushes in the continuous-current dynamo has been reduced to such a form as to be susceptible to approximately exact calculations. As soon as the calculation of this quantity became common knowledge, the correct proportioning of interpoles, and a recognition of the advantages obtainable by employing this type of design of continuous-current machine became apparent. Oelschläger points out, however, that even at the present day a large number of incorrectly designed interpole machines are to be found, and that there is danger that these will bring the entire type into discredit. The author goes on to point out that it has sometimes been said that interpole dynamos do not work satisfactorily in parallel. This he maintains is an error; they work very satisfactorily in parallel, but owing to the high armature strengths employed in the interpole type of dynamo, the reaction of the armature on the field is highly dependent upon the brush position, and thus a very slight change in the brush position will have a very marked effect upon the extent to which a machine shares the load with the other machines with which it is in parallel. Oelschläger regards this as an advantage, considering it preferable to adjust the compounding by this means than by the more customary method of employing an adjustable shunt in parallel with the compound winding. Oelschläger criticises Dettmar's view that much lower densities will be used in the design of the interpole type than have been customary in the ordinary type of design, and considers that, on the contrary, the same high densities will be employed.

Déri contributes certain interesting information to the discussion elicited by Dettmar's article. The data which Déri publishes contains a statement to the effect that his experiments with a 400 volt design with six poles and 61 segments have demonstrated that good results may be obtained with an average pressure of 40 volts between adjacent commutator segments. He is of opinion that a still higher average voltage between adjacent segments will be permissible, and considers that there is no doubt whatever but that railway motors of the sizes which are now customary for a pressure of 700 volts will, with correspondingly increased insulation, give thoroughly satisfactory results with from 2,000 to 3,000 volts when provided with his system of compensating for armature interference and of supplying a commutating field. Dettmar, in his reply to the letters from Oelschläger and Déri, makes acknowledgment of Déri's important contributions to the development of compensating windings. With reference to Oelschläger's criticism in the matter of magnetic densities, Dettmar adheres to his opinion that lower saturation values will generally be employed in interpole designs. Pohl also criticises Dettmar's proposal to decrease the magnetic densities in the interpole type, and criticises Déri's claim to priority in the matter of compensating windings as applied to continuous-current machinery, alluding to the much earlier work of Ryan, in America. Pohl is of opinion that the application of Déri's construction to machines of normal outputs and speeds would involve not only a very considerable increase in their cost but also a decrease in their capacity in consequence of a decreased thermal limit. Pohl confirms Déri's experience that an average pressure of 40 volts between adjacent segments is practicable under good conditions, but he throws out the caution that unavoidable accumulations of dust on the commutator, when such high pressures between adjacent segments are employed, is apt to result in flashing over about the entire commutator. Déri takes exception to Pohl's suggestion that Ryan's work antedates his own, and implies that very unsatisfactory results were obtained in America with Ryan's designs, and that these are in striking contrast with the excellent results now obtained by many manufacturers building under the Déri patents. Déri further contends that the interpole alone affords but a very crude and insufficient means for improving the commutation. In Déri's opinion, the provision of the reversing flux should be supplemented by the provision of a compensating winding in accordance with his system.

V. and VI. THE FLUX DISTRIBUTION IN AN INTERPOLE MACHINE: *Arnold—Correspondence on Arnold's Article.*—In this article and the consequent correspondence, the question to which allusion has already been made—namely, that of the correct graphic representation of the main magnetic flux and the auxiliary flux—is resumed. Arnold publishes tests showing that, to all intents and purposes, these fluxes may be considered as quite independent of one another, with the exception that the leakage coefficient is considerably increased by the presence of the auxiliary poles, and also that the saturation of the yoke is at parts higher in virtue of its affording a common path for the main and the auxiliary flux. It is, however, shown that there is no need for providing a separate yoke for the auxiliary flux so far as regards accomplishing any purpose relating to the avoidance of any undesirable consequences arising from any interference of these two fluxes.

VII. INTERPOLE MACHINES AND COMPENSATED MACHINES: *Arnold.*—Arnold contrasts the effect of the voltage per segment as relating to flashing over in (1) the ordinary design without reversing poles or compensating winding; (2) the design with reversing poles, and (3) the design provided both with a reversing field and a compensating winding. He concludes that the ordinary design is most disadvantageously affected as regards flashing over as the result of field distortion and the consequent increase of the maximum voltage between adjacent commutator segments. This liability, for a given peripheral loading of the armature, is somewhat decreased with interpole designs, and is considerably further decreased by the compensated designs of the Déri type.* Arnold also deals with the question of the magnetic leakage in interpole designs. It is evident that designers are at last realising that the difficulties encountered in the ordinary design without any of these auxiliary devices, have still to be dealt with in interpole designs, and it is still desirable to reduce the inductance per commutator segment as far as practicable, and to use a liberal number of commutator segments when conducive to this result.

While the average voltage between the commutator segments may, in an interpole design with comparatively few segments, be well within permissible limits at no loads and at light loads, the maximum voltage between adjacent segments will, in the presence of the armature distortion consequent upon increasing load, very greatly exceed the average voltage, and unless the number of segments provided is such that at no load—*i.e.*, with uniform distribution of the magnetic flux, the average voltage is needlessly low, the maximum voltage between segments at high loads may exceed safe limits.

VIII. THE INFLUENCE OF THE INTERPOLE ON THE DESIGN OF STANDARD CONTINUOUS-CURRENT MACHINES: *Oelschläger.*—We now come to the last article in the series. This is by Oelschläger, and owing to its thoroughly practical nature, its temperate phraseology, and its evidence of being founded on a considerable experience in the designing and building of interpole machines, it stands, together with Breslauer's article, in striking contrast with most of the publications relating to continuous-current machines with interpoles. Oelschläger first states that the output of a machine may be increased by some 30 to 40 per cent. by the use of interpoles, and without any material increase in the weight of the machine. In a later paragraph, however, he qualifies this statement by explaining that this great increase in the rating will only be practicable where heating is not already the limit of output. Since heating is generally the limit of output in machines of the range of from 10 H.P. to 50 H.P. he explains that the interpole designs have heretofore been less employed for this range of output than for large high-speed machines, such, for instance, as turbo-dynamos. Oelschläger, however, inclines to the opinion that interpole designs could well be employed even for such small machines as those of from 10 H.P. to 50 H.P. output. He points out that in the ordinary type of design for these sizes, either the 440 volt motors must be inferior, as regards commutation, to the motors for lower pressures, or else they must be given considerably lower ratings for a given size and weight than the lower pressure motors. And this will be the case even when the 440 volt motor is designed with a considerably greater number of segments than the lower pressure motor of the same size. Oelschläger does not propose to materially decrease the magnetic densities when employing interpole designs, but he points out that the air-gap may be reduced to the minimum consistent with satisfactory mechanical proportions, and that thereby a considerable decrease may be effected in the necessary amount of field copper. This advantage may be taken up by shortening the radial length of magnetic cores, and thereby decreasing the external diameter of the machine for a given armature diameter.

We now come to the most important portion of Oelschläger's article—that portion, namely, in which he sets forth certain controlling data at which he has evidently arrived by his own experience with this type of machine. He states that a design in which the interpole has too small a pole arc is exceedingly sensitive, and can frequently not be made to operate sparklessly; consequently he recommends that with four-pole machines of from 10 H.P. to 50 H.P. output, the pole arc of the main pole shall not be over 70 per cent. of the pole pitch, thus leaving room for a sufficiently large arc for the interpole. He states that the number of slots must not be chosen too low. So small a number of slots as would with ordinary machines lead to excellent results, can rarely be employed in interpole machines, owing to the interference with the constancy of the flux from the interpole. If, for instance, a slot should be nearly as wide as the arc of the interpole, violent variations in the amount of the flux from the interpole would occur during the passage of the slots past the pole. Oelschläger sets forth the rule that the total surface of iron under the interpole shall, for every position of the armature, be as nearly as possible constant in value, and this, he points out, is altogether out of the question with a small number of slots. This condition will, in the case of four-pole machines of small output, be sufficiently fulfilled when the arc of the interpole covers at least from $1\frac{1}{4}$ to $1\frac{1}{2}$ of the slot pitch. Six-pole interpole machines are found to be still more sensitive in this respect, and in the smallest sizes of such machines one should not go below pole arcs of from $1\frac{1}{2}$ to $1\frac{3}{4}$ of the pole pitch. Mistakes in this respect have the gravest consequences, especially in designs for wide speed regulation, since such machines are apt to surge at the higher speeds. This surging can often be partly overcome by corresponding alteration in the brush position, provided that the machine is not too sensitive as regards sparking, and that an adjustment of the brushes is permitted. We thus see that Oelschläger has arrived at very different results as regards the most desirable arc for the interpole, to those arrived at by Breslauer, whose conclusion was that a very narrow pole arc for the interpole was highly desirable, and who recommended that the pole thickness should be as small as 40 per cent. of the slot pitch, "even with five segments per slot."

Oelschläger proceeds to the conclusion that one should not go over from four-pole to six-pole designs too early in a series of interpole machines, since a six-pole interpole design for small outputs does not permit of sufficient room between the poles, and leads to very impractical relations. To build six-pole interpole machines for 30 H.P. is a mistake. It is sound economy not to go over to six-pole designs under outputs of from 60 H.P. to 70 H.P. This is strikingly at variance with Dettmar's conclusions that interpole designs will have a larger number of poles than ordinary designs. Oelschläger states that short chord windings should not be employed with interpole machines. He also prefers two-circuit to multiple-circuit windings, and gives certain reasons why the former should lead to the better results. Oelschläger states that, as always in the introduction and carrying out of a new idea, poor results are still of very frequent occurrence. These, he states, are due to the work of inexperienced engineers, and that there is great danger that the interpole design will thereby be brought temporarily into disrepute. He is, nevertheless, of the opinion that we stand on the threshold of a new epoch in the design of continuous-current dynamo electric machinery, and that it is only a question of time before manufacturers will have 1,000 to 2,000 volt ratings on their lists of standard machines.

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* The frequent allusion by these engineers to the question of flashing over at the commutator of interpole dynamos is noteworthy. It recalls the statement on p. 1,004 of *The Electrician* for April 6, 1906, in the description of an interpole type turbo-dynamo, to the effect that, although "the commutation is good," there is a tendency to flash over at the brushes which the manufacturers of the machine "are sanguine of overcoming." It is not at all unlikely that in taking advantage of the lesser restrictions as regards reactance voltage, designers have gone too far in the reduction of the number of commutation segments.

BRAKES FOR TRAMWAY CARS.

BY HENRY M. SAYERS.

Next to the due and sufficient provision of motive power, reliable and ample means of slowing and stopping at will is the most necessary part of the mechanical equipment of a tramway car. It is more important to a vehicle on a fixed track than to one running freely over the width of the highway, because the free vehicle may avoid an imminent collision by an alteration of course, whereas the car on rails has no such alternative. It must stop or collide with the obstacle in its path, unless the latter can be removed in time.

Every increase in weight and speed calls for corresponding certainty of control, and it may be said that the safe working speed of a tramcar under given conditions of traffic density is limited by the possibility of bringing it to rest from that speed within a given distance. The relation between maximum running speed and overall-service speed is just as much dependent upon the deceleration applied by the brakes as upon the acceleration given by the motors, so that the efficiency of brakes affects the excellence of every-day service as much as it does the avoidance of occasional accident. The accidents which risk life and limb as well as property attract the greater public attention; but time being the stuff that life is made of, it would be true in a sense to say that good brakes save more life stuff by permitting the best service for the speeds allowable than by the avoidance of fatal accident.

The mechanical function of a brake is always that of absorbing and expending in some way the kinetic energy of the moving car, but the circumstances under which it has to perform vary greatly even on a particular route; and as between various routes the differences in the conditions are sufficiently wide to make the problem of efficient braking a many-headed one, not to be satisfied by any single answer.

On a given route the work required of the brake equipment falls into at least two categories—service stops and emergency stops. As to the former, the conditions are fairly calculable, the problem being to run a car over the route without exceeding the authorised speeds, making the prescribed number of stops and starts, and performing the whole journey within a minimum time. Here the brake power comes in by setting a minimum distance from each stopping place, at which power must be cut off and the brakes applied. Other things being equal, the shorter this interval the smaller will be the difference between the running speed and the overall or service speed. Where tramways are worked up to their maximum capacity brake power thus becomes an important factor in the carrying power.

Emergency braking varies in degree from the gentlest slackening of speed, to enable a moving vehicle or person to clear the track, to the sharpest possible stop, to save collision, at a fraction of a second's notice. The essence of the emergency is this very absence of notice. Hence, the means of meeting it should be applied automatically by an acquired "reflex action," so to speak, requiring no intervention of conscious thought, or selection as between alternative methods. That is to say, the emergency brake in every case should be the service brake which the driver applies almost without volition, at every service stop. It should have sufficient range in its decelerating power to serve the double purpose.

It is advisable to have two brakes on a car, either of which will answer the two functions, and drivers should be trained to use both indifferently for both purposes—never to regard one as a "service" brake and the other as meant for "emergencies" only.

On routes having steep gradients brakes have another task to perform, that of keeping the speed of the car down to a safe limit so that it can be as readily stopped on the gradient as if it were on the level. The ideal brake for a gradient absorbs the work corresponding to the acceleration of gravity, so that the car descends at a steady speed, travelling no faster at the bottom than it did on commencing its descent. On long gradients this involves the absorption and dissipation of a good deal of energy. Evidently, just as much energy as is required to lift the car from the bottom to the top of the hill, and if there were no conversion losses the energy so dissipated by the brakes would be a measure of the extra energy given out by the motors in lifting the car on the return journey, above the energy spent on an equal length of level track.

Special brakes for descending hills should be applied regularly at the top of each slope as a routine procedure; they should not interfere with the operation of the service brakes, and should be kept on during the whole length of each incline. These conditions and the considerable amount of energy dissipated justify the use of brakes which are not suitable for either service or emergency use.

This classification divides brakes into two classes only—service brakes, which must also be emergency brakes, and hill brakes or speed controllers, answering to the "skid-pan" of the waggon. It is important to bear this division in mind when considering the applicability of any particular form of brake.

Braking effects are generally expressed in acceleration units, "feet per second per second," for example, very conveniently converted into the number of seconds elapsing or feet traversed between application of the brake and the stop; this measurement gives no direct idea of the work done. A brake has to absorb and transform the energy of the moving car, and it may, in so doing, be working at a higher rate than the car motors when they are accelerating. Almost without exception the work consists of abrasion and heating.

Take, for example, a 10-ton car moving at 12 miles per hour. To bring this to rest kinetic energy equal to 48·4 ft.-tons, or 108,000 ft.-lb., has to be transformed into heat or other form of work. Twelve miles per hour being 17·6 ft. per second, a braking effect, or "negative acceleration" or deceleration, of 3 ft. per second per second, if kept uniform, would stop the car in 5·9 seconds, or a space of 52 ft. The rate of doing work, 108,000 ft.-lb. in 5·9 seconds, is about 32 H.P. Very generally and roughly it may be said that the work done by the motors in accelerating and lifting is finally disposed of by the brakes in decelerating.

The limit of brake power is of importance as determining the minimum time or space of stopping from any given speed. A practical upper limit for service purposes is set by the comfort and safety of the passengers carried; probably 3 ft. per second per second is as high a value as should be used.

For emergency stops a considerably higher limit is permissible, because it is a less evil to shake up passengers occasionally than to collide with other vehicles or pedestrians, and also because at service stops there is a probability that passengers will be rising or walking to the platform and more easily thrown down or otherwise hurt. Therefore in making up a service time-table the lower figure should be used, but in reckoning the safe limit of running speed in relation to braking power some increase may be allowed.

The attainable limit where any form of wheel brake is concerned is that corresponding to the slipping point of wheel upon rail, and therefore varies with the condition of the rail and the corresponding adhesion or coefficient of friction.

(To be continued.)

Electric Railway in Spain.—The first standard gauge electric railway in Spain, according to *Elektrotechnik und Maschinenbau*, is shortly to be opened between Barcelona and Sarria, a distance of slightly over 3 miles. The line is equipped on the ordinary overhead trolley system. Each motor car carries two 55 H.P. continuous-current motors, and weighs 12·5 tons. The trailers weigh 5 tons each.

ELECTRIC TRACTION IN THE SIMPLON TUNNEL.

A regular service of trains hauled by electric locomotives is now in operation between Brigue and Iselle through the new Simplon Tunnel, which thus affords the most direct route through Switzerland to Italy and thence to the Far East. This service was referred to briefly in our issue of the 7th inst. In the present article we give some particulars of the electrical installation, which, on account of the nature of the work and the importance of the service, is of very considerable interest.

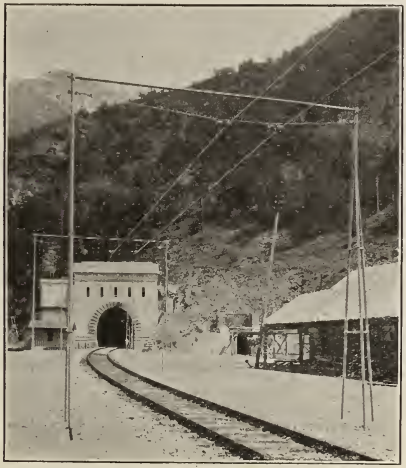


Fig. 1.—Entrance to Simplon Tunnel at Brigue.

In the autumn of 1905 Messrs. Brown, Boveri & Co. made an offer to the Swiss Federal Railways to lay down a complete installation for the purpose of working the Simplon traffic, and to have this installation completed in time to permit of it being utilised for handling the heavy traffic which it was anticipated the International Exhibition at Milan would give rise to in the summer of 1906. The Brown, Boveri Company offered to put the whole of this installation at the disposal of the Federal Railways, so that they could make a comparison on a large scale between the steam working and electric working of heavy express trains.

The advantage of electric haulage, in respect to the absence of smoke, was in itself sufficient to ensure the adoption of this method of working for such a service as that of the Simplon Tunnel, particularly as the experience of those railroads which had been employing electric traction for years past (such as the Burgdorf-Thun line) had demonstrated conclusively that main line electric traction, when installed under proper conditions, presented great advantages from the points of view of economical and reliable operation. So that the Board of the Swiss Federal Railways did not hesitate to accept this offer, especially having regard to the standing and experience of the contracting firm.

It was not, however, until the end of the year 1905 that the negotiations and preliminaries were settled by the authorities, so that a relatively short time was allowed the contractors in which to fulfil the undertaking they had given with regard to completion. On account of this shortness of time, Messrs. Brown, Boveri & Co., while fully recognising the advantages of the other systems which were available, were compelled to adopt that method of working which could be most quickly installed, and thus three-phase working was decided upon. For it so happened that at that time there were two 1,000 H.P. three-phase locomotives in course of construction in the Baden works, ordered as extensions for the Valtellina line, and the Italian Railway Board were willing that these locomotives should be used for the Simplon service, and new ones put in hand for them, in order to gain time. At the same time, the management of the Valtellina Railway agreed to lend Messrs. Brown, Boveri & Co. three of their locomotives until such time as additional locomotives could be built, for the working of the tunnel as at present arranged requires four locomotives.

For a similar reason—the shortness of the time available—it was necessary to make use of the existing power stations at Brigue and Iselle (which had been put up for supplying power to the many machines used in boring the tunnel) for the purpose of supplying the necessary power to work the trains, rather than to erect a new water-driven power station. Plants were thus put down in each station—namely, a 1,200 H.P. plant at Brigue, and a 1,500 H.P. plant at Iselle, which when coupled in parallel (and having regard to the large overload capacity of each) are sufficient for the power requirements of the tunnel service. The pressure of the three-phase alternators is 3,300 volts, and the frequency 16 cycles.

The Overhead Conducting System.

As is usually the case, two of the conductors necessary for conducting the three-phase current to the locomotives are overhead, the track rails constituting the third. The entire line is divided into five sections, as follows:—

(1) From the station at Brigue to the northern end of the tunnel.

(2) Northern half of the tunnel.

(3) Siding in the middle of the tunnel.

(4) Southern half of the tunnel.

(5) From the southern end of the tunnel to the Iselle station.

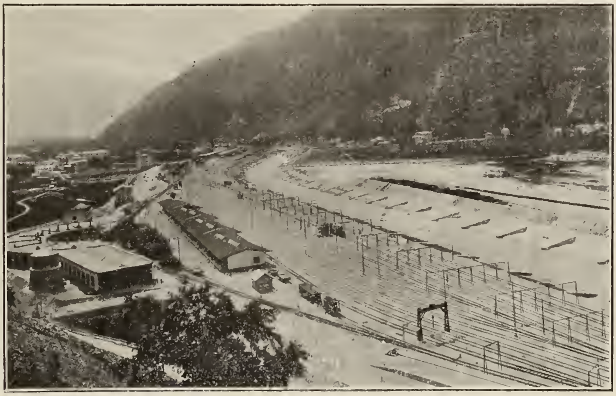


Fig. 2.—General View of the Station at Brigue.

Section switches are provided at Brigue, at Iselle, and at the station in the middle of the tunnel, and the necessary means for telephonic communication are provided.

Outside the tunnel the overhead line is carried on steel cross wires strained between poles of drawn steel, which are placed on either side of the track; on curves these poles are stiffened in the manner shown in Fig. 1 (which shows the entrance to the tunnel at Brigue) for the purpose of increasing their resistance to side stresses.

At Brigue there is a separate set of poles for each track, so that the whole line construction is exceedingly solid; and, further, work can be carried out on one of the lines without affecting the others. Fig. 2 gives a general view of the station, tracks and overhead work at Brigue, while Fig. 3 clearly shows how the overhead work is carried out at that end. At Iselle, on the contrary, this method of overhead construction could not be employed, as the tracks are too near to one another to allow of poles between them: a very much longer cross wire is used, the poles being placed on each side of the tracks, and a catenary type of suspension employed. Fig. 4 shows the nature of the overhead work at a loop, while Fig. 5 shows the Iselle entrance to the tunnel.

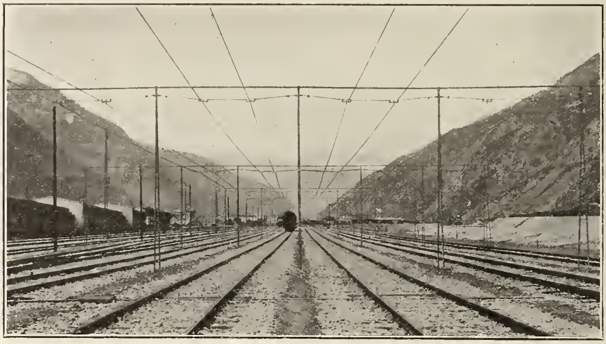


Fig. 3.—Overhead Work at Brigue.

In the tunnel itself the conductors are carried on steel cross wires, which are stretched between gun-metal studs, cemented directly into the face of the tunnel, as shown in Fig. 6; no strain insulators are used, as it is necessary to keep the over- head work in the tunnel as simple and as strong as possible. The cross wires are insulated at each end from the gun-metal studs by strong porcelain insulators, the method of attachment being such that the cross wires can be drawn as tight as required. The spacing of the cross wires on the straight portions of the line is about 83 ft., and about 42 ft. on the curves. It has not been found necessary to place the suspensions closer together, as the temperature in the tunnel is practically constant, and the conductors can be strained very tightly, so that the sag of the latter is quite small, even with spans of 80 ft. or more.

The conductors are carried from the cross wires by means of a special type of insulator, which can be seen in Fig. 6. For the purpose of ensuring high insulation under the most unfavourable conditions in respect to dirt, moisture, &c., the insulators are double, being partly of porcelain and partly of ebonite. The ebonite portion is made in the form of a bolt, to which the conductor is attached; this bolt is carried by a gun-metal cross-piece fixed at each end in strong porcelain insulators by means of hemp and asbestos. The complete insulator is carried in a gun-metal fitting, by means of which it is attached to the cross wire.

The design of the insulator is such that should one portion become defective the insulation of the other will be amply sufficient to prevent harmful leakage, and thus the service can go on without interruption until a suitable opportunity occurs for replacing or repairing the insulating block. Repairs to the latter can be carried out exceedingly quickly, as all parts of the insulators are separately replaceable. Each insulating block will easily withstand a test pressure of 40,000 volts, which is amply sufficient for a working pressuer of 3,300 volts, even under the most unfavourable atmospheric conditions.

The section of the conductors employed is 0·15 sq. in. in the tunnel, and 0·0775 sq. in. outside, a larger section being necessary in the tunnel in order to keep the pressure drop of the 12 miles of conductor within proper limits. In the tunnel each conductor consists of two wires, the diameter of each being 0·315 in. It was considered preferable to employ two wires per pole rather than one wire of larger diameter, firstly, because the smaller wires are far more easy to handle; secondly, because the fact of having two wires per pole ensures a better contact on the bow collectors; and thirdly, because the diameter of 0·315 in. is the largest in general use for overhead contact wires, and it is possible to obtain wires of this diameter which are thoroughly homogeneous and uniformly hard. In addition to these advantages, the supply is not interrupted if one of the wires breaks, for current can still be supplied by the second conductor until pressure can be taken off the line and the damaged conductor replaced. In order to equalise the wear on the bow collectors as much as possible, the overhead conductors are not kept exactly parallel to the track rails along their whole length, but are arranged to zig-zag slightly on the cross wires.

The track rails are bonded with the patent Brown Boveri plastic bond, the leading feature of which is that the ordinary fish-plates only are used to conduct the current from one length of rail to the next, no copper connections being employed. This system is a very simple one, and has given satisfactory results in the numerous cases where it has been used for railway work on the Continent. Tests recently carried out at Brigue have shown conclusively that the conductivity of the bonds is as good as that of the homogeneous rails.

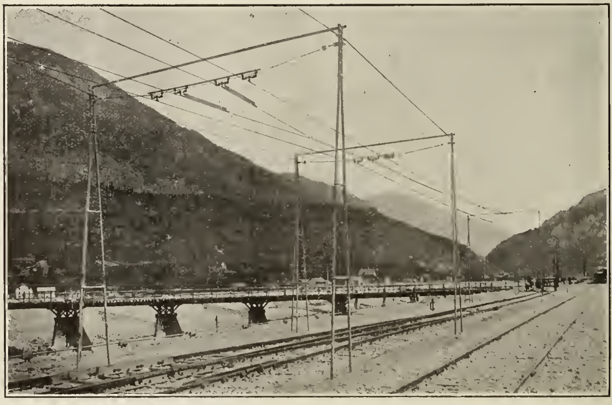


Fig. 4.—Overhead Work at a Loop Outside the Tunnel.

Locomotives.

Figs. 7 and 8 illustrate the construction of the Brown Boveri locomotives, and it will be seen that these are of the bogie type, with five axles altogether, three of which are driven by the motors. The two motors are placed between the three pairs of driving wheels, and both drive on to the middle axle by means of a bar, coupling them rigidly together; this axle in turn drives the other two axles by means of a coupling rod. Thus the motors are gearless, and at the same time they are not directly keyed on to the driving axles of the locomotive; it was considered advisable not to adopt the latter plan, for the dismounting of the motors in this case would be much more difficult.

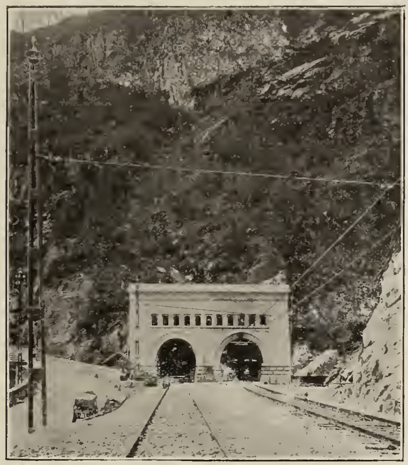


Fig. 5.—Entrance to the Tunnel at Iselle.

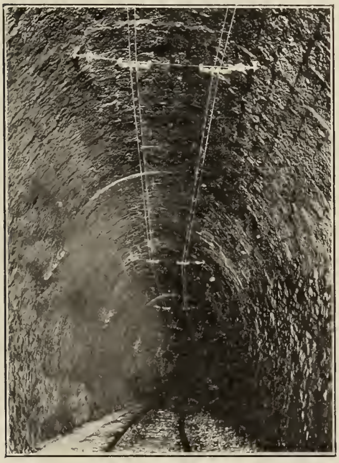


Fig. 6.—Overhead Construction in the Tunnel.

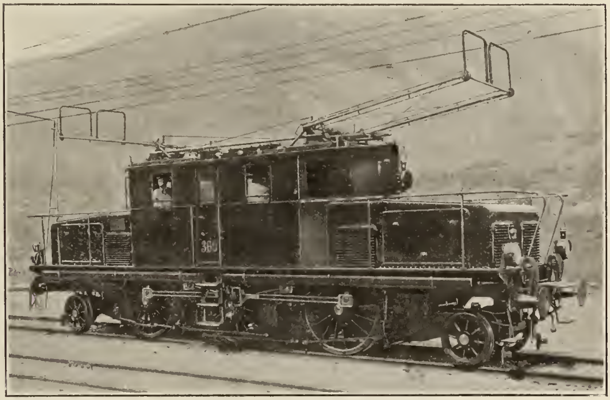


Fig. 7.—Three-phase Locomotive for Simplon Tunnel.

The general design of the locomotives is due to the joint deliberations of the engineers to the Valtellina railway with Messrs. Brown, Boveri & Co., and the Swiss Locomotive Works of Winterthur, which latter firm constructed the framework and other non-electrical parts of the locomotives for Messrs. Brown, Boveri. The following are the leading particulars of these locomotives:—

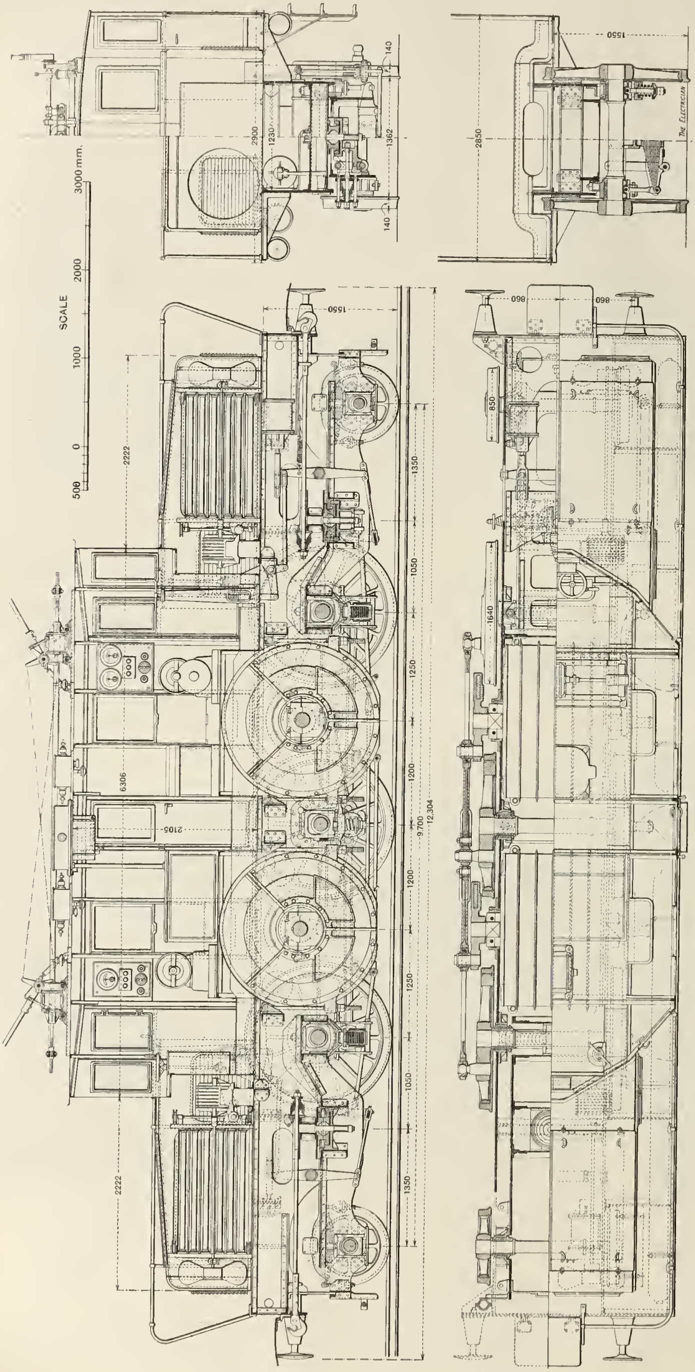
Overall length (between buffers)	40 ft. 6 in.
Distance between centres of bogie axles	31 ft. 10 in.
,, ,, ,, outside driving axles	16 ft. 1 in.
,, ,, ,, bogies	23 ft.
Diameter of the driving wheels	5 ft. 4½ in.
,, ,, bogie wheels	2 ft. 9½ in.
Weight on the driving wheels	42 tons.
Weight of the mechanical portion of the equipment	34 tons.
Weight of the electrical portion of the equipment	28 tons.
Total weight of locomotive, complete	62 tons.
Rated full-load output of the two motors together	900 B.H.P.
Maximum output of the two motors together	2,300 B.H.P.
Weight of each motor complete with its coupling bar	10¾ tons.
Normal speeds of the locomotive	42 miles and 21 miles per hour.
Draw-bar pull of locomotive at 42 miles per hour	7,700 lb. normal. 20,000 lb. maximum
Ditto ditto 21 ditto	13,500 normal. 31,000 maximum.

It will be seen that the locomotives are built on liberal lines. When starting at the higher speed with a passenger train weighing 300 tons a draw-bar pull of 16,600 lb. is required in order to obtain the specified acceleration of 0·5 ft. per second per second, and when starting at the lower speed with a goods train weighing 400 tons a draw-bar pull of 20,000 lb. is required in order to obtain the specified acceleration of 0·36 ft. per second per second.

The design of these motors is well shown by Figs. 11 and 12, which illustrate respectively the stator and rotor construction. As indicated above, the full-load rating of each motor is 450 B.H.P., this being at 2,700 to 3,000 volts and 16 cycles. At the higher speed the short-period overload capacity of each motor is as high as 1,150 B.H.P., while at the lower speed (at which the full-load rating is 390 B.H.P.) each motor can be continuously over-loaded up to 575 B.H.P.

The control of the motors is effected by means of rotor resistances in combination with altering the number of stator poles, this method being adopted in preference to the system employed by the Ganz Company, on the Valtellina line, of coupling the motors in tandem. By working with two combinations of stator poles and rheostatic control it has been possible to reduce the weight of each motor by about 2½ tons, and it is thought that these motors are the lightest which have yet been constructed for their output. As indicated above, each motor weighs only 10¾ tons, including the coupling rods, and develops a maximum output of 1,150 B.H.P. The motors are now completely enclosed, in order to protect them against the bad climatic conditions of the tunnel, the hot air in which is mostly saturated with moisture.

The pole changing of the motors is effected by means of a mesh-star combination of the stator windings, by which either



Scale 1 : 40.

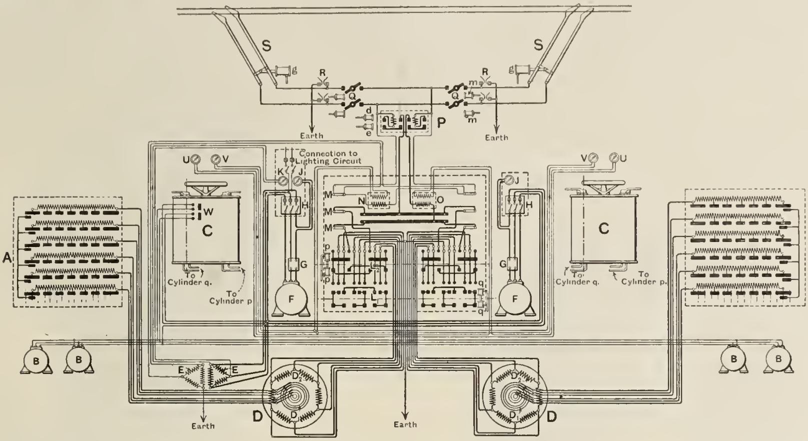
Fig. 8.—General Arrangement of Locomotive.

16 or 8 poles can be made, corresponding to speeds of 112 and 224 revolutions respectively. The rotors are provided with six-phase windings, so arranged that when the number of poles is changed on the stator no modification whatever is required of the rotor.

Fig. 9 is a diagram of connections on the locomotives, showing the arrangement of the different circuits, from which it will be seen that the locomotives are arranged for operation from either end, there being two controllers, &c. Current is collected by means of the bow collectors from the overhead conductors, from which, after passing the lightning arresters, it is led to the line switches and then to the emergency switch, which is placed in the roof of the locomotive. From this the circuits pass directly to two 'bus bars and then through fuses to the reversing switch, which controls the direction of working of the locomotive. Then they pass to the pole-changing switch, and finally to the motors themselves. The third phase is brought in, as has been already mentioned, from the track trails, and just as with the other two phases the current passes through the reversing switch and the pole-changing device before reaching the motor.

The controller, shown with the cover removed in Fig. 13 controls the reversing switch, the pole-changing switch and the rotor resistances of the motors, there being a controller at each end of the locomotive. Each is provided with two handles and a hand wheel, the first handle being for the pneumatic operation of the reversing switch, the other for the pneumatic operation of the pole-changing switch, and the hand wheel for the control and operation of the rotor resistances. The reversing and pole-changing switches are actuated by means of compressed air relays, and can be operated equally well by either controller.

As indicated above, the starting resistances for the motors are operated from the hand wheel of either of the controllers. The resistances are placed at each end of the locomotive under extensions of the cab, there being one set for each motor, and the contacts are mounted directly upon them; it is these contacts which are actuated by gearing from the controllers, and it will be apparent that the removal of the contacts themselves from the controller proper not only simplifies the construction and enables a better job to be made, but it renders the inspection or repair of the contacts very easy.



A Starting resistance.
B Fan motor.
C Main controller.
D 500 H.P. motor.
D_1 Rotor winding.
D_2 Stator winding.

E Transformer.
F Compressor motor.
G Circuit-breaker.
H Three-pole switch.
J Ammeter.
K Voltmeter.

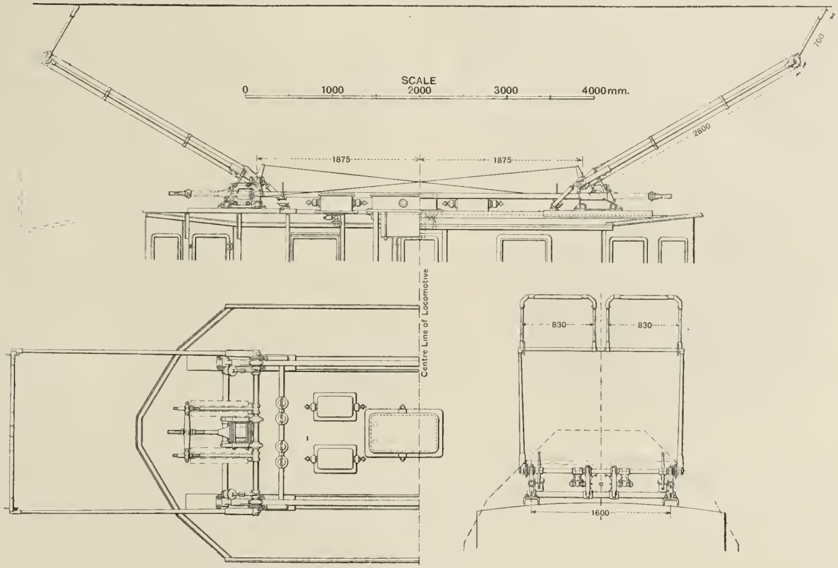
L_1 Pole changer.
L_2 Reverser.
M Switch fuse.
N Voltage transformer.
O Current transformer.
P Main circuit-breaker.

Q Collector switch.
R Lightning arrester.
S Collector.
U Ammeter.
V Voltmeter.
W Fan motor switch.

d Cylinder for releasing circuit-breaker.
e Cylinder for restoring circuit-breaker.
g Cylinder for raising and lowering collector
m Cylinder for operating collector switch.
p Cylinder for operating reverser.
q Cylinder for operating pole changer.

Fig. 9.—Diagram of Connections of Locomotive.

The resistances proper are of rheostane strips, mounted in frames sliding in slots, so that each resistance unit can be taken out independently, and thus inspection and repairs can be readily carried out.



Scale 1 : 60.

Fig. 10.—Arrangement of Current Collectors.

An interesting detail in connection with the design of these resistances is that they are artificially cooled by means of four blowers, placed in pairs at each end of the locomotive. These blowers are operated by means of small three-phase motors connected to the rotor circuits of the motors. Thus, the blower motors start up when the main motors start, and when the latter are at full speed (with short-circuited slip rings) they are automatically cut out of circuit, for ventilation of the resistances is then no longer required.

The admission valves, controlling the action of the relays for the different apparatus enumerated above, are all interlocked, either pneumatically or mechanically. Both the reversing switch and the pole-changing switch operate under oil, and the same remark applies to the emergency switch in the roof. The latter can be opened in three different ways; first, by hand by the driver; secondly, electrically by a maximum-current relay; and thirdly, pneumatically by an air relay. The object of the latter provision is in order to prevent possible damage to the motors, should the train be brought too quickly to a standstill by the injudicious operation of the air brakes.

A 7 kw. oil-cooled transformer supplies the necessary power at 110 volts for the air-compressor motors and for part of the lighting. The air compressors are of the standard Christensen type, there being two compressors and four reservoirs, the latter being mounted in pairs at each end of the locomotive; each compressor supplies 14·5 cubic ft. of air per minute at a pressure of 110 lb. to the square inch. The compressors may be started by hand, or automatically by an electromagnetic governor, which disconnects the motors as soon as the pressure rises to 110 lb., and switches them on again when the pressure falls below a certain minimum. All the compressed air pipes are fitted with return valves, so that they may be operated from either of the two controllers, and thus if either controller is out of order, the locomotive can be driven from the other.

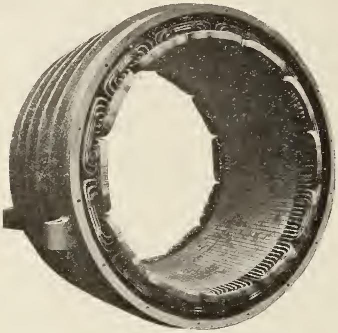


Fig. 11.—Stator of 500 h.p. Motor.

The lighting circuit of the locomotive is either supplied from the above-mentioned 7 kw. transformer, or from the special train-lighting equipment (Brown Boveri-Aichele patent) which is mounted on the locomotive.

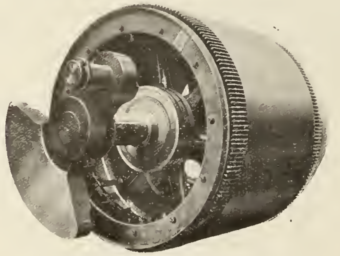


Fig. 12.—Rotor of 500 h.p. Motor.

The design of the current collectors (see Fig. 10) has been the subject of much careful consideration; as will be seen from the illustration of the locomotive, two bow collectors are provided, one at each end of the locomotive roof. Each collector is formed of two main parts, the lower being a hinged frame and the upper the collector proper, which is pivoted to the upper end of the frame.

The collector is so arranged that on the outside tracks, where the overhead conductors are 17 ft. from the ground, the upper part of the collector alone comes into action, while in the tunnel, where the height of the overhead conductors from the ground is reduced to 15 ft. 9 in., the main frame makes a correspondingly smaller angle with the horizontal.

The bow collectors are kept in contact with the overhead conductors by means of a compressed air piston, which piston acts upon a controlling spring so as to raise or lower the collector. If the locomotive has been standing (no compressed air being available) the air cylinder can be worked by means of a small air pump, thus raising the collectors and making contact with the line; as soon as this takes place the motor compressors at once start.

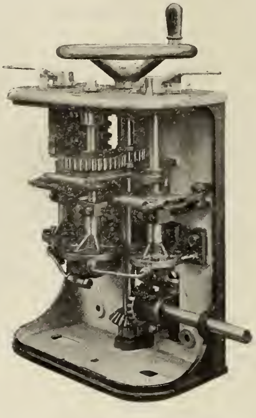


Fig. 13.—Main Controller Mechanism.

All the high-pressure switch gear and apparatus is enclosed in a sheet metal case, the opening of which can only be effected when the bow collectors are not in contact with the overhead line.

The remaining locomotives which are now in course of construction at Messrs. Brown Boveri's Baden works will differ in certain details from the first two locomotives described above, as it has been found possible to simplify the controlling gear still further; but in all essential respects they will be as above described, as it has been found that the general performance of the locomotives could not be improved.

THE ENGINEERING AND MACHINERY EXHIBITION AT OLYMPIA.

(Second Notice.)

The apparatus exhibited on the stand of the Cambridge Scientific Instrument Co. is largely devoted to apparatus for the determination and recording of temperature by electric means, more especially as applied to the practical needs of engineering. Several of the firm's well-known forms of resistance pyrometers and thermometers are shown, with and without recording apparatus, as well as thermometers involving the use of thermo-junctions. An example of the latter is a copper-constantan couple placed about 500 ft. away from the stand in one of the steam pipes of the exhibition generating plant, connected to a new design of recording apparatus on the stand, in which an attachment to the moving coil of the galvanometer is caused to strike the paper every minute and leave a mark produced by an inked thread. Another interesting piece of apparatus showed is the Fery radiation pyrometer. It will be remembered that this instrument, which was described in Prof. J. B. Henderson's Paper on "Radiation Pyrometry," read before the York meeting of the British Association (*The Electrician*, August 17th, p. 700), consists of a small thermo-electric couple placed in the focus of a concave mirror, the heat from a furnace or other source of heat being focussed by the mirror on to this couple. An example of the way in which the resistance thermometer has emerged from the limitations of the laboratory and become an instrument suited to everyday purposes is shown in a substantially designed fitting for a hot-air flue of which a model, illustrated in Fig. 1, is exhibited. A number of other instruments of interest are shown, including the latest form of high-tension oil immersed Duddell oscillograph which was described and illustrated on p. 884 of our last issue in Mr. D. A. Ramsay's article on "Oscillographs," and a new form of the Duddell thermo-galvanometer (see *The Electrician*, Vol. LVI., p. 559), in which a pointer is used instead of a mirror, and the coil is mounted on pivots instead of a quartz fibre suspension.

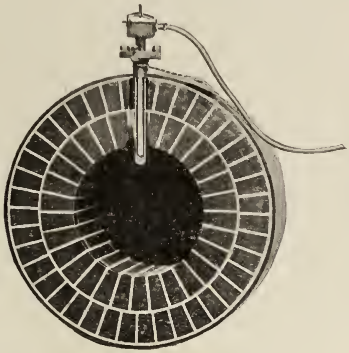


Fig. 1.—Thermometer Fitting for Hot-Air Flue.

Messrs. J. Richmond & Co. show a working model of the Richmond-Carey patent automatic passenger lift with push-button control, similar to that described in *The Electrician*, Vol. LI., p. 213; but the most interesting feature of their stand is an entirely new pattern of push-button lift of remarkable simplicity, designed by Messrs. Burnett and Lyon, which is shown in action as applied to a small dinner lift. The general principle of the action is shown diagrammatically in Fig. 2, which shows respectively (1) a passenger lift, which can be fetched to any floor and then controlled from the car; (2) a combined goods and passenger lift, controllable either from the car or from any floor; and (3) a goods lift similar to that shown on the stand. The action in the three cases is the same, the only difference being in the number and location of the push buttons. The pushes belonging to the various floors are connected in series with the corresponding relays Upon a button being pressed, current is fed to the reversing "up" or "down" solenoid through the medium of reversing switches fixed at each floor; when the button is released the function of its corresponding relay is to continue the flow of current through the control circuit belonging to the floor to which the lift is to be brought until the cage arrives at the desired level, and itself opens the reversing switch at that floor. The connections are so arranged that the pressing of another push button while the lift is moving will in no way interfere with the working. The reversing switches referred to are of very simple construction, and consist each of an annular disc having a contact at its periphery of sufficient length to connect either the "up" or "down" brush, according to the direction in which the cage last passed. This disc is rotated through a certain angle every time the cage passes by a friction "skate" mounted on springs on the cage, and in its intermediate position, of course, interrupts the particular control circuit of which it forms a part. The whole system is remarkable for its simplicity and convenient arrangement.

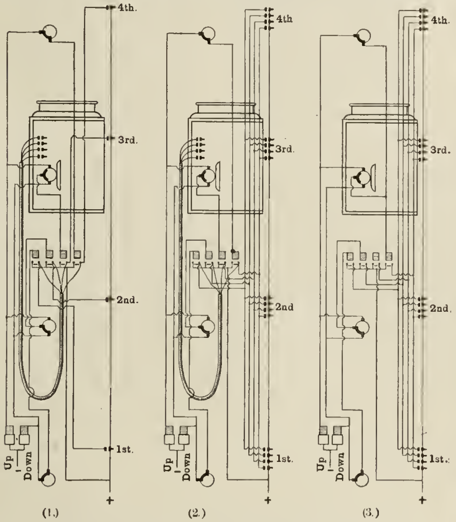


Fig. 2.—Connections of Richmond Push Button Lift.

Appliances for making photo-copies of tracings are shown on one or two stands. One of these is Hall's patent electric copier, in which a specially-constructed arc lamp is lowered gradually into the cylinder which forms the printing frame. The whole apparatus, one form of which is illustrated in Fig. 3, is compactly arranged and convenient in use. The lamp is suspended by a pair of wire ropes passing over pulleys and terminating in a counterweight. The slow motion is secured by a fan escapement geared to a small drum which gradually pays out the rope holding down the counterweight and allows the lamp to descend. Messrs. Hall & Co. also show a new process for making prints which are absolutely true to scale, an advantage over the ordinary photo-copies in which the developing in water and drying produce alterations of dimensions. In this process a special material which is known as "Ordoverax" is employed. This material is heated to a temperature of about 130°F., poured on to a flat glass or metal plate and allowed to cool and set. A blue print is then taken from the tracing to be copied in the ordinary way, but not developed. This undeveloped print is laid face downwards on the prepared surface and a slight pressure applied. A faint outline can then be seen upon the plate, and on the application of an inked roller, ink will adhere to the lines of the drawing only, so that a good clear print can be obtained on a sheet of paper pressed lightly on the surface.

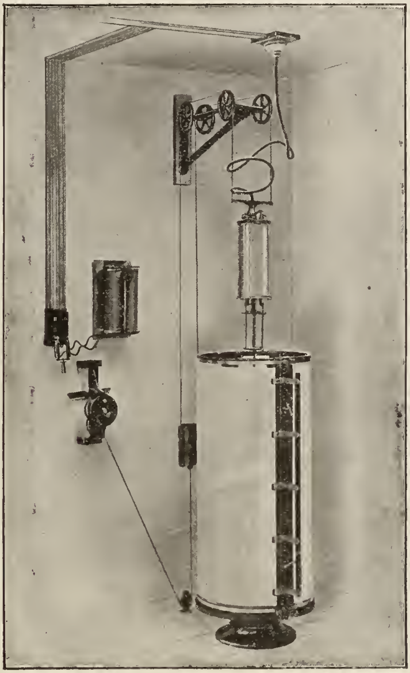


Fig. 3.—Apparatus for Copying Tracings.

A most interesting exhibit amongst the electrically-driven machine tools is the planing machine shown in action by Messrs. Bateman's Machine Tool Co. This is one of the few machines in the exhibition driven by a single-phase motor. This motor, which is of the constant-speed type, and was supplied by Messrs. Harding, Churton & Co., is mounted on the top of the machine, and drives by a raw hide pinion on to a change speed gear box, also placed at the top of the machine. There are one or two other interesting features of the planer itself. The table is attached to the rack which works it through springs instead of rigidly, which results in the table being brought to rest without shock or jar. Another feature is the provision of heavy flywheels on either side of the machine. These flywheels are brought alternately into action, and the energy stored in them is utilised in starting the table at the moment of reversal. It is thus possible to work a large size of planer at the high speeds rendered possible by modern tool steels without an excessive demand for power.

A stand of some interest devoted principally to apparatus and material for small electric light installations is that of Messrs. JOHN BARKER & Co. On this stand is shown a very compact self-contained generating set, consisting of a single-cylinder vertical oil engine direct-coupled to a 3·5 kw. continuous-current dynamo. The engine, which is designed by Mr. Wade, of Messrs. Wade & Jones. is made by Messrs. Belliss & Morcom and is arranged to run on paraffin, although petrol is used, through a separate carburettor, for starting up. Another plant for running a slightly large installation is a 7½ H.P. portable suction gas plant, which occupies a floor space of only 7 ft. 6 in. by 3 ft., and is under 5 ft. 6 in. overall height. Interesting features of this apparatus are the ingeniously arranged charging device used instead of the usual hopper with double doors, and consisting of an enlarged stop-cock, into the aperture of the revolving plug of which the charge is placed, and the use of a rubber diaphragm at the top of the scrubber chamber instead of a separate gas bag on the pipe leading to the engine. Another novelty is a new pattern of distribution box for use with conduit wiring, provided with double water-tight doors. Some branch distribution boards are shown, in which the fuse clips are mounted on a narrow fibre base. The firm also show a variety of useful accessories for wiring of simple but well-thought-out design, some of which have been adopted by the War Office, such as a special form of circular malleable cast-iron conduit box with interchangeable covers for switch fuses, wall plugs, &c., and a handy form of rack, to which various forms of clip can be affixed for carrying various sizes of pipes and cables in subway and similar situations. Other articles on the stand comprise electric ignition coils and other accessories for automobiles, and a working model of the Hawthorn patent fire detector.

Attention should be drawn to the Chapman patent automatic graphite cylinder lubricator made by Messrs. Knowles & Wollaston and exhibited by the JOSEPH DIXON CRUCIBLE Co., specially intended for the lubrication of engines using highly superheated steam. The lubricant employed consists of a mixture of oil and pure flake graphite, with a sufficient proportion of graphite to prevent the mixture becoming unduly thin at high temperatures. A difficulty which has hitherto existed in the use of such a mixture is the liability of the graphite to separate out and settle in the pipes and body of the lubricator, preventing a mixture of constant proportions of oil and graphite being delivered into the cylinder and often choking the pipes. This difficulty is overcome in the Chapman lubricator by a continuous agitation of the mixture from the moment it is poured into the body of the lubricator until it reaches the non-return valve through which it enters the steam pipe. Not only is mixture stirred in the body of the lubricator before entering the pump barrel, but a rotating spiral steel wire inside the pipe leading to the steam pipe prevents all further possibility of settlement. We understand that several sets of this apparatus are in use at the Lot's-road power house of the London Underground Railways. The same firm also show a collection of samples of carbon dynamo brushes and several other applications of graphite in the electrical industries, such as boxes, formers and ground graphite as used in the baking of incandescent lamp filaments, resistance rods graphite for electrotyping purposes, commutator dressing and preservative paints.

A NEW METHOD OF EMPLOYING TWIN LEAD-COVERED WIRE FOR ELECTRIC LIGHT WIRING.*

BY E. L. BERRY.

At the present time there are practically only two modes of running wires for house lighting; namely, wood casing or metal tubing. Wood casing, although no doubt answering its purpose in dry situations, utterly fails in damp places. Metal tubing, if welded, brazed or seamless, thoroughly well screwed at all fittings, undoubtedly affords perfect protection from damp from without, but unfortunately its use is attended by a trouble peculiarly its own, that is to say, "condensation," so that in cases where metal tubing is employed to overcome possible defects arising from a damp situation, it is done at the expense of introducing another and equally fruitful source of trouble.

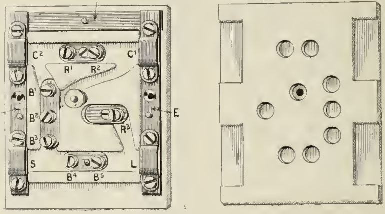
When metal tubing is employed it is undoubtedly very desirable, and in some cases even compulsory, that it should be "earthed."

Of course, in theory this is quite a simple matter, more particularly with screwed tube, yet few of the tube installations in use at the present time would stand a continuity test of the tubing from each switch and light point to the mains.

Having pointed out a very few of the defects which are possessed by tube and wood casing I suggest a substitute which in itself is by no means new, but the mode of employing it has, I think, some claim to novelty. I refer to vulcanised rubber twin lead-covered wires. I think we shall all agree that from the electrician's point of view twin lead-covered wires are ideal, in so far as there can be no damp troubles from without or condensation troubles from within, and the only reasons I can assign for its not having been more popular are, firstly, the difficulty of satisfactorily jointing the wires, or of looping, if joints are to be dispensed with, in which case one wire would be wasted at each switch and light run; and secondly, the difficulty of making the lead covering electrically continuous throughout for the purpose of earthing.

Both these difficulties have, I think, been satifactorily overcome by means of a porcelain joint box, illustrated in the figure, which has been devised by my firm.

It consists of two blocks of porcelain, the base and the cover; on three sides of the rebated edge of the base is an "earth plate," E, to which are screwed, opposite the points at which the wires enter, four saddles, C^1, C^2, S and L, by means of which the lead sheathing of the twin wire is securely cramped to the earth plate, thus ensuring metallic continuity of the lead sheathing of the four lengths of wire which enter the box. In the centre of the base, and entirely embedded in porcelain when the cover is in position, are four contact plates fitted with the requisite number of pillar terminals for connecting the four pairs of wires, marked R^1, R^2—B^1, B^2, B^3—R^3 and B^4, B^5. Two of these contact plates, R^1, R^2 and R^3, are permanently connected together in a recess at the back of the base.



BASE AND COVER OF JOINT BOX.

The wires are connected in the following manner: A pair of 3/20 circuit wires from the distributing board enters the box at C^2, the red wire being connected at R^1, the black wire at B^1. On the opposite side of the box at C^1 is connected another pair of 3/20 wires, the red wire at R^2, the black wire at B^2, and is carried on from box to box up to the full number of wire points which it is arranged to connect to this one circuit. A pair of 3/22 wires is run from the ceiling rose or light point and enters the box at L, the red wire being connected at R^3, the black wire at B^5. A pair of 3/22 wires is run from the switch point and enters the box at the opposite side S, the red being connected at B^4, the black at B^3. Thus it will be seen that a joint box is required for each wire point.

In the case of a wall socket not controlled by a switch the pair of wires from the wall socket point enters the box at L, the red wire being connected at R^3, the black wire at B^5, and the terminals B^3 and B^4 are connected by means of bare copper wire.

In the case of a wall socket controlled by a switch the pair of switch wires would enter the box at S, and be connected to the terminals B^3 and B^4, instead of the bare copper wire as previously described.

If it is required to govern, say, three wire points by means of one switch, the box to which the switch wires were run would feed two boxes for the said three wire points from its terminals R^3 and B^5, and the two boxes so governed would each have their terminals B^3 and B^1 connected by bare copper wire as in the case of a wall-socket point without switch, the second box having the wires from the third light connected to the terminals R^2 and B^2, which is to say that if two lights only are controlled by one switch both the light wires are connected to the second box, and if more than two lights are controlled by one switch the last box has the wires from two lights connected to it. Any further wire points on this same circuit requiring to be controlled by separate switches would be connected to the terminals R^2 and B^2 of the box to which the switch wires are run which control the three points referred to.

From the foregoing, it will be seen that every length of wire where it enters the joint box has its lead sheathing cramped to a plate which is common to all the wires entering the box. It only remains, therefore, at each distribution board to connect the circuit wires by means of a metal strip fitted with the requisite number of saddles as fitted to the earth plate of the joint boxes, the said metal strip being connected to the lead sheathing of the mains where they enter the distribution board with a metal clip and copper wire, so as to ensure the whole of the lead sheathing of all the wires of the installation being metallically continuous throughout. If the lead sheathing of the mains at the supply end is connected to a water pipe by means of clips and copper wire, we shall have, I think, a more reliable system of "earthing" than is the case with any iron or steel tubing in use at the present time.

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* Abstract of a Paper read before the London Section of the Electrical Contractors' Association on September 25, 1906.

To avoid damaging the insulation when removing the lead sheathing at the end a special form of lead cutter has been devised which, while removing the sheathing in a fraction of the time it would take to do so with a knife, effectually prevents any injury to the insulation.

Where the wiring is done on the surface the wires are fixed by means of metal saddles, either nailed or screwed, as is most suitable to walls and ceilings, the joint boxes fixed on the walls close to ceilings and in such positions as will be most convenient to the run of the wires. In cases where the wires are fixed to brickwork or plaster in damp situations, as a precaution against possible trouble arising from the local action of dissimilar metals in contact, it would be advisable either to interpose some substance such as damp-proofed tape or paper between the saddle and the lead sheathing or use lead saddles.

In the case of sunk work the joint box is fixed by means of an angle plate which is nailed to the side of the joists midway between ceiling and floor boards; the wires running with the joists are fixed by saddles nailed to the centre of the joists, and wires running across the joists are threaded through $\frac{1}{2}$ in. holes made in the centre of the joists with an auger bit, no further fixing being necessary. Where wires run down walls a chase is made in the brickwork wide and deep enough to take the wire; the wire is laid in and covered over with hoop steel 2 in. wide, which is secured by means of clout nails, driven into the joints of the brickwork close up to the edge of the steel. Where wires pass through brick or stone walls I would suggest they should be drawn through bitumen tubing.

In new buildings it may be desirable to interpose water-proof tape or paper or something of a like nature between the wire and the hoop steel covering the wire chase, to obviate any local action between the lead sheathing and the steel, as in the case of metal saddles in damp places just referred to. In surface work the lead sheathing should afford ample protection against anything short of deliberate or wanton injury. Under floors the wires in all cases being run midway between ceiling and floor are out of the reach of all nails or screws. Under plaster, the covering of hoop steel will protect the lead sheathing from stray picture nails, &c., and also keep the wet plaster from contact with it.

With regard to the handling of lead-covered wire, of course it cannot be sent on to the job in coils like ordinary vulcanised wire, and I think the most convenient way would be to have the 3/20 and 3/22 supplied by the makers in 220 yd. lengths on small drums about 24 in. diameter by 14 in. and weighing with the wire about $1\frac{1}{2}$ cwt. This can be readily carried about and when in use the drum should be mounted on a small stand leaving it free to revolve. The wireman measures with a tape the run of the particular wire he is wanting, goes to the drum, pays off the required length of wire, measures it and cuts it off. In the case of a large building I would suggest probably one drum each of 3/20 and 3/22 for each floor. Lead-covered wire lends itself very readily to the more accurate checking in and out of the stores, inasmuch as it can be supplied by the makers marked at intervals of say 5 yds. throughout its length, thus enabling the storekeeper by paying off the wire and measuring to the first mark to know exactly how many yards of wire the drum has on it.

In addition to the absolute freedom from all troubles arising from the action of damp and condensation upon the insulation of the wires, and the good protection given to the wires, the system has one or two other advantages. Alterations, additions, the fixing and connecting of fittings, and the removal of faults in installations thus wired, will be as easy to a strange electrician as to the man who did the work originally, a claim, I think, which can hardly be made for wood casing or tube methods as carried out. The locating of faults is a very simple matter, as the removal of the joint box cover gives access to both ends of every unbroken length of wire throughout the installation.

Less skilled labour is required, the only part of the work requiring electrical knowledge being the connecting of the joint boxes, fittings, switches and distributing boards. The cost of a mile of 3/20 twin lead covered wire, as compared with a mile of $\frac{5}{8}$ in. slip socket tube with the average number of bends, tees, &c., enclosing 2 miles of 3/20 ordinary vulcanised wire of the same class, shows a saving of anything from 12 to 20 per cent., the difference being due to the varying proportion of tube fittings to tube on different installations.

To put this method of wiring from its economic point of view in the worst light, and assuming that there is no saving in either labour or material, I still maintain it will effect a very considerable reduction in the work entailed in office, stores, and in the value of the contractor's stock, a saving which I think we can ill afford to ignore in these days of keen competition, arising not only from the members of our own trade, but from the ever to be reckoned with gas companies. "And there are others."

The use of steel tube came upon us gradually and we were told by the makers that its use would not increase the cost of wiring, a statement which, to put it mildly, is, I think, open to question, but the point they did not draw our attention to (no doubt it was quite an oversight) and one which I fancy most of us overlooked, was the extra labour this tubing with its endless variety of fittings would throw upon our stores and clerical staff. To give some idea of what this really means to the contractor I may mention that I referred to my firm's stock book and found that when we took stock last March we had 110 varieties of steel tubes and fittings, all of which we find it necessary to keep, and this number is entirely exclusive of junction boxes and the many other articles the makers so thoughtfully provide for us. Now, if by the adoption of some such method of wiring as I have endeavoured to describe, we can dispense with this multitude of articles, only introducing one new accessory—namely, a joint box and so many pounds of hoop steel, and at the same time leave in our hands the materials necessary to secure sound work, both from a mechanical and electrical point of view, then I think the saving it will effect in our stores and offices alone is worthy of our earnest consideration.

A short discussion followed the reading of the Paper.

Mr. W. R. RAWLINGS said he personally had not much regard for lead-covered wires, which were easily destroyed by the strong alkalies used in cements and plasters. One weakness in this system was that it was not water-tight. In actual practice it was impossible to secure an absolutely water-tight system, but it was ordinarily possible to make the portion between the switch and the fitting water-tight. In this system, however, one of the porcelain boxes intervened, and these were not water-tight. He also objected to the large number of screws in the boxes—viz., seven. A screw was always a source of trouble, and in an installation of 50 lights there would be fifty times seven screws, independent of those in the switches and ceiling roses, and these would all be liable to loosen. The protection provided for the system might be ample in a finished building, but not in connection with carcase work. It was true that there was no condensation inside with twin lead cable, but with surface work condensation would take place on the outside, and the moisture trickling down on to the switch or holder would speedily cause trouble if there were any current in it. He had even had this happen with screwed tube, and the switch became packed solid with verdigris in 10 days. He would like to know whether the system had been arranged for a number of switches to one point, and made the further suggestion that the positive and negative should be run to the switch first, distribution taking place from that point. In that case the present box could be combined with a switch or a number of switches. He failed to see that this would be dangerous. In fact, he had carried this out with other systems of wiring and regarded it as most economical.

Mr. FRANK BROADBENT concurred in Mr. Rawlings' criticisms, and added that twin lead cable had been used in connection with ship work for 15 or 20 years. But it was no good on ironwork or mortar without protection, and whilst Mr. Berry's system would be suitable for cottage wiring, &c., it could not be used in factories, where there would be a succession of lamps down a workshop. He recommended that the porcelain box should be superseded by a box made of a mixture of tin and lead with a porcelain centre and water-tight insertion.

Mr. L. TATE failed to see much use for the boxes, and doubted whether the system would be cheaper.

Mr. C. E. ELGAR asked for a comparison of cost between other systems. That cheaper wiring was necessary he fully agreed, and believed that the Continental method of bare wires on insulators was the one to which all tendencies pointed.

Mr. CHARLES RAWLINGS thought there would be too much surface leakage. As a matter of fact, he had given up the use of lead wire for economic reasons. He believed that in time the lead would pull out of the boxes. On the question of screws, these were made a great point of by the fire insurance companies, and on this system there were a great many.

Mr. F. B. JOSEPHS thought there would be nothing inartistic in the system, even if used for surface work, especially as it was apparently intended for cottage work. None of the speakers had quite grasped the main points of the system.

Mr. F. SUTER, who presided, disagreed with the suggestion that there would be external condensation, as the temperature of the lead would be the same as that of the room in which it was placed. The trouble anticipated from screws could be got over by the use of a spring washer, whilst by soldering up the lead a water-tight system could be obtained. Altogether he thought the system was a very promising one, and that it had no disadvantages which were not in the existing systems, whilst it had several advantages.

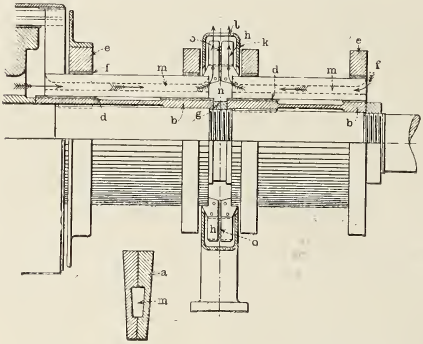
Mr. BERRY, in reply, said that the destruction of lead by the alkalies in cement, &c., only took place whilst a new building was drying, and to get over this he left an air space around the lead where the wires were laid in walls. With regard to surface leakage, he had made a test of the system and got 250,000 ohms insulation test. By coating the interior of the box, however, with a black paint supplied by the Ruberoid Company, he had obtained 10 megohms. He claimed nothing new in the use of twin lead, but only in the method of connecting it. He was so convinced that the system was a good one that he intended pushing it for all he was worth. As a matter of fact he had interviewed seven fire offices and only one had refused to sanction the system, and this for the reason that it was not provided for in its regulations. As to the comparative cost, he had carried out two jobs, and as soon as the details had been got at he promised to give the members every possible item.

A vote of thanks was then passed to Mr. Berry for having described his new system.

AN ARTIFICIALLY-COOLED COMMUTATOR.

A method of cooling the commutators of continuous-current generators by causing air to pass through longitudinal passages or tunnels in the commutator bars themselves has recently been patented by Messrs. Siemens Brothers and C. M. Toplis. The system is particularly intended for use in connection with continuous-current turbo-generators, as a means of reducing the length of commutator required, which in certain cases is apt to become unwieldy in size on account of temperature rather than commutation considerations. The accompanying illustration represents a section of a commutator on this principle, the following description of which is extracted from the patent specification.

Each commutator bar has a longitudinal passage, *m*, through it, whose cross-section may be of any suitable shape, but is preferably of such shape that the largest area of metal is exposed to the air passing through the passage compatible with the preservation of suitable electrical resistance and mechanical strength of the bar, and suitable low resistance to the passage of the air. For convenience of manufacture the bars are preferably made up of two sections, put together so that a groove in one registers with a like groove in the other to make up the passage. The construction of commutator shown is one usual for high-speed commutators. The bars are mounted on the sleeves *b* keyed to the shaft, and are insulated from the sleeves by mica rings, *d*. Steel rings, *e*, hold the bars in place on the sleeves, being insulated from the bars by mica rings, *f*. Nuts screwing on the shaft hold the sleeves in position. The two parts of the commutator have an air-gap, *n*, between them, and at this place the end of each bar has sweated to it a copper vane, *h*; these two sets of vanes are united to each by flexible copper strips, *o*. Surrounding the vanes is a casing, *k*, having an opening or openings, *l*, in its periphery, preferably at the top. When the commutator rotates the vanes *h* act as a centrifugal fan which draws air through passages in the bars, as indicated by the arrows, thus cooling the commutator in this manner as well as in the manner described in the aforesaid specification. As the heated air is thrown out at the openings *l* there is little chance of its circulating through the commutator again until it has cooled. It is obvious that, instead of constructing the commutator in two parts, the bars *a* may be continuous from end to end of the commutator, and may be perforated to open the passages to the air at the place where the vanes are, which need not be at the middle of the bars, although this is the most suitable place. Instead of a single passage, *m*, each bar may have two or more passages.



Section of Commutator with Forced Ventilation.

The Artificial Production of Soft Graphite.—It is stated in the *Western Electrician* that Mr. E. G. Acheson, as a result of six years' experimental work, has discovered a process for producing softer varieties of graphite in the electric furnace than have hitherto been manufactured. It is intended shortly to commence manufacturing the new material which is of soft-soapy consistency, specially suitable for lubricating purposes, at Niagara Falls, where the harder grades of artificial graphite are already produced.

CONSTANCY OF MANGANIN RESISTANCES.*

BY W. JAEGER AND S. LINDECK.

Since the last communication was made on this subject by the Reichsanstalt eight years ago, a great deal of new material has become available for judging of the constancy of manganin resistances, and the result is that the latter can be relied on for actual use over long periods as working standards in place of mercury-filled tubes. This is of some importance for the accurate measurement of resistance, as frequent comparison with mercury standards involves lengthy and troublesome operations and some risk of damage to the standard tubes. The mercury-filled tube, however, as prescribed by the German law of June 1, 1898, relating to electrical units, must still remain the ultimate standard of resistance.

The cause for the lack of accuracy in measurements of mercury resistances is partly the high temperature coefficient (about 0·1 per cent. per degree) and partly the fact that the standard value of each tube is the mean of several fillings. Every filling has a fault of its own which considerably exceeds the error of measurement of manganin resistances.

The authors have, therefore, in controlling the manganin standards, adopted the mean value of several manganin resistances as an invariable and reliable standard, and they show that the difference between this and the corresponding mercury standard remains below the limit of error involved in comparisons with mercury standards.

The mercury standard of the Reichsanstalt consists of five mercury tubes, three of them being of 1 ohm, one of ½ ohm and one of 2 ohms.

The manganin resistances now reported upon consist of four wire standards, numbered 148a, 149a, 150a and 151 respectively, and were manufactured in 1891, at a time when little was known as to the correct method of construction of such resistances, and when they had only their small temperature coefficient and small thermo-electric force to recommend them. The following table shows the results of the comparison of their mean resistance, reduced to the international ohm, with the mean resistance of the mercury standards:—

Date.	Value.	Difference.
March, 1892	(1·001726)	—
January, 1895	37	−3
June, 1897	44	+4
March, 1903	48	+8
February, 1904	36	−4
March, 1905	36	−4

The first value is vitiated by a constructive feature abolished afterwards. But the results show that the mean value does not differ from its own time-average (1·001740) by more that eight units in the last place, and since this error is below the limit of error involved in comparing them with the mercury standards, nothing is gained by making such a reference. Moreover, the copies in mercury made of the mercury standards had to be abandoned owing to a regular decrease of the resistance by 0·001 per cent. per annum, due probably to the dissolving of the platinum terminals or the action of the mercury on the glass.

The authors give other tables exhibiting the great constancy of other manganin resistances, including the secondary standards at Ilmenau, Hamburg, Munich, Nürnberg, Chemnitz and Frankfort. These are sent annually by rail to the Reichsanstalt for testing.

The 0·1 ohm boxes are not quite so good, probably because the wires are considerably deformed in the preparation of the boxes, so that they cannot be so effectively aged.

The 0·01 ohm boxes show a decrease of 0·003 per cent. in seven years. On the other hand, four 0·001 ohm boxes of sheet manganin have remained quite constant within the errors of observation. This is all the more encouraging, as they were only protected by a thin varnish, and it should dispose of all fears based upon the rapid oxidation of manganin at ordinary temperatures.

The high resistances of the order of 10,000 ohms labour under the disadvantage that the thin manganin wire must be drawn cold. This makes it very hard, and shows greater after effect. Where considerations of expense do not arise it would, of course, be easy to construct high resistances of longer and thicker wires.

Manganin compares very favourably with the best wire standards hitherto made of other materials. Thus a good German-silver standard shows a change in 13 years of +0·147 per cent., a nickelin standard +0·05 per cent., a platinum silver standard −0·03, and a "patent nickel" standard −0·008.

No substance hitherto discovered can be compared with manganin as to constancy. Since its temperature coefficient is only 0·001 per degree C., and its thermoelectric force against copper 1·5 microvolt per degree, it has special advantages besides constancy. But the standards must, of course, be prepared by properly-trained experts.

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* Abstract from the *Zeitschrift für Instrumentenkunde*, No. 1, 1906.

THE CORROSION OF IRON ELECTRODES BY EARTH CURRENTS.*

BY MESSRS. F. HABER AND F. GOLDSCHMIDT.

The destruction of gas and water pipes by earth currents has hitherto been mostly examined by engineers, who have made many calculations but few experiments. The authors have undertaken the more difficult part of the work in attacking the problem from its electrochemical side, and their work, although only in the initial stages, gives much promise of throwing light on the electrolytic processes.

The appearance of the iron pipes, which have been attacked, is not altogether conclusive evidence of the effect of earth currents. With cast-iron pipes the attacked portions, as apparent to the naked eye, look little changed, although the iron has been altered into a form that can be easily cut. However, the silicon and phosphorus in the iron have been oxidised to silica and phosphoric acid, which remain mixed as ferrous salts with the particles of iron and carbon, the whole preserving the original shape of the pipe; at the same time, the main portion of the iron has been eaten away. But it may be pointed out that precisely similar effects are observed in such pipes, in cases where the effect of stray currents is completely excluded.

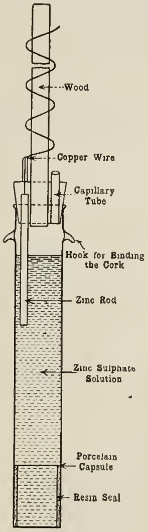

FIG. 1.—NON-POLARISABLE ELECTRODE.

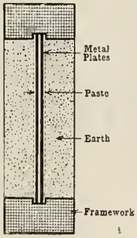

FIG. 2.—VOLTAMETER.

For the purpose of measurements, non-polarisable electrodes are recommended for determination of voltage, and voltameters for ascertaining current density. Such an electrode is shown in Fig. 1, and consists of a glass tube, sealed at the bottom by a porcelain capsule. The glass tube is filled with a saturated solution of zinc sulphate, containing some undissolved crystals in which a zinc rod, connected to a copper leading-in wire, is immersed. An air-tight stopper fits into the tube, though air can be admitted, if desired, through a capillary tube. If two of these electrodes are fixed in the earth no voltage will exist between them due to their own action. Voltages are measured by Poggendorf's method. With these electrodes it is possible to note the differences of earth potential, and, consequently, the direction of the currents.

The voltameter consists of two metal plates, built into a wooden framework. The plates are surrounded by a saturated solution of a suitable salt, containing some undissolved crystals. The currents can be either read by a sensitive ammeter, if the plates are separated by a sheet of mica, or a similar result can be obtained by noticing the differences of their weight, if the plates are merely laid against one another. This voltameter is also non-polarisable, so that no error can arise owing to polarisation voltages. It ought to be buried in the earth as far as possible in the direction of the earth currents, and during a series of readings its position should not be altered.

The strength of the current passing out of an iron pipe is not sufficient to determine the extent to which it is being attacked. The condition of the iron must be known—*i.e.*, whether under the given circumstances in relation to the current it is on the one hand active and destructible, or on the other hand passive and capable of resisting attack.

Faraday's law holds good, according to which 1 ampere in one hour passing from the pipe to earth destroys $(1-x)\times 1{\cdot}024$ gramme of iron by oxidisation, developing $x\times 0{\cdot}298$ gramme of oxygen. If $x=0$, the current acts destructively on the iron, which is in the active state; if $x=1$, no iron is destroyed, but oxygen alone is generated, and this constitutes the passive condition. The passivity of iron can probably be explained by the presence of a fine porous coating of oxide. Whether the iron is active or passive depends on the electrolyte, or, in other words, on the nature of the soil.

Currents act on iron in the same way that rust does. Circumstances which promote or prevent rusting will favour or hinder electrochemical action. The worst effects are produced by chlorides, which almost entirely prevent any alkaline reaction. Sulphates slightly promote rust, but are much better than chlorides. Nitrates prevent rusting. With bicarbonates much depends on whether the carbon dioxide is present in the free state, or whether it is gradually generated. Besides chlorides, free carbon dioxide in the moisture of the earth is a great source of danger to iron. In this way it is possible to map the ground out into dangerous and harmless zones. There is no voltage at which iron is not capable of attack. In the passive state, no voltage acts destructively. The transition from the passive to the active state depends not on the voltage but on the current density—*i.e.*, on the diffusion in the earth. With active iron, continuous electrolysis goes on at that voltage at which the hydrogen on the kathode is continuously removed. Since the pipes or rails, forming the kathode, are surrounded by earth containing air, they are continually depolarised by the oxygen of the air. Practically, of course, low voltages can be considered harmless, since in this case the current density will be so small that long periods must elapse before signs of attack become noticeable. This arises from the low electrolytic conductivity of the soil, and from the relatively high value of the electrochemical equivalent. For determining the conductivity of the earth, the formula of Kohlrausch and Holborn can be used, according to which the $0{\cdot}75\times10^6$th part of the salt contents of a litre of a very dilute solution, expressed in milligrams, may be taken as its specific conductivity per cubic centimetre. According to this the conductivity of 1 cubic centimetre of the earth's soil may be taken as 125 ohms. The contact resistance between the pipe and earth has been experimentally determined as being 0·03 ohm per square metre, but having regard to the fact that actually much of the earth consists of non-conducting matter, this value has been raised to 0·2 ohm. This low value is probably explained by the fact that the tar coating is in many places destroyed or scratched. By insulating the pipes the contact resistance can be greatly increased; but an imperfectly insulated packing may be a source of great danger to a joint. Similarly, seeing that the diffusion would be decreased, the danger of attack might be increased. The passive portions of the iron would be protected at the expense of the active ones, and these zones can be detected, as already described, by the use of an exploring electrode. In the passive zone the differences of voltage, measured by day and night, are much greater than in the active zone.

Electrolytically-formed salts may increase the conductivity of the soil. Iron as an anode in an alkaline solution is passive, but in the presence of free carbon dioxide it is easily dissolved. Iron passes from the passive to the active state if the electrolyte is changed from one containing an alkaline carbonate to one of a similar nature containing in addition free carbon dioxide. This change may be effected by the current itself if the parts of the electrolyte in contact with the electrode are not replaced through some form of diffusion, or if a rise of temperature causes an accumulation of carbonic acid. Everything which tends to prevent diffusion is therefore harmful. Unfortunately the conditions are not favourable to diffusion. In the same way insulating patches, which also prevent diffusion, may be sources of danger. But with low-current densities, the natural circulation which takes place in the moisture of the earth may provide a remedy. A reversal of the direction of the current is only of advantage in certain cases, and this depends on the nature of the soil. If at the anode there is an increase of carbonic acid and chlorides in contact with the iron, tending to remove the protection afforded by an alkaline reaction, a reversal of direction will cause the polarisation of the kathode to retain the layer in contact with the electrode in its alkaline state. But in a distinctly acid soil no advantage would arise from reversing the current, as is seen in the case of alternate current, which can also produce electrolytic effects.

Practical tests were carried out in Strassburg with the non-polarisable electrodes. In one spot the voltage between the pipes and rails was found to be 0·01 to 0·02 by night and 0·8 by day. Differences of voltage in the earth itself were found up to 0·2 volt. Currents passed from the pipes to the rails, the iron being in the active state. The current passed for the most part out at the upper side of the pipes, this side being nearer to the rails. The greater part of the current passing through the earth was carried by the pipes, and yet no signs could be discovered of any corrosion. The voltage variations in the earth became smaller the greater the distance from the rails. Judging from the chemical composition of the soil corrosion was possible quite apart from the earth currents, as the air contained in the earth was found to have from 1 to 8 per cent. of carbonic acid.

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*Abstracted from the *Zeitschrift für Elektrochemie*, January 26, 1906, and the *Elektrotechnische Zeitschrift*, August 23, 1906.

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This, however, is a difficult matter; for once a society has been formed, its founders and its members generally do not care for the idea of its identity being lost by the absorption of the society into another, and the longer its career is continued the more is this the case. Moreover, those who are mostly concerned with the affairs of the society very possibly would be given no position in the direction of the body into which it is to be merged. Consequently, while human nature is what it is, the smaller societies are not likely to be absorbed by the larger, except, as a last resource, when difficulty is experienced in carrying them on.

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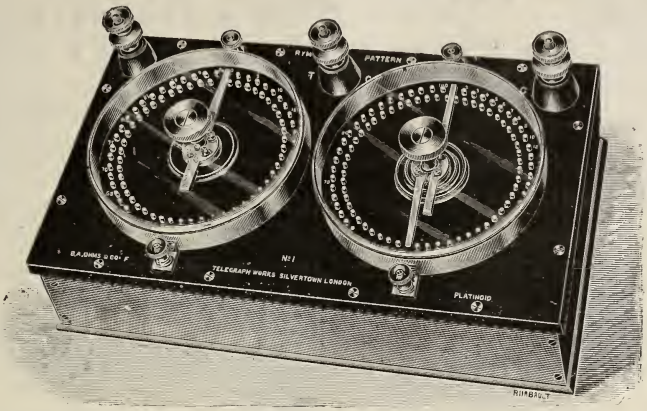

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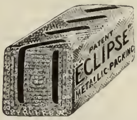

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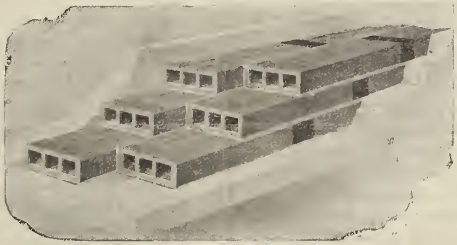

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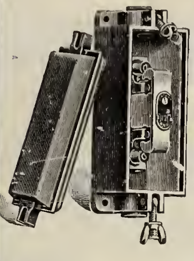

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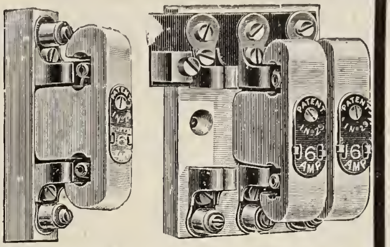

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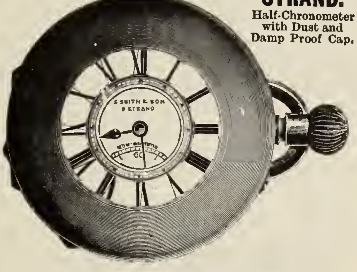

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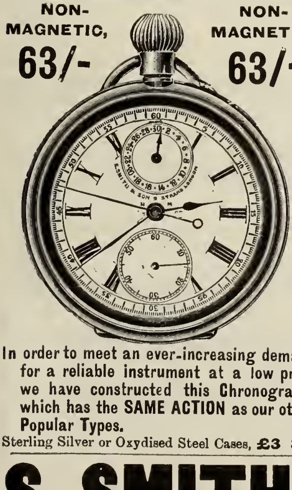
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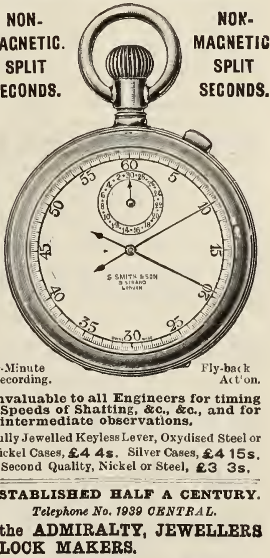

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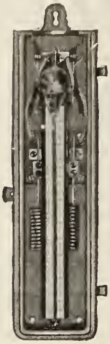

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tion of new bodies, for these always arise on account of either local conditions or the development of some particular branch of science. London being the home of most of the large societies, those members in its neighbourhood have the fullest benefits of membership, while those at a distance are apt to gain little more than the perusal of the Papers that are read, and that are very possibly published at an earlier date in the scientific and technical press than in their own *Proceedings.* There is thus a great inducement to form local societies, the more so that provincial members seem to have a greater *esprit de corps* and more energy for such matters, probably because they have to spend less time in useless travelling about the suburbs of a large metropolis. The formation of the late Northern Society of Electrical Engineers is a case in point. Fortunately this Society was absorbed by the Institution of Electrical Engineers and a remedy adopted, with which the late Mr. W. G. McMillan was closely identified—namely, the formation of Local Sections. This remedy has proved eminently satisfactory, and is also found to give good results in some other societies, such as the Society of Chemical Industry. If the remedy had been adopted earlier by all the leading societies, it is probable that the formation of small local societies would have been avoided almost entirely, with the result that efforts would have been more concentrated, a higher general standard would have been maintained, and many papers of value would not have been hidden away and become somewhat difficult to be found.

The rapid growth of any particular branch of science will always be an excuse for the formation of a new society, and is one which an old society should undoubtedly guard against by giving such new developments adequate attention. This may be difficult at times, and it may be felt that such developments appeal to only a small proportion of the membership, and are, therefore, not of sufficiently general interest to require any special effort. In such cases there would be a great advantage in the formation of a section which would be managed by those members who are specially interested in that particular development, and which would meet at intervals for the reading of Papers on subjects connected therewith. So far societies have not adopted this method, and the result is that certain subjects exist which do not interest any society in particular, and that state of things continues until finally a new society springs into being for meeting a want which really ought not to exist.

As a result, not only is there waste of energy, but there is also much waste of money. Every society aims at having, sooner or later, a home of its own, if indeed it has not already reached that goal, and for most societies that is a very expensive luxury. So costly is this luxury that the Institution of Electrical Engineers, with a membership of over 5,000, has still to be content with temporary quarters. Though co-operation may be difficult in other ways it would seem to be comparatively easy for societies to combine to provide a joint home which would be worthy of the name, a building which would be more complete than any single society could provide, with suitable accommodation for each of those concerned. New York is setting an example in this direction, and, as a result, a large building has been erected, known as the United Engineering Society Building. Apart from the better accommodation for meetings, there would be a great advantage in combining to have one large comprehensive library open to members of each of the societies, and although the published *Proceedings* of the co-operating institutions might not be susceptible of being combined, there should be a considerable economy in the staff necessary for their production. Is it too late for London to follow the example of New York?

REVIEW.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

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Jahrbuch der Elektrochemie und Angewandte Physikalischen Chemie. 1906. Edited by Dr. Heinrich Danneel (Halle-a-S.: Wilhelm Knapp). 28 marks.

This monumental tome covers the field of work indicated by its title up to the end of 1904 and, considering the huge collection of material which it represents, can scarcely be called belated. There is a vast and significant contrast between this, the current number, and the first modest volume, both in size and in scope. The first of the series was moderate in size and special in subject; the latest is too fat for comfortable handling, and ranges from the relation between atomic weights and the properties of the elements to the Dolbear electrostatic separator.

In former years we have expressed the opinion that an annual record in which some discrimination was exercised between useful or probably useful things and such as are rubbish on the face of them would be in all ways preferable to a collection as receptive as a contemporary dustbin, but this view is not in accord with the mechanical diligence of the compiler. As a result of his exertions we have a large mass of what is called in the States "second-class matter," upholding the traditions of the Jahrbuch, and a worthy successor of its forerunners. Making due allowance for the fact that in the present volume general physical chemistry is included as well as electrochemistry, how comes it that the amount of stuff recorded is so much greater than that chronicled 10 years ago? It is to be feared that the true sad answer is that physical chemistry is a fashionable study, attracting those who are chemists among physicists and others with celebrity as physicists among chemists, and leading to an output of insignificant "researches" unhappily just not still-born. Hence the Jahrbuch must be regarded not as a digest but as a miscellany, not to be read even in parts, but to be consulted with the hope that the index is adequate.

Out of 836 pages, 559 are allotted to the Wissenschaftlicher Teil. As this includes general physical chemistry the amount occupied by theoretical electrochemistry is not so large as seems from a mere statement of the number of pages; it is, however, ample. There are the usual lengthy tables of conductivity values of various solutions, and of potentials of various metals in various salts mixed with calculations, which would be impressive in their complexity if one felt any reasonable certainty of the observations on which they are based, and any serious conviction that they led to anything in particular. Pending this millennial condition, a patient hope that by-and-by out of a great deal of erudition which bears the same relation to science as sophistry does to logic, there may emerge some solid contribution to our knowledge of the relations of phenomena.

In the part of the book dealing with applied electrochemistry a good deal of interesting matter is recorded, though there is no great invention or technical advance to be registered. The never-failing subject of the carbon cells receives due attention and is now handled in a rational manner, a welcome change from the era of Borchers and Jacques. Secondary cells are very much where they were—mechanically improved but unaltered in principle. Electrolytically prepared oxygen and hydrogen seemed to have attained the dignity of commercial products, and the same may be said of ozone; on the authority of Warburg it is possible in practice to prepare by the silent discharge 1 gramme equivalent of ozone with 500 coulombs, instead of the 96,540 coulombs which would be necessary for the electrolytic production of the same quantity; hence, whatever the mechanism of the reaction induced by the silent discharge, it must be fundamentally different from that of an electrolytic process. In speaking of the synthesis of nitrates it is pointed out that the form in which nitrate is most readily obtained—namely, calcium nitrate—has the disadvantage that this salt is deliquescent. Truly a drawback, but surely not so great as to weigh appreciably against the great advantage of cheap combined N. A French patent of Wilhelm Ostwald is interesting; it is "a process for facilitating electrochemical reactions between gases," and claims that the preparation of ammonia or oxides of nitrogen by sparking or of ozone by the silent discharge is aided by adding 1·5 to 10 per cent. of argon, helium, neon, metargon, krypton or xenon; without accepting or denying this one would like to have experimental facts. There is a short section on fused quartz, but it contains no definite news of what is certain to come, and is even now nearly accomplished—the manufacture of large vessels at a low price. There are many trivial patents, covering what are obviously paper processes, which might well have been omitted if selection had been the keynote of the book; they serve only to fill space and to hide what is worth consideration. Carbide is adequately treated. It is stated that current of relatively high frequency—*e.g.*, 130 alternations—is economical for carbide making, the reason alleged being that a current of lower frequency may act in some degree like a unidirection current and cause electrolysis and consequent loss of carbide. This view is combated by the editor, probably correctly. Sometimes a joke occurs. After a very mad kind of recipe this comes "Man vermisst hierbei die Mandeln und Rosinen. D. Ref." No one who has wrestled with the Jahrbuch would cavil at that; it is welcome as a judicial quip in a dull case. It is reported against all previous experiment that MgC_2 has been obtained by heating MgO and C in the electric furnace, and that, naturally, it gives more C_2H_2 than is produced by an equal weight of CaC_2. After this it is a mere trifle that a mixed carbide is said to have been prepared from dolomite. Worth recalling in this connection is the fact that in Willson's English patent, now upset as a master patent, the use of dolomite is claimed, and it was by the merest chance that its validity was not contested on that ground.

There is a considerable section on contact chemistry, an example of which is the modern process for making sulphuric acid; it is interesting, but falls into the category of general, not of electrochemistry.

No noteworthy step in obtaining metals from their solutions, as distinguished from refining them, is recorded. A good deal of space is allotted to purely metallurgical processes, interesting enough in themselves but out of place here; no discoverable system has been adopted for their inclusion or rejection. The report of the Canadian Commission on the electrical production of iron and steel, already familiar to our readers, is given proper prominence. Electrolytic processes for recovering gold from cyanide solutions are compared with modern methods of direct precipitation and various devices for aiding extraction of gold by electrolysis are described. Many details of not very interesting experiments on the products of electrolysis of acetates occupy a space out of all relation to their importance; a sense of proportion is not the compiler's *forte*. Reduction of nitro compounds occupies quite enough space; in fact throughout the section on the electrolysis of organic substances experiments of just the kind that anyone would make who wished to ascertain empirically the best conditions for bringing about a given reaction are accorded the dignity of a tabulated record; it is a waste of time to reprint such things. Not much has to be recorded in the application of electrolytic processes to the extraction or purification of organic substances; there is a word about the removal of water from peat, but nothing so definite as to warrant the belief that this material will take its proper rank as a fuel. Alkali and bleach are dealt with at sufficient length, and the difficulties of electrolytic factories are attributed to the unavoidable production of chlorine; in this respect electrolysis is its own enemy, for consumers of chlorine now have the option of buying bleaching powder or making hypochlorites on the spot in their works.

The usual section dealing with appliances—electrodes and the like—necessary for industrial electrolytic processes adequately describes what was novel at the time of writing. There is a little table on p. 801, giving the consumption of various sorts of carbon electrodes when used as anodes for the preparation of hypochlorite. Retort carbon still holds its own.

It is high time that this Jahrbuch should be divided into two parts. Theoretical electrochemistry should occupy one, and with this might be included such physico-chemical investigations as have a direct bearing on electrochemical matters. If it be held—and it may quite reasonably be held—that all physical chemistry is one, then let there be a year book on the subject, free from the misleading title, "Jahrbuch der Elektrochemie." The other part should relate solely to electrochemistry in practice. It is quite a good subject, and surprisingly independent of nebulous hypotheses.

FIFTH ANNUAL CONFERENCE OF THE MUNICIPAL TRAMWAYS ASSOCIATION.

(*Continued from page 902.*)

The following Paper was read and discussed at the meeting of the Association on Wednesday, September 19th, at Leeds, at the close of the Presidential Address:—

MUNICIPAL OPERATION OF TRAMWAYS: SOME POINTS OF A COMMITTEE'S POLICY.

BY COUNCILLOR R. A. SMITHSON

(Member of the Leeds Tramways Committee).

At the outset, let me remark that I do not wish for a moment to raise any controversial point as between municipal and company operation of tramways. There is ample scope for the enterprise and ability of both. Sufficient to say that whilst nearly all the great cities and large towns of the United Kingdom have adopted the complete control of the trams, there still remains a considerable number of towns and districts in which private enterprise supplies the necessary means of transit.

The constitution of a Tramways committee is one of the most important factors in the success or otherwise of municipal operation. The number of members differs considerably in different corporations. In Leeds we have had a varied experience, the Tramways committee being originally formed as a sub-committee of the highways department, when it varied in numbers from 12 to 18, according to the anxiety of members to take part in what was then looked upon as an interesting experiment. As the system grew, and the importance of the undertaking became more apparent, it was realised by the Council that the work was of a sufficient magnitude and importance to warrant the establishment of a full standing committee, responsible to the Council only for the discharge of its duties. In 1898 such a committee was formed, consisting of 21 members, as was then the custom of the Council in regard to all its standing committees; the basis for the formation of such committees being ward representation, that is, one councillor from each of the 16 wards forming the electoral divisions of the city, with five aldermen as ballast, or as some assurance of stability. This continued for six years, during which period I had the honour of serving as chairman of the committee. Whilst appreciating very highly the devotion to duty of the members of that committee during the strenuous time of construction and equipment and the laborious task of initiating entirely new conditions, I was very glad when, in 1904, the Council came to the unanimous decision to abolish ward representation and re-constitute all its committees, with one or two exceptions, on the basis of 12 members each, to consist of three aldermen and nine councillors, the members being chosen to fill these positions from the knowledge of the work of the different committees, or their inclination thereto, instead of, as previously, from the mere fact that they represented a particular ward. For a business undertaking of so great a magnitude as a tramway system it is important that the men chosen to control should have good commercial experience, and be capable of grasping all its bearings and directing its organisation and administration without fear or favour. There will, I think, be no difference of opinion as to the policy of a municipal tramways department being committed only to the care of a full standing committee, and whilst there may still remain in some corporations a preference for ward representation on such committees, my experience of both methods leads me, without any hesitation, to support the committee of smaller numbers, who are much more likely to form an independent judgment on the problems they have to deal with and to work with a clearer understanding towards the success of the system as a whole when unfettered by election promises to advocate the claims of some particular district. Another point to be borne in mind is the rapid change which takes place in the personnel of the members of corporation committees. Whilst the small proportion of aldermen allotted to each committee may be generally depended on for a fairly continuous period of service, the change taking place every year in the councillors is very marked. Of the 16 councillors who helped to form the first full Tramways committee, only two have been continuously members from that moment to this, and one of those two has announced his intention of retiring from the Council this year, leaving me as the oldest inhabitant. The average length of service of the present councillors on the Leeds Tramways committee amounts only to less than three years each and, since 1892, 31 different councillors have had a share in the committee's work. This fact appears to me to be a warning to committees against too hastily making changes in policy or embarking upon new schemes. The first consideration is the number and length of routes to be equipped. Naturally the main streets and roads in the most populous districts come first, and extension of these principal routes is almost invariably found necessary as the population begin to realise the ease and celerity with which a tramway system enables them to reach their work from a home in the suburbs. The danger of wholesale extensions, however, become apparent when, as is often the case, the financial success of the principal routes is used as an argument for the opening of fresh lines in every district of a town, regardless that some of them may run on roads parallel to those already installed; such lines, instead of being a source of additional revenue, only act as poachers, and incur considerable additional and unremunerative expenditure. Here it is particularly that ward representation on the committee becomes most dangerous. I have heard of most extraordinary suggestions for extensions of this character; indeed, at one period there were persons in Leeds so intoxicated with the success of the tramways as to predict that in time we should have a tramway in every street in the city, and that all other forms of vehicular traffic would necessarily disappear. Fortunately our method of gradually transforming the system, route by route, gave us an excuse for postponing these applications on the grounds that we were very busy just then, and we have managed so far to "weather the storm" without any very serious length of unremunerative lines.

We shall all agree in the advisability of having double lines wherever at all possible, both from the point of view of a quicker and more punctual service and the general convenience of other traffic. Double lines, however, in many cases involve street widenings, and the question as to whether the whole or any part of the cost of such widenings should be paid by the Tramways department is one upon which general unanimity has so far failed to obtain. The Leeds Tramways department has not as yet paid any direct contribution to the very large expenditure which has taken place in recent years in the widening of its streets. Powers to do so were sought by the Corporation in their Consolidation Bill of 1904-5, but Parliament in its wisdom saw fit to strike out the clauses in deference to the position of the railway companies, who feared that the application of tramway profits on this account might effect to some extent their rating liability. The attitude appears somewhat inconsistent when we remember that Parliament has in many cases laid upon private companies operating tramways in municipal areas the obligation of paying the whole or part of street widenings on tramway routes.

The question of inter-communication between tramways owned respectively by municipalities and by private companies by means of joint running powers over each other's lines is one that has agitated the tramway world very considerably during the past few years, and I am glad to see that a spirit of reasonableness has developed generally; the idea once apparently prevalent in the municipal mind that the permission for a company-owned tramcar to run on a municipally-owned tramline would be intolerable at any price has now practically disappeared, the achievement of this happy position being largely contributed to by the more reasonable proposals now made by private companies seeking these powers than was originally the case, say, in Birmingham. Many cases of such inter-communication are now well established, with profit to both parties and to the great convenience of the general public. We have a notable example of this in the amicable agreement arrived at between Leeds and the Wakefield Tramway Co., which has worked with absolute smoothness and freedom since its inception some 12 months ago.

Now as to finance: whether the policy of the committee shall be to operate the tramway system with a view to making a profit, or to attempt so nicely to estimate the receipts and expenditure as to balance accounts, may be a proper subject for discussion, but I think we shall be unanimous in expressing the opinion that the policy of every municipal tramway department must be so framed as to ensure its being entirely self-supporting. Philanthropy at the expense of the ratepayers must be rigidly avoided. A certain amount of missionary work may be necessary or permissible in some localities. Missionaries have achieved many noble results, but we must remember that many have only succeeded in pleasing the palates of the natives, and it behoves every committeeman to curb his naturally generous impulse when he comes to deal with the fixing of fares and stages. It is, of course, impossible to expect general uniformity throughout the country. The conditions suitable and profitable to one set of local circumstances might be unsuitable and financially disastrous to another locality. The rates now obtaining on the Leeds system—viz., 2 miles for 1d. in every direction, with plenty of overlapping stages, so that the passenger may get his full value, and ½ mile stages for a half-penny on all routes except three (which may be described as high-class residential)—have been evolved from many experiments, almost all of them being in the nature of reductions or concessions. Our experience has been that high fares beyond a certain point reduce traffic, that every reduction has meant increased gross returns, whilst proper concessions popularise the service. The tendency to increase facilities and to lower fares below cost prise for services rendered should be carefully watched by committees. On nearly every tramway the 1d. fare is the backbone of the system. The fare favoured by the large majority of passengers, and the longest distance given for that fare, would appear to be a sound policy.

There is justification for giving all possible advantage to the long-distance riders, as this encourages the people to live at a greater distance from the centres of population. The policy of the committee should be to make their fares proportional on all sections. Special favours should not be granted to particular districts.

Halfpenny fares for any distance over about ½ mile are generally a mistake, but if kept within that limit may prove, as they have done in Leeds, fairly successful. The advantage on working-class routes of having them means a considerable increase of revenue, with no additional cost, and evidently serves a large number of people who would probably otherwise not use the cars. Care should be taken not to stretch the length of the halfpenny stages, or they immediately begin to encroach on the penny fares with an adverse effect on the gross revenue. The ideal policy as regards fares may be summed up briefly: "Let each passenger pay for his ride, and receive full value for his money." This appears a truism, but the rule is by no means universally observed. The London County Council is already carrying workmen at fares which are admittedly less than the cars can be operated for; the same is said to be true of the Metropolitan District Railway, which recently raised various fares, and is probably true of many municipalities, including Leeds. It appears to me that even workmen's fares at less than cost price are unfair to the rest of the inhabitants.

Renewals and Depreciation.—The necessity for reserve in addition to maintenance out of revenue is a burning topic on many committees. Different policies have been adopted, which may roughly be grouped under these heads:—(*a*) Those who take all surplus profits (after providing working charges, interest, and sinking fund) to a renewals and depreciation account in some form or other; (*b*) the other extreme, where only the working charges, interest, and sinking fund are retained, and the whole of the balance paid in relief of rates; (*c*) the medium policy, such as has been adopted in Leeds, where a substantial sum has been set apart out of each year's profits to form a reserve for renewals and depreciation, and the balance of profit (averaging during the past five years about £54,000 per annum) applied in relief of rates. The reserve fund so accumulated now amounts to £118,500, representing nearly 10 per cent. on the capital expenditure, in addition to the sinking fund account, which now amounts to £175,200, making a total of the two funds £293,700, or about 22 per cent. on the capital expenditure.

In our earlier days some members of our Council maintained that we had no right by law to form a reserve fund, but that all profits, after providing for interest and sinking fund, must automatically pass to the city fund. My committee, however, were unanimous as to the advisability of our forming such a fund, and the Council, with some protests, allowed it to be commenced, and in 1904 obtained powers from Parliament in their Consolidation Bill to set aside a sum not to exceed at any one time a sum equal to one-fifth of the aggregate capital expenditure for the time being—*i.e.*, not more than 20 per cent.

Without venturing to offer an opinion on this vexed question as to a general practice, I may say that we in Leeds are quite satisfied with the financial position of our undertaking, and consider it a sound policy for the ratepayers to receive some benefit in the relief of rates as interest on the capital employed, for which they as ratepayers are responsible.

Under the heading of "Administration" I propose to deal briefly with one of the most interesting and at the same time most important points in municipal tramway management. What is the proper function of a tramways committee? On the one hand there is its relation to the Council and the public; on the other its relation to officials and employés. On the one hand it may be regarded as the custodian of the public interests, on the other hand it is the adviser of the Council, and in conjunction with the manager it is the administrator of the tramway undertaking. As administrators, the committee naturally determine all questions of policy, whilst the executive function pertains to the office of the manager of the undertaking, whose duty it is to carry out the policy decided on by the committee. His work is likely to be much more effectively and economically performed if the policy of the committee be to have a completely self-contained department—*i.e.*, one in which the whole of the work of the department, including the supply of power and the responsibility for the permanent way, can be co-ordinated from one centre. That this contributes to a great saving of time and to the smoother working of the whole system we have proved by practical experience in Leeds, and that it tends to great economies in working costs can easily be seen by reference to statistics comparing costs of other places where this same happy condition is not carried out. The situation of the head office is a matter of some importance, and should be in a prominent position, as nearly to the centre of the system as is possible, thus enabling the manager to be in equal touch with all his various departments. Such a situation will also be found to be of great convenience to the general public, who so frequently have occasion to come in contact in some form or other with the tramways office. The relations of a committee with its employés have been frequently used as an argument against municipal management of tramways, on the ground of the alleged difficulty of making discipline effective. With a well-defined policy, however, this matter need not give any inconvenience. The general question of wages, length of working day or week, may be regarded as legitimate questions for discussion and settlement by the committee; but discipline must be ruled to be without the scope of policy—it is undoubtedly the duty of the executive—and the general manager must be held responsible by the committee for its proper maintenance. If the committee would resolutely decline to concern itself with this function, its work would be greatly simplified, its position would be strengthened, and under capable management the efficiency of the tramway service would be far greater than it could otherwise be.

The discussion was opened by Councillor FLINT, of Leicester, who dwelt mainly upon the relations of Tramway committees and their employés. The labour question would soon become an aggravated one generally, and he believed that active steps would have to be taken to deal with it. There was at present too great a diversity between the wages paid to tramway employés in all parts of the country, and some move was needed which would put the earning conditions of the men on a more generally uniform basis. Until something was done to substitute the present widely varying scales of wages and arrangements for holidays, &c., for a principle which could be generally applied with modifications, labour troubles would recur. He approved some action by a committee of the association appointed to look into the matter.

Ald. HEY (Halifax) strongly emphasised the importance of giving the tramway manager complete control over the men, and deprecated any tendency for the committee to deal with matters of discipline. The Halifax incident ought not to have occurred, but in the circumstances they had done the best they could.

Councillor BULL (Reading) approved of the building up of a good reserve fund before any attempt at relief of rates was made. He saw trouble ahead with the labour question, but nothing with which good, strong managers, having complete control, could not cope. He considered that committees might surpervise the tramways in a general way, but should not interfere with details.

Bailie McFARLANE (Glasgow, attending in place of Bailie Alexander) spoke in favour of a continued policy on the part of the Tramway committee, adding that length of service was essential to secure this. In Glasgow a man might serve on a committee for 10 years. Ward representation was pernicious because it led to agitations in committee for reduced fares in certain wards and it should be replaced by a scheme placing men interested in tramways matter on the committee. Surplus moneys from profitable municipal departments when voted to the relief of the rates were, at any rate in Glasgow, spent in other ways and did not benefit the ratepayer at all.

Sir BAXTER ELLIS (Mayor of Newcastle) said that Newcastle had submitted its labour troubles to arbitration, and so far had got over them, though he saw trouble ahead. His committee had been approached by the men for the institution of wages conditions and holidays similar to those at Glasgow, but when these were conceded they were not satisfied. His opinion was that Newcastle was to be the centre of a general agitation among tramway employés which would spread throughout the Kingdom. He thought the Newcastle tramway men were treated as well as any in the country.

Councillor W. H. LITTLER (West Ham), dealing with the constitution of tramway committees said that changes took place at West Ham every five years, which was somewhat better than the shorter periods obtaining elsewhere from the point of continuity of policy. In case of strike he thought they could replace their present staff at West Ham without difficulty, and any attempt at coercion would be vigorously resisted.

Councillor MONK (Plymouth) favoured the practice of paving and track maintenance by the tramways department instead of by a works department which, as at Plymouth, repaired the track how and when it pleased.

Ald. WAINWRIGHT (Manchester) held that the labour question merited consideration at an early moment – and the federation of the various corporations to safeguard their interests. He strongly deprecated the practice of halfpenny fares as being detrimental to long-distance traffic which tramways were built to encourage.

Councillor FENTON (Sheffield) disapproved the idea of a combination of corporations as it would make the men feel that their employers were taking concerted action against them. Local conditions must decide the rates of wages, holidays granted, and general conduct of the system, and no general principle could be applied to the country as a whole. Dealing with tramway accounts, Sheffield had nearly as much reserve fund as Leeds, but they had paid away more in street improvements; in his opinion such items of expenditureshould be distinctly marked in the accounts. As to reserve fund, Sheffield set aside £20,000 a year and had £30,000 put by for contingencies, and he thought this might be made the basis for other large towns. Any profit over these figures might then be put to the rates.

Councillor TAGGART (Aberdeen) said they were afflicted with ward representation in Aberdeen, and councillors made strenuous efforts to have the system extended into unremunerative districts simply to satisfy the whim of a particular ward.

Councillor NEW (Sunderland) approved of giving the general manager complete control of the men, and stated that in Sunderland they hadhad no direct labour troubles which needed the attention of the committee.

The MAYOR OF HUDDERSFIELD suggested that a conciliation board, such as had been formed in Huddersfield, might help to avert trouble with the men, as it permitted both parties to meet and discuss grievances.

The PRESIDENT, in closing the discussion, said that the association could not directly act on behalf of the consolidation of the interests of the various corporate bodies represented on it in dealing with labour disputes, but he thought the suggestion of a conciliatory board might very well be put into effect by the formation of such a body within the association.

The first Paper to be read at the meeting on Thursday, September 20th, was the following:—

TRAMWAY TRACK WORK.

BY R. C. BULLOUGH.

(General Manager and Engineer, Colchester Corporation Tramways.)

The endeavour of the writer will be to discuss in as concise a form as possible what he considers to be important matters concerning present-day tramway track work. If the Paper is sufficiently interesting to cause further discussion, the writer's object will be attained. Much has, of course, been written on the subject, and nearly all this by engineers, who have been at some pains to give ample engineering formulæ, which, of course, is very useful to a trained engineer, but not to the lay mind. The writer therefore makes no excuse in leaving out all formulæ and dealing with the subject from a practical point of view only and, he hopes, in a manner easily understood without elaborate calculations. Considering that such a large proportion of the capital of an undertaking is expended on track work, it is surprising that so little heed is given to this branch by tramway authorities. It is only after lapse of time, when joints begin to "knock," paving lifts, rails creep or hogback, corrugation takes place, points and crossings require renewing, and curved rails wear out, &c., that track work begins to take its place as an important branch of tramway systems. A member of a certain committee once said that the permanent way is laid for the cars to run upon; everybody knows that, but those aerial wires and the fishing-rod arrangement on the car are past all understanding. This idea may account for much of the indifference shown with respect to permanent way.

Concrete.—This is one of the most important parts of tramway construction, and very great care should be bestowed, with consequent benefit to future maintenance. Pot holes (soft earth) ought to be removed, and the places filled up with concrete, at whatever cost; if this be neglected the concrete will certainly fail, and it is possible that this is, in many cases, the cause of hogback or sagging of rails. A quick-setting cement may be used, but a slow-setting cement is better where there is time to allow it to set before the traffic is turned on, as in the case of a new tramway. Cinders or brickbats should not be used, because the depth of concrete is usually so slight that the strongest and cleanest material only should be used—viz., broken stone and sharp sand. Every possible care should be taken to ensure a perfectly solid foundation, and the writer is of opinion that where possible the concrete should be laid in situ at the proper level to receive the rail, and not packed up at the joint first and then the metals filled in. This latter method is usually favoured by contractors because it is a little cheaper. When the concrete is packed under the rail in bulk a certain amount of subsidence takes place, and the ends of the rails being held up they (the rails) sag in the middle, causing a permanent set. The writer saw some joints opened out on a tramway which had been constructed in this manner, and at every joint the packings (dry stones) had been left in, with the natural result that the joints were all defective. This would not take place if the concrete bed is first formed throughout and the rails laid upon it. It is thought by some that where the concrete is laid for the full length of the rail in the first instance, and that as the rail has to be packed slightly with thick grout on the top of the concrete which is said to be set, that there is no amalgamation between the grout and the concrete; but considering that concrete is several months in setting finally, we may dismiss this as not quite correct.

Rails.—The writer is of opinion that the chemical analysis of the rails for straight track and curved track should vary, the straight track being composed of the hardest material consistent with the rails not breaking, and the curves being of considerably softer material for the purpose of bending, and also to prevent undue wear on the wheel flanges. The manufacturers are now making curved rails of manganese. The writer has not had any experience with manganese curved rails, but considering the extraordinary wear that takes place on sharp curves at the present time, both on wheel flanges and rail guards, it does seem to him that manganese curved rails are wrong, as the wheel flanges would wear away very much quicker. The inference is, therefore, that a softer rail should be used round sharp curves so that undue wear on the wheel flanges should not take place, for, after all, it is not a very big expense to take out a couple of curved rails and replace them with new ones when required. The writer is of opinion that this would be very much cheaper than lifting cars and re-tyring car wheels so frequently. Another important thing with regard to curved rails occurs to the writer, and that is that all sharp curves should be laid with an ordinary T-rail, similar to those used as a rule in car depots, and a separate guard might be attached to the paving, this paving being ashlar stone laid in cement. If this were done, this separate guard could be renewed when required without disturbing much of the paving, and without taking up the rails. The groove in this case would be run with cement from the flange of the rail to within the required depth below the head of the rail, so as to leave just sufficient room for the depth of wheel flange. As an alternative, the separate guard might be fixed to the web of the T-rail with filling-in pieces between the web and the guard, the whole being bolted together, the space between the rail and the guard being run with cement, as stated above.

Points and Crossings.—The engineering formula for the leads and angles of crossings is so well known that it is not necessary to give any details. It would, perhaps, be sufficient to say that the practice now generally adopted of long leads and easy curves is satisfactory. It is, however, very necessary to deal with the question of hard-steel plates and manganese castings. The idea of manganese insert plates for crossings originated in America, and in theory it appears good, but in actual practice the writer has found it to be a very costly thing. The theory of the manganese plate is that the crossing is used double the number of times of the outer rails, and therefore a hard plate is required to withstand the additional wear, but in practice it is found that the plate is made so hard that the rails at each end of the plate are worn down very much sooner than the plate itself, and the wear and tear on wheel flanges become excessive. Would it not be better, instead of having a manganese steel plate, to have a mild-steel plate or a cast-iron plate made of sufficient toughness to withstand the strain? There would be several advantages in this: the first would be that the plates could always be made locally, and would be comparatively inexpensive, either as first cost or renewals. It is not at all necessary to wedge the plates down in the manner suggested by American engineers. A sufficient bed of spelter should be prepared for the plate to rest upon, and it could be fastened with wedges from the surface, which might be easily removed in case of necessity. The present system of fastening the plates is altogether too difficult to deal with when renewing the plates.

With regard to points, these are in many cases being made wholly of manganese steel. This, in the opinion of the writer, is wrong. Wherever manganese is used, it is a terrible strain upon wheel flanges and tyres. Manganese cannot be drilled or tapped; it is, therefore, practically impossible to make any alteration that may become necessary. After taking up a manganese point it is worthless; it cannot be sold even for scrap. The same thing occurs here as at the crossing; the rails at each end of the point are of softer material than manganese, and the consequence is the manganese does not wear at the same rate as the adjoining rails, and when these get worn down at the ends "knocking" occurs. The curved switch is all right, but if made of manganese the same wheel flange grinding occurs, and the writer has seen a strip $\frac{1}{16}$ in. thick and 15 in. long actually pared from a wheel flange by a manganese switch. Surely this is an expensive way of meeting a difficulty. In the writer's opinion, cast-steel box points with wrought-steel tongues and renewable plates of mild steel, made to the same pattern as the present approved ones, are the proper points to adopt, the reason being that the wear and tear on the wheels of the car causes far more expense than having to renew the points or the crossing plates frequently. Again, scrap price can be obtained for old cast steel, and that is a consideration when taking up old points.

Tie-bars.—It has been stated that tie-bars are not necessary in tramway track, as the paving will keep the rails in their proper position. It is not likely that anyone will make this experiment. The tie-bars are very important, the slightest lateral movement of the rails causing irregular gauge tends to do considerable damage to the rolling stock, in addition to causing the cars to oscillate to an objectionable extent.

Fish-plates.—The writer has found in practice that it is not at all necessary that the fish-plates should take any vertical strain whatever. The rigidity of the joint may be insured, as shown below.

Joints.—As the strength of a chain is represented by the weakest link, so is the strength of a tramway track represented by the joint. Given that the length of the rail is first bedded solid on a good foundation of concrete, the first trouble that occurs is at the joint; and once the joint becomes loose and defective, then it has a tendency to cause either hogback or a sag anywhere along the rail. It is, therefore, very important that the joint should be so made in the first instance that it becomes as solid as any other part of the rail. Once the ends of the rails begin to work, it is not long before trouble presents itself all along the track. The writer has studied this question for some years with the object of finding means of making the joints adjustable from the surface of the road, so that when the joint does show signs of becoming loose it may be adjusted with the smallest trouble and expense. He has succeeded in perfecting an "adjustable rail-joint support," which has now been used for upwards of two years, and which has been reported upon to the Board of Trade. This device is very simple indeed, and is composed of two steel plates—one, 6 in. wide, as a base plate and the other, 4 in. wide, as a supporting plate. Both these plates are placed on the concrete underneath, and exactly central with the rail joint. The 4 in. supporting plate is tapped at each end for 1¼ in. screws, and when these screws are turned they bear upon the base plate, lifting the supporting plate and the two ends of the rail to any required position, and maintaining them there. The screws are protected by a stuffing box. The paving may be laid close up to the stuffing box, so that a hole of about 3 in. square only is left in the paving; this may be filled up with chippings, or may be a cast-iron cover, a block of wood or any other means which is found to be the easiest of adoption. In the case of one rail being slightly deeper than the other, which sometimes occurs, a liner may be put on the supporting plate under the end of the shallow rail, and in turning the screws the two heads of the rails will become exactly level. In using this device, short, flat steel fish-plates may be used, these to fit close against the web of the rail, as they are not required to take any vertical strain, being there simply for the purpose of keeping the rails in alignment and to act as washers. Shorter bonds also may be used at the joint. The device is the exact opposite to the so-called "anchor joint," of which the writer has had considerable and sad experience. It may be taken for granted that all mechanical joints will fail in time, and the expense to be incurred in remedying the defect is usually great, particularly so with anchor joints. It must, therefore, be a very considerable advantage to have a joint that can be adjusted from the surface of the road and renewed with the least possible expense. As it has been tested for two years, there can now be no doubt that this device has proved an instant cure for "knocking" joints in old track and a preventative in new track.

With regard to welded joints, the writer has superintended the welding of 50 joints, and had two short rails welded together for experimental purposes. The superfluous welding material was planed off for examination of the weld, and it was found that the rails were thoroughly amalgamated to within about an inch of the surface of the rail. Having had no experience as to the maintenance of these joints he cannot speak as to this, but several points occur to him that appear to be important. The head of the rails not being welded would lead one to suppose that "knocking" will occur in time. Again, the extraordinary heat to which the rails are subjected must have a tendency to change the nature of the metal; and, to look further ahead, difficulty must arise when it is required to take out a rail or to take up the whole.

Paving.—Sett paving of some description is the best and most satisfactory finish to a tramway track, and there are two important things which occur to the writer: the first is, why should tramway authorities remote from granite quarries follow the example of tramway authorities whose tramway systems are within reasonable distance of the granite quarries? There are English quarries supplying a good hard stone suitable for paving setts. We know, of course, that extraordinary wear takes place against the tramway rails that would not take place if the rails were not there, but one cannot help thinking that economy would result in putting hard setts against the rails and local setts between.

Another very important question is the maintenance of this paving. The writer could never clearly see the justice of tramway authorities first providing, in some cases, one-half the street with the best possible paving, and then being compelled to maintain it. This may be all right as far as large tramways are concerned, where the manager has the joyful satisfaction of turning over thousands of pounds to the relief of the rates, but it tells very hard on small concerns, and it would be an assistance to these tramways if such maintenance were carried out at the cost of the highways or other department of the corporation.

Creeping Rails.—The writer has never known a case of rails creeping except when a canal bridge subsided about 18 in. owing to coal workings underneath. It may be that creeping rails were noticed after the invention of the first anchor joint. The writer is firmly convinced from practical experience that anchoring, except in very special cases, is an unnecessary expense.

Corrugations.—The writer has had no actual experience of this trouble, but from what he has read of the experience of others there can be but little doubt that the trouble originates at the rolling mill. This conclusion may be reasonably arrived at by the fact that the corrugation occurs at any place along the tramway route—on straight track, on curves, on inclines and declines. Until the trouble can be located to one particular or similar place on several tramways, it is reasonable to assume that the cause is not outside. If it could be located to one particular or similar place always, a pertinent question would be: "Is this where the magnetic brake is always applied?"

General Remarks.—The writer would like to add, in conclusion, that he thinks the manufacturers of points and crossings and special track work have been of great assistance to managers in the past, but as they can have no actual experience with regard to the maintenance of permanent way, they are apt to look at the question from an engineering point of view only, without any regard as to how it affects the rolling stock. Defects and mistakes should, therefore, be remedied after actual experience, and the writer has always found the maufacturers willing to make any alteration that he has found necessary.

DISCUSSION.

Mr. H. MOZLEY (Burnley), speaking from an extensive experience, stated that the malformation of "turn-outs" was a frequent cause of broken axles. He suggested that in such cases there should be a straight lead into the point. He could not agree that corrugations originated at the rolling mill. He attributed them to the rolling stock, such as surging axles and trucks being out of square.

Mr. J. S. D. MOFFETT (Rochdale) disapproved of first laying the concrete and packing up the rail afterwards. He considered the reverse process better, as in the first instance the packing had a tendency to disintegrate permitting the entrance of water which subsequently occasioned the sagging of the rail. Soft rails on curves were not to be recommended. In his own case he preferred to turn up tyres rather than re-lay rails. Inset points and crossings, if of uniform hardness, gave rise to wear at the rail ends. He thought it was now possible to obtain plates tempered from the outside and consequently harder in the centre. On the subject of paving he could not agree with hard stones between and near the rails and softer setts on the outside, as such an arrangement was dangerous to horse traffic.

Mr. R. B. HOLT (Leeds) stated that the wear on curves referred to by the author pointed to soft rails. In his own experience he had found wheels run 60,000 to 82,000 miles without re-tyring, the depth of the new tyre being 2½ in. and the worn tyre ⅞ in. Manganese steel was difficult to drill, but he had succeeded in burning holes in it by electrical means. He had had three years' experience with about 1,000 Thermit joints, and had had no trouble from hammering.

Ald. TRAVIS (Southport) stated that they had commenced with cast-iron points and crossings, but had given these up in favour of manganese steel.

Councillor MONK (Plymouth) was glad to hear Thermit joints well spoken off, as they had been introduced at Plymouth about 12 months ago. They had also spent a good deal of money in the anchoring of their track, and he was anxious to know why this had been done if it was not really necessary.

Mr. BULLOUGH, in reply, adhered to his contention that the concrete should be put in first and the rail packed up afterwards. He quoted Manchester as a successful instance of this practice. He found with his own tramway system that the curves ground away the wheel flanges every 5,000 miles run, and would rather renew rails every two years than re-tyre wheels every three months. As to the entrance of water under the rails, he thought that it usually found its way in now, consequently the question of its occasioning sagging of the rail could not be of much importance. He regarded it as a good sign that managers could now state their requirements to the makers and get what they wanted. Previously they had to take what the manufacturers would give them.

The next Paper to be read was on—

DEPRECIATION AND RENEWALS FUNDS IN RELATION TO TRAMWAYS UNDERTAKINGS.

BY G. W. HOLFORD.

(General Manager, Salford Corporation Tramways.)

Having recently had occasion to report to my committee with reference to our depreciation and renewals fund, I forwarded to my colleagues, who have charge of the several undertakings in the country, certain queries upon the subject generally, and it was afterwards suggested to me that as the matter was one of very great importance to all those interested in municipal tramway work, this meeting of the association would form a fitting opportunity to introduce a discussion on the subject, and to lay before the members of the association in tabulated form the information which had been so kindly supplied to me.

In dealing with this subject I would first respectfully impress upon you that I do not refer to depreciation in the same manner as it is usually dealt with in the balance-sheet of a tramway undertaking, but more especially with regard to the provision of a fund to cover the cost of renewals which will be required in a *municipal* tramway undertaking before the period for which the borrowing powers have been allowed has expired. I have deemed it desirable for the purpose to divide the undertaking into the following branches, namely: (*a*) Rolling Stock; (*b*) Buildings; (*c*) Overhead Equipment; (*d*) Permanent Way.

With regard to the first item, rolling stock, I am of opinion, taking into consideration the period generally sanctioned by the Board of Trade for repayment of money borrowed to cover this expenditure, that there will not be required within that period any abnormal expenditure for renewals, provided that careful attention is paid to the maintenance of the rolling stock. If this course is followed, the rolling stock should outlive the period of the borrowing power. Respecting buildings, these certainly also should outlive the period of the loans, and our standardised accounts already provide for their proper maintenance out of revenue account. The next item, overhead equipment, is one also which I consider is maintainable out of revenue. I think it will be admitted that the poles will outlive the loan period, provided they are painted at regular intervals, and although the trolley wire, &c., will, we know, require renewal from time to time, the cost of this periodical renewal is not a very serious item when we take into consideration the price obtainable for copper as scrap material.

I submit, therefore, that with regard to these three first-named branches, it is not necessary for a municipal tramways undertaking to establish a special renewals fund; but at the same time, whilst I state that I do not deem it a *necessity* to provide for depreciation, &c, in connection with these branches of the undertaking, I certainly would not advise any authority which has already established a fund for this purpose to discontinue the provision, as I am sure that good use will be found for the money in future years, if not for this identical object, for others, perhaps, of greater importance. I would, therefore, with your permission, confine my paper to the subject of the renewal of the tramway track or permanent way, which is, indeed, a very important branch of our several undertakings. The two main points to be taken into consideration in dealing with this question are: (1) The probable life of the rails; (2) The probable cost of renewing the metals and relaying the track.

Embodied in the queries which I have before referred to was the following: "If you have considered the question of the life of tramway rails, overhead equipment, cars, &c., I shall be pleased to hear your views thereon."

From a perusal of the replies which I received, and which will be found in Appendix hereto marked A, it will be noticed that this point is one upon which but few managers desire to venture an opinion at present, as the field of experience has not yet been of an extensive character, and much depends upon the method of construction and other local conditions; but, as far as I could gather from the opinions expressed, the life of the rails is estimated at, approximately, 12 years.

In connection with the Congress of the International Tramway Association at Milan in the present month, a number of queries were issued to the various tramway authorities on the Continent, and a portion of one of these queries directly bears upon the subject now under consideration. The one I refer to is as follows, namely: "What is the average life of your tracks, and of your rails (1) in sections of straight line with light traffic or heavy traffic; and (2) on curves with feeble or heavy traffic?" I am pleased to be able to place before you in the Appendix hereto marked B the replies which were received to part 1 of this query, and which I think you will agree are of a very interesting character. From a perusal of the replies of the various Continental tramway authorities, it will be found that the general estimate of the life of a rail over which the traffic is fairly light—that is, not less than every five minutes—would average out at about 15 years, and that on a line where the traffic is heavy at about 10 years.

In my own opinion, after a careful study of the subject, and from a number of measurements I have had taken of the wear so far on numerous portions of our rails, I came to the conclusion that these figures were the most desirable to adopt, and in reporting to my committee I based my calculations thereon.

Before leaving this portion of the subject, relating to the probable life of the rails, I would desire to specially mention two points which came to my notice, the first being the excess in wear which was found at the rail ends as compared with that about 3 ft. away, and secondly, that in grinding the rails to take out corrugation, we had to reduce the thickness by nearly $\frac{1}{16}$ in., which means a lessening of the life of the rail of probably one year, and if the corrugation returns, this may possibly have an important bearing on the question of the date at which the renewals will be required.

With regard to excessive wear at the rail ends, the means we have so far adopted in dealing with this is to weld the joint by the Thermit process. No doubt other gentlemen who have had wider experience on this subject will, in the discussion to follow, provide us with some valuable advice and information thereon.

I now arrive at the second portion of the question of renewals, which is the probable cost that will be incurred in providing new rails, &c., and in relaying the track. On this point I am able to speak with a greater degree of certainty, as the laying of practically the whole of our tramway track was carried out under the immediate control of the department, and a careful record kept of the same. It was found that for reconstruction work, with a concrete bed throughout and using new granite setts, the average cost was about £6,500 per mile of single track. This figure may appear somewhat high, but it must be remembered that whilst the reconstruction was taking place in most cases the service of the cars had to be maintained, and this will occur again when the renewals are required to be made. In the case where new setts were not used, the cost was, approximately, £4,930 per mile of single track. It should be borne in mind that it will not be necessary to reconstruct a new concrete bed throughout, and in consideration of this fact the cost of the work will be lessened by, approximately, a further sum of £600, leaving the amount at £4,330; but this will further be reduced, as the old rails taken up will certainly be worth, as scrap material, not less than £2 per ton, and as there will be, approximately, 160 tons of metal to be taken from each single mile of track, a further reduction will take place to the extent of £320, leaving the net cost of the work at £4,010—say £4,000—which I consider is a fairly high figure, and no doubt may possibly be still further reduced when the time arrives to carry out the work.

Taking this figure, however, of £4,000 for our calculation means that, in order to provide an adequate fund for the future expenditure to be incurred in the renewal of the track, it is necessary and desirable to set aside annually a sum of £400 in respect of each single mile of tramway with an estimated life of 10 years, and £267 in respect of each mile of tramway with an estimated life of 15 years. The total amount of the annual contribution will have to be increased each year pro rata to the increase in the mileage of track added from time to time which is maintainable by the authorities respectively.

I would desire, before concluding, to call the attention of those present to the information contained in the tabulated statements appended to this Paper, and particularly to the various methods which have been adopted by the several tramway undertakings in dealing with the establishment of a depreciation and renewals fund; in one instance it will be noticed that the annual contribution to the fund is calculated on a car-mileage basis, and it will be very interesting to hear the reasons which led to the adoption of this particular method. In several instances, so far as my humble judgment guides me, I feel sure that ample provision is being made for the expenditure that will have to be met in a few years' time; in other instances the authorities have been of a perhaps too generous spirit, and whilst making handsome contributions to the relief of the rates in their respective cities and towns, have hardly dealt as they ought with the provision of an adequate depreciation and renewals fund. Many undertakings, particularly the smaller ones, have, I regret to say, so far been unable to establish any fund. In conclusion, I would desire to earnestly impress upon those gentlemen responsible for the control of the undertakings in which proper provision is not being made the very serious results which will follow in some 10 or 12 years' time, when, owing to the non-provision or insufficient provision of such a fund, heavy calls will inevitably have to be then made upon the ratepayers to meet the requisite expenditure for the work, causing great dissatisfaction and no doubt strong adverse criticism of municipal management, which may result in a serious set-back to municipal progress for many years to follow.

APPENDIX A.

Showing the Provision made by Tramway Undertakings with regard to a Depreciation and Renewals Fund.

Town.	No. of cars.	No. of miles of track.	Annual contribution to depreciation and renewals fund.	Total amount of such fund at M'rch 31, 1906.	Estimated life of		
					Rails.	Cars.	Overhead.
Aberdeen ..	69	27¾	Whole net profits	£14,379	15	15	15
Ashton	18	9	Nil	Nil	..	..	..
Ayr	17	7½	3% less cost of renewals	£9,021	..	..	..
Barking	7	1⅓	Nil	Nil	Period of loan	..	Period of loan
Belfast	220	73	Not yet settled	,,	20	..	..
Birkenhead..	59	23½	Whole net profits	£11,466	..	..	..
Blackburn ..	48	23¾	Nil	Nil	23-20	20-15	..
Blackpool ..	61	21¼	No fixed amount	£6,342	Under	consid	eration
Bolton......	86	42	Track, £360 per mile; overhead, 5%; cars, &c., 10%; depots, 3%	£33,928	12½	10	20
Bournemouth	81	24¾	Nil	*a*	Under	consid	eration
Bradford....	239	96	Whole net profits	£48,469	15-12	*b*	*b*
Brighton	50	17	,,	£2,766	Cannot say	*b*	*b*
Burnley	46	19½	,,	£11,797	..	..	..
Bury	41	23	,,	£4,343	15	*b*	*b*
Chester	12	4¾	Nil	£539	..	..	..
Colchester ..	18	8	,,	Nil	..	..	..
Darlington ..	16	8	,,	,,*c*	..	..	..
Darwen	15	7½	£170 for cars	£5,250	20-15	15	Wire 7 p'les 25
Derby	39	8¾	Intended to use all profits	£6,529	..	..	..
Doncaster ..	25	11	Nil	Nil	..	..	..
Dundee	54	12½	No fixed amount	£20,992	..	..	..
Glasgow	783	158¾	Track, £500 per mile; *d* poles, &c., 3%; cars, 7½%; depots, 2½%	£905,254	..	..	..
Gloucester ..	30	15	Nil	Nil	..	..	..
Gt. Yarmouth	28	12	No fixed amount	£1,200	..	..	..
Halifax	96	52	Whole net profits	£10,221	..	..	..
Huddersfield.	70	30	3% of total cap. expenditure	£44,268	12	15	10
Hull	116	27	No fixed amount	£63,000	..	..	..
Ilford	22	6⅝	..	£5,636	..	..	..
Keighley ..	10	6¼	Nil	Nil	15	..	..
Kilmarnock ..	14	5	,,	,,	..	..	..
Kirkcaldy ..	22	7½	3% on cars and tools	£858	Under	consid	erati'n.
Leeds	270	94¾	Track, £11,565; overhead, 2½%; cars, 5%; depots, nil	£118,493	..	..	..
Leicester ..	140	36¾	Whole net profits	£27,558	..	..	..
Lincoln	8	1¾	Nil	Nil	..	..	..
Liverpool ..	479	103	No fixed amount *e*	£214,398	Con amoun	sider ts suffi	these cient
Lowestoft ..	20	5	Nil	Nil	..	..	..
Maidstone ..	7	2¼	,,	£2,009	..	..	..
Manchester ..	542	142	Track, £400 per mile; overhead, £50, do.; cars, 5%; depots, nil	£249,212	10	20	*b*
Newcastle ..	187	57¼	No fixed amount	£28,658	12	*b*	*b*
Newport	40	14½	,,	£1,000	15-7	..	..
Northampton	22	9¼	,,	£2,070	..	..	..
Oldham	80	35½	,,	£2,375	12	15	Line 8, poles, &c., 25
Preston	30	14	*f*	£4,000	..	..	..
Pontypridd ..	12	5½	Nil	Nil	..	..	..
Reading	36	13¼	Whole net profits	£5,115	..	..	..
Rochdale ..	52	28¼	Nil	Nil	20-15	20	Lne 10, p'l's 30
Rotherham..	30	7	Whole net profits	£4,980	5% on	whole	suffic't
Salford	175	54¾	No fixed amount	£30,439	15-10	*b*	*b*
Sheffield	257	66	£20,000	£108,479	12-7	Equipment 6	Line 6
Southampton	49	16	Whole net profits	Not stated	12	18	Line 8
Southend ..	22	7	Nil	Nil	..	..	..
Southport ..	26	19½	£1,053	£5,477	..	..	..
Stockport ..	45	25	Whole net profits	£5,941	..	..	..
Sunderland ..	64	19½	£6,400	£25,166	..	..	..
Wallasey ..	35	12	1·47d. per car-mile	£15,466	..	..	..
Walsall	28	17½	Whole net profits	£6,163	..	..	..
Warrington ..	21	6½	,,	£220	..	..	..
West Ham ..	93	26	No fixed amount	£10,092	..	..	..
Wigan......	67	20	Nil	Nil	..	..	..
Wolverh'cn*g*.	40	20	No fixed amount	£13,498	12	10	..

a Accumulated profit of £23,967. 19s. 11d. not yet appropriated.
b Can be maintained out of revenue.
c Decided by Council not to provide fund until after third year of working.
d Nothing for overhead wire, which is maintained out of revenue.
e £50,639 set aside last year.
f Act of Parliament provides that no contribution can be made to other funds until renewals fund amounts to £5,000. Intended for some years to place all net profits to reserve fund. *g* Lorain system.

APPENDIX B.

Containing Information from Continental Tramway Undertakings on the Subject of the Probable Duration of Rails.

City or town.	Estimated life of rails: On straight line light traffic.	Estimated life of rails: On straight line heavy traffic.	City or town.	Estimated life of rails. On straight line light traffic.	Estimated life of rails. On straight line heavy traffic.
Aachen	18	15	Hanover .	20	14
Amsterdam ..	20	8	Havre	..	10
Basle	14	10	Konigsberg.	20	..
Gros Berliner	12 - 10	8—5	Copenhagen	20—10	10—5
Bochum Gelsenkirchen ..	20—10	..	Christiania.	18	14
Bremen	12—10	10	Leipsic	16—15	12—10
Breslau	15	10—8	Liege	12	..
Crefeld	15	10	Lyons	20	12—10
Dresden	20—15	12—10	Metz	15—13	10—8
Dusseldorf ..	18—15	15—10	Paris......	..	15—12
Barmen Elberfeld	15	..	East Parisian......	20	10
Geneva	30—15	25—10	St. Gall....	10—8	..
Hamburg ..	16	12	Stuttgart ..	20—15	..
			Turin	25	20

N.B.—All the above undertakings are worked by electric traction.

DISCUSSION.

Councillor J. McCORMICK of Belfast opened the discussion, stating that he did not agree with the amount suggested by the author—namely, £400 per mile per annum for depreciation of track. In Belfast, where they had 70 miles of track, this policy, if adopted, would entail the setting aside of an enormous sum. He considered that £400 was too great a sum to be universally applied for track depreciation. He suggested that some arrangement be made for subdividing the amount between those sections of the track subjected to heavy, medium, and light traffic. In the centre of the city the wear and tear of track was greater than the routes on the outskirts. Failing this, he thought that £200 per mile per annum was a more reasonable sum to set aside.

Councillor MONK (Plymouth) thought that heavy sums could be set aside for depreciation and renewals when only $\frac{1}{3}$d. was paid for current. In the case of Plymouth, where they had been paying 2d. per unit, and provided all repairs and renewals out of revenue, he did not think a depreciation fund was needed.

Councillor FLINT (Leicester) was of the opinion that all tramway undertakings should make provision for renewals and maintenance, but thought that the sum suggested by the author in his paper for track depreciation was too heavy.

Mr. P. FISHER (Dundee) quoted his experiences with the assessors from which he found that £200 per mile per annum for track maintenance and renewals was not enough. In certain cases £500 was not considered an excessive figure.

Mr. STEPHEN SELLON, when called upon by the President to make a few remarks, pointed out the fallacy of confusing a sinking fund with a depreciation fund.

Mr. H. E. BLAIN (West Ham) also emphasised the need for distinguishing between depreciation and sinking funds. In the case of the latter the sum borrowed was automatically wiped out at the end of the borrowing period. As to maintenance and renewals he considered that the overhead system and cars might very well be taken care of out of revenue, but a sum was necessary for the maintenance of the permanent way. £400 per mile per annum was too high a sum, but £300 at compound interest would, he suggested, be a suitable figure. In the cases of large cities like Glasgow, it was an easy matter to set aside very large sums for either depreciation, renewals or sinking funds.

Mr. J. DALRYMPE (Glasgow) stated that no more than was actually needed was set aside in Glasgow.

Mr. A. NANCE (Belfast) considered that the present generation was being robbed for the benefit of the next generation. He took as a parallel the case of a leaseholder of property maintaining that property in fair repair up till the end of the term of the lease.

Mr. HOLFORD then briefly replied to the discussion, stating that he would deal with the main points in a written reply to be published in the *Proceedings*.

THE GENERATING STATIONS AT ST. GALL, SWITZERLAND.

The arrangement of the generating stations which supply the town of St. Gall, in the Swiss canton of that name, described in a recent issue of *L'Eclairage Electrique*, although of no great size, are of interest on account of the way in which the considerable extensions which followed the first small beginnings were dealt with. In 1886 the only source of electric supply in the town was a small continuous-current gas-engine station at the gas works, partly used to light the hospital. In 1889 the municipality acquired the hydraulic rights of the river Goldach, and at the same time put down another small gas-driven set at their existing station and a battery of accumulators. This, however, did not increase the capacity of the station beyond the equivalent of 500 16 c.p. lamps, nor was the water power of the Goldach immediately developed. In 1895 a private three-phase power station was established on the river Sitter, at Erlenbach, from which some 60 E.H.P. was purchased by the town, and a motor-generator set was put down in the existing station to transform this to continuous current. The next extensions were necessitated by the construction of an electric tramway, and some further gas-driven sets were installed. In 1897, however, the demand had again outgrown the supply, so it was decided to develop the rights already possessed over the water power on the river Goldach and enter into an agreement with the neighbouring Kubel water-power station for the supply of a certain amount of current to the town. The original gas engines were kept in reserve in case of shortage of water at either the Goldach or Kubel works, and provision was made for transforming the power received from these two stations to continuous current, both at the old station and by the establishment of a new sub-station in another part of the town.

The river Goldach, which rises in the canton of Appenzell and flows into the lake of Constance, is extremely variable in its flow, so that a considerable amount of barrage work was necessary to secure the amount of storage required to sufficiently equalise the power available. The water is taken to the power house by a canal nearly $1\frac{1}{2}$ miles long and a cast-iron pressure pipe 2 ft. in diameter about $\frac{3}{4}$ mile in length buried in the ground. The total head available is 442 ft. The power station is just over 3 miles from the town of St. Gall, and contains two 200 H.P. horizontal shaft impulse turbines by Theodore Bell & Co. each direct-coupled by a flexible coupling to a three-phase Oerlikon inductor alternator working at 3,600 volts 53 cycles and running at a speed of 530 revs. per min. The exciters are mounted on the alternator shafts, and a separate continuous-current dynamo driven by a 3 H.P. turbine running at 1,650 revs. per min. supplies the station lighting and auxiliaries.

The central station in the town, adjoining which is the car shed and workshop of the tramways, contains six different groups of machines. The first group is composed of two continuous-current 40 kw. 550 volt generators direct-coupled to a 60 H.P. three-phase motor running at 725 revs. per min. The couplings are so arranged that either both dynamos may be driven of the motor which receives current from the Erlenholz station at 1,560 volts 53 cycles, or they may be driven independently, one by the motor and one through a belt by the 60 H.P. gas engine which belongs to this set. The second group consists of two dynamos wound for 130 volts, each with its own 30 H.P. gas engine and a 60 H.P. three phase motor running at 770 revs. per min., which can be arranged to drive either or both of the dynamos. The third set is of 100 H.P.; the single dynamo being arranged as before to be driven by a three-phase motor at 520 revs. per min., or to be belt-driven by a gas engine. The fourth and fifth sets are only gas-engine driven and are of 150 H.P. and 200 H.P. respectively, the former being a three-wire machine for 2 × 275 volts, and the latter having a pair of dynamos each for 275 volts coupled together. The sixth group consists of a pair of continuous-current generators driven by a 250 H.P. three-phase motor running at 450 revs. per min. The three-phase motors of second, third and fifth groups can be supplied either from the Goldach or Kubel stations at 3,300 volts 53 cycles. The 275 volt generators can be used either two in series on the 550 volt traction mains, or singly at a slightly reduced excitation on the 2 × 120 volt lighting system. Those in the second group can either be used one on each side of the lighting network or for battery charging. The lighting battery consists of 150 cells of 887 ampere-hours capacity arranged in two groups of 75 cells each. A separate traction battery is employed, consisting of 300 cells of 162 ampere-hours, and is worked in connection with a booster.

The sub-station is for the reception of current from the Kubel works at 10,000 volts and contains step-down transformers reducing to 3,400 volts. Part of the current at this pressure is transmitted to the central station described above, but a portion is connected into continuous current by means of three motor-generator sets in the sub-station itself. The transmission lines from the three water-power stations are partly overhead and partly underground.

CORRESPONDENCE.

CAR BRAKES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must congratulate you upon the very full report of the discussion on my Paper re "Car Brakes." Your report is the first opportunity I have had of seeing Mr. Fell's Paper in reply. Naturally I could not reply to it at the time, but the information will appear in the Municipal Tramways Association records in due course.

I did not "disregard" Mr. Fell's criticisms as you put it. I simply did not know what they were until your journal was placed in my hands. Whilst I was not able to read my Paper (and we all know that in a large meeting like the one in Leeds only a small proportion of those who attend take the trouble to read "printed Papers"), Mr. Fell was permitted to read his "Paper," which, it will be seen, was full of important data, worthy of more than a moment's consideration.

I am not sure that the real point of my Paper was understood, and certainly it was little discussed. What the Association desired to know was the experience of brakes in Burnley and the conclusions come to in regard to them. These are clearly set out in the Paper, but received very little comment. However, more anon.—Yours, &c.,

Burnley, Sept. 24. HENRY MOZLEY.

THE MAGNETIC FIELD IN THE SINGLE-PHASE INDUCTION MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of September 14th you reprint an article with the above title by Dr. A. S. McAllister which appeared in the *Electrical World* on August 18, 1906. I have read this article with special attention. I am glad to see that Dr. McAllister champions the theory I put forward in

February of this year, but I would suggest that the conclusions which he draws from it are incorrect. I also note that he substitutes the term "speed field" for the term "motor field" originally used by me; I prefer my own terminology, and will make use of it in the following remarks.

The general proposition which Dr. McAllister wishes to prove may be concisely stated as follows: In a self-excited single-phase shunt induction motor the magnetising current absorbed by the stator must equal the sum of the magnetising currents required for the "transformer" and for the "motor field." Since in the ordinary motor of that type these two fields are nearly equal in magnitude, this amounts to saying that the magnetising current of such a motor will be equal to twice the magnetising current required for the transformer field only, or to twice the magnetising current which is taken by the motor when standing still with the rotor on open circuit.

I have stated before, and I repeat now, that no such relation exists between the exciting current in the rotor, responsible for the motor field, and the exciting current in the stator winding and responsible for the transformer field; the former is not represented in the stator winding, accurately or otherwise.

I have shown that in all such motors the two fields are not exactly in quadrature, and that, therefore, the back E.M.F. (E_b), due to the rotation of the rotor conductors in the motor field is not quite of opposite phase to the working or transformer E.M.F. (E_t), so that, even when the motor is driven by external means at about synchronous speed, there can be a more or less large current flowing in the armature axis of the rotor, and independently of the fact that under these special conditions no power need be exerted by the motor itself in order to overcome the usual losses plus those due to the currents producing the motor field. This "parasitical" current must, of course, be balanced by an equal and opposed current in the stator winding. The latter increases the no-load current of the motor, but has no connection whatsoever with the exciting current responsible for the motor field.

The value and phase of this "parasitical" current practically depend on the design of the motor, and it is by no means necessary, as contended by Dr. McAllister, that this "parasitical" current in the armature axis of the rotor should be exactly equal to the rotor current responsible for the motor field.

In an ideal motor the phase difference would be 90 deg., and no "parasitical" current out of phase with E_t could therefore exist. The main factors on which the magnitude and phase of the "parasitical" current depend are the phase difference between transformer and motor field and the motor resistance along the armature axis. In order to recognise this it is necessary to examine into the reason why in a commercial motor the "motor field" is not exactly in quadrature with the "transformer field" even at or near synchronism. The study of the ordinary transformer diagram as shown in Fig. 1 at once reveals this reason. Using the usual notation, the point to note is that the field does not lag by exactly 90 deg. behind the E.M.F. (P_1) applied to the terminals of the transformer winding. This E.M.F. (P_1) must equal and oppose the three E.M.F.s ($-E_1$) ($-J_a r_1$) and ($-J_a x_1$). The first of these is the back E.M.F. induced by ϕ, the second is the E.M.F. lost in overcoming the ohmic resistance of the primary, and the third is the E.M.F. of self-induction due to the primary leakage field. It is clear that the phase difference between P_1 and ϕ will vary quite independently of the actual magnitude of ϕ as the design is altered—in other words, as either ($-J_a r_1$) or ($-J_a x_1$), or both, are varied. It will also be understood that the influence of these factors on α varies in an obvious way with the phase difference ϕ_a. As a rule, both E.M.F.s just mentioned will be very small in the case of a good stationary transformer, but they will attain very appreciable values in the case of the self-excited single-phase shunt induction motor.

The conditions which we have been considering are, of course, reproduced in the motor-field axis of such motors. The E.M.F. (E_r) due to rotation of the rotor conductors in the transformer field acts on the rotor winding along the motor-field axis. E_r corresponds with P_1 in Fig. 1, and the rotor winding along that axis is to all intents and purposes the primary of a transformer on open circuit. In this combination ($J_a r_1$) will as a rule be considerably greater than ($J_a x_1$) and ϕ_a will be near 90 deg., in which case the motor field ϕ_m will lag by less than 90 deg. behind E_r (see Fig. 2). Should the contrary be the case with smaller values of ϕ_a then ϕ_m might lag by more than 90 deg. behind E_r (see Fig. 3). Now E_b, which ought at no load to balance E_t, is in phase with ϕ_m, whereas E_t lags just 90 deg. behind ϕ_t, the relation between these E.M.F.s and their respective fields remain unaltered, irrespective of the variations of ϕ_a, or ($J_a r_1$), or ($J_a r_1$); it thus follows that the "parasitical" current will lag behind E_t in Fig. 2 and will lead E_t in Fig. 3. (As a matter of fact, the conditions of Fig. 3 cannot be obtained in practice without external help.) This great change directly influencing the magnitude of the no load current of the motor is brought about by simply changing the rotor winding of an imperfect motor and without necessarily altering the magnitude of either ϕ_t or ϕ_m to an appreciable extent, whereas the resulting alteration in the no-load current might easily amount to 100 per cent. It must also be clear that as the phase of ϕ_m varies with respect to ϕ_t not only does the phase of the parasitical current vary, but also its magnitude. In Figs. 2 and 3 the "parasitical" current is only indicated approximately by the vector i_p, the effect of the small self-induction in the armature axis of the rotor not having been taken into account. Enough, I think, has been said in order to show that there is no reason whatever why the magnetising current absorbed by the stator should be equal to the sum of the magnetising currents required for the "transformer" and for the "motor field." The actual value of the no-load current of such motors has a well-defined minimum but has no fixed maximum. The minimum is equal to the magnetising current of the transformer field, whereas the maximum depends on the design and varies in practice between about 1·7 and 2·5 times the minimum.—Yours, &c.,

London, S.E., Sept. 20. VAL. A. FYNN.

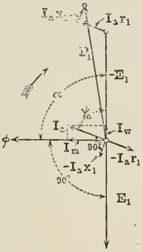

FIG. 1.

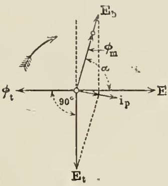

FIG 2.

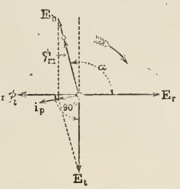

FIG. 3.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Alternating Currents." By C. G. Lamb. (London: Edward Arnold.) 10s. 6d.

"Researches on Cellulose." II. (1900-1905). By C. F. Cross and E. J. Bevan. (London: Longmans, Green & Co.) 7s. 6d. net.

"A First-Year Course of Practical Magnetism and Electricity." By Dr. P. E. Shaw, B.A., D.Sc., &c. (London: "The Electrician" Printing and Publishing Co.) 2s. 6d.

"A Manual of Hydraulics." By R. Busquet. Translated from the French by A. H. Peake. (London: Edward Arnold.) 7s. 6d.

"Practical Methods of Inorganic Chemistry." By F. Mollwo Perkin. (London: Archibald Constable & Co.) 2s. 6d.

"Technological and Scientific Dictionary." Part XIV. (and last). Edited by G. F. Goodchild and C. F. Tweney. (London: George Newnes & Co.) 1s.

"Elementare Vorlesungen über Telegraphie und Telephonie." By Dr Richard Heilbrun. Issued in nine parts. (Berlin: G. Siemens.)

"Turbinen und Turbinenanlagen." By Viktor Gelpke. (Berlin: Julius Springer.) 15m.

"Clive's Mathematical Tables." (London: W. B. Clive.) 1s. 6d.

"Einführung in die Elektrotechnik." By Prof. A. Zeeman. (Vienna: A. Hartleben.) 2m. 70pf.

"London University Guide and Correspondence Calendar," 1907. (London: University Correspondence College.)

"German Scientific and Technological Reader." By E. Classen and J. Lustgarten. Books I. and II. (London: Harper Bros.) 2s. each.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The trustees of the Victoria Jubilee Technical Institute, Bombay, invite applications for the position of head of the department of physics and electrical engineering. Preference will be given to candidate with experience in works and in actual technical teaching in physics and electrical technology. Salary 600 rupees, rising to 800 rupees, per month. Applications to Prof. W. E. Ayrton, F.R.S., 41, Norfolk-square, London, W. See also an advertisement.

A superintendent of telephones and foreman of electric light service is required for Dominica, West Indies. Salary £240 per annum, with free passage out and home. Engagement for three years. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Oct. 8. See an advertisement.

A leading hand is required for the test room by the Jandus Arc Lamp Co., Hartham Works, Hartham road, Holloway, London, N. See an advertisement.

Two switchboard attendants are wanted immediately at H.M. Dockyard, Chatham, with experience in direct-current generating station work. Applications to the Electrical Engineer. See an advertisement.

A manager will be wanted next year for asphalte factories. Knowledge of French language and of electrical and steam machinery essential. Salary £350 and furnished house.

Southampton Electricity committee have appointed Mr. H. L. Mills chief assistant electrical engineer (in place of Mr. Bridger, who resigned) at £210, rising by increments of £10 to £250 per annum, and Mr. J. B. Howat as second assistant and station superintendent at £170, rising by £10 to £200.

Mr. Walley, of Bournemouth, has been appointed on the staff of the Watford electricity department, at a commencing salary of £90 per annum, increasing by annual increments of £5 to £105.

Mr. Eric Hayward, senior shift engineer at Croydon, has been appointed shift engineer at Fulham.

Hebden Bridge Electricity committee have appointed Mr. W. Harwood assistant engineer at the electricity works.

EDUCATIONAL NOTICES.

University of Liverpool.—The 1906-7 session commences on Oct. 9. The courses of study in the faculty of engineering, leading to the ordinary degree of B.Eng. (or the certificate in engineering) are so arranged as to afford a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are also afforded for postgraduate work and research. Prospectuses may be obtained from the Registrar.

Merchant Venturers' Technical College, Bristol.—There are courses for electrical, civil, mechanical and mining engineers, chemists, architects and builders. The instruction includes preparation for the matriculation, B.Sc., and D.Sc. degrees (including engineering) of the University of London. Calendars (6d.) or short prospectus (free) from the Registrar.

King's College, London.—The 1906-7 session commences on Wednesday, Oct. 3. In addition to the ordinary day courses in engineering and applied science there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Courses of instruction are arranged (in connection with the evening classes at the college) for the intermediate and final examinations for the B.A. and the B.Sc. degrees of the University of London. There are also classes in engineering and architectural subjects. Full information and prospectuses from the Dean (Mr. R. W. K. Edwards), or the Secretary.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opens on October 2; matriculation and exhibition examinations on Sept. 24-29. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Finsbury Technical College.—The session for the evening departments in electrical and mechanical engineering, chemistry and applied art begins on Oct. 1. Programmes containing particulars of courses of instruction may be obtained from the Registrar at the college Leonard-street, Finsbury, E.C.

An introductory course of six lectures on the Calculus for engineers will be given by Prof. Coker, commencing Tuesday, Oct. 2, at 8 p.m. These courses will serve as an introduction to the advanced course of lectures and laboratory work on steam and other heat engines, and will occupy the remainder of the session.

Electrical Standardizing, Testing and Training Institution. This institution affords a complete theoretical and practical training in electrical engineering, including workshop practice in well-known works.

Northampton Institute.—Full-day courses in the theory and practice of electrical and mechanical engineering commences on Oct. 1. These courses, which include periods occupied in workshops, extend over four years, and also prepare for the B.Sc. degree in engineering at the University of London. Full and part-time day courses in all branches of technical optics are also given in specially-equipped laboratories and lecture rooms. Particulars of fees, &c., can be obtained at the institute or on application to the principal, Dr. R. Mullineux Walmsley.

Evening technical courses in all branches of electrical and mechanical engineering commenced on Monday last. The laboratories are well equipped for both alternate (single and polyphase) and continuous-current work and for all kinds of electrical testing.

Borough Polytechnic Institute.—A four year course of instruction in electrotechnics (comprising lectures and laboratory work) for evening students commenced at this Institute on the 24th inst. Particulars of these courses, and also of the chemical, electrochemical and engineering courses, may be obtained on application to the principal (Mr. F. C. Millis), 103, Borough-road, London, S.E.

General Engineering College.—At this college individual coaching is given in engineering subjects, especially in preparation for the technical schools and London University examinations. Particulars from the principal, Mr. J. H. Reeves, M.A., 2, Penywern-road, Earl's Court, London, S.W.

Birkbeck College.—On Wednesday the 1906-7 session of this college was opened by Sir Edward Busk, who devoted his opening address mainly to a sketch of the work of the London University under its new constitution, recalling the facts that the Birkbeck College was founded in 1823, 13 years before the University, and that as early as 1830 it admitted women to its lectures.

Morley College for Working Men and Women.—The new session opened on Monday. There are classes in electricity and magnetism, mathematics, chemistry, physics, drawing, French and German, book-keeping and other commercial subjects. The fees for all classes are very low. Copies of the programme may be obtained at the College, Waterloo-road, London, S.E. The annual distribution of certificates takes place on Oct. 2.

"Simplex" Sample Cabinets.—We would remind principals of Technical Colleges and others concerned in teaching and demonstration work that Simplex Conduits (Ltd.), 11, Queen Victoria-street, London, are issuing their sample cabinets for the forthcoming winter session. The company will be pleased to hear from those who can make use of these. The cabinet comprises a specially constructed stained box with lift-up lid, lock and key, four movable trays or shelves, each fitted with sub-divisions for the various samples, &c. In addition to various types and sizes of Simplex conduit, with the necessary couplings, bends, &c., there are a number of accessories and erecting tools. In fact, the equipment is complete for demonstration purposes.

Assessment Appeals.—The Coatbridge magistrates have reserved their decision in the appeal of the Scottish House-to-House Electricity Co. against the assessments of their generating station and cables. The ratable value in Coatbridge was £1,477 and in Airdrie £490.

The appeal of the Yorkshire Electric Power Co. against the assessment of their generating stations and mains was recently heard by the Dewsbury Union Assessment committee, and the ratable value placed upon the stations and mains has been reduced from £1,484 to £50.

Australasia.—Sydney Electric Lighting committee recently adopted a report by the city electrical engineer (Mr. T. Rooke) on the electric lighting of the Sydney domain.

In Mr. Rooke's estimate of the cost of the installation provision is made for erecting 54 1,400 c.p. arc lamps. If underground cables are laid the cost will be between £3,700 and £4,000, but if overhead cables are used the expenditure will be £2,500, less £5 for every pole omitted—if the lamps are suspended on trees, as in Hyde Park. The cost of maintenance of lamps and supplying electricity would be £1,504 per annum, or £26 per lamp.

The "Australian Mining Standard" says:—

Subiaco (W.A.) Municipal Council have decided to charge a licence fee of £2. 2s. to all electricians engaged in electric installation work in the municipality, and all applicants for licences will be subjected to an examination by the Council's chief electrician. The general rules for wiring issued by the Fire Underwriters' Association of W.A.[*] have been adopted, and as a penalty for infringing the Council's proposed bye-laws the installing contractor will be liable to have his licence cancelled.

A recommendation that all installations should also be examined by the Council's electrician and that a certificate should be given by him has been referred back to committee.

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[*] The F.U.A. of W.A. practically adopt the rules of the Institution of Electrical Engineers (London). An abstract of the F.U.A. rules is given in "The Electrician" Electrical Trades' Directory and Handbook, 1906, (p. 325).

Williamstown (Victoria) Council contemplate the erection of a high-level electrically-operated transporter bridge over the river Yarra at an estimated cost of £18,000.

Sydney Electric Lighting committee recommend the rescission of the resolution to invite tenders for the duplication of the last contracts for additional generating plant, and advise the Council to duplicate the contracts now in hand with Dick, Kerr & Co., the Australian General Electric Co. and the Stirling Boiler Co.

Birmingham.—The official inauguration of the Summer-lane power station has been fixed for Oct. 10.

Brazil.—In the city of Rio de Janeiro extensive municipal improvements have been progressing for some years and are still the subject of much enterprise. Beyond the improvements in the sanitary conditions of the Brazilian capital the work of demolition and reconstruction of the principal thoroughfares in order to provide widened streets for purposes of general sanitary improvement and traffic requirements has proceeded, and there are now many large avenues open for traffic where formerly existed tortuous networks of narrow streets. This has, of course, led to the adoption of electric lighting on a considerable scale and the extension of the tramways in the district.

The Rio de Janeiro Tramways, Light & Power Co. is a company incorporated in Canada in 1904, with headquarters at Toronto. The company has a share capital of $25,000,000, with $25,000,000 debentures. Most of its promoters are associated with similar enterprises in Canada and the United States, including the Sao Paulo Tramway, Light & Power Co. (Ltd.), the Mexican Light & Power Co. (Ltd.), Trinidad Electric Co., the Montreal Light, Heat & Power Co., &c. The scheme of the company includes the development of water-power and its utilisation in the form of electric energy in Rio de Janeiro and other places. The company has already acquired two large water powers, one on the Parahyba river, a distance of about 80 miles from Rio de Janeiro, capable of giving about 100,000 H.P., others on the Rio das Lages and streams in the vicinity, about 50 miles from Rio de Janeiro, where the company is now developing 40,000 H.P. This can be increased to 100,000 H.P. as the demand develops. The company expects to commence supply of electric energy in Rio de Janeiro and the adjoining city of Nitheroy about the end of 1906.

The company has acquired the Carris Urbanos, Saõ Christoraõ and Villa Izabel Street Car Companies, and has also a large interest in the Carioca Company, which works the electric line from the centre of the city to the district of Santa Thereza. These comprise all the street car companies in Rio de Janeiro other than the Jardini Botanico Co., which operates in a separate zone. The Carris Urbanos and Saõ Christoraõ Companies at present employ animal traction. Prior to the acquisition of the Villa Izabel Company, the electrification of its lines had been commenced, and they are now about to be operated electrically. It is the intention of the new company to shortly commence the transformation of the rest of the system, which it is expected will be completed within two years. The Carris Urbanos, Saõ Christoraõ and Villa Izabel Companies have now 125 miles of track, which will be increased in the transformation. The concessions of these companies vary from 30 to 50 years, with monopoly of zone. The new company is applying for a new concession unifying all the existing concessions.

The same company has acquired the Federal concessions for the railways to Tijuca and Corcovado, the former being already worked by electric traction and the latter by steam. The Corcovado Railway will shortly be equipped for electric traction, and the hotel at Panieiras, which is owned by the same concessionaires, will undergo reform. The company has also acquired the Société Anonyme du Gaz de Rio de Janeiro, which, under its concession from the Federal Government, controls the illumination of the city until 1915. At present there is a small amount of electric lighting, current being generated by steam plant belonging to the company.

The company has also a concession from the municipality of Rio de Janeiro, which includes a monopoly for the distribution of electric energy for power until 1915, when the concession continues for a long period without monopoly.

The company has also recently acquired the city's telephone enterprise, whose business has heretofore been conducted by a German company. The telephone concession gives monopoly for a period of 30 years. The installation recently destroyed by fire has now been completely renewed.

Brighton.—An attempt was made last week to rescind the resolution recently passed by the Corporation in regard to the collection of the electric lighting accounts and the erection and fitting up of show-rooms for the electricity department, but after discussion the motion to rescind was rejected.

Acting on the advice of their borough electrical engineer and manager (Mr. John Christie) the Lighting committee have accepted an offer for the purchase of the tramways plant (one large and two small sets, with spare parts, &c.) at Bread-street, for £3,300. The original cost of the plant (in 1901) was £7,750, of which £894 has been paid off.

Bristol.—The adjourned inquiry into the application of the Corporation for sanction to borrow (inter alia) money for extensions of the electricity undertaking was resumed on Thursday last week. The proceedings at the former hearing were given in our issue for Aug. 3.

The inspector (Mr. H. Ross Hooper) said he understood the application as regarded electrical works had been increased from £108,554 to £118,000, and he inquired if there had been a resolution of the Council on the subject.

The assistant town clerk (Mr. Wise) said there had been no meeting of the Council since that figure had been arrived at, but the matter would be brought before them and a resolution would, no doubt, be passed.

The Inspector gave a summary of the alterations in the amounts applied for. For Temple Back works the amount (£10,400) had been reduced to £9,890; for Avon Bank the original sum was £57,100, but this was reduced to £43,137. The additional amount apparently arose for the distribution system. The original amount for the latter was £40,709, but £69,767 was now asked for.

The provision of a low-tension switchboard came under consideration, and the borough electrical engineer (Mr. H. Faraday Proctor) said the demand for electricity, both for power and lighting, was on the increase and the new switchboard was required.

The estimates for work at Avon Bank were next considered, and Mr. Proctor gave technical evidence of what was required.

The Inspector said the evidence clearly warranted the extra machinery which was asked for, and which accounted for two of the heaviest items of the application, amounting to £24,000. That conclusion was arrived at in view of the load experienced last winter and that anticipated for the coming winter.

At the previous sitting the question of a crane was raised, and Mr. Proctor stated that it was very desirable, though not absolutely necessary, and the item was left open. It now transpired that after the inquiry a contract for the crane was sealed, the cost being £900.

Mr. Proctor explained that although the contract was not sealed till after the first sitting of the inquiry, the Corporation were pledged to the purchase before that date.

A question having arisen as to permanent employés, the Inspector said it was a principle of the L.G. Board that the work of all permanent employés should be chargeable to revenue and not to capital account.

Mr. Prosser said the committee would probably discharge the men and let the work out to contract. There had been altogether 16 loans for electricity supply. On the first 12 loans there was £8,578 under expended and £3,833 over expended, so that there was a balance in hand of £4,745, which it was proposed to allocate towards the reduction of the present application. In relation to the other four loans, the accounts still remained open, the works not being complete.

The Inspector said they had discussed all particulars of the application in some detail with the exception of £4,000 for boilers and boiler plant.

The clerk to the Electric Light committee (Mr. Prosser) having submitted particulars as to the balance of £17,335 on previous loans,

The Inspector said it was not the intention of the L.G. Board to sanction loans for plant and machinery that were not required at the time. He saw they had £6,000, and he understood they were not sure whether they were going to carry out the work. In regard to an application made to the Board over two years ago, they were not sure whether they wanted £6,000 or not.

Mr. Proctor said the only item in the present application which would not be expended immediately was £750 for ash-handling plant.

Ald. Pearson said he would like to know the extent to which the committee might look forward in those matters. In estimating an increase of power and lighting how many years, would the inspector say, should they look forward?

The Inspector: You must look to the machinery you are laying down to meet your future requirements, but it is something different I am alluding to. If water-softening apparatus, for instance, was needed two years ago, why was it not yet put in? Application should only be made for loans for works which they knew they would carry out.

Ald. Pearson said it was hopeless to expect gentlemen carrying on a business like that to forecast what they wanted in 12 months' or two years' time. They did not know what loan they required from year to year, and they might find themselves out in their estimates. He quite agreed that things should be made clear at the next inquiry.

The Inspector said that with regard to the £6,000 it was a question of principle. The Board would allow a fair licence in the case of machinery. In the matter of cables they sanctioned a loan three years in advance of the expected expenditure. But that did not apply to machinery. It must be known what machinery was required, because it took pretty nearly a year to get it.

Ald. Pearson said that was the point. They could not walk into a shop and buy their machinery. What they wanted was a reasonable allowance in their estimates. Personally, he would be satisfied with two years for cables. Then might they not change their minds as to the nature of work they intended to do?

The Inspector: No, the application must be for certain items. If they wanted to make any change it was right and proper that they should report it to the Board.

Mr. Proctor repeated that the whole of the work now proposed would be put in hand at once, with the exception of the £750.

In giving a summary of the various items and their cost the Inspector said that the net amount available from former borrowings which the Corporation had not exhausted and which they asked should go to the reduction of the present application was £7,016, bringing the net amount now applied for to £105,032. 10s. 10d.

In regard to the cost of street lighting, Ald. Pearson said the original estimate for the first 100 lamps was included in the estimate of Sir William Preece when the undertaking was started. He did not know, and he considered it no part of his business to know, whether any item in their books was properly chargeable, because he must leave it to the accountant and the auditors. The figures had been given to the committee in detail. He did not know that that subject was going to be discussed there. It came to him as a surprise that they should be expected to know the whole of the doings of the gas company compared with their own undertaking. The committee had received information from the engineer, and on that basis had formed an opinion as to the price to charge for street lamps. He had had occasion to go into the prices of gas and of electricity in 1905, and he had then an opportunity of considering their position, and therefore made some comparison between the inclusive charges of the electricity and gas undertakings. He took the price of gas at 1s. 9d., the price then charged the city, and he took the estimated candle-power of their lamps and the amount of gas the gas company would take to illuminate the streets. The gas company always said they would "adequately" light the streets, or used some phrase of that kind. They never pretended to say they would supply the same candle-power in the streets as the Electricity department. He endeavoured to compare like with like. With gas at 1s. 9d. per 1,000, he found the cost of a gas lamp purporting to give 1,000 c.p. was £1. 7s. 10d., the upkeep costing another £1. 7s. 4d., making in all £2. 15s. 2d. per annum. He calculated that they could get 1,000 c.p. of light in the streets by electricity against only 450 by gas.

Ald. Pearson followed with a long and spirited defence of his conduct while chairman of the Electrical committee. Imputations had been made on his good faith and the good faith of those who managed the electrical undertaking. He thought he had a right to ask the Inspector if he had discovered, in that very exhaustive inquiry, a single fact of which any honourable man need be ashamed. If the inspector was satisfied on that point, would he say so?

The Inspector replied that he did not think that was an inquiry in which questions of that sort could be asked. He was merely there to hear the evidence for or against the application. He would say, however, that he thought in their Bristol undertaking they had a very valuable asset.

Ald. Pearson said that, as a public man for 30 years, he was prepared to be attacked. He objected, however, to be told that he was doing the slightest thing dishonourable. That had been suggested by a certain section. He strongly objected to being charged with dishonourable conduct. He gave an undertaking that no portion of the money applied for should be used as wages of permanent employés.

The inquiry, which had lasted two full days, was then closed.

Customs Duties.—It has been decided that under the New Zealand customs tariff an import duty of 10 per cent. ad val. is payable on generator panels and incandescent lamps for electric torches.

Durham.—A special meeting of the County Council was held on Wednesday to consider certain resolutions in regard to the promotion of a bill to enable the Council to engage in electricity supply. After discussion, the vote being equal, the motion to promote a bill was rejected by the casting vote of the chairman.

Two resolutions were adopted in favour of a systematic investigation of the powers and responsibilities of private electricity undertakings and the general question of compulsory purchase by local authorities.

Electric Automobiles in Germany.—The Accumulatoren und Elektrizitätswerke Akt. Ges. vorm. W. A. Boese & Co. (Berlin) has started the construction of light electromobiles.

Electricity in Mining.—The report of the El Oro Mining & Railway Co. (Ltd.) for the year ended June states that the erection of another mill and the introduction of electrical power and of improved metallurgical appliances had resulted in a substantial decrease in working expenses and an increase in the percentage of precious metals extracted from the ore. The replacement of steam by electrical power was commenced in February last and is now practically completed.

Exeter.—The Alphington-street tramway route was opened for traffic on Saturday.

The Tramways committee have instructed the surveyor to fit up tramcars with two or three sample types of outside seats for use in inclement weather.

Fulham (London).—The Council's application for sanction to borrow money for electricity supply has been sanctioned by London County Council, but on the suggestion of the latter body the period of repayment has been reduced from 42 to 30 years, and the amount applied for (£17,328) has been decreased by £3,327.

Grantham Disaster.—Amongst the passengers by the ill-fated Scotch train which met with such a terrible disaster outside Grantham station was a member of the staff of the Great Northern Telegraph Co., employed at the Newcastle branch. Mr. William Carlsen was returning from Denmark, where he had spent his summer holidays. He was fortunate enough to come out of the catastrophe with but slight injury.

Greece.—A company is being formed to take over and convert to electric traction the street railways of Athens and Piræus and the project has been approved by the Greek Parliament. The concession is for 42 years. The work of conversion and extension is to be completed within eight years.

Greenwich (London).—Major Cardew (Messrs. Preece & Cardew) has been invited by the Council to advise and report (for a fee of £50) on the question of purifying the atmosphere of the sewers by means of ozone electrically produced.

Grimsby.—The L.G. Board have informed the Council that they cannot reconsider their decision as to sanctioning a loan for executing part of the electricity supply extension scheme by employés of the Council. The Council have sent a further letter of remonstrance to the Board regretting the new rule of the Board.

Hackney (London).—Current is to be supplied to Dalston Theatre upon the following terms for a trial period of 52 consecutive weeks, with the consumers' option to continue same for a further period not exceeding three years, or, alternatively, to return to the prices then current and applicable to the supply for theatres and music halls within the borough: For any quantity of energy each week of seven days, not exceeding the equivalent of one hour's supply per day at the maximum demand, 6d. per unit; for any further quantity of energy used per week, 1d. per unit. Terms net, with weekly payment.

The Works and General Purposes committee have agreed, in consequence of the decision to substitute flame arc lamps for ordinary lamps in the extension scheme now being carried out, to pay £12 per lamp per annum instead of £11 as previously arranged. The borough electrical engineer (Mr. L. L. Robinson) reporting on this matter, says: The maintenance of flame lamps costs rather more than those of the existing lamps, but the flame arcs give at least 100 per cent. greater illumination and have much better penetrating power during foggy weather.

Hanley.—The Council have approved a scheme of the borough electrical engineer (Mr. C. H. Yeaman) for extending the plant at the electricity works. An additional generating set is required to meet the increasing demand for current, especially for power.

Hong Kong.—A cablegram from the manager of the Electric Traction Co. of Hong Kong (Ltd.) (Mr. J. Gray Scott) announces that the disastrous typhoon which occurred on the 18th inst. did small damage to the company's undertaking, and that the service was resumed on 19th inst.

Inquests.—An inquest was held on Friday last, at Enfield, on the body of a mechanical engineer named Winepress, who was killed at the North Metropolitan Electric Power Co.'s generating station at Brimsdown, where he was employed.

The evidence showed that deceased was employed to do small mechanical work. Whilst engineers were engaged in putting plugs in the wall in the cable trench (under the high-tension room and the engine room) deceased asked for the loan of a quarter-size stock and die for making a thread in a piece of copper tubing which he held in his hand. He was told he would find what he required in a tool box, made a half turn and was in the act of making his way out in the same direction as he entered when there was a report and a flash. The workmen did not know what had happened, but made for an opening. The engineer-in-charge was informed, and the engines were stopped. Some of the men went through the high-tension tunnel and saw deceased lying across a joint box, and the piece of tubing was lying 2 ft. or 3 ft. away from his hand. Deceased had no business in the trench, as notices were placed about warning employés against so doing. Winepress was dead, current of 10,000 volts having probably gone through his body.

The jury held that deceased went to a place where he had no business to go, and returned a verdict of misadventure.

An inquest was opened at Derby on Friday last week into the death of Thomas W. Allsopp.

Evidence was given to the effect that deceased (a journeyman butcher) was employed in King-street, Derby, and went into a cellar to switch on current to an electric fan, when he came in contact with a live wire and received a shock which proved fatal.

Medical evidence was subsequently given to show that deceased was a strong, muscular man, and that death was due to sudden failure of the heart consequent upon shock.

Mr. T. P. Wilmshurst, borough electrical engineer at Derby, said the voltage of the current was only 200, and by the Board of Trade regulations up to 250 volts was low pressure. He had never before heard of a healthy man being killed by such a low pressure, and he thought that the exceptional circumstances of the man standing in a briny puddle, his hands covered with brine and the fan also covered with brine, must account for the fatal result.

Mr. John F. C. Snell, who was called by Allsopp's employer, said the apparatus was in perfect working order. He agreed with Mr. Wilmshurst's conclusion, and added that before that accident he would never have suggested that such fans should be earthed. He had since altered his views on the point.

Mr. G. Scott Ram, H.M. Electrical Inspector of Factories, said that 200 volts are regarded as quite safe. In his opinion, in a damp cellar certain precautions should be taken.

The jury returned a verdict of accidental death, and recommended that the risks of portable fans and other electrical apparatus should be carefully considered, and any necessary warning issued to those using them.

Italy.—*Electrical Developments in the Venice District.*—For some time past there has been talk of the adoption of electrically-driven launches for the public service on Venetian waterways, but (according to a lengthy and interesting report from Mr. Consul De Zaccato) the project appears to have been abandoned by the municipal authorities notwithstanding the advantages that would have been derived from the increased speed of the launches and the absence of smoke. Mr. De Zaccato considers that the schemes for improving the island waterways in Venetia and Lombardy will soon be taken up more energetically, and his report continues:—

It seems to me that the principal task will be to provide a proper mode of traction. As great progress in mechanical haulage on canals is taking place everywhere, there cannot be any difficulty for competent engineers to decide whether electric motor cars running on the canal banks, tugs with electric motors, or a modern system of overhead traction should be adopted, I presume the required power for towing the barges might be cheaply produced by the waterfalls that are plentiful everywhere here, and the energy might be supplied through stations along the river. The hydro-electric plant might be municipalised for the purpose, under Government control. I believe that the use of tugs would not prove successful, owing to the greater difficulty of navigation, the low speed at which they would be compelled to go, and the difficulty of having at such a distance electric power supplied to boats for towing purposes. Previous experiments on a large scale with steam tugs have been unsuccessful. The best method of towing the barges would consequently appear to be by suitably-designed light tractors running either on a line built along the canal bank or on an overhead railway supported on masts erected on the sides of the canal. Small tugs, electrically propelled, might be used in those parts of the river where it would not be possible to get a tow-path made for the tractors. I am unable to give any details of the expenditure that would be required, nor do I know the condition of the paths along the banks of the river well enough to be able to express any opinion as to which system is to be preferred. The communal and provincial authorities, supported by the State, might each assume a portion of the expense for the reorganisation of the canals, which would, of course, be not inconsiderable, as stated in my commercial report for 1903-4, but, in the event of the authorities not being disposed to municipalise this enterprise, I am inclined to believe that a strong company might be formed for this purpose, and to carry on the working of the navigation on the canal, provided fair subsidies were given and concessions granted by the authorities concerned. There is no doubt that agriculture would benefit considerably, as would also the general trade of the country. There cannot be any conflict of interests between the railroads (now owned by the State) and the rivers, as the former are generally employed for goods requiring speedy delivery, while the latter are chosen for merchandise to be transported at a low cost and admitting of retarded delivery.

On June 5, 1906, some experiments were made with a boat furnished with a gas motor, supplied by the Società Milanese di Industrie Meccaniche, to the local Società di Navigazione Fluviale, and it is said that for short distances the trial was successful.

Owing to the rapid increase of all industries in Venetia and Lombardy and the to improvements on the canals, Venice has a brilliant future before her. The Austrians, who are pushing their interests in every possible way, are stated to have facilitated an arrangement between the Unione Austriaca di Navigazione of Trieste and the local Società di Navigazione Fluviale for the conveyance by barges of goods from Mantua to Venice to be shipped on board the steamers of the Unione for exportation to the United States, Mexico, Central America and the Antilles. It is said that an agreement will also be made with the railways and tramway companies connecting the principal industrial centres with Mantua, where goods will be loaded and unloaded.

A Venetian company has been formed, with a capital of 500,000 lire (£20,000), to be subsequently increased to 2,000,000 lire (£80,000), with the object of carrying on the motor car industry in all its branches, and to this effect they are said to have made an arrangement with the Società Anonima Garages Italiani. A factory will be established at Mestre, where all foreign motorists may deposit their cars and have any repairs effected in case of need. A special service of lagoon launches will also be started to convey them to their hotels in Venice. Modern engineering science and the employment of motive power, which is to be derived from waterfalls, are making such progress that there is no doubt that there will be a rapid development in the use of eletric motor cars and omnibuses for the conveyance of passengers, mails, &c., which may ultimately affect the financial prospect of tramways.

Railway directors appear to have the intention of adopting a new autocar service to give more frequent facilities to travellers, with a view, I presume, to competing more successfully with tramways running on lines close to the railways.

The Cellina hydro-electrical installation is now working and the principal industries in the town are supplied with electrical power from that river. Another company has been formed for establishing hydro-electric plant on the rivers Cismon and Brenta, under the name of the Società Forza Motrice Cismon Brenta, with a capital of 2,000,000 lire (£80,000), and shares of 200 lire (£8) each have been issued. The first plant will be erected on the Ponte della Serra, and, it is asserted, will produce 700 H.P. to supply electric energy for industrial purposes to the provinces of Belluno, Vicenza and Padua. At Verona there is a canal with a fall of about 38 ft., which distributes power to several factories erected on the spot. A portion of the power is utilised to generate triphase current at 3,000 volts, which is dispensed to the small industries in the town. The waterfalls in these provinces continue to be utilised for industrial purposes, and hydro-electric plants are erected or planned in all directions.

It has been announced that a preliminary contract for building and working an electric railway on Lake Garda has been signed in London by Messrs. Rothschild, and that a sum of 250,000 lire (£10,000) will be deposited at the Cassi di Risparmio of Verona (Verona Savings Bank). The cost of building the line has been computed to be about 13,000,000 lire (£520,000). The committee hope soon to obtain the concession from the Italian Government.

The Verona Horse Tramway Co., a very lucrative concern, is about to adopt electric traction. The municipality accepted the project presented by the company on account of the advantages offered to the commune, but the question whether the working of the tramways is to be left to the present company or to be municipalised has not yet been decided by the council. The company offered to build and equip the station and line and give the municipality a liberal proportion of the profits earned by the company. It is stipulated that the running stock, equipment, &c., may be taken over after ten years at valuation prices, and that after 30 years the undertaking will become the property of the commune. Three new lines are to be laid by the company—one to Borgo-Trento, passing through Ponte Umberto and San Stefano; one to the San Zeno gate from Castelvecchio; and one to Porta Vescovo through Via Leoncino. The terms proposed are so advantageous to the commune that there is every probability the project will be accepted by the municipality.

The Mestre-San Giuliano horse tramway service in connection with the small steamers from Venice has been transformed into an electric line, and new shares for an increase of capital of 1,000,000 lire (£40,000) have been issued.

The Società Veneta, which owns the steam tramway route Fusina-Padua, also in connection with the steamers from Venice, has decided to work the lines in future by electricity.

The syndicate for the formation of a company with a capital of 1,000,000fr. (£40,000), to build and work tramways in the province of Vicenza, to be called the Società per le Guidovie Vicentine, has applied to the provincial deputation for a concession with respect to the following lines: (1) Bassano-Vicenza, with a branch line to Marostica, through Breganze Thierre, Lugo and a prolongation to Noventa and Montagnana. (2) Valdagno-Recoaro, in connection with the tram Vicenza-Valdagno. (3) Montecchio-Montebello-Lonigo, in connection with the tram Vicenza-Tavernelle-Montecchio. The lines will be of normal gauge, with Vignoles steel rails of 45 lb. per running yard, laid on timber sleepers, secured by clamps. The gradients are not to be more than 30 per 1,000, except on the line Valdagno-Recoaro, where they may be as much as 45 per 1,000. The curves are to be of a radius not less than 40 yds. It is expected the concession will soon be granted, and that it will be for 50 years. The lines are to be liberally subsidised by the Vicenza provincial deputation and by the communes concerned.

The Vicenza-Valdagno-Arzignano tramway line has been extended to Chiampo.

With reference to the scheme for constructing tramways starting from Venice, Padua and Treviso in different directions, chiefly through districts not traversed by the railway, it has been announced that a company to carry out this project was formed at Brussels on Feb. 21, 1906, with a capital of 1,300,000fr. (£52,000), in 13,000 shares of 100fr. each. The syndic of Treviso, Count de Fellissent, has handed over to the company the concessions given by the provincial deputations for the lines Pieve-Oderzo with the branch lines Tezze-Conegliano-Treviso-Marano and Treviso-Meolo of the total length of 106 km.

There is also a project to build an electric tramway from Mestre to Treviso on the provincial road called Terraglio.

The whole of the region at the foot of the Carnic Alps between the rivers Astico and Tagliamento is without rapid means of communication, except where the State railways touch at a few distant points, but do not pass through it. It is a zone about 150 km. long, thickly populated and with great mineral, agricultural and industrial resources. I think there might be an opening for the profitable investment of capital if a powerful company studied the question with a view to a well-devised scheme of building and working the railways or electric tramways. Very extensive tracts of marsh land have been and are being reclaimed in these provinces.

A wireless telegraphy station was installed in the arsenal at Venice on May 28 last.

King's Norton.—The Council have decided to take electric current for the Moseley and King's Heath tramways from Birmingham Corporation.

Lancaster.—Messrs. Kershaw & Co., Birmingham, who made proposals to purchase the municipal tramways, have withdrawn their offer, and the Tramways committee are now open to receive other offers.

Largs and Wemyss Tramways.—A scheme is being prepared for the construction of a tramway between Largs and Wemyss Bay, and a provisional order will be applied for next session.

London County Council Tramways.—The line from the Hop Exchange, Southwark-street, to Vauxhall, via St. George's Circus, which has been converted to electric traction, was opened for traffic on Monday. This section forms part of the routes to Wandsworth and Battersea.

The service between Tooting and Plough-road will be extended on Monday to Queen's-road, Battersea, and the line from Clapham Junction to Queen's-road will be opened on the same day.

A conference, convened by the Royal Arsenal Co-operative Society, was held at Woolwich on Wednesday, and passed a resolution to urge London County Council to extend their electric tramways to the county boundaries at Abbey Wood and Eltham.

Malvern.—An inquiry was held on Monday into the Council's application for sanction to borrow £4,500 for electric lighting extensions.

The clerk (Mr. H. L. WHATLEY) gave evidence as to the present position of the electricity undertaking. For the year ended March, 1905, the adverse balance was £1,336. 14s. 4d., but for the year ended March last this loss has been reduced to £834. 2s. 2d., and would have been further reduced had certain items been credited. The inspector (Mr. H. R. HOOPER) explained that the application was for two separate loans of £2,500 and £2,000 respectively. He understood that part of the former amount (£1,629. 12s. 7d.) had already been expended. The L.G. Board could not sanction the loan unless details as to the proposed expenditure were submitted. He would point out that it was necessary for all permanent employés of the Council, whether employed on work entailing capital expenditure or not, to be paid out of revenue. No permanent employé must be paid out of capital.

In reply to an objection that the electric light undertaking was unprofitable, and that further extensions could only be made at the expense of the gas works, from which a profit was derived, Mr. WHATLEY said that while the young electric supply undertaking had been feeling its way, and gradually increasing its revenue, profits on the gas works had considerably increased.

Manchester.—The Tramways committee have decided upon some further extensions of the tramway routes in the city.

Marylebone (London).—The Electric Supply committee have approved a scheme of bonuses to employés at the generating station.

The scheme, which has been prepared by the resident engineer (Mr. F. A. Wilkinson), is being tried during the present quarter, and will be continued during the December quarter. The total number of units which will be generated during that time is estimated at 4,500,000, and the bonus is to be paid on the ascertained works cost of units sold, the repair cost of plant to be included. The average cost per unit for the period under review would be approximately 0·54d., and with the bonus scheme in force it is anticipated that this figure will be reduced to 0·44d. This saving will mean about £1,900, of which £200 will be paid in bonuses to the men. Employés discharged for insubordination forfeit the right to bonus, but any man discharged for slackness or who leaves to better himself will receive the amount due to him.

"Municipal" Football.—A match played at Wigan on Wednesday, between Wigan and Sheffield teams in the Municipal Tramways League, resulted, after a well-contested game, in a win by Wigan by two goals to nil.

Newport (Mon.).—The question of extending the Corporation-road tramway route to the transporter bridge is under consideration by the Tramways committee.

Parcels Service on Tramways.—Manchester Tramways committee have decided to restrict the work of parcel carrying to the area covered by their tramways.

Bolton Combined Traders' Association are agitating for the inauguration of a parcels service on the local tramways, and the Tramways committee have decided to receive a deputation on the subject.

Personal.—Mr. J. A. McMullen, having resigned his position as station engineer of the large gas-driven electric generating plant belonging to Johannesburg Municipality, will, we learn, be returning to England about the end of October.

Pontypridd.—The Electricity and Tramways committee have postponed for six months the proposal to arrange mutual running powers with the Rhondda Tramways Co. from Pontypridd to Porth.

Provisional Order Transfer.—Wellington (Salop) Council have decided to transfer their Electric Lighting Order (1901) to the Shropshire, Worcestershire & Staffordshire Electric Power Co.

Railway and Tramcar Shed and Siding Regulations.—It will be remembered that the Tramways and Light Railways Association and the engineers and managers of municipal and company-owned tramway undertakings strongly objected to tramcar sheds being included in the scope of the draft regulations issued by the Home Office in May, 1905, and in regard to which Mr. Chester Jones held an inquiry in November last. Mr. Chester Jones has now issued a report recommending certain exemptions, including depots or sheds used for storing, cleaning and repairing tramway or light railway cars.

St. Austell.—Tenders, submitted by the local electric lighting and gas companies, for the public lighting are under consideration by the Lighting committee. The electric lighting company offered to supply 74 c.p. lights at 25s. per annum, and five 250 c.p. at the same price.

St. Pancras (London).—In the annual report of the Baths committee it is stated that it was anticipated at the time when electric motors were substituted for the old steam engine for driving the machinery at Whitfield-street baths, a substantial saving would be effected. The past year was a complete one for the working of the motors, and comparing that period with the last complete year of the old engine's running, and having regard to the relative values of the coals used (including cost of electricity consumed) there has been a saving of £120. As the motors cost £103, they have paid for themselves in less than one year. At the King-street baths, where motors and hydros have been substituted for the old machinery, a substantial saving is anticipated.

San Juan (Porto Rico).—It is announced that Canadian capitalists have acquired the electricity supply and tramways in this city. The purchasers intend to develop water power available about 15 miles from the city, to extend the tramways and to modernise the generating plant and rolling stock.

Southampton.—The Council have approved the revised scale of charging for electric current drawn up by the borough electrical engineer, Mr. H. F. Street.

The new scale will be: General rate for all consumers (as at present), 4d. per unit; for consumers using current during March and June quarters (taken together), and the September and December quarters (taken together): Over 17,000 units, 2½d. per unit; over 25,000 units, 2d.

South Africa.—The Cape of Good Hope "Government Gazette" contains the text of two Acts promulgated on Aug. 21, authorising the construction, alteration, &c., of railways at a cost of £2,051,266, the equipment of locomotive workshops £25,000, and electric lighting, £50,000. The "Gazette" may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

Steam Turbines in Germany.—The Allgemeine Elektricitäts Gesellschaft, Berlin, reports that its turbine department has been actively engaged during the past year. Sales reached 5,000,000m. (£250,000) and orders in hand amount to about 10,000,000m. Altogether, about 200,000 H.P. of plant has been supplied and erected. About 10,000 H.P. is on order for the Berliner Elektricitäts-werke. There are 1,700 hands now employed in the company's turbine department.

Stourbridge.—The Council have approved the draft agreement with the Shropshire, Worcestershire & Staffordshire Electric Power Co. for the transfer of the Council's provisional electric lighting order of 1899.

Street Work.—London County Council recently called the attention of the London Borough Councils to the subject of the breaking up of streets in London by companies and others having statutory rights to do so.

Useful legislation might be promoted to strengthen the hands of the Borough Councils in supervising and controlling the works carried out by statutory companies, provision being made for the framing of regulations to deal with the following matters—viz., (1) position, depth and direction of mains; (2) maintenance of the surface at the expense of the company for a period after the surface has been disturbed; (3) the time during which intended works may be carried out after reasonable notice has been given by a Council to a statutory company of such Council's intention to renew the surface of given streets.

The engineer's views are to be submitted to the County Council.

Swinton (Yorks.)—The National Electric Construction Co. have submitted terms to the Council for the electric lighting of the district, and the Lighting committee have been requested to report upon the matter.

Tramway Disputes.—A ballot has been taken of the *Newcastle-on-Tyne* tramways employés as to whether their grievances should be submitted to arbitration. In June they decided to come out on strike to enforce the payment of extra pay for Sunday duty, but were prevailed upon to withdraw the notices, and they then decided to ballot as to whether they could adhere to the agreement which ended the strike last November, for all matters of difference to go to arbitration. The majority are largely against arbitration, and declare a preference to abide by a decision of the elected representatives of the city, or a plebiscite of the inhabitants.

On Friday morning the tramway workers in *Salford* rejected a motion that they should be balloted on the question of sending in their notices, and by a majority of two to one decided to accept the terms of service offered by the Tramway committee of the Corporation.

The manager of the *Halifax* tramways department (Mr. F. Spencer) states that 60 men have so far applied for reinstatement, and of these 28 motormen and 15 conductors have been re-engaged and work provided for them.

Wages Dispute at Loughborough.—A wages dispute between the Brush Company and the coachbuilders engaged in the car body building branch of the company's Loughborough works has been made the most of in the daily journals. The fact is that the men belonging to the Coach Builders' Society asked for higher weekly wages, with the object of making a uniform minimum rate of 34s., rising to 38s. This the company was not able to grant. There appears to be no other point involved. The company have, however, as a result of the dispute, had to decline a contract from Manchester Corporation for 20 tramcar bodies. About 160 men have been paid off. Mr. W. Horton, secretary of the Coach Builders' Society, asserts that the men at Loughborough are "asking for a general betterment of conditions and increased wages," the object being to bring the men into line with other firms doing the same class of manufacturing work as the Brush Company, particularly the United Electric Car Co. at Preston, who have recently, it is said, given their men an advance. There is a conflict of statement as to the wages paid by the two firms mentioned.

Water Power in Germany.—A company has been formed at Nied (near Hochst-on-Main), entitled Elektrizitäts Aktien Gesellschaft, with a capital of 1,500,000m. (£75,000) for the generation and supply of electricity by means of water power available on the rivers Main and Nidda.

West Ham.—Additional cables are to be laid at an estimated cost of £490.

The terms provisionally arranged between the borough electrical engineer (Mr. A. Hugh Seabrook) and the British Alazarine Co. for supply of current to the company's works have been approved by the Electric Lighting committee. The details of the proposed agreement for the electric lighting of the Borough Theatre have also been confirmed by the Council.

Legal opinion upon the question as to whether the Council have power to invest the reserve fund of the tramways undertaking in the Corporation's own securities is to the effect that the Corporation have power to lend only their sinking fund to themselves, and that any sums set aside for reserve, either in respect of electric lighting or tramways, must be invested in other securities.

Willesden.—An alternative flat rate of 5d. per unit is to be offered to all consumers from Christmas quarter, but either system of charge selected must remain in force for at least 12 months.

ELECTRICITY SUPPLY ACCOUNTS.

Leicester.—It was reported to the Corporation on Tuesday that the total expenditure on the electricity undertaking was £275,634.

The annual expenses were £6,278, an increase of £769. Receipts from sale of current were £15,253, an increase of £914, and the total income was £16,104, an increase of £985, the net profit for the half-year being £2,714. Out of the accumulated profit account new machinery and plant have been purchased, and during the past two years over £23,000 on new machinery has been expended, all paid out of profits of the department. Meter rents (which brought £750 into the above account) have now been abolished.

TELEGRAPH AND TELEPHONE NOTES.

Telephone Trunk Wire Charges.—From Oct. 1 the following reductions of trunk wire charges will come into force in the U.K. between 7 p.m. and 7 a.m. :—

25 miles or under	3d. for 6 min.	100 miles or under	6d. for 3 min.
50 ditto	6d. ,, 6 ,,		1s. ,, 6 ,,
75 ditto	6d. ,, 3 ,, 9d. ,, 6 ,,	140 ditto	9d. ,, 3 ,, 1s.6d. ,, 6 ,,

And so on at half the rates for the day service.

Australia.—The total cost of the proposed trunk telephone line between Melbourne and Sydney is estimated at £30,204 for the New South Wales portion and £12,791 for the Victoria portion, the principal expenditure being for hard-drawn copper wire at £100 per ton, of which 223 tons (£22,300) will be required in New South Wales and 107 tons (£10,700) in Victoria. The annual revenue is put at £4,714, against which has to be set an anticipated decrease of £2,500 in the revenue for telegraph and postal services.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

The demand for the first issue of "The Electrician" INDUSTRIAL SUPPLEMENT (published gratis with *The Electrician* for Sept. 14) has necessitated an additional printing. We have now a small further supply of copies available.

In answer to numerous requests for filing cases for the Supplement, the Publisher begs to announce that these are ready and are being distributed next week. The filing cases are made to hold twelve copies of the Supplement.

TENDERS INVITED.

Newport (Mon.) Borough Council invite tenders for supply of the following apparatus for their electricity and tramways department: (1) Three feeder boosters, one balancer, one electrically-driven feed pump and one two-throw pump; and (2) switchboards and instruments. Specification and forms of tenders from the borough electrical engineer and tramways manager (Mr. H. Collings Bishop), and plans relating to the switchboards may be inspected at the Electricity Offices, Town Hall, Newport. Tenders to the Town Clerk by Oct. 13. See also an advertisement.

The directors of the *Metropolitan Railway Co.* invite tenders for supply of general stores during the 12 months ended Oct. 31, 1907, including electric lamps, carbons, fuses, ebonite, &c., electric wires and cables, telegraph fittings, battery jars, zinc, insulators, &c. Forms of tender, &c., from the secretary, Mr. R. H. Selbie, 32, Westbourne terrace, London, W. Samples and patterns may be seen at the office of the company's storekeeper, adjoining Neasden station, N.W., from Oct. 1 to 6 inclusive. Tenders to the Secretary not later than 10 a.m. Oct. 8.

Tenders are wanted by Oct. 5 for delivery and installation of 18 electric derricks for the Customs Harbour on the Veddel, *Germany*. Conditions of tender can be seen at Secretariat II. of the Finanz Deputation, Hamburg, and may be purchased for 4s.

The "Madrid Gazette" of Sept. 21 contains a notice inviting tenders for electric lighting at *Pontevedra* for 15 years from April 12, 1908. The upset price is 20,000 pesetas per annum. Tenders will be received until 11 a.m. Oct. 31, at the Municipal Palace, Pontevedra, and at the Direccion-General de Administracion Local, Madrid.

The "Madrid Gazette" of Sept. 22 gives notice that tenders are wanted for lighting *Linares* by electricity or gas, or a combination of both systems. The number of lights required will be 700 of 30 c.p., 200 of 10 c.p., and 4 of 500 c.p. The upset price is 42,000 pesetas per annum. Tenders will be received until Oct. 29 at the Secretaria del Excmo Ayuntamiento de Linares, and at the Direccion de Administracion, Madrid.

The "Gazette" containing the conditions of contract, &c., of the above tenders can be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Hackney Electric Lighting committee report that they have examined tenders for the proposed street lighting by arc lamps.

The specification was divided into three parts, so as to get alternative tenders, the first part being applicable to posts and apparatus suitable for ordinary arc lamps, the second to flame arc lamps, and the third to switch pillars, which would be required whichever type of lamp was selected. The report continues: With the exception of D. Santoni & Co., Oliver & Co., General Electric Co. and Union Electric Co. all the tenders for "flame" arc lamps were incomplete, or the firm did not comply with the conditions of the tender. With regard to the tenders for the ordinary type of arc lamp, the committee did not consider it desirable to submit the engineer's report upon them. The tenders received for flame arc lamps were:—

General Electric Co. (*recommended for acceptance*)	**£1,808**	R. W. Blackwell & Co.	£1,557
Oliver & Co.	1,767	Johnson & Phillips	1,531
Brockie-Pell Arc Lamp (Ltd)	1,754	Armorduct Mfg. Co.	1,500
D. Santoni & Co.	1,671	Brit. Thomson-Houston Co.	1,451
Union Electric Co.	1,604	Crompton & Co.	1,400
British Electric Equip. Co.	1,579	Electrical Co.	1,307
		Improved Electric Supplies.	1,183

Exhaustive tests have been made by the borough electrical engineer (Mr. L. L. Robinson) of sample lamps submitted. The Angold lamp, tendered for by the General Electric Co., had given the best all-round results, taking into consideration not only the burning of the lamp but also the cost of carbons. The higher amount of the tender was due to the cost of their better type of contact gear. As an alternative tender the company offered a cheaper type of gear, which reduced the amount to £1,585, still leaving it strictly comparable with the tenders of the other makers. The committee were advised that the higher-class gear only should be used, and recommended that the tender of the General Electric Co. for Angold flame arc lamps at £1,808 be accepted.

The following tenders for pillars were received:—

W. Lucy & Co. (*recommended*)	**£1,174**	General Electric Co.	£1,543
W. T. Allen & Co.	2,010	Johnson & Phillips	1,477
S. Pontifex & Co.	1,916	British Elec. Equip. Co.	1,456
J. & A. Law	1,811	Jas. Allen (sen.) & Son	1,402
Falkirk Iron Co.	1,605	Rowland Carr & Co.	1,367
Armorduct Mfg. Co.	1,599	John Spencer (Ltd.)	1,261
W. Macfarlane & Co.	1,575	R. W. Blackwell & Co.	1,218
Mackenzie & Moncur	1,572	Brush Co.	1,214
Improved Elec. Supplies	1,548		

The following tenders were received for erection of pillars:—

W. Lucy & Co. (*recommended*)	**£479**	R. W. Blackwell & Co.	£495
W. T. Allen & Co.	582	Improved Elec. Supplies	485
Johnson & Phillips	547	General Electric Co.	443
British Insulated & Helsby Cables	536	Brush Co.	376
		British Elec. Equip. Co.	362

The following tenders were received for switch pillars:—

Cable Accessories Co. (*recommended*)	**£163**	British Insulated & Helsby Cables	£210
Callender's Co.	308	Improved Elec. Supplies	172
General Electric Co.	237	Johnson & Phillips	170
J. E. Spagnoletti & Co.	221	British Elec. Equip. Co.	141
Armorduct Mfg. Co.	220	R. W. Blackwell & Co.	120

Oxford City Council have accepted the tender of the National Electric Construction Co. for the reconstruction and conversion to electric traction of the local horse tramways.

The consulting engineer (Mr. Stephen Sellon) had reported in favour of the tender of the Oxford Tramways Co., who offered to construct the lines and equip them on the Lorain or Griffiths-Bedell surface-contact systems or on the conduit system. In the discussion on the subject members of the Council urged the acceptance of the offer of the National Electric Construction Co. (who proposed to use the Dolter system) as it was more advantageous in regard to the rental to be paid, &c. It was then resolved by 32 votes to 10 to accept the tender of the National Electric Construction Co., subject to the guarantees offered proving satisfactory and also to an undertaking that if the Dolter system did not prove satisfactory the company would adopt another, and introduce such other modifications as might be required by the Corporation.

The following tenders have been received for the electric lighting installation at H.M. Theatre, Aberdeen, for the Robert Arthur Theatres Co.

Aberdeen Electrical Eng. Co. (*accepted*)	**£3,994**	Roger Dawson (Ltd.)	£5,144
G. E. Taylor & Co.	5,985	Claud Hamilton (Ltd.)	4,965
Drake & Gorham	5,390	Belshaw & Co.	4,904
Warings Limited	5,264	Buchanan & Curwen	4,874
Strode & Co.	5,154	Leo Sunderland & Co.	4,710
		Cowtan & Sons	4,239

The contract is being executed to the specification of Messrs. Owen Lucas & Pyke.

Fulham (London) Council have accepted the tender of Gilman & Co. for supply and delivery, to June 30 next, of 1,500 tons of "nutty slack" from West Hallam pits at 9s. 11d. per ton.

The tender of A. W. Davies & Co. for wiring the new boiler house at the electricity works at £385. 6s. has been accepted.

West Ham Corporation have accepted the following tenders for coal-handling plant:—

J. Fraser & Co., 4 ton hopper, £49; Thames Iron Works Co., special hone grab, 20-cwt. capacity, £155 (less 2½ per cent.); Chatteris Engineering Co., 5 ton crane, £875; Dick, Kerr & Co., turntable, £70. 5s.

Brighton Corporation received seven tenders for the supply of electric motors for hiring-out purposes, and on the recommendation of the borough electrical engineer (Mr. J. Christie) the quotations of Crompton & Co. for 1 H.P. and 3 H.P. sizes and of Royce (Ltd.) for 5 H.P., 10 H.P. and 20 H.P. sizes have been accepted.

Battersea (London) Council have accepted the tender of the Tudor Accumulator Co., at £195 per annum for 15 years, for renewing the cells and maintaining the efficient working of the battery at the electricity station.

West Ham Corporation have ordered seven additional tramway cars under their contract with the British Westinghouse Co., and have further accepted a quotation of Ferranti Limited, at £39. 15s. each, for six panels for sub-station equipment.

Walsall Council have accepted the following tenders:—

Bunch & Sons and Mantle & Co., ironwork for tramcar covers; Rawlinson & Son, tower waggon, £49; Jones & Evans, boiler flue, £22. 16s.; C. Ross, electric bells at the Higher Education schools.

Southampton Council have accepted the tender of Raworth's Traction Patents for regenerating equipments at £100 and motors at £73 each.

The Victoria (Australia) Government have accepted the tender of the British Insulated & Helsby Cables for 2½ miles of cable, at £670, for the extension of the St. Kilda-Brighton Electric Railway.

Leyton Council have accepted the tender of Herbert Morris & Bastert for supply and erection of an overhead crane.

Yarmouth Guardians have appointed Gray & Palmer to execute electrical engineering work at the workhouse for the next half-year.

BUSINESS NOTICES.

The Lancashire Dynamo & Motor Co., Trafford-park, Manchester, have, owing to the increase of their business in the Newcastle district, decided to open from Oct. 1 an office at Star-buildings, Northumberland-street, Newcastle-on-Tyne, where Mr. Hearn will represent the company, and where he will be pleased to hear from clients. The telephone number is 1,923.

The Rhodes Electrical Mfg. Co. (Ltd.) have removed their works and registered offices from Bradford to Riverside Works, Doncaster. Telegrams "Rhodique Doncaster." Telephone 113.

H. G. Mayer & Co., 67, Aldersgate-street, London, E.C., notify that Mr. B. Listner, who has been connected for the last five years with the Nernst lamp department of the Electrical Company, has joined their firm, and will in future sell Nernst lamps on their behalf. Messrs. Mayer have opened a special department for Nernst lamps.

The technical department of the New Phonopore Telephone Co. has been removed from 85, Queen Victoria-street, London, E.C., to the works, Southall, Middlesex.

After 29th inst. the business address of Mr. W. Stepney Rawson, consulting electrical engineer, will be 23, Fitzroy-square, London, W. Telegrams: "Maborlim London." Telephone: 8,368 Gerrard.

Ernest A. Edwards & Hy. Magnus, electric fittings manufacturers, Heneage-street, Birmingham, have dissolved partnership.

BANKRUPTCIES, LIQUIDATIONS, &c.

Ernest Rosenberg, patent broker (formerly electrical engineer), 465 and 466, Birkbeck Bank-chambers, W.C., and 51, Drayton-gardens, Kensington, W., London, has been adjudicated bankrupt.

Robt. O. Thompson, electrical engineer, 30A, Dorset-gardens, Brighton, has been adjudicated bankrupt. First meeting of creditors Oct. 3 at 4, Pavilion-buildings, and public examination on Oct. 4 at the Court House, Brighton.

In the bankruptcy of Chas. L. Ford, electrician, &c., 13, Hyde-road, Woodley, near Stockport (lately trading at 55, Market-street, Stalybridge), the first meeting of creditors will take place on Oct. 5 at 6, Vernon-street, Stockport, and the public examination at the same place on Oct. 12.

Claims against Geo. A. Benton, electrical engineer, Shareshill, Staffs. (formerly of 8, The Exchange, Muswell-hill, London, N.), to Mr. S. W. Page, 30, Lichfield-street, Wolverhampton, by Oct. 11.

A meeting will be held on Nov. 2 at 72, Market-street, Bradford, to receive an account of the voluntary winding-up of the Electrical Wool Pulling Synd. (Ltd.)

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the receiver for the debenture holder of the Thames Electric & Motor Boats (Ltd.) to sell by public auction in one lot, at the works, Eel Pie Island, Twickenham, at an early date, the freehold works and land, containing about 1¼ acres, with a frontage to the river Thames of approximately 300ft., together with substantially-built engine house, workshop, stores, &c.

Messrs. Wheatley Kirk, Price & Co. will also sell by public auction, piecemeal, in the lots of the catalogue, immediately after offering the freehold, the contents of the works, including sliding, surfacing, screw-cutting and other lathes (by well-known makers), wood-working machinery, planing, drilling, bending and other machines, electric motors and accessories, loose tools, utensils, &c. Catalogues (gratis) from the auctioneers, 46, Watling street, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester.

During the sale of the above plant the newly-built electric launch "Victory" will be offered at auction. Further particulars are set out in an advertisement.

Plant, &c., for Sale.—Barber & Coleman (Ltd.), 38, King street West, Manchester, advertise for sale two electric motors (2½ H.P. and ½ H.P.).

The Forth Shipbreaking Co., Bo'ness, N.B., advertise for sale some copper armoured cable.

Works Site for Sale.—Messrs. R. Heber Radford, Son & Squire, 15, St. James's-row, Sheffield, advertise some conveniently situated land (over 20 acres) in Sheffield, suitable for large works.

CATALOGUES, &c.

J. & P. Lists.—A number of Messrs. Johnson & Phillips' recent lists have been put up into an extensible file, to be handy for reference, and may be obtained by interested parties on application to the firm. The list includes direct current dynamos and motors, d.c. motor starters, main switches, arc lamps, junction boxes, ammeters and voltmeters, &c.

Water-cooling Plant.—Cooling towers or ponds are now a recognised institution of central stations of large output; consequently interest attaches to plant devised specially for the purpose of cooling condenser water. W. H. Roy & Co., 30, Spring-gardens, Manchester, have favoured us with a copy of their booklet on condensing and water-cooling plant. Their standard patterns include a patent cooling stack, self-ventilating and open-type chimney and fan draught cooling towers. The booklet contains a useful table of monthly averages of the daily maximum temperature in London, Manchester and Glasgow.

B T.-H. Edison Lamps.—A particularly neat show-card is being distributed by the British Thomson-Houston Co., Rugby, got up to "boom" the "B.T.-H. Edison" incandescent lamp. It is a very effective form of advertisement.

Nernst Lamps.—An attractive booklet on Nernst lamps has been issued by the Electrical Co., a copy of which will be sent on request to any interested inquirer.

Jandus Arc Lamps.—A well-illustrated list of Jandus arc lamps has been issued, and copies can be obtained from Messrs. Drake & Gorham, 66, Victoria-street, London, S.W., or from their Manchester and Glasgow branches. Besides the Jandus flame lamp, single-enclosure and double-enclosed lamps are listed as well as inverted and photo lamps, for all types both continuous and alternating-current circuits. A list of spare parts, carbons, reflectors, &c., is also given.

Arc Lamp Lowering Gear.—The London Electric Firm, George-street, Croydon, are issuing a list of users of "one working part" arc lamp lowering gear and self-sustaining winches. In addition to Government departments and consulting engineers, the list includes a large number of corporations and borough councils, electric supply companies, railway and dock companies, public buildings, theatres, electric contractors, &c., to whom this apparatus has been supplied.

Direct Reading Cymometer.—A well got-up pamphlet has been issued by Marconi's Wireless Telegraph Co., comprising instructions for the use of the direct reading cymometer, designed by Dr. J. A. Fleming, and giving a full illustrated description of the instrument and its method of construction. The particulars given are more than usually comprehensive and complete. Prices of the different sizes of instruments made and the accessories used with the cymometer are included in the catalogue.

A New Electric Sign.—We have inspected this week a new form of electric changing sign embodying many novel and ingenious features. It is light and portable, narrow enough to use as a hanging sign, and equally effective by day as at night. At night a constantly changing effect is produced. We shall be describing the main points of this decidedly interesting device (invented and manufactured by Mr. Horace Simon, 2, Mincing-lane, London, E C.) in an early issue.

Exports of Electrical Goods and Apparatus.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Sept. 19 to 25 with the ports of destination :—

Aden, £89 (including £69 telegraph material). *Africa*—Alexandria, £35; Beira, £91 (telegraph material); Cape Town, £194; Delagoa Bay, £468 (including £139 telegraph material) and 81 tons iron telegraph poles; Durban, £610 (including £34 telegraph material); East London, £10; Port Elizabeth, £724; Port Said, £165; Sekondi, £21 (including £16 telegraph material). *Argentina*—Rosario, £307 (telegraph material). *Australasia*—Adelaide, £45 (including £35 telegraph material); Auckland, £260; Fremantle, £560; Lyttelton, £149; Melbourne, £1,775 (including £1,183 telegraph material); Nelson, £14; Perth, £321; Sydney, £680 (telegraph material). *Azores*, £86 (telegraph material). *Belgium*—Brussels, £47; Ostend, £171. *Burma*—Rangoon, £101. *Ceylon*—Colombo, £83 (including £78 telegraph material). *China*—Foochow, £24; Shanghai, £1,031. *Denmark*—Copenhagen, £229 (including £190 telegraph material). *France*—Marseilles, £14 (telegraph material); Paris, £40. *Germany*—Cologne, £21. *Gibraltar*, £25 (including £17 telegraph material). *Holland*—Amsterdam, £61; Rotterdam, £63 (including £12 telegraph material). *Hong Kong*, £313. *India*—Bombay, £981; Calcutta, £1,254 (including £314 telegraph material); Madras, £75 (including £30 telegraph material). *Japan*—Tokyo, £2,643 (including £2,499 telegraph material). Yokohama, £5,403. *Malta*, £267 (including £241 telegraph material). *Maderia* £34 (telegraph material). *Russia*—Windau, £100. *Siam*—Bangkok, £17. *Spain*—Huelva, £19. *Straits Settlements*—Penang, £166; Singapore, £712 (including £34 telegraph material). *Sweden*—Gothenburg, £20 (telegraph material); Stockholm, £75 (telegraph material). *U.S.A.*—New York, £50. Total £20,643, against £30,618 in the corresponding week last year (Sept. 20 to 26.)

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON CO. (LTD.)—At the meeting on Wednesday, Mr. J. F. Nauheim, who presided, said that the electrical industry had so far profited very little from the general improvement that had set in in the trade of the country, but the directors hoped that 1906-7 would give better results. They had been able to dispose of a very large amount of their investments, and had considerably reduced their indebtedness. Consequently, the balance at March 31 last showed a much more satisfactory state of affairs than the preceding one. While they owed last year to sundry creditors £670,000, the amount was now £339,000, and whereas they owed to their bankers £40,000, this sum had been reduced to £25,000. The trading profit for the year, after the usual deductions, amounted to £31,549, and the available profit was £33,245. The whole of that, with the exception of £4,124 carried forward, had been applied to various depreciations, which the directors believed to be ample.

DICK, KERR & CO. (LTD.)—At the general meeting yesterday, the chairman, Mr. John Kerr, in moving the adoption of the report and accounts (abstracted in our last issue) said the volume of work executed had been greater than in any previous year, but this had been largely discounted by keener competition. They had had to let business go past them through the cutting of prices to a point which they did not think it wise to follow. At present the productive power of electrical engineering works in England was in excess of the demand, and British manufacturers had not the absolute control of either the home or colonial trade. They had therefore to exercise great economy, and, as the first desire of the directors was to place the company in a position of security, they were of opinion that the best policy was not to recommend a dividend beyond 10 per cent.

GENEVA TRAMWAYS CO. (LTD).—At a meeting last week the Hon. A. Brand submitted a scheme of reconstruction. He said that it was proposed, in place of the 850,000 debentures issued at present and the various income certificates and shares, to register a new company with a capital of £300,000 4 per cent. debentures and £550,000 in £1 shares, the first coupon for the year's interest being payable on Oct. 1, 1907. Of the £300,000 debentures £255,000 were proposed to be given to present debenture holders, as well as £510,000 in £1 shares. The remainder of the debentures will be held in reserve. Of the remaining £40,000 ordinary shares £30,000 would be paid to present holders of third debentures. On the lines in Geneva a fair income was earned, but under the terms of the concession they were bound to run tramcars to several small villages, every mile of which service was run at a loss. The terms for the supply of power were not satisfactory. They were under the thumb of the Geneva authorities, and they had to run their services under great difficulties compared with lines in other countries. There had been considerable increases in traffic receipts in the past three years, the passengers carried numbering respectively 12,466,000, 13,928,000 and 14,564,000, and the profits £211,000, £461,000 and £512,000. The scheme was adopted.

UNITED ELECTRIC CAR CO. (LTD.)—At the meeting last week Mr. R. H. Prestwich said the Board regretted the necessity to recommend a smaller dividend than last year. The Hadley and Trafford Park works had been purchased to remove them from the field of competition. It was thought they would largely increase their business by obtaining orders which would go to those two concerns if they fell into other hands than their own, and as increased demand implied larger output, they assumed that larger earnings and a better dividend would result. Those anticipations, except the last important one, had been realised. In the number of cars produced and delivered the past year had exceeded any previous year by a very large percentage. Their experience of the year's trading, while disappointing, had been useful to them, as they now plainly saw where some mistakes of control and management could be avoided in future. They had still plenty of work on hand with the prospects of being employed at full strength for some months to come. He regarded the trading result of the past year as adversely affected by accidental circumstances, which in no way affected the future of the business.

WILLANS & ROBINSON (LTD.)—The 25th half-yearly report of the directors, just issued, shows a profit of £4,084. 19s. 5d. for Rugby, and a loss of £10,620. 1s. 8d. at Queen's Ferry, or a loss of £6,535. 2s. 3d. in all for the half-year (against £13,075 in the preceding half-year). This correctly states the results of the trading operations of the half-year by itself, after providing for depreciation. But it must be pointed out (the report continues) that serious losses will have to be faced, arising out of transactions of earlier date, not connected with Queen's Ferry, which must eventually lead to a considerable writing down of some of the assets. As regards the Queen's Ferry items, this is already understood by the shareholders, who will realise that it would be premature to attempt to assess the loss until the Queen's Ferry works are actually disposed of. As regards the other items in question, some are in part ascertainable at present, while others can only be estimated. Without going into details, it may be said that the financial position of certain of the electric power companies, recently disclosed, makes it inevitable that there will be a heavy loss under the head of "Debtors," and for the same reason "Shares and debenture stock in other companies" require to be largely written down.

A considerable amount has been expended upon patents and experiments, and development work generally, in connection with large gas engines, including considerable losses resulting from the first orders taken. In view, however, of the successful development of the steam turbine business, it is improbable that it will be worth while to make gas engine building a permanent part of the company's business, and under these circumstances the whole expenditure ought to be written off. Recent improvements in the Willans engine have affected the value of many of the spare parts of older pattern kept in stock, and although the value of these spare parts has been heavily written down in recent half-years, yet it is desirable to write off a considerable further sum.

From the foregoing causes (which are independent of Queen's Ferry) it is estimated that an amount of £92,875. 4s. 11d. may ultimately require to be written off. It is desirable that this should be dealt with at the same time as the Queen's Ferry loss, rather than by writing off by instalments as exact figures are obtained. A suspense account has therefore been opened, to the amount stated, which is balanced by corresponding amounts written off under various credit items of the balance-sheet.

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Tuesday Mr. A. G. Lupton said that the share capital of the company now amounted to £256,000. Progress had not been so rapid as the directors anticipated. Still, there were satisfactory features. The actual revenue from sale of current during the past half-year had more than doubled compared with the preceding half-year. Confidence in the advantages of their service was growing, and the average length of agreements with customers was between six and seven years. Of these agreements over 20 per cent. of the horse-power was with customers who had first tried the company's supply in a small way and had since increased their demand and extended the period of their agreements. Local authorities, too, were realising the benefits which the company gave to the ratepayers and the industries of the districts; and already they were supplying nearly half their present output of current in areas which were at first cut off from them.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

AMALGAMATED RADIO-TELEGRAPH CO. (LTD.) (90,129.)—Reg. Sept. 15, capital £450,000 in £1 shares, to adopt an agreement with the De Forest Wireless Telegraph Synd. (Ltd.), to acquire and turn to account inventions and rights relating to wireless or other telegraphs, telephones, &c., and to carry on the business of owners of telegraph and telephone systems, electricians, electrical and general engineers, &c.

CALEDONIA MOTIVE POWER SUPPLY CO. (LTD.)—Reg. Sept. 10 (in Edinburgh), capital £100,000 in £1 shares, to purchase Caledonia Engine Works, Leith, and to develop the manufacture and sale of the central valve internal combustion engine, &c., patented by William Peck. First directors, T. Davidson, W. H. Dodds, M. J. M. Tindall, J. G. Scott and W. Peck. Reg. office, 245, Union-street, Aberdeen.

ELECTRIC VEHICLES DEVELOPMENT CO. (LTD.) (90,213.)—Reg. Sept. 22, capital £1,000 in £1 shares, to carry on the business of motor vehicle proprietors, carriers of passengers and goods, electric and other motor manufacturers, &c. First directors, H. B. van Daalen, G. Breffitt, F. Griffiths, and H. F. L. Pilet. Reg. office, 149, Bishopsgate-street Without, London, E.C.

GALVANO CHEMICAL CO. (LTD.) (90,168.)—Reg. Sept. 19, capital £10,000 in £1 shares (250 5 per cent. preference), to acquire patents relating to the manufacture of chloride of magnesia and red oxide paint, to adopt an agreement with G. F. Thomson and to carry on the business of manufacturing chemists, manufacturers of electrical and other apparatus, &c. Reg. office, 21, Spring-gardens, Manchester.

GOODMAN MFG. CO. (LTD.) (90,153.)—Reg. Sept. 18, capital £50,000 in £1 shares (20,000 "A" and 30,000 "B"), to carry on the business of manufacturers of and dealers in coal and other mining machinery, electric mine locomotives, dynamos and mining supplies of all kinds, engineers, machinists, &c. First directors, F. S. Washburn and H. E. Goodman (both of Chicago), A. J. Bloemendal, W. H. Court and one other (to be nominated by H. E. Goodman). Reg. office, 69, Aldersgate-street, London, E.C.

GROSVENOR ENGINEERING WORKS (LTD.) (90,132.)—Reg. Sept. 15, capital £5,000 in £1 shares (2,500 preference), to adopt an agreement with H. Beadle and E. T. Giles, and to carry on the business of engineers, electricians, gas, oil and electric engine and motor manufacturers and dealers, &c. First directors, H. Boadle (chairman) and E. T. Giles. Reg. office, 20, Danvers-street, London, S.W.

SEVENOAKS MOTOR CAR & ELECTRICAL CO. (LTD.) (90,070).—Reg. Sept. 6, capital £6,000 in £1 shares (2,000 4 per cent. cumulative preference), to carry on the business of motor vehicle and cycle manufacturers and dealers, electrical engineers, &c. First directors, Capt. H. Fulton (permanent chairman) and A. Whitehead. Reg. office, Tubs Hill, Sevenoaks, Kent.

YSTRADGYNLAIS ELECTRIC LIGHT CO. (LTD.) (90,178).—Reg. Sept. 19, capital £3,000 in £1 shares, to generate, store, accumulate and distribute electricity for lighting or other purpose, &c.

STATUTORY RETURNS.

ANCHOR CABLE CO. (LTD.)—Return to July 7 gives capital as £250,000 in £10 shares, of which 6,500 have been taken up. £10 per share has been called up on 4,600 and £5 per share on 1,500 and £53,500 has been received. £4,000 is considered as paid on 400 shares. Mortgages and charges, nil.

BLACKBURN, STARLING & CO. (LTD.)—According to return to Aug. 2 capital is £12,000 in £1 shares, of which 8,483 have been taken up. £4,583 has been received and £3,900 is considered as paid. Mortgages and charges, nil.

BROCKIE-PELL ARC LAMP (LTD.)—The capital in the return to July 10 is £80,000 in £1 shares, of which 79,751 have been taken up. 2s. 6d. per share called up and £9,930. 5s. 6d. has been received, including £12. 5s. 6d. paid on 221 forfeited shares, leaving 17s. 6d. in arrears. £69,776 (17s. 6d. per share) is considered as paid on 79,744 shares. Mortgages and charges, nil.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—The capital in return to May 11 (filed July 10) is £1,000,000 in 120,000 ordinary and 80,000 preference shares of £5 each, of which 60,000 ordinary and 40,000 preference have been taken up. £5 per share has been called up on 6,047 ordinary and 40,000 preference and £1 per share on 53,053 ordinary and £284,191 has been received, including £3 paid on three forfeited shares. Mortgages and charges, £300,000.

CROMPTON & CO. (LTD.)—In the return to Aug. 17 capital is £300,000 in 100,000 shares of £3 each, of which 85,000 have been taken up. £3 per share has been called up on 83,000 and £249,000 has been received, £6,000 is considered as paid on 2,000 shares. Mortgages and charges, £100,000.

D. P. BATTERY CO. (LTD.)—In return to Sept. 4 capital is £10,000 in 4,996 A, 4,996 B and eight other shares of £1 each, all of which have been taken up and paid for in full. Mortgages and charges, £14,000.

ELECTRIC CONSTRUCTION CO. (LTD.)—In return to Aug. 2 capital is £400,000 in 50,000 preference and 150,000 ordinary shares of £2 each, of which 31,390 preference and 112,100 ordinary have been taken up. £2 per share has been called up on 18,245 preference and 2,100 ordinary and £40,690 has been received. £246,290 is considered as paid on 13,145 preference and 110,000 ordinary. Mortgages and charges, £250,000,

ELECTRIC SUPPLY CORPN. (LTD.)—Return to Aug. 8 gives capital as £250,000 in 50,000 shares of £5 each, of which 41,500 have been taken up. £5 per share has been called up on 30,800 and £4 per share on 3,700 shares, and £168,863 has been received, leaving £117 in arrears. £35,000 is considered as paid on 7,000 shares. Mortgages and charges, £50,000.

EXCHANGE TELEGRAPH CO. (LTD.)—According to return to Aug. 9 capital is £246,250 in 8,125 " A " and 16,500 " B " shares of £10 each, of which 8,023 " A " and 16,200 " B " have been taken up. £9 per share has been called up on 6,000 " A " and £1 per share on 2,023 " A " and £56,023 has been received. £162,000 is considered as paid on the " B " shares. Mortgages and charges, nil.

GENERAL ELECTRIC CO. (LTD.)—Return to Aug. 3 gives capital as £800,000 in 40,000 preference and 40,000 ordinary shares of £10 each, of which 25,000 preference and 33,122 ordinary have been taken up. £10 per share has been called up on 18,000 preference and 8,122 ordinary and £261,220 has been received. £320,000 is considered as paid on 7,000 preference and 25,000 ordinary. Mortgages and charges, £200,000.

HENLEY'S (SOUTH AFRICA) TELEGRAPH WORKS (LTD.)—In return to July 27 capital is £2,000 in £1 shares, all of which have been taken up and paid for in full. Mortgages and charges nil.

MIDDLETON ELECTRIC TRACTION CO. (LTD.)—Return to May 16 (filed July 30) gives capital as £100,000 in 10,000 ordinary and 10,000 preference shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £50,000.

MONOBLOC ACCUMULATOR SYND. (LTD.)—Return to Aug. 8 gives capital as £20,000 in £1 shares, of which 10,000 have been taken up. £7,000 has been received and £3,000 is considered as paid. Mortgages and charges, nil.

SCOTTISH HOUSE-TO-HOUSE ELECTRICITY CO. (LTD.)—In return to July 16 capital is £100,000 in 14,900 ordinary, 5,000 preference and 100 founders' shares of £5 each, of which 970 ordinary and 100 founders' have been taken up. £5 per share has been called up and £5,350 has been received, in addition to £108 paid on 54 forfeited shares. Mortgages and charges, £98,618. 1s. 4d.

SLOAN ELECTRICAL CO. (LTD.)—Return to July 23 gives capital as £15,000 in £1 shares (5,000 " A " preference, 5,000 " B " preference and 5,000 ordinary), of which 5,000 " A " preference, four " B " preference and 2,750 ordinary have been taken up. £1 per share called up on four " B " preference and 1,250 ordinary. £6,500 considered as paid on 5,000 " A " preference and 1,500 ordinary. Mortgages and charges, nil.

SPANISH TELEPHONE CO. (LTD.)—According to return to July 24, capital is £41,000 in 1,600 ordinary shares of £10 each and 1,250 preference shares of £20 each, of which 1,600 ordinary and 641 preference have been taken up. £20 per share has been called up on 641 preference and £12,820 has been received. £16,000 is considered as paid on 1,600 ordinary. Mortgages and charges, nil.

SUNBEAM LAMP CO. (LTD.)—Return to Aug. 9 gives capital as £25,000 in 2,500 shares of £10 each, of which 1,765 have been taken up. £10 per share called up on 908 and £9,080 received. £8,570 is considered as paid on 857 shares. Mortgages and charges, £8,500.

THOMAS PARKER (LTD.)—In return to Aug. 13 capital is £75,000 in 7,500 shares of £10 each, all of which have been taken up. £10 per share has been called up on 5,750 and £57,500 has been received. £17,500 is considered as paid on 1,750. Mortgages and charges, £65,000.

YORKSHIRE PRIVATE TELEPHONE CO. (LTD.)—Return to July 16 gives capital as £6,000 in £1 shares, of which 5,550 have been taken up. £1 per share has been called up on 3,475 and £3,475 has been received. 2,075 shares are considered as fully paid. Mortages and charges, nil.

MORTGAGES AND CHARGES.

BRITISH ELECTRIC CO. (LTD.)—Issue on Sept. 3 of £200 10 per cent. debentures, part of series created Oct. 13, 1905, to secure £250, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £50.

CONSOLIDATED SUPPLY CO. (LTD.)—Issue on Sept. 5 of £10,500 5 per cent. debentures, part of series created July 18, 1906, to secure £15,000, charged on company's undertaking and property, present and future, including uncalled capital. Holders, Consolidated Electrical Co. No trustees. No previous issue of same series. A memorandum of satisfaction in full of debentures dated Oct. 6, 1905, and Jan. 1, 1906, securing £3,000 has also been filed.

DEWSBURY ELECTRIC MFG. CO. (LTD.)—A 5 per cent. debenture for £410, dated Sept. 12, 1906, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, J. Bentley.

CITY NOTES.

MEMORANDA (Sept. 27).—Bank rate 4 per cent. (since Sept. 13, 1906). Price of silver $31\frac{7}{16}$d. per oz. Consols $86\frac{3}{8}$—$86\frac{1}{2}$ for money, $86\frac{7}{16}$—$86\frac{9}{16}$ for account; $2\frac{1}{2}$ per cent. annuities $84\frac{3}{4}$—$85\frac{1}{4}$. Consols Pay Day, Oct. 3; Stocks and Shares Continuation Days, Oct. 10 and 24; Ticket Days, Oct. 11 and 25; Pay Day, Oct. 12; Mining Share Carry-over Day, Oct. 9.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The directors have declared an interim dividend to June 30 of 4s. per share on the ordinary shares (at the rate of 8 per cent.), tax free, payable Oct. 8.

BABCOCK & WILCOX (LTD.)—The directors have declared an interim dividend of 1s. $7\frac{1}{5}$d. for the half-year ended June 30 (at the rate of 8 per cent.),

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—An interim dividend at the rate of $6\frac{1}{2}$ per cent. for the half-year ended June 30 has been declared, payable Nov. 15. The number of units delivered to consumers during the four weeks ended July 27 was 574,479, compared with 416,207 in the corresponding period of last year, and for the five weeks to Aug. 31 646,142, compared with 567,544.

CALCUTTA TRAMWAYS CO. (LTD.)—The directors have declared an interim dividend of 3s. 6d. per share on the ordinary (old) shares (at the rate of 7 per cent.) for the half-year ended June 30.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—The directors have declared an interim ordinary dividend for the half-year ending 30th inst. at the rate of 8 per cent.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO.—The profit for the period from April 4 to July 31 was £2,565. 4s. 11d. The tramways were opened for traffic on Dec. 27, 1905, and the profits earned are derived from seven months' working.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The directors recommend a dividend of $4\frac{1}{6}$ per cent. for the year ended June 30, being 2s. 6d. on the partly-paid and 4s. 2d. on the fully-paid shares.

HOVE ELECTRIC LIGHTING CO. (LTD.)—An interim dividend has been declared at the rate of 8 per cent. for the half-year ended June 30, payable Oct. 15.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed Oct. 3 a special settling day in a further issue of 20,000 £5 (fully-paid and £2. 10s. paid) ordinary shares of the *United River Plate Telephone Co. (Ltd.)* and Oct. 11 a special settling day in a further issue of 10,000 £10 fully-paid 6 per cent. cumulative preference shares of the *County of London Electric Supply Co. (Ltd.)* The committee have been asked to allow £250,000 5 per cent. prior lien debenture stock of the *Lancashire United Tramways (Ltd.)* to be quoted.

UTAH LIGHT & RAILWAY CO.—The following summary of earnings and expenses (for which the Electrical & General Investment Co. acts as trustee for $500,000 6 per cent. notes) for the four months ended July 31 have been issued: Gross income, $506,983.14 (compared with $432,035.73 in 1905); less operating, general and maintenance expenses, $324,254.01 (against $276,678.10); net profit from operating, $182,729.13 (against $155,357.63).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	AGGREGATE.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 19	1,491	+ 33	16	25,360	+ 461
Airdrie	,, 14	240	+ 27	37	8,180	+ 690
Anglo-Argentine	,, 23	15,534	+ 1,794	38	561 441	+ 62 603
Ashton-under-Lyne Corp.	,, 22	362	+ 17	26	9,431	+ 1,157
Ayr Corporation	,, 22	846	+ 81	19	8,076	+ 107
Baker St. & Waterloo Ry.	,, 22	1,550	...	12	16,240	...
Barnsley	,, 14	168	+ 9	37	6,068	+ 78
Barrow	,, 14	295	+ 23	37	9,721	+ 622
Bath Electric Trams, Ltd	,, 19	954	+ 80	38	31,997	+ 5,826
Birkenhead Corporation	,, 23	1,066	+ 50	...	...	...
*Birmingham Corporation	,, 22	1,395	+ 1,022	25	24,429	+ 15,494
Birmingham & Mid.	,, 14	10,102	+ 71	37	376,904	+ 17,779
Blackburn Corporation	,, 19	922	− 115	¶25	27,567	+ 1,726
Blackpool Corporation	,, 20	1,901	+ 140	24	41,018	+ 2,565
Blackpool and Fleetwood	,, 22	1,341	+ 394	...	...	...
Blackp'l, St. Anne's & Lytham	...	...	...	...	...	...
Bolton Corporation	,, 23	2 071	+ 184	25	55,095	+ 3,955
Bournemonth Corporation	,, 19	1,963	+ 256	†25	46,338	+ 9,299
Bradford Corporation	,, 22	4,485	− 75	25	118,499	+ 4,746
Brighton Corporation	,, 23	1,051	− 7	25	28,235	− 910
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 21	5,166	+ 59	6	16,354	+ 1,639
Bnenos Ayres & Belgrano	,, 16	3,710	+ 73	37	132,644	+ 6,589
Bnenos Ayres Elec. Trms.	Aug. 25	1,203	− 2	35	46,034	+ 7,430
Burnley Corporation	Sept. 22	1,242	+ 57	25	30,028	+ 1,754
Burton Corporation	,, 23	285	− 8	§25	7,882	− 472
Bury Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 22	R50,528	+ R5,994	12	R535,205	+ R18,033
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 15	2,167	+ 114	24	52 230	− 23
Cavehill	,, 14	122	+ 78	37	3 476	+ 1,509
Central London Railway	,, 22	6,011	− 164	12	65,887	− 2,885
Chatham & Dist. Lt. Rys.	,, 20	839	+ 132	†38	25,900	+ 285
City & South London Rly.	,, 23	2,587	− 41	12	29,623	+ 1,764
Colchester Corporation	,, 20	223	+ 9	...	...	...
Cork Electric Trams Co.	,, 20	517	+ 12	38	18,573	− 207
Croydon Corporation	,, 14	1 589	+ 244	16	26,027	+ 1,908
	,, 21	1,396	− 66			
Devonport & Dist. Trams.	,, 14	503	+ 44	37	17,100	− 158
Dover Corporation	,, 22	270	+ 45	25	7,269	+ 1,072
Dublin & Lucan Railway	,, 21	137	+ 1	§12	1 746	− 51
Dnblin United	,, 21	5,118	+ 292	‡12	69,473	+ 3,889
Dundee Corporation	,, 19	1,117	+ 77	§18	20,605	+ 4,211
East Ham Council	...	...	...	...	...	...
Exeter Corporation	,, 21	312	− 20	25	7,815	− 323
Falkirk and District	,, 19	288	...	...	...	...
Gateshead & Dist. Trams.	,, 14	994	+ 47	37	35,848	+ 1 971
Glasgow Corporation	,, 22	17,894	+ 1,730	17	277,980	+ 24,622
Glossop	,, 8	146	+ 29	38	4,796	+ 426
	,, 15	155	+ 29			
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 14	290	+ 36	37	9,132	+ 411
Gt. Northern & City Rly.	,, 22	1,670	+ 107	12	18,820	+ 1 363
Greenock & Port Glasgow	,, 14	799	+ 15	37	25,193	+ 1,282
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 14	310	+ 56	37	11,412	+ 1,479
Hastings Elec. Trams Co.	,, 20	992	...	12	13,955	...
Huddersfield	,, 22	1,513	+ 85	25	39,048	+ 3,584
Hnll Corporation	,, 22	2,243	+ 95	25	57,070	+ 1,340
Ilford Dist. Coun.	,, 22	453	− 34	25	12,975	+ 161
Ilkeston Dist. Council	,, 19	145	+ 29	25	3,502	+ 381
Ipswich Corporation	,, 22	452	− 19	25	12,077	− 133
Isle of Thanet Co.	,, 22	838	+ 45	50	31,484	− 14
Keighley Corporation	,, 20	153	+ 2	12	1,916	+ 133
Kidderminster & District	,, 14	140	+ 8	37	4,671	+ 6
Kilmarnock Corporation	,, 22	163	+ 3	19	3,133	+ 60
Kirkcaldy Corporation	,, 19	306	+ 94	12	3 291	+ 452
Lanarkshire Trams Co.	,, 20	955	− 2	†38	33,382	+ 5,839
Leamington	,, 14	174	− 20	37	6,665	+ 2,662
Leeds Corporation	,, 22	6,203	+ 164	25	161,269	+ 9,279
Leicester Corporation	,, 22	2,117	+ 34	38	84,034	+ 5,056
Leith Corporation	,, 22	550	− 32	...	...	...
Lincoln Corporation	,, 22	109	..	25	3,012	...
Liverpool Overhead Rly.	,, 23	1,473	+ 12	12	18,732	− 575
Liverpool Corporation	,, 15	11,137	+ 286	37	399,033	+ 6,882
*London County Council	,, 15	26,063	+ 10,785	24	637,061	+ 271,145
London United	,, 21	6,070	− 6	†38	249,816	+ 16,545
Lowestoft	,, 22	292	+ 45	52	9,626	− 493
Maidstone Corporation	,, 22	121	− 25	25	3,292	− 312
Manchester Corporation	,, 22	14,059	+ 1,148	25	350,163	+ 21,929
Mersey Railway	,, 22	1,635	+ 142	12	19,647	+ 1,460
Merthyr	,, 14	215	+ 23	37	7,283	+ 200
Metropolitan Dist. Railway	,, 23	7,741	+ 763	12	86,794	+ 8,984
*Metropolitan Elec. Trams	,, 14	3,979	+ 822	37	127,945	+ 30,045
Middleton	,, 14	405	+ 98	37	13,416	+ 568
Nelson Corporation	,, 22	148	+ 6	26	3,840	+ 333
Newcastle-on-Tyne Corp.	,, 22	4,033	+ 270	25	102,835	+ 6,390
Newport (Mon.)	,, 22	676	+ 95	25	16,498	+ 1,002
Northampton Corporation.	,, 21	444	+ 5	25	11,802	+ 198
Oldham, Ashton & Hyde	,, 14	588	+ 17	37	21,187	+ 618
Oldham Corporation	,, 23	1,829	+ 227	26	47,959	+ 4,625
Perth (N.B.) Corporation	,, 19	182	...	18	3 150	...
Perth (W. A.) Elec. Trams	,, 21	1,318	+ 38	38	55,438	+ 3,359
Peterborough	,, 14	147	− 1	37	4,935	− 301
Pontypridd District Coun.	...	...	...	..	...	...
Portsmouth Corporation	,, 22	2,006	+ 44	25	57,013	− 671
Potteries	,, 14	1,851	+ 157	37	65,494	+ 3,212
Preston Corporation	...	...	...	...	...	...
Reading Corporation	,, 20	629	− 34	...	...	..
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 20	489	− 37	25	12,693	+ 1,205
Rothesay	,, 14	341	+ 104	37	9,724	+ 1,554
Salford Corporation	,, 24	4,816	+ 610	25	116,310	+ 3,127
Sheerness	,, 12	74	− 4	37	2,263	− 445
Sheffield Corporation	,, 23	5,288	+ 415	26	138,743	+ 8,946
Singapore Trams	,, 22	$8,003	...	13	$95,312	...
Sonthampton Corporation.	...	...	...	...	...	...
Southend Corporation	,, 19	476	− 11	25	12,126	+ 558

(a) These comparisons are with the corresponding period last year. ¶ Plus 3 days. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	AGGREGATE.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Sonthport Tramways	Sept. 14	362	+ 26	37	12,436	+ 315
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	,, 23	1,379	+ 78	25	37,141	+ 1,982
Sunderland & District	,, 19	423	...	38	15,289	...
Swansea Trams	,, 14	940	+ 89	37	31,183	+ 4,963
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 14	52	+ 32	37	1,731	− 163
Tynemonth and District	,, 14	314	+ 33	37	10,269	+ 55
Tyneside Trams Co.	,, 19	445	+ 35	38	17,454	+ 1,399
Wallasey District Conncil	,, 22	817	+ 41	25	21,843	+ 974
Walsall Corporation	,, 22	509	− 10	23	19,636	+ 1,007
Warrington Corporation	,, 20	361	+ 12	25	9,323	+ 687
West Ham Corporation	,, 20	2,177	...	25	58,167	+ 14,022
Weston-snper-Mare	,, 12	308	+ 52	37	6,468	+ 476
Wolverhampton Corpn.	,, 19	815	...	12	10,639	...
*Worcester	,, 14	326	− 62	37	10,748	− 807
Wrexham	,, 14	130	+ 4	37	3,877	+ 73
Yorkshire W.R. Trams	,, 23	817	+ 37	38	31,825	...
Yorkshire Woollen District	,, 14	924	+ 233	37	33,598	+ 9,652

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Sept. 26.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Sept. 26.	
				£ s. d.		Highest.	Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	5/0	Anglo-Argentine Ord. Shs.	7½—7½	5 5 6	Ap, Oct	$7\frac{7}{16}$	$7\frac{9}{32}$
5	2/9	Do. 5½% Cnm. Pref.	5¾—6	4 11 8	—	$5\frac{15}{16}$	$5\frac{27}{32}$
St.	6%	Do. Permanent 6% Deb. Stock	133 —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103 —105	4 15 0	—	103⅝	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	$1\frac{9}{16}$	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—4¾	5 5 0	—	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	101½	..
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	118 —121	4 19 0	—	[illegible]	..
St.	5%	Do. Pref. Ord. Stk	110 —113	4 8 6	—	110¼	..
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	104—103%	4 5 0	—	..	..
100	4½%	Do. Vanconver Power Debs.	102 —105	4 5 6	—	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	3¼—3½	5 0 0	—	3¼	..
5	3/0	Do. 6 per Cent. "A" Cm. Pref.	5½—5¾	5 4 0	—	..	..
5	3/0	Do. "B"	5 —5½	5 0 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —107	4 13 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —101	4 19 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	—	—
100	6%	Do. 6% 1st Deb. Bonds.	102 —107	5 12 0	..	..	..
5	4/6	Calcutta Tramways (Nos. 1 to 105)	8¼—8¾	4 11 6	—	$8\frac{9}{16}$	..
5	2/6	Do. Nos. 105,001 to 137,610	7⅞—8⅜	4 14 6	..	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	..	..
1	0/6	Cape Electric Tram Shares	½—¾	3 6 6	..	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —103	4 18 0	—	..	—
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	95	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	83 —87	6 18 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	1⅜—$1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 — 103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	103 —105	4 5 6	—	98⅞	..
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	104	..
..	$2	Sao Paulo Tramway, Light and Power Co. $100 Stock	141 —143	5 12 6	..	..	..
..	5%	Do, 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	..	99¾	..
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5½—5¾	4 17 0	..	..	..
5	5/3	Calcutta Elec. (1–80,000)	8⅛ - 8⅝	4 12 9	..	$8\frac{11}{16}$	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	43 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	..
St.	5%	Do. 5% Debs.	88 —92	5 8 6	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108 —111	5 8 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$—$\frac{27}{32}$	7 8 6	—	..	..
1	1/6	Rand Electric	1 —1⅛	..	—	..	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}$—$\frac{11}{16}$	..	..	..	..
1	1/2¾	Do. 6% Non. Cum. Pref.	⅞· 1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	100⅝	..
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	5⅛—5⅝	5 8 6	..	..	..
100	4½%	*Royal Elec., Montreal 4½% 1st Mort. Deb	99 —102	4 8 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101	4 19 0	..	99½	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Sept. 26.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Sept. 26. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	10 –11	6 7 0	..	10¼	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾–10¼	4 8 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾–11¾	5 2 0	..	..	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	104 –106	4 4 10	..	..	..
5	8/6	Bromley (Kent) El. Lt. & Power Shares	8⅛–8⅝	4 18 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	8¼–8¾	5 14 0	–	..	..
5	3/6	Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	101 –104	3 17 0	–	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4⅜–4⅞	5 2 6	Feb, Aug	4 11/16	4 9/16
5	2/3	Do. 4½ per Cent. Pref.	4½–5	4 10 0	Feb, Aug	4⅝	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 0	–	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 –4½	5 0 0	–	4½	..
5	2/3	†Chelsea Electric Supply Ord.	5⅜–5⅞	5 2 2	March	5 7/16	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	10 –11	5 9 0	Feb, Aug	10 13/16	10¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	12⅛	12
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec	123½	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	100 –103	4 7 6	..	102¼	..
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞–3	4 0 0	April, Oct	..	–
5	5%	Do. Do. 5% non cum. pref.	5 3/16–5⅝	4 13 11	April, Oct	5⅜	..
10	4/0	County of London Elec. Supply Ord.	8½–9	5 5 0	–	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 4 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	109½	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	103	..
5	8/6	Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 9	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	..	..
5	5/0	Hove Electric Lighting Ord.	8 –8½	5 6 0	–	8	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	–	..	–
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 –102	3 18 6	..	..	..
St	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	101 –103	3 17 6	–	..	..
8	2/4½	London Electric Supply Ord.	1⅞–2⅜	4 4 0	–	–	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	..	..
5	4/0	Metropolitan Electric Sup. Ord.	8 –8½	5 6 0	April, Oct	8 1/16	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	4 8 6	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec	–	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11 –11½	3 18 3	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102½–103½	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7½–7⅝	5 5 6	Feb, Aug	7⅝	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾–6	4 6 11	Feb, Aug	6	5⅞
100	4%	Do. 4% Mort. Deb. red. 1907	98 –100	4 0 10	Jan, July	..	–
1	8%	Northern Counties Elec. Sup.	1 3/16–1¼	2 8 0	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	Do. 4 per Cent. 1st Mt. Debs.	97 –99	4 1 0	..	..	..
5	2/6	†Oxford Electric Ord.	6¼–6¾	4 19 0	March	6 5/16	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	9¾–10¾	5 16 0	Feb, Aug	10⅜	10 5/32
5	3/6	Do. 7 per Cent. Pref.	7 –8	4 7 0	Feb, Aug	..	–
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	–
5	4/0	Smithfield Markets Electric Sup. Ord.	2 –2½	8 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	2¾–3¼	6 8 0	..	2⅞	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16–⅞	–	..	..	–
1	0/8¾	Do. 7% Cum. Pref.	1⅛–1⅜	4 14 0	..	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	103 –106	4 5 0	–	..	–
5	2/6	Urban Electric Supply Ord.	3½–4	6 10 0	–	3¾	..
5	2/6	Do. 5% Cum. Pref.	4½–5	5 0 0	–	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	99 –102	4 8 0	..	..	–
5	5/6	Westminster Elec. Sup. Ord.	9¾–10¾	6 6 0	Mar, Sept	10	9 15/16
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	5 11/32	5 5/16
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	–	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	15/16	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	102 –105	4 5 6	–	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	99¼	..
10	9½%	Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	5 –5½	5 9 0	–	5½	5¼
10	6/0	Do. 6 per Cent. Cum. Pref.	8¾–9¼	6 10 0	Feb, Aug	9½	9 1/16
St.	5%	Do. 5 per Cent. Perpetual Debs	112 –116	4 6 0	..	113½	113½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92½–95½	4 14 0	..	..	..
St.	4%	Central London Ordinary Stock	83 –85	4 14 0	June, Dec	84½	83½
St.	4%	Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	98½	–
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	73⅞	..
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	108¾	108½
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	84 –89	4 10 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	42 –44	4 11 0	Feb, Aug	43½	42½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 –122	4 2 0	Feb, Aug	..	..
St.	5%	Do. (1896)	114 –117	4 5 3	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	115	114
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	–	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½–4	10 0 0	..	..	..
St.	4½%	Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	100 –103	4 7 6	..	102	101½
10	9%	‡ Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	102½–104½	4 6 0	Jan, July	..	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16–8 5/16	3 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10½	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 3	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	8¾–9¼	5 8 0	–	9	–
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 0	–	93¼	..
St.	..	Mersey Con. Ord. Stock	5 –7	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 –10	–	–	..	..
1	–	Metropolitan Elec. Trams Def.	½–⅝	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	5 9 0	–	31/32	..
St.	4½%	Do. 4½% Deb. Stock	98½–100½	4 9 6	–	..	–
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¼	5 10 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¾–8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	100¾	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	86 –91	5 10 0	–	86	..
..	5%	Und. Elec. Rys. Co. of Lond. Coup. No. 7	90 –92	5 8 8	–	91	90
St	3%	Waterloo and City Ord.	102 –105	2 17 0	June, Dec	..	–
	..	Yorkshire W.R. El. Trs. Ord.	1¼–1¾	..	..	–	..
	..	Do. 6% Cum. Pref.	8 –8½	..	..	–	..
8	4½%	Do. 4½% 1st Debs.	93 –95	4 14 9	–	..	–

Shre.	Last Dividend	Name.	Price Wed., Sept. 26.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week Sept. Highest	Lowest
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	–	½	
1	2/4½	Babcock & Wilcox Ord	3⅞–4⅛	4 12 6	..	4⅜	
1	7½d.	Do. Pref	1½–1⅝	3 14 0	..	..	
5	4/0	†British Insulated & Helsby Cables Ord.	6¼–6¾	5 10 0	July, Feb	..	
5	3/0	Do. 6 per Cent. Pref.	5⅝–6⅛	4 18 0	Jan, July	..	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94 –98	4 12 8	..	..	
5	..	British Westinghouse 6% Pref.	1½–1¾	..	..	1 9/16	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	..	
2	1/0	Brush Electrical Engineering	13/16–1 1/16	..	March	..	
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1⅜–1⅞	6 8 0	Mar, Sept	1 15/32	
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –98	4 11 9	Mar, Sept	..	
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..	
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5 11/16	
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	..	
1	6⅞d.	Castner-Kellner Alkali Co.	1 1/32–1 3/32	5 4 6	..	1 1/16	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	–	..	
1	1/4½	Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	–	..	
1	7½d.	Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	–	–	
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅜–1⅞	3 13 6	Jan, July	1⅜	
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–97%	5 2 0	Jan, July	..	
5	10/0	Dick, Kerr & Co. Ord.	1⅝–1⅞	5 11 0	Sept	..	
5	8/0	Do. 6% Cum. Pref.	1⅛–1⅜	4 5 0	Sept	..	
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	–	..	
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1¼–1¾	4 5 6	Feb, Aug	1 11/16	1
5	2/6	Do. (£5 paid)	2¼–2¾	4 11 0	Feb, Aug	2⅝	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..	
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	–	..	
5	1/6	Edmundson's Elec. Corp. Ord.	3⅜–3⅞	9 6 0	H'lf-yearly	..	
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅞–5⅛	5 11 6	..	..	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	..	
2	1/7½	Electric Construction Co.	¼–½	14 0 0	July	..	
2	2/2¾	Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	85 –88	4 11 0	Jan, July	..	
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	..	
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	93 –97	4 2 6	–	..	
5	5/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	..	
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 2 0	Feb, Aug	..	
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½–109½	4 2 0	..	..	
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	..	
100	4%	† Do. 4% Debs. Red.	98 –101	3 19 0	..	..	
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..	
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	15/16–1	6 0 0	..	31/32	
1	7½d.	Do. 6% Cum. Pref.	1 –1⅛	5 7 0	..	..	
St.	4½%	Do. 4½% Perp. Deb. Stock	98 –101	4 9 0	..	..	
1	..	Simplex Conduits Ord.	1½	..	..	..	
5	..	Do. 6% Cum. Pref.	5⅛	..	..	..	
12	12/0	Telegraph Construction & Mainten'ce.	33½–35½	5 12 6	Mar, July	33⅞	
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2 5/32–2 9/32	5 17 6	..	2 3/16	
1	6d.	Do. 5% Non-Cum. Preference	1 5/32–1 7/32	4 4 6	..	1 3/16	1
St.	5%	Do. 5% Non-Cum. Preferred	113 –116	4 6 0	–	114½	113
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	105	
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	103 –106	4 5 0	–	105½	104
5	–	Willans and Robinson Ord.	¾–1¼	..	Apr, Oct	–	
5	–	Do. 6 per Cent. Cum. Pref.	8¾–9¼	..	Apr, Oct	–	
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	..	
		TELEGRAPHS.					
10	–	Amazon Telegraph	3½–4	–	Jn, Dec	..	
100	5%	Do. 5% Debs. (red.)	87 –92	5 8 8	..	..	
St.	15/0	Anglo-American	66½–68½	4 15 0	F, My, Ag, N	67½	66
St.	30/0	Do. Preferred	113 –114	5 5 6	F, My, Ag, N	114⅛	113
St.	10/0	Do. Deferred	22⅞–23⅜	2 2 6	F, My Ag, N	23 7/16	23
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	97 –99	4 1 0	Jn, Ap, Jy, O	98½	97
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..	–
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	–
5	2/0	Direct Spanish Ord	3½–3¾	5 6 8	April, Oct	3⅝	–
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	–
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	8 19 0	Jan, July	..	
20	6/8	Direct United States Cable	15½–16	5 6 0	Ja, Ap, Jy, O	15¾	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec	..	..
St.	65/0	Eastern Ordinary	144 –147	4 15 0	Ja, Ap, Jy, O	146¾	145½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90 –92	3 17 9	Ja, Ap, Jy, O	91¾	90½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108⅛	108
10	2/6	Eastern Extension	14½–15	4 10 0	Ja, Ap, Jy, O	14¾	14
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 3	Feb, Aug	..	
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 0	Feb, Aug	..	
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–108%	5 17 6	May, Nov	..	
10	5/0	G. N. (of Copenhagen) with coupon 68	26 –28	6 5 0	Jan, July	27⅝	27½
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	
25	52/6	Indo-European	59 –61	5 6 6	May, Nov	60¾	60½
100	4%	Mackay Companies Common	74 11/16–75 1/16	5 6 0	Jan, July	–	..
100	4%	Do. Preference	73 7/16–73 13/16	5 8 0	Ja, Ap, Jy, O	..	–
1	..	Marconi's Wireless Teleg. Co.	15/16–1 3/16	..	..	..	..
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	–
5	–	West Coast of America	⅝–⅞	..	–	..	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..	..
10	–	West India and Panama	⅜–½	..	May, Nov	..	..
10	4/0	Do. 6% 1st Pref.	6¼–6¾	8 18 0	May, Nov	6 9/16	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	..
10	8/0	Western Telegraph	14½–14¾	4 15 0	Mr, Jn, O, D	14⅝	14⅜
100	5%	* Do. 5% Debs. (2nd Series, 1906)	–	4 17 0	June, Dec	..	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	..	104	103¾
		TELEPHONES					
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	–	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 –103	4 17 0	..	..	..
5	5/0	Chili Telephone (fully paid)	6¾–7¼	5 11 0	August	..	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	1 1/16	..
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	..
St.	6%	National Co. Pref. Stock	109 –111	5 8 0	–	110¾	110
St.	6%	Do. Def. Stock	109 –111	4 10 0	–	110½	109½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	–	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 3/16–5 7/16	4 7 6	Feb, Aug	5 7/16	5
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½–104½	3 16 6	–	103½	..
1	0/9⅜	Oriental	1 1/16–1 3/16	4 8 6	April, Oct	.	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16–1 5/16	4 11 0	–	..	..
St.	4%	Do. 4% Red. Deb. Stock	97 –99	4 1 0	–	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	102½	101½
5	5/0	United River Plate	7 –7½	5 6 8	July	7⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¾–6	4 2 0	June, Dec	..	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 –112	4 9 3	June, Dec	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	4½–5½	5 10 0	–	..	..
10	2/0	Globe Telegraph and Trust	10⅞–11⅛	4 10 0	Ja, Ap, Jy, O	11 1/16	10⅞
10	3/0	Do. 6 per Cent. Pref	14⅝–14⅞	4 0 6	Ja, Ap, Jy, O	14¾	14⅝
10	6%	Submarine Cables Trust (Cert.)	159 –162	4 11 0	April, Oct	161⅛	159⅜

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

IF any part of the United Kingdom is well supplied with electrical power, it will be allowed that Durham is the favoured county. We can only conclude that this is so evident, and that private enterprise in power supply has been so successful, that the Durham County Council can no longer rest under the stigma of having such enterprise within its jurisdiction and yet not under municipal control. The matter has apparently exercised the Councillors' minds for the past three years, and this has now culminated in a letter to Mr. JOHN BURNS, asking whether the Council has the power to prepare a county scheme as a Bill for power and light, and whether they can pay for expert assistance in preparing such a scheme. Why such a letter should be necessary, considering that a Bill was passed in 1903 to empower County Councils to promote Bills in Parliament, is not quite clear; but in any case, an affirmative reply was received, and after this encouragement a special meeting of the Council was called.

◆

THE account of this meeting reads more like an extract from "Alice in Wonderland" than a record of solemn history. The first resolution was that the Electricity Supply Committee should be re-elected; but Ald. HOUSE pointed out that at their last meeting it had been decided that the Committee should not be re-appointed, and that therefore, according to the standing orders, the Committee could not be re-appointed within six months. The Chairman accepted this unfortunate situation. Then Ald. SAMUEL pointed out that another standing order gave the power to discuss the resolution after a certain number of members had signed a requisition, and thereupon the Chairman ruled that the motion was in order. But after the resolution had been duly supported, the Chairman discovered that the requisition had only 10 signatures, instead of 11, and so the motion collapsed after all. The resolution as to promoting a Bill had a somewhat longer life. Ald. SAMUEL opposed the scheme on the ground that the area is too large and the Council have not the necessary local knowledge; and he drew attention to one great danger of municipalisation due to the fact that the credit of a County or Borough Council is unlimited. A Company could fail or reconstruct in the event of serious loss, but a Council cannot get away from losses in that way. Finally, Col. PALMER pointed out that the area was already covered by electric mains from existing undertakings, with the exception of one-fifth part, and most of this remaining fifth was agricultural land. Nevertheless, it was only by the casting vote of the Chairman that the resolution was defeated, so strong is the spirit of municipalisation in the average councillor. If nothing so far had been done to meet the demand for power it would be more easy to understand this progressive spirit. As it is, we suppose this attitude must be attributed to the view expressed by Mr. HOPPER, and doubtless held tenaciously by many other people, that under a municipal scheme the public gets 30 per cent. more than under a company. If that is the case, we are surprised that the companies do not pay very much higher dividends.

◆

THERE has been more or less of a deadlock between the London United Tramways Co. and the Wimbledon Town Council over the new tramway extensions. Apparently, a mile of line having been duly completed, the Company thought that this part might as well be utilised, no doubt with a view to make some of the work dividend-earning as soon as possible. Quite apart from such a sordid motive, most people would take the view that, when a tramway has been laid down, the sooner it is used the more useful is it to the public.

The Council, however, thought otherwise, notwithstanding the protests of their constituents, and refused to allow this part of the line to be worked until all the street widenings and other improvements, in which the Company has been heavily mulcted, as usual, have been completed for the whole of the scheme in Wimbledon. The Company is making the best of a nasty situation by putting the remaining work in hand at once, but situations such as these make private concerns chary of dealing with local authorities which may have any opportunity of taking up an arbitrary attitude, and one that seems wholly opposed to the public good as well as to private enterprise.

◆

The second International Conference on Wireless Telegraphy, which, after having been postponed from last year, commenced its proceedings at Berlin on Wednesday with an address of Imperial welcome delivered by Herr Kraetke, Secretary of State for the German Imperial Post Office, has to wrestle with a broad issue. The question, namely, to what extent a working degree of standardisation in wireless telegraphy can be attained without undue monopoly is one which will involve the most delicate balance of diplomacy and compromise if it is to be settled to the satisfaction of the various conflicting interests. The German Government will propose a draft treaty for discussion, with the hope of putting an end to the present anomalous state of affairs under which stations fitted with the apparatus of one so-called system refuse to accept messages from stations equipped with rival apparatus, and to generally introduce international methods of control. It will be remembered that the first, or "preliminary," Conference held in August, 1903, was far from successful in promoting the desired result, as the Governments of two important countries out of the eight whose representatives attended—namely Great Britain and Italy—refused to sign the protocol embodying the recommendations of the Conference, owing to their agreements with the Marconi Company. The famous incident of the "Nantucket" lightship in 1904 is an example of the complications which have arisen, and the action of the American Government, who ordered the removal of the apparatus on account of which the messages of the German liners were refused, is, perhaps, significant of the views held in some quarters. In any case, we hope that the resulting methods will be wireless in more senses than one, and that "wire-pulling" for private interests may be effectively dispensed with.

◆

We regret to note that the Brush Company is meeting labour troubles just at a time when, in other ways, the outlook is more satisfactory than it has been for some years past. According to Mr. Kinggate, who represented the men at a public meeting at which the managing director, Mr. W. L. Madgen, presided, the coachbuilders should be paid the same minimum rate of wages as at Preston. In his reply Mr. Madgen pointed out that Loughborough is not Preston, where living is more expensive, that the company's scale of wages is higher than the current rate in Leicestershire and the adjoining counties, and that the profits would not permit of a higher rate. This controversy in itself would not call for comment were it not that the men are adopting methods of coercion, and trying to damage the Company in its trade. Thus it has been found necessary to withdraw a tender sent in to the Manchester Corporation to avoid coercion, owing to the influence that has been brought to bear upon the councillors; and at the end of the meeting Mr. Kinggate read a telegram to the effect that the contract for cars at Sheffield would not go to the Brush Company unless the result of the meeting were in favour of the men. At some future time, when British firms find it impossible to take municipal contracts on account of coercion, local authorities will, presumably, place their orders with firms abroad, where inquiries as to rates of wages cannot be made so easily and no minimum can be enforced.

◆

The Junior Institution of Engineers.—The members of this Institution will pay a visit to the Engineering and Machinery Exhibition at Olympia on Saturday afternoon, October 13th.

The Great Northern, Piccadilly & Brompton Railway.—It is announced that trial trips are being run on this railway and that the line will be opened for traffic in January.

Birmingham and District Electric Club.—A Paper, entitled "Some Points about Single-phase Motors," by Messrs. W. Langdon-Davies and F. B. O. Hawes, will be read on Saturday, October 13th, at a meeting of the Birmingham and District Electric Club, to be held at the Colonnade Hotel, New-street, Birmingham.

Personal.—It is stated in *Nature* that Prof. Wien, who occupies the chair of physics at Würzburg, has declined the invitation to succeed the late Prof. Drude as professor of physics in the University of Berlin, because the Prussian Government is unable to undertake the erection of a modern physical laboratory there.

Development of the Steam Turbine.—The lecture by the Hon. C. A. Parsons and Mr. K. J. Walker, which was given at the Engineering and Machinery Exhibition at Olympia on Saturday last, was attended by a large audience, including a number of the members of the Institute of Marine Engineers, and was largely devoted to the developments of the steam turbine as applied to marine purposes. An interesting sketch of the history of the turbine as applied to dynamo driving was, however, also included, tracing its progress from the time when the first Parsons turbine was coupled to a dynamo in 1884 to the present time, when the steam turbines in use or under construction for land purposes alone aggregate some 2,000,000 H.P. Mr. Parsons himself was, unfortunately prevented, from being present.

Electric Power from Windmills.—A novel method of applying windmill power to the driving of a dynamo is described in the *Western Electrician*. Instead of the dynamo being driven through mechanical gearing by the windmill itself, a system which requires delicate speed-regulating apparatus, the windmill is employed to pump water into a hydraulic accumulator, and the dynamo is driven by a small water turbine. Automatic valves control the passage of water to and from the accumulator, and the pressure is kept at about 75 lb. per square inch. Additional storage of energy is obtained by a battery in the usual way. A cut-out, operated by the water pressure, disconnects the dynamo from the battery directly the water pressure falls in the event of the accumulator becoming emptied.

Cable Interruptions.	Date of Interruption.
Tarifa—Tangier	Jan. 18, 1904
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906
Môle St. Nicholas—Port au Prince	Aug. 16, 1906
Grand Canary—Lanzarote	Sept. 18, 1906
Gibraltar—Tangier	Oct. 3, 1906

The New York Central & Hudson River Railway.—Work is rapidly progressing on the sections of the New York Central & Hudson River Railway which are being equipped for electric traction, and it is announced that experimental trains were run over the portion of the line from Highbridge to New York, a length of about 7 miles, on Monday last. The train weighed about 550 tons and consisted of eight coaches, hauled by a locomotive. No attempt was made to accomplish high speeds, but the trial is reported as having been in every way satisfactory.

The Association of Engineers-in-charge.—Arrangements have been made, through the kindness of Mr. Alexander Ritchie, chairman of the City Lands committee of the Corporation, for the members of the Association of Engineers-in-charge, and ladies accompanying them, to visit the new Central Criminal Court on Saturday next at 3 p.m., to inspect the various engineering features of the building. Mr. William Key, who was responsible for the installation of the ventilating and warming arrangements, will give a short lecture, and representatives of the firms of contractors who carried out the work will be in attendance.

Obituary.—A remarkable personality, and one who contributed in no small way to the spread of electrical knowledge in Ireland, has passed away by the death of the of the Right Rev. Monsignor Molloy, Vice-Chancellor of the Royal University of Ireland and Rector of the Roman Catholic University College, Dublin, who died at the age of 73 on Monday morning at Aberdeen, where he was present as a delegate the University celebrations As a "popular" scientific lecturer, in the best sense of the term, he had few equals, and he was a frequent speaker at the meetings of the Royal Dublin Society, of which body he was a member of council. He took considerable interest in the affairs of the Dublin Local Section of the Institution of Electrical Engineers, especially in its earlier days, and was at one time a member of the local committee. It will be remembered that Monsignor Molloy read a Paper before the Dublin Local Section of the Institution in December, 1903, on "An Experimental Study of Stationary Electric Waves" (see *The Electrician*, Vol. LII., p. 320), when he showed a number of striking experiments.

The Institution of Civil Engineers.—The Council of the Institution of Civil Engineers have, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the last session, made the following awards in respect of other Papers dealt with in 1905-1906: A Telford gold medal to Mr. G. A. Denny (London); a George Stephenson gold medal to Prof. W. E. Dalby; Telford premiums to Messrs. W. R. Baldwin-Wiseman (Southampton), G. N. Abernethy (London), H. R. C. Blagden (Alexandria, Egypt), M. R. Collins (Jersey) and James Kelly (Preston); a Crampton prize to Mr. P. T. Gask (Peru). For students' Papers the awards are: Miller prizes to Messrs. Ralph Freeman (London), A. F. Harrison (Manchester), A. J. Grinling (Derby), R. T. Grigson (London), J. W. D. Ball (London), A. Morris (Manchester). Mr. A. F. Harrison also gained the James Prescott Joule medal. The first meeting of the forthcoming session will be held on Tuesday, November 6th, when the President, Sir Alexander B. W. Kennedy, F.R.S., will deliver his inaugural address and the presentation of the Council's awards will be made.

Sheffield Electrical Exhibition.—The principal feature of the electrical exhibition which was opened last week at the Corn Exchange at Sheffield, under the auspices of the Sheffield Corporation Electric Supply Department, is the demonstration of the number and variety of the industrial uses to which electricity may be applied. One of the most interesting sections is that devoted to metallurgy, prominent in which is the working model of an electric steel furnace shown by the Gröndal Kjellin Co., and the hardening and annealing furnace at work on the stand of the Electrical Company. This latter, which is specially intended for the treatment of tools, consists of a bath of a fused metallic salt maintained in a molten condition by the passage of an electric current. Temperatures up to 1,325°C. can be obtained. Electric welding and other metallurgical apparatus is shown by T. Scott Anderson. A number of local firms have stands, the objects shown varying from medical appliances to machine tools. Amongst these an exhibit of some interest is the air purifier shown by Messrs. Ibbotson Bros. The Sheffield Corporation themselves have an attractive display of electric apparatus for lighting, heating and domestic purposes, apparatus in connection with street cable work, switching and transforming gear, a model electrical foundry and electrically-driven workshop. Electric cooking is demonstrated by Messrs. Isenthal & Co. and heavy electrical machinery is represented by a 300 kw. synchronous motor-generator and a number of motors exhibited by Messrs. Vickers, Sons & Maxim. The leading incandescent lamp makers are represented, the Robertson Company showing the actual process of lamp manufacture. Altogether an excellent display is provided, which should do much to popularise the use of electricity in Sheffield.

The Wireless Telegraphy Conference.—The following are the British delegates who are attending the Wireless Telegraphy Conference now sitting at Berlin :—

Mr. H. Babington Smith, C.B., Secretary to the Post Office; Mr. J. Gavey, C.B., Engineer-in-Chief to the Post Office; Mr. R. J. Mackay, of the Post Office; Capt. the Hon. A. E. Bethell, Assistant Director of Naval Ordnance; Col. J. F. Daniell, Assistant Director of Naval Intelligence; Lieut. J. G. Loring, R.N.; Col. R. L. Hippisley; and Col. F. J. Davies, Assistant Director of Military Operations. Egypt is represented by Major J. S. Liddell, Inspector-General of the Telegraphs Administration.

The total number of delegates is about 100 and the following countries are represented :—

Argentina, Austria-Hungary, Belgium, Brazil, Bulgaria, Chili, Denmark, Egypt, Germany, Greece, Great Britain, Italy, Japan, Mexico, Monaco, Montenegro, Netherlands, Norway, Persia, Portugal, Roumania, Russia, Siam, Spain, Sweden, United States, Uruguay.

It is reported that Turkey has failed to reply to the invitation to attend and, as we have already announced, China and Peru have declined to send representatives. One of the American delegates is Mr. Charlemagne Tower, United States Ambassador in Berlin, and Dr. Shunkichi Kimura is present on behalf of Japan.

At the first meeting of the Conference an address of welcome was delivered in the name of the German Emperor by Herr Kraetke, Secretary of State for the Imperial Post Office. Herr Sydow, the Under-secretary of the German Post Office, then took the chair, and the following delegates were elected vice-presidents: Mr. Babington Smith, Vice-admiral Manney and M. de Szalay. The proceedings of the Conference will be private.

An Electrical Anemometer.—An apparatus for measuring the velocity of wind is described by R. Goldschmidt in the *Bulletin* of the Société Belge d'Electriciens. It depends for its action upon the variations in temperature, and therefore of the resistance, of a platinum wire heated by an electric current and exposed to the cooling action of the wind. In order to compensate for the effect of variations in the temperature of the air itself, another similar platinum wire, shielded from the wind, is contained in the apparatus, and the resistances of the two are compared. The measuring apparatus consists of a Wheatstone's bridge arrangement, of which the two platinum wires form two of the arms, and is so adjusted that when they are of equal resistance the galvanometer is not deflected. After a balance has been attained no further alteration of the ratio arms is made and the deflection of the galvanometer is used to indicate directly the velocity of the wind. A very simple method was used to calibrate the instrument. The apparatus was mounted at the edge of a large revolving stand and driven through calm air at a series of known speeds, while the deflection of the galvanometer was noted. A great advantage of this system over the usual mechanical anemometer is its freedom from inertia errors and the rapidity with which it responds to small changes in velocity of the wind. The leads connecting the measuring apparatus with the anemometer wire can, of course, be made of considerable length without affecting the accuracy of the indications. The apparatus is particularly suited for use with a recording galvanometer, and an electrical recording weather-cock, which acts by altering the position of a contact on a circular slide wire, has been devised, so that the direction as well as the velocity of the wind can be recorded at the same time.

BRAKES FOR TRAMWAY CARS.

BY HENRY M. SAYERS.

(*Continued from page 920.*)

Excepting one pattern, which belongs to both classes, all brakes in practical use are either wheel or track brakes.

The wheel brake is limited by the "adhesion" or static friction between the wheel and the rail. Any attempt to exceed this limit results in the wheel "skidding," when the frictional resistance immediately diminishes, it may be, to less than one-third of the adhesion. The possible acceleration due to the motors and the deceleration due to brakes acting through the wheels are both limited by this factor, and are, therefore, equal under similar conditions.

The point at which skidding will occur varies with the condition of the rails, and cannot be accurately estimated. "Greasy" mud produces the worst effect; clean rails give the best. Sanding improves a "greasy" rail. Skidding is the worst defect of wheel brakes; is an element in nearly every runaway car accident; the liability to it is constantly varying, not only from hour to hour, but from yard to yard of the rails. This limited and uncertain action of wheel brakes has led to the development of various patterns of track brakes.

The arduous conditions of service in streets, and also on steep gradients, require greater power than the wheel brake can afford at its best. This additional power is provided by some form of track brake, the general feature being that special brake blocks are pressed against the rails, the resulting friction retarding the car. The material of the blocks may be so chosen as to have a high coefficient of friction with the rail. The braking power available is evidently proportional to that coefficient and to the pressure that can be brought to bear. In mechanically-applied track brakes the pressure cannot equal the weight of the car or the wheels would be lifted off the rails. In any case the weight upon the wheels is lessened by exactly the amount of pressure upon the track brakes, and therefore the wheel brakes become so much the less effective. It follows that the intrinsic superiority of mechanical track brakes lies in the higher coefficient of friction that may be obtained by proper choice of material and the scraping action which cleans the rail table of mud and dust. When magnetic track brakes are employed the available pressure is due to magnetic attraction and no weight is taken off the wheels.

Wheel Brakes.—The application of blocks to the wheels by manual power is the oldest and commonest form of brake. The substitution of mechanical for manual power became necessary on railways as the length, weight and speed of trains increased, and this example has been followed to some extent on tramways.

Several forms of electric or magnetic brakes are, in effect, wheel brakes, although they apply no brake blocks.

The hand gear consists of an upright staff carrying a cranked handle or a hand wheel at a convenient height and position for operation by the driver's right hand. When rotated, the lower end of the staff beneath the platform winds up a chain connected to the brake rigging. On the platform floor, controlled by the driver's foot, a pawl engages a ratchet wheel keyed to the shaft. The driver can with it lock the brake in any desired position or release it promptly.

When the cranked handle is employed it should have a pawl and ratchet movement gearing it to the staff, thus enabling the driver to apply the brakes by a short-stroke reciprocating motion with an effective pull every time. With a revolving handle only a fraction of each revolution gets the man's full power, and the manipulation is awkward. The hand wheel gives nearly as good an opportunity as the cranked handle and ratchet, but the hold on the rim is not so good and the wheel occupies more room.

A 10 in. handle on a 20 in. diameter wheel gives sufficient leverage with the brake rigging employed for any man whose physique justifies his engagement as a driver.

The lower end of the staff engages the chain by an eye or hook, and when operated the chain is wound up on the staff until the brake blocks are pulled on as tightly as necessary. This winding up of the chain on the staff is a clumsy-looking device and strains the links somewhat severely. The chain and its attachment should have daily inspection for signs of weakness. A better arrangement is a cam or guide on the spindle, so formed as to take up the chain at a quicker rate on the first movement when the slack has to be pulled up, and slowing down as the blocks come on and the full leverage is required.

The brake rigging has to apply all the brake blocks simultaneously and with equal force. It is therefore a linkage of which four points are moved simultaneously and equally upon a fifth point being moved by one of the brake chains.

These conditions are met in various ways in the different forms of truck in use. The important points in design are that each block shall be independently adjustable, and provided with a separate pull-off spring acting as directly as possible; that the rigging is not liable to jam or spring and that sufficient clearance is provided from the motors, wheels and truck frame to ensure its free action in all conditions. These points are by no means always studied by car builders, and such things as rods fouling the wheels and being cut by the flanges or sprung and jammed against motor cases, with consequent stiffness of movement, are the results of the neglect.

Where bogie cars are in use the chains from the platform are led to a "floating lever" secured under the car body floor, in the centre of its length, and connected to the brake rigging on the two bogies, as nearly as possible at their centres of swing. The rigging on equal-wheeled bogies has to perform the functions above described, but on "maximum traction" bogies the blocks should bear on the wheels with pressures proportional to the weights carried, and therefore different leverage ratios are required for the driving wheel and the pony wheel blocks. As the distribution of weight between the wheels is not constant, and the wear and travel of the brake blocks are necessarily different, the action of wheel brakes on such trucks is less regular, and the maintenance more troublesome than on equal wheeled trucks. This is an important element in the dislike commonly entertained towards "maximum traction" trucks, but there are others foreign to this article.

Cast-iron brake blocks are in general use. As they wear out rapidly they should be of cheap metal and inexpensive design, requiring no machinery or fitting, and attached to the cradle or sling by a cotter or bolt. It is important that they should be "straights," not right and left hands, and most truck manufacturers recognise this requirement.

Braking action necessarily wears both wheels and brake blocks. It is the main item in wear of wheels. As wheels or tyres are far more expensive than blocks the material of the latter should be such as to wear the more rapidly. The happiest combination would dissipate all the energy in heat without abrasion of either member, but no such result seems attainable, and if it were it is probable that the temperatures reached would crack the wheels.

Chilled iron wheels should have a life of 30,000 car-miles, steel tyres from 60,000 to 80,000, and if worn out on a lower average mileage softer brake blocks should be tried.

A hard "grey" pig generally gives good results.

There are some patent brake blocks on sale for which special advantages are claimed, longer life especially. They have a composite face partly of hard chilled iron, partly of soft wrought or cast iron, the softer metal held in a frame or matrix of the harder. It is evidently insufficient to show a saving in the life of brake blocks if the wheels are ground away at a greater rate. On the other hand, the softer metal has a higher coefficient of friction than the harder, but wears faster. It is possible, therefore, that a composite-faced block, in which the wear of the softer iron is regulated by the harder frame may give better braking results than a homogeneous block, without sacrificing the wheels. It is evidently a question best answered by practical trial.

Steel tyres are suited by a rather softer block than chilled iron wheels.

Excessive wear of wheels and tyres is such a serious expense that it is worth while to take some trouble to prevent it, and hence brake block materials are worthy of attention.

Carborundum brake blocks are sometimes used to grind out "flats" due to skidding. It is claimed that this may be done during service running, but it is better to confine the work to the shed. Ordinary brake blocks fed with sharp sand and water may be used in the same way, but work less rapidly.

The hand brake under the control of a careful man is a good service brake where speeds are moderate and other traffic is not dense, but for speeds exceeding 10 miles per hour the stopping distance required is too great. It is true that it is widely used without serious accidents upon many lines which run their cars at higher maximum speeds, but investigation will show that the practice in these cases is to cut off current, and drift to near the stopping place, using the brake when the speed has fallen to 6 or 7 miles per hour, when it will stop the car in from 15 ft. to 40 ft., according to the state of the rails. Such a practice saves power but wastes time, and consequently diminishes the carrying and earning power of the line. As an emergency brake it is distinctly unsatisfactory, since the stopping distance from 10 miles per hour may vary from 45 ft. to 65 ft., according to the state of the rails.

If skidding occurs the stopping distance is greatly increased. The skilful driver perceives by his muscular sense the pressure on the blocks and judges how much he can put on without skidding. This is a valuable feature of the hand brake, and goes a long way to account for its survival in spite of its limited power. It has its reverse side, of course, and a nervous, inexperienced or frightened man will fail to make effective use of the means put into his hands, with more or less serious results, unless he is eliminated or educated in good time.

The application of mechanical power to wheel brakes effects an improvement in two main directions. Firstly, the time lost in winding up the slack chain is almost entirely saved by the rapid movement of the piston or other mechanism, and, secondly, the pressure on the blocks may be automatically reduced as the speed falls, so that it is kept just below the skidding point throughout the stop.

No more braking power is available, for that depends entirely upon the adhesion coefficient. The automatic reduction of pressure is not better than will be effected by a good cool driver, and cannot be made to allow for varying conditions of rails, but it is better than the uncertain and irregular action of an unskilled man. When trailer cars are used mechanical application of the brakes is a great advantage, and it is probably only in such cases that the expense is worth incurring.

Compressed air is the most generally used agent. The actual mechanism of application is by means of a cylinder and piston acting on some part of the brake rigging, which is usually arranged for hand application also. For tramway work the "straight air" system, in which air is admitted to the cylinders to apply the brake, is generally employed. The "automatic" air brake, invaluable on long trains, hardly justifies itself in tramway practice.

The driver's apparatus consists of a valve with which he can admit and exhaust air to and from the cylinder, and can close both ports, so that the air admitted gradually leaks, so reducing the pressure on the blocks. A gauge showing the reservoir pressure is provided, and in some equipments a second gauge showing the pressure in the brake cylinder.

Thus the driver can admit air at full pressure and get the maximum power at once, can close both ports, and the pressure leaks off gradually, and can get a complete release of the blocks by opening the exhaust port.

The physical relief to the driver is undeniable, and where labour is expensive or difficult to obtain the air brake may be commercially justifiable even on single car working. Such conditions do not yet obtain in the United Kingdom.

Three methods of supplying the compressed air are in use The storage system is the simplest. An air reservoir on the car is filled up at a pumping station and used from as needed This plan is the least expensive in first cost and working if a considerable number of cars are supplied. It has the serious defect that the supply may not last out the estimated length of run, leakage, or an unusual number of brake applications, causing premature exhaustion.

It involves the use of a pressure-reducing valve and supplementary or service tank, and also the compression of the air to a much higher point than required in the brake cylinder. These are less serious defects than the risk of exhaustion.

Compressors driven respectively from a car axle and a separate motor are the self-contained arrangements.

In both, automatic devices stop and start the pump in accordance with the pressure in the reservoir. The axle driver operates through a cam or a gear, the compressor being put in or out of action by some form of clutch. This arrangement occupies no floor space, and requires no special electrical arrangements. It is cheaper than the motor-driven set. Against it is the objection that the size and capacity is limited by the room available under the car, and that it is somewhat inaccessible if anything is out of order. Experience shows that the wear of the clutch mechanism, and some other parts, is severe and the maintenance cost unduly heavy. The best disposition is to drive the compressor from the "pony" axle of a maximum traction truck, more room and therefore better inspection resulting.

For severe service, particularly where trailers have to be supplied, the motor-driven compressor is more suitable. It can be made of any required capacity within reason, and being carried on the platform is under continuous observation. The automatic control is electrical, the air pressure switching the motor on or off as it arrives at the predetermined upper or lower limit.

An important advantage over the axle drive is that the compressor may be run and the reservoir filled to working point while the car stands in the shed or at any stopping point; and, further, that the rate of compression may be regulated to suit the service requirements. The axle drive lends itself to neither of these desirable objects.

The motor-driven compressor is in general use on electric railways, notably the London underground lines, generally supplying power to automatic brakes. It is also in somewhat extensive use on American tramways, especially of the "interurban" class.

So far as the writer knows, it has not been adopted on any English tramway, and the few cases in which axle-driven compressors and air brakes have been used have mostly resulted in their abandonment on the score of expensive upkeep. It is very easy to cause skidding and wheel flatting with the air brake, and the driver has no such "feel" of the pressure on the blocks as he has with the hand gear. For single car working there is very little to be gained, and the air brake is not likely to find wide application here.

(To be continued.)

OLDHAM CORPORATION TRAMWAYS ACCOUNTS.

The feature of the working of the Oldham municipal tramways for the year ended March 31, 1906, was that a deficiency of £4,176. 1s. 9d. in the previous year has been turned into a surplus of £7,284. 15s. 3d., in both cases after paying capital charges. The following comparative statement gives at a glance the financial results of the undertaking for the past three years :—

—	Year ending March, 1906.	Year ending March, 1905.	Year ending March, 1904.
Total receipts..........	£85,912 0 6	£66,840 14 5	£60,402 13 1
Net working expenses ..	29,539 17 3	29,146 19 9	29,667 0 10
Electric energy	19,307 1 7	15,686 15 6	13,608 3 8
Gross profit............	37,065 1 8	22,006 19 2	17,127 8 7
Interest, sinking fund and other establishment charges (net) ..	29,780 6 5	26,183 0 11	24,953 15 7
Net result	Surplus. 7,284 15 3	Deficiency. 4,176 1 9	Deficiency. 7,826 7 0
Net working expenses per car-mile (excluding electrical energy)	4·04d.	4·64d.	5·01d.
Percentage of total expenses to receipts....	56·85%	67·07%	71·64%

The extension of through communication which is going on in the South Lancashire district is being assisted by the Tramways committee at Oldham, arrangements being in course of completion for the running of through cars between Oldham and Rochdale and Oldham and Manchester.

Taking the most important points in the report of the tramways manager, Mr. W. Slattery, mention may be made of the fact that 13 extra cars have been fitted with steel tyred wheels during the past year out of revenue, making a total of 35 cars so fitted. A further 12 cars will be treated similarly this year and so on until the whole of the rolling stock has been dealt with. The manager points out that although the initial cost may be high, as compared with the chilled wheel, he is of the opinion that there is an appreciable saving in the cost of renewals, inasmuch as a steel-tyred wheel has greater life and does not necessitate the car being taken out of service as often for re-wheeling.

Dealing with accidents, a car ran away on one occasion on a 1 in 11 gradient, due to the driver not having placed his slipper-brake handle in position. To obviate a recurrence an additional operating handle has been placed on each car, so that the conductor will now be able to apply the slipper brake from the rear platform of the car. The Tramways committee has approved of the suggestion of the tramways manager that an accident reserve fund shall be formed by setting aside each year the sum of £1,000, less the amount actually paid in compensation, until such fund reaches £5,000.

The cost of the maintenance of the overhead equipment during the year has been heavier than usual—viz., £2,432. 6s. 5d., compared with £1,749. 5s. 9d. in 1904-5 and £1,135. 0s. 4d. in 1903-4. This has been due to the fact that many miles of guard wiring has been renewed, owing to it being in a corroded and dangerous condition. Many spans and section insulators have also had to be renewed, and all single insulation is to be taken out as speedily as possible, owing to it having proved unsatisfactory. Attention is also drawn to the fact that the time is fast approaching when it will be necessary to carry out extensive repairs to the track and renew many points and crossings. On several sections hammered joints are rapidly developing, and unless taken in hand shortly will not only be a source of annoyance to passengers, but will cause considerable damage to the rolling stock.

The total electrical energy used for propulsion, lighting of cars, depots and workshops, and for motors, &c., in the workshops was 3,089,133 units, and the average units used per car-mile 1·76. The increased consumption per car-mile over the previous two years (1·66 units in 1905 and 1·53 units in 1904) is attributed to additional top-covered cars, increased traffic, more regular running of four motor cars, and general wear and tear of track and car equipment, &c. Complaint is made both in the tramways manager's report and in a joint report by a member of the Tramways committee and the general manager as to the price charged the Tramways committee by the Electricity Department for electrical energy—viz., 1½d. per unit, and an application for a reduction is urged.

The total receipts for the year ended March 31, 1906, were £85,912. 0s. 6d. and the net working expenses £29,539. 17s. 3d. We give below an analysis of the costs in pence per car mile :—

	Year ending Mar. 31, '06.		Year ending Mar. 31, '05.
TRAFFIC EXPENSES.			
Salaries and wages	2·056d.	..	2·191d.
Cleaning and oiling cars	0·217d.	..	0·228d.
Cleaning, salting and sanding track	0·045d.	..	0·060d.
Ticket check	0·135d.	..	0·174d.
Uniforms	0·044d.	..	0·087d.
Miscellaneous	0·030d.	..	0·028d.
Total traffic expenses	2·527d.	..	2·768d.
GENERAL EXPENSES.			
Salaries and wages	0·123d.	..	0·144d.
Rents, rates and taxes	0·334d.	..	0·382d.
Printing, stationery and office expenses	0·031d.	..	0·087d.
Legal expenses, compensation, &c.	0·041d.	..	0·018d.
Insurance	0·004d.	..	0·004d.
Miscellaneous	0·030d.	..	0·049d.
Total general expenses	0·563d.	..	0·684d.
REPAIRS AND MAINTENANCE.			
Permanent way	0·097d.	..	0·117d.
Electrical equipment of line	0·333d.	..	0·279d.
Cars, buildings, workshop, tools, &c.	0·523d.	..	0·754d.
Total repairs and maintenance	0·953d.	..	1·150d.
Reduction and depreciation of stock	—		0·043d.
POWER EXPENSES.			
Cost of current at 1½d. per B.O.T. unit	2·642d.	..	2·500d.
TOTAL WORKING EXPENSES (excluding capital charges)	6·685d.	..	7·145d.

CAPITAL CHARGES, &c.	Year ending Mar. 31, '06.
Interest	2·171d.
Sinking fund	1·475d.
Income tax	0·047d.
Rent of leased lines	0 600d.
Total capital charges	4 293d.
TOTAL EXPENSES (including capital charges)	10·978d.
Net amount for appropriation	0·997d.

The surplus, which amounts to £7,284. 15s. 3d., has been carried to appropriation account. The gross capital expenditure to date is £440,168, whilst of the total borrowing powers, amounting to £507,769, these have been exercised to the extent of £439,547. The Corporation owns 7 miles 4·72 chains of single track and 10 miles 7·85 chains of double track, whilst in addition 3 miles 3 furlongs 9·43 chains single track, and 2 miles 3 furlongs 8·26 chains double track are worked on lease, making a total mileage worked by the Corporation cars 23 miles 5·54 chains. The car miles run were 1,753,546 and the passengers carried were 16,668,026.

THE TELTOW CANAL AND ITS EQUIPMENT.*

(*Concluded from page 883.*)

THE PRODUCTION AND DISTRIBUTION OF ENERGY ON THE TELTOW CANAL.

In view of the possibility of night and day traffic becoming ultimately necessary, it was decided that it was undesirable to make provision only for the power necessary for haulage. One of the chief objects of the power station was the supply of electrical energy at a cheap price for industrial undertakings, as it is hoped that this may serve to attract to the district of Teltow large manufacturers who require a supply of cheap power. The power station is not authorised, however, to supply individual consumers, but only in bulk to the municipalities of the district, the current being taken to certain predetermined points. All industrial consumers must obtain their supply from the municipality.

The power house, a plan of which is shown in Fig. 19, is equipped with 2,300 H.P., and is so designed that extensions can readily be made. The power consumption for the canal, when it is in full working order, will vary between nil in winter and at night, to a maximum of 500 H.P. with an average traffic of two million tons per annum. The load from private consumers may be expected to be equally variable, and, in order to avoid undue waste, two steam turbines of 1,000 H.P. have been fitted, and a small Kolben steam engine of 300 H.P. to take the winter day load and Sundays. The power house is situated near the 11·3 km. mark on the canal and opposite the village of Teltow. The foundations are on sandy soil, so that special precautions were essential to prevent settlement, and the discovery of water springs during the boring operations necessarily added to the difficulties. This water is now diverted and led into the canal.

The building is arranged in two main halls, each 42 ft. 8 in. wide. In the west wing are the machines, and in the east the boilers. There is also a dwelling house for the engineer and two assistants, besides offices and stores. The architecture is simple : the outside walls are of brickwork, with the exception of the end walls, which, together with the partition wall between engines and boilers, are built on an iron framework filled in with cement. On the east side of the main building is the chimney, 147 ft. high and of 6 ft. 6 in. diameter at the base. A special quay is placed close to the boiler house, to which barges can come, the coal being unloaded from them by a 1 ton crane fitted for that purpose. The feed water is drawn from the canal through a pipe in the east side of the canal banks, with a screen to catch any floating matter, then in iron pipes to an opening in the east side of the main buildings, through a cement pipe of 2 ft. 4 in. bore to a special reservoir, to which a weir is fitted. The greater part of the water flows over this weir, and then through a cement pipe back to the canal at a point about 320 ft. from the inlet pipe. A part of the water before reaching the weir flows to one or other of two gravel filters of about 237 sq. ft. area and thence into a tank. Both filters, the weir reservoir and the pure water tanks are arranged in a special building. From the main tank the water flows into two feed-water heaters under the feed-pump chambers in which its temperature is raised by about 60°C. by the exhaust steam from the boiler-feed pumps and by the condenser water. The general arrangement of the engine room was designed by the Siemens Schuckert Co. The boiler equipment consists of four water-tube boilers, each of 2,200 sq. ft. heating surface with built-in superheaters of about 650 sq. ft. heating surface. Each boiler can produce 8,000 lb. of steam at 300°C. per hour. The working pressure is 180 lb. per square inch. The boilers are fitted with automatic feed arrangement (Hannemann) by which a uniform water-level is maintained. The boilers are built by Messrs. Cyklop, Mehlis & Behrens, of Berlin. Beside the boiler house is a space for the boiler-feed pumps which consist of two direct Duplex pumps by Weise & Monski, each for about 450 litres of water per minute. Messrs. Frantz Seiffert & Co. have supplied practically all the pipework for steam feed water, &c., used in the station, the steam pipes being supported on double conical rollers to allow for expansion.

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* Based on articles which have appeared in the *Elektrotechnische Zeitschrift.*

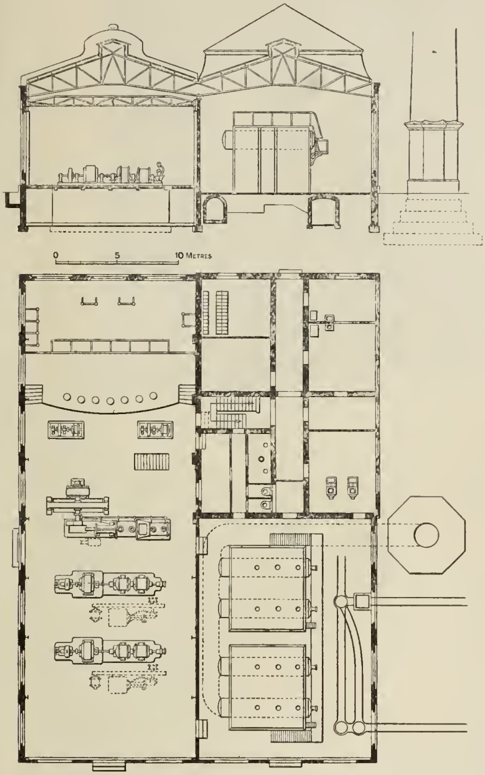

Fig. 19.—Cross-section and Plan of Power House.

The steam turbines are of the Zoelly type, built by Escher Wyss & Co., of Zurich, and the steam engine is a tandem horizontal Kolben type, built by Kuhn, of Stuttgart. The steam turbine is of the ordinary Zoelly type running at 3,000 revs. per min. and direct-coupled to a two-pole three-phase alternator. The condensers are of the injector type, the auxiliary pumps being driven by three-phase motors with belt drive and running at 60 revs. per min. The vacuum obtained is 95 per cent. = 14·25 lb. per square inch. The following figures were obtained for steam consumption: Full load, 13·5 lb.; three-quarter load, 14·4 lb.; half load, 15·7 lb. of steam per effective horse-power-hour.

The steam engine has a high-pressure cylinder 14·8 in. in bore, and a low pressure of 22·6 in. bore, arranged in tandem, with 32·7 in. stroke and runs at 125 revs. per min. The air pump is double acting and is driven from the crank shaft of the engine by the connecting rod. The machine is also fitted with an oil separator placed between the low-pressure cylinder and the condenser, by which the greater part of the cylinder oil is collected before entering the condenser. In order to regulate the speed of the three machines before paralleling, small electric motors are attached to the throttle valves for controlling the steam inlet. These motors are driven by low-pressure current, and are operated by switches arranged on the switch pillars, to be described later. A general view of the engine room is shown in Fig. 21.

During the first year of electric driving only one, or at most two, of the main machines will be required. In order to economise as much as possible, therefore, two dynamos were coupled to each steam set, one for producing three-phase current at 6,000 volts and 50 frequency, and the other to give continuous current at 600 volts pressure. For extensions, separate machines, giving three-phase current and continuous current, will be installed. The load of the three-phase dynamos comprises the various motors and motor-generators, while the continuous current is only used for towing in proximity to the power station. The machines coupled to the turbines are designed for a load of 650 k.v.a., and for the steam engines for 230 k.v.a., while the continuous-current dynamos give 200 kw. and 110 kw. respectively. The shafts of those machines coupled to the turbines are connected thereto by a special coupling carried on three special bearings bolted to the main turbine bed. The bearings are all lubricated with oil pumped into them from an oil pump, and are water cooled. After passing through the bearings the oil goes to a special cooler, from which it is pumped back, as already explained. The three-phase dynamo is of the usual type for direct turbine driving, with internal poles; the conductors are supported on the cast-iron stator frame, and the magnet is two pole. The stator is built up out of thin soft-iron plates bolted together, with radial ventilating channels at short intervals. The slots which contain the high-pressure winding are lined with micanite tubes. The rotor is built up of iron plates to a cylindrical shape, on which the winding is arranged, so as to produce two poles of opposite sign at opposite ends of a diameter. Besides the ordinary ventilating channels in the stator, channels are also cut through the iron in the direction of the shaft to allow of further ventilation. The windings on the rotor are held in position by wedge-shaped pieces, and at the ends the winding is protected by conical steel rings to hold it in place; the two slip rings are at the two ends of the shaft. The iron case completely encloses the machine, so that all conductors carrying current are protected from damage and cooling is effected by special ventilating contrivances. The air is sucked in through two ring-shaped side channels in the cover, thence it passes the ends of the stator coils, then into the rotor and through the ventilating channels to the stator iron, thence into the axial channels in the stator iron and thence out to the open air.

The continuous-current dynamos that are driven by the turbines are fitted with auxiliary commutating poles. There are four main poles excited both by shunt and series coils; the auxiliary poles are arranged midway between the main poles and are excited by series coils. The poles are built up out of iron sheet, and the main poles are fitted with pole shoes. The winding is of copper strip arranged edgewise, the armature is former wound and the coils are placed in radial slots, being kept in position by fibre wedges.

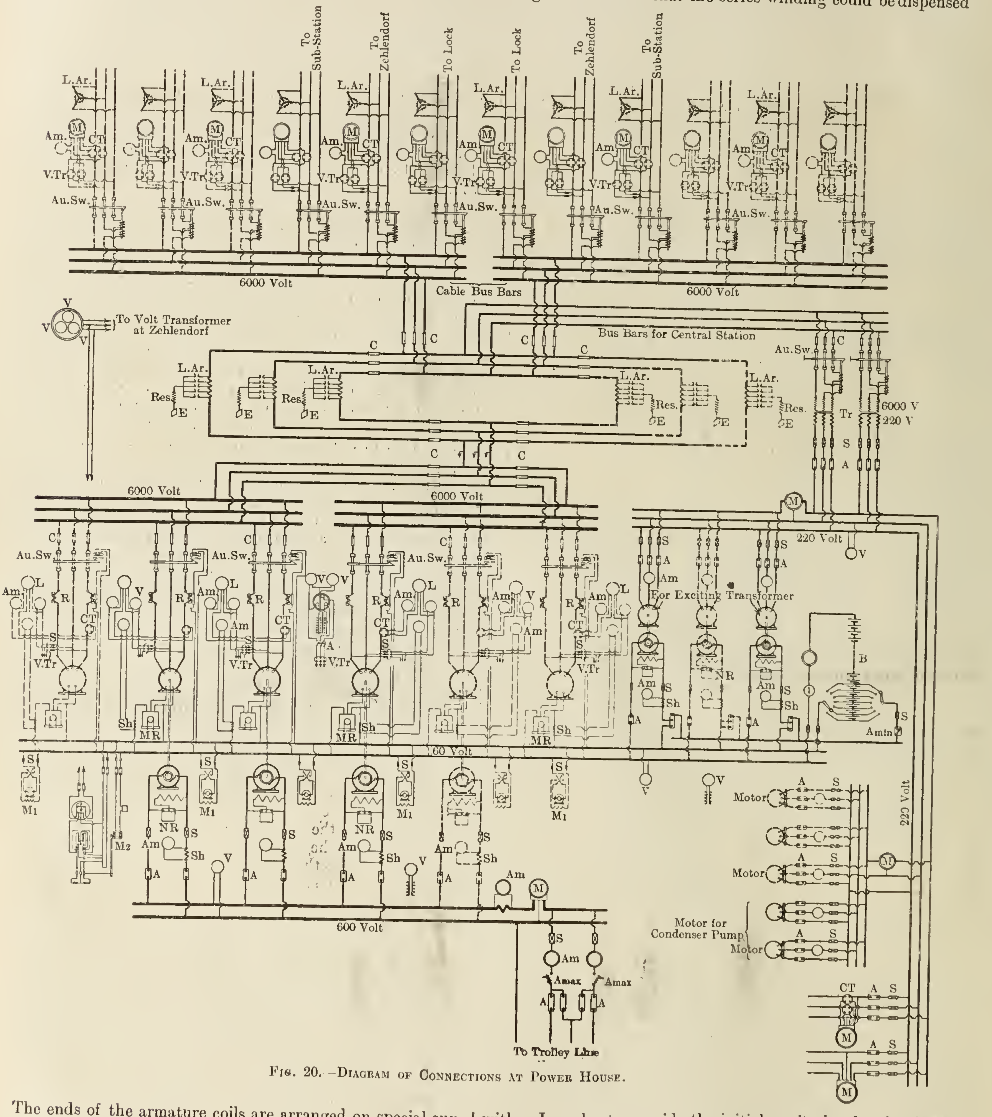

Fig. 20.—Diagram of Connections at Power House.

The ends of the armature coils are arranged on special supports and are held in place by conical bronze end covers. The commutator and brush holders call for no special mention; air cooling is effected as in the three-phase dynamos.

As has already been mentioned, the continuous-current dynamos only supply the current necessary for towing near the power station as well as for the capstans and other appliances. This current is, as a rule, so steady that there is no necessity to arrange a floating battery to take up load variations, the machines are compounded and this does all that is necessary as regards pressure regulation. It was found with the turbine machines that, even without auxiliary series coils, the full no-load pressure was very nearly maintained at full load, and even with considerable load variation the pressure change was so small that the series winding could be dispensed with. In order to provide the initial excitation for the three-phase dynamos a small battery of 36 cells to give 126 amperes was installed, which will provide the excitation for the two large dynamos and the auxiliary light for half an hour, if required. The excitation of the three-phase dynamos is at 65 volts and is supplied normally by an induction motor-generator of 50 H.P.

The general arrangement of the circuits is shown in the diagram of connections (Fig. 20). There are two sets of 'bus bars for the three-phase current distribution at 6,000 volts, from each of which three sets of cables go, one to Zehlendorf to supply the current required in that municipality, one to the lock, the other to a sub-station, of which more will be said later. Each cable is fitted with excess-pressure cutouts to obviate any resonance or other effects that may occur when switching on or off. These protectors consist of six horn lightning arresters arranged as shown in Fig. 22 so as to provide a bypath for current at excessive pressure either between the phases or between each phase and earth; the arresters are placed in series with oil insulated resistances so as to avoid excessive momentary currents. The power supplied through each high-pressure cable is measured on an energy meter. In place of the ordinary high-pressure fuses to protect against excessive current, high-pressure automatic cutouts are employed. The switch gear for controlling the current produced by the machine is arranged in the middle of the switchboard and is so devised that either section of the main 'bus bars can be made dead, if desired, by multiple break switches. The dynamos are protected by lightning arresters arranged in connection with subdivided choking coils (Fig. 20). The excess pressure protective devices are led from separate 'bus bars, these bars exciting two 90 k.v.a. transformers which supply three-phase motors used for driving the condenser pumps and for the lighting of the power house and for other motors in the power house.

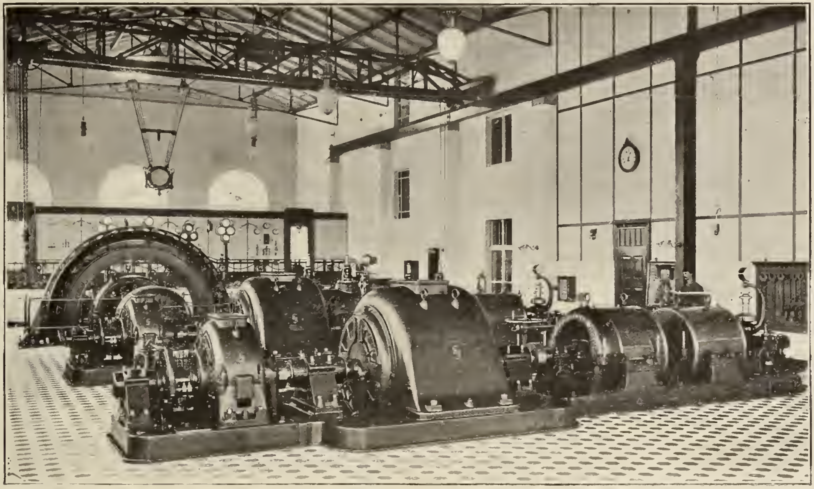

Fig. 21.—Interior of Power House.

The right-hand side of the switchboard is arranged for the distribution of the low-pressure three-phase current, and calls for no special mention. The induction motor-generators work in parallel with the same battery and supply current to the bars, which in turn supply current to the exciting circuits of the three main machines.

Fig. 23 is a section through the switchboard showing the arrangement of the various appliances in connection with it. The lightning arresters and main switches are placed in a basement underneath the switchboard, the lower level of the upper floor being about 3 ft. 3 in. above the level of the main machine floor.

For each of the three-phase dynamos a switch pillar is erected which contains an ammeter, wattmeter, voltmeter and an ammeter for the exciting circuit. Under these is the small switch for controlling the motor which controls the steam inlet valve and thus changes the speed, and under this again the handle for the high-pressure switch, as well as two hand wheels for regulating the pressure of the generators. A further switch pillar is used for paralleling the alternators, and carries two voltmeters with switches and synchronising lamps. The synchroniser contains three lamps arranged so as to light up in succession at intervals corresponding to the amount by which the incoming machine is out of synchronism. The order of lighting up shows whether the machine is running too fast or too slow. A multiple switch is used so that this pillar can be used for synchronising any of the machines in the station to the main 'bus bars. The pressure of the generators is so regulated that the pressure at a feeding point 2·3 miles from the power house is 6,000 volts. For this purpose a measuring transformer (ratio 6,000 : 110) is connected at the feeding point, and a three-core cable is led back to the central station, the current from which flows to a special voltmeter with a dial 24 in. in diameter, hung over the top of the main switchboard and visible all over the engine room. The front switchboard carries all the instruments and switches in connection with the main dynamos, the excitation and the battery. In order to avoid the necessity of using long leads from the battery to the regulating switch, on the switchboard the regulating switch is placed on the wall of the battery room and is worked from the main switchboard by a chain.

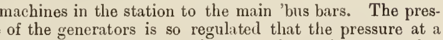

Fig. 22.—Diagram of Connections at Distributing Points.

The main switchboard occupies the whole width of the engine room, with the exception of two door spaces which lead to the back, where auxiliary boards are fitted. On the right is a switchboard containing all switches and meters in connection with the electrical haulage. Two switchboards, parallel to the main boards, carry the switch levers, meters and ammeters for the outgoing high-pressure cables. Two switchboards to the left control the transformers in the basement and the station lighting respectively.

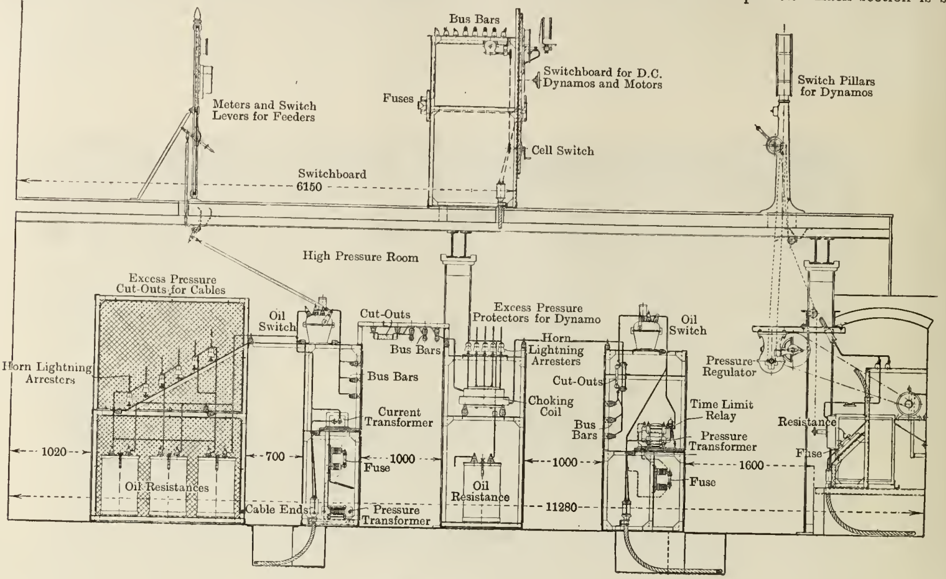

Fig. 23.—Arrangement of Switch Gear in Power House.

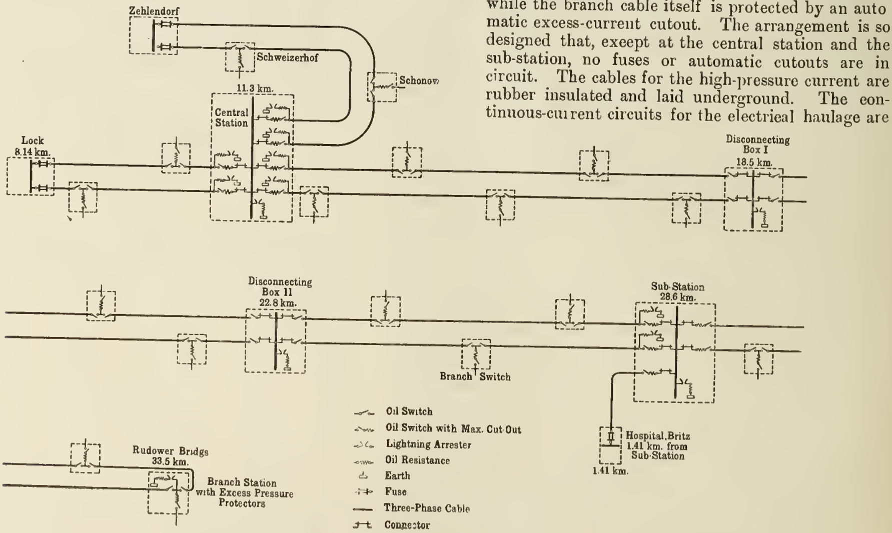

Fig. 24.—Plan of High-pressure Ring Main.

The current is carried along the canal by a cable arranged as a ring main (see Fig. 24), the pressure being 6,000 volts between the wires of the three phases. Each section is so arranged that in case of damage it can be completely cut off from the supply of power. For this purpose two switches are fitted at each branch, before and behind the connection, while the branch cable itself is protected by an automatic excess-current cutout. The arrangement is so designed that, except at the central station and the sub-station, no fuses or automatic cutouts are in circuit. The cables for the high-pressure current are rubber insulated and laid underground. The continuous-current circuits for the electrical haulage are designed so that the pressure drop at any point under the most unfavourable conditions shall not exceed 15 per cent. Special feeder cables are not used, but only auxiliary overhead conductors, which can be lengthened or shortened as desired. The trolley wire has a section of 0·1 sq. in, the auxiliary feeder having a section of 0·11 sq. in.

A sub-station is placed at the 28·6 km. mark on the canal bank, to provide current to the eastern half of the canal. It is a three-storied building; in the basement are the transformers and part of the high-pressure apparatus. Besides this is a room in which a large auxiliary battery can be placed, if necessary. The ground floor serves as a machine room, while the upper floor provides accommodation for an attendant.

The sub-station is shown in plan and sectional elevation in Fig. 25, and is fitted with two rotatory converters of 150 kw. capacity running at 1,000 revs. per min. fed from a transformer connected to the main feeders. The converters are fitted with pressure regulators by which variations in pressure between 5,700 and 6,400 volts on the feeder do not appreciably affect the steady P.D. of 600 volts on the direct-current side. This is done by an ingenious use of self induction in the alternating-current side of the rotary. Each rotary has its own transformer, no special starting machines are installed, the rotaries being run up from the direct-current side. The switchboard arrangements are much the same as those in use at the central station, all feeders being protected by excess pressure "horn" arresters.

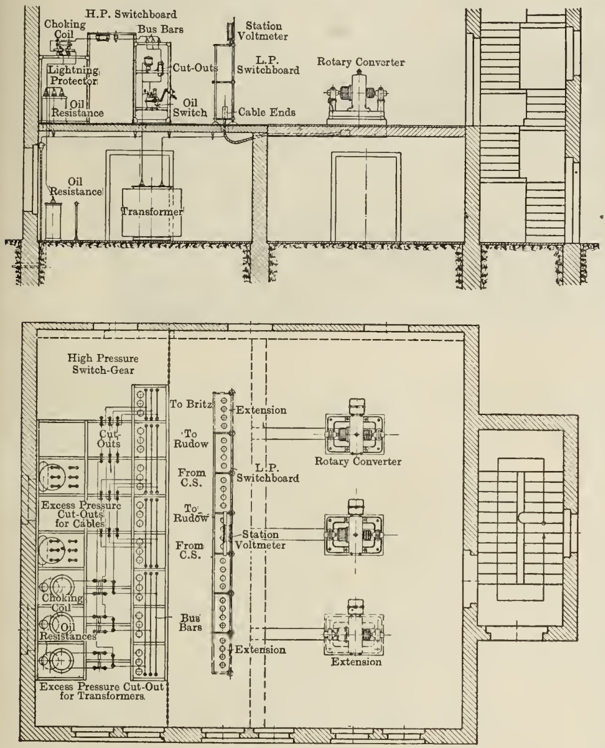

Fig. 25.—Cross-section and Plan of Sub-station.

This canal is the first in which the manifold uses of electrical energy for power have been used exclusively; power production is centralised and all mechanical operations are performed electrically. The supply of electrical energy was of great service for driving pumps, dredgers, &c., during construction, and it is now used for the haulage of the barges, for the lock, for cranes at the quay and harbour, for capstans and winches at the harbour, for driving the machinery in the workshops, and for lighting the harbours and locks; the centralisation, in fact, is as complete as it is possible to make it.

Conclusion.

The management of the canal traffic is conducted by the Teltow Canal authorities, who have their office in Berlin. For the local supervision of the traffic there are three sub-offices, one at the eastern end of the canal, one at the western end, and one near the electric power station. The collection of the dues and the superintendence of the joint tug and traction haulage is to be in the hands of superintending officials called the "kanalmeistern" (canal-masters). For purposes of management the main canal is divided into four sections (see the map, Fig. 1):—

1. The section from the Havel to the upper entrance to the Teltow Canal, in the Griebnitzsee.
2. The section from the upper end of the Griebnitzsee to the Machnow lock.
3. The section from the lock to the Zehlendorf–Little Machnow road bridge.
4. The section from the Zehlendorf–Little Machnow road bridge to the end of the canal at Grünau (Spree), and also
5. The section Britz–Kanne (the branch canal).

The locomotives traverse sections 2 and 4 on the right-hand side of the tow-path in the direction Havel to Spree, and at the ends of the section cross to the other side of the canal by the bridges and come back on the opposite banks. On section 2 the locomotive drivers remain for the whole day on the same locomotive, while on section 4, which is about 17½ miles long, the drivers change locomotives at the Victoria Strasse, in Steglitz, and at the Späthstrasse, in Britz. The drivers take their locomotives to these places, cross to the other side of the canal and return on the next locomotive coming in the opposite direction. This sub-division is necessary on section 4, because the whole journey along it occupies seven hours, and it is not possible for a driver to go backwards and forwards along the whole of it in one day; he could not, therefore, get back home in the evening. The advantage of using short sections is that the drivers quickly learn the character of their track and its attendant difficulties, while, on account of the simple and uniform construction of the locomotives, there is no trouble about changing locomotives. The locomotives stop towing at a given time every evening and return to the nearest shed, one of which is built by the Albrechts Teerofen on section 2 (Fig. 1), one by the Machnow-road bridge, two opposite each other at the Späthstrasse bridge, in Britz, and one at the canal entrance, in Britz. The sheds are rectangular in shape with three tracks and an examination pit. As may be readily seen from the above, for efficient working, the tractors must run in accordance with a definite schedule, but on account of the variable nature of the traffic this has to be frequently changed. For a one-hour service 6 tugs, 20 locomotives and 22 drivers are necessary for the working of 32 trains of barges. The canal-master at the power house is connected by telephone with the lockmasters on the canal leading to the Tetlow Canal (*i.e.*, the Havel and the Oberspree Canal) and receives from them each afternoon a statement as to the number, kind and destination of the various barges which will traverse the canal during the next day. Besides this, all boats that have completed their loading are obliged to communicate with the canal master of the middle section one day before departure. Both canal-masters at the entrances to the canal are connected by telephone to the canal-master at the power house, and the latter each evening has to make out a schedule for the next day, so as to employ the smallest number of locomotives and tugs possible, and so that the various men employed may get back near their homes in the evening. After preparing his schedule the canal-master communicates by telephone to the above-mentioned locomotive sheds, where the superintendent settles which drivers shall be at work during the next day. The shed superintendents are thus able to see whether the schedule can be worked without difficulty.

The trains are made up and have a net load of 1,200 tons, and with two 600 ton barges, for example, two passages through the lock are necessary, but this should only take half an hour. At the canal entrance moorings are, of course, necessary. Fig. 26 gives a view of a complete train with locomotives attached. With the arrangements described each boat is towed right through the canal or to its destination without delay. The time of passage through the canal, allowing half an hour for the passage through the lock, is $10\frac{1}{2}$ hours

For a yearly traffic of 4,000,000 tons the driving cost comes to 0·0418d., interest, depreciation, &c., 0·0298d., giving a total of 0·0716d. per ton-mile.

These figures show clearly that a system of this kind is applicable only to canals with a heavy traffic.

It should be noted that the figures given are very unfavourably affected by the difficult conditions met with in this canal: the large number of bridges and harbours, and also the fact that driving is not carried on entirely by locomotives; the figures given must, however, be regarded only as an approximation. The advantages of a monopoly for the method of traction along the canal are very great; with a number of different systems of haulage the most efficient will take the bulk of the traffic, and the others remain more or less unused.

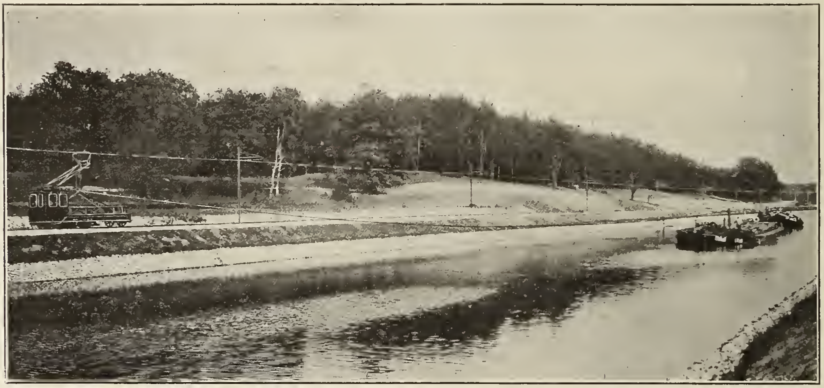

Fig. 26.—Tractor and Barges on Canal.

As regards the cost of the haulage, this depends very much on the traffic. For a yearly traffic of 2,000,000 tons it is as follows:

1. Current consumption of locomotive for 1 ton-mile..	0·0084d.
2. Oil consumption of boat (tug) per ton-mile	0·0080d.
3. Lubricating oil for locomotive and boat..........	0·0010d.
4. Maintenance and wages for 1 ton-mile	0·0222d.
5. Maintenance costs of the building and machinery for 1 ton-mile	0·0142d.
Total prime driving cost for 1 ton-mile ..	0·0538d.

Interest and sinking fund charges on the capital expended, taken together at $4\frac{1}{2}$ per cent., give for 1 ton-mile 0·036d., the depreciation for 1 ton-mile 0·0142d., giving a total driving cost of 0·1040d. per ton mile. For a yearly traffic of 3,000,000 tons the driving cost comes to 0·0454d., and interest, depreciation, &c., 0·0364d., giving a total of 0·0818d. per ton-mile.

In any case, the control of the traffic must be entrusted to one man to attain efficiency.

An approximate calculation for the Teltow Canal gives the driving costs with steam tugs about the same as that with electric locomotives with a traffic of 2,000,000 tons. With 3,000,000 tons it is about $12\frac{1}{2}$ per cent. higher, while with 4,000,000 tons it is 27 per cent. higher than with electric traction, besides which the greater cost of upkeep of the canal due to the wearing away the canal banks and the stirring up of mud from the bottom of the canal by the waves caused by the screws of the tugs must be taken into account.

It is hoped that the advantage of this method of haulage will soon be well recognised, and that the large canals now being planned by the German Government will adopt electric driving by locomotives.

KRIZIK SURFACE CONTACT SYSTEM AT PRAGUE.*

The reasons for the choice of the system used on the Karlsbrücke in Prague were partly æsthetic and partly mechanical. The space which can be occupied by constructional work is small, consisting in all of 26 cm. ($10\frac{1}{4}$ in.), which is the distance between the level of the roadway and the top of the arches of the bridge, consequently a conduit system was considered to be out of the question. A surface contact system was therefore adopted.

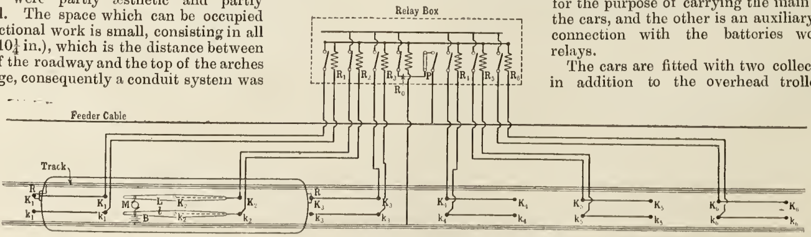

Fig. 1.—Arrangement of Track Connections.

In this system two metallic contacts are placed between the rails of each track, and at a distance 0·25 metre on either side of the centre of the track, successive pairs of contacts being arranged at distances of 2·5 metres apart in the roadway. One of each pair of contacts is for the purpose of carrying the main current for the cars, and the other is an auxiliary contact in connection with the batteries working the relays.

The cars are fitted with two collecting shoes, in addition to the overhead trolley connections; they are lowered as soon as the portion of the track fitted with surface contacts is reached. Those shoes were in the first instance made of wood, to the lower side of which flat pieces of iron were fastened by means of screws; but this method was found to tend to smear the contacts with mud, and to be consequently ineffective in muddy weather. The shoes are now constructed of a length of channel iron, between the flanges of which a smaller channel iron is fixed in zigzag fashion in such a manner that the flanges of the smaller channel iron slide sideways over the contact, and keep it clean.

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* Based partly on an article by Herr Schwerak in the *Elektrische Bahnen u. Betriebe*, August 4, 1906.

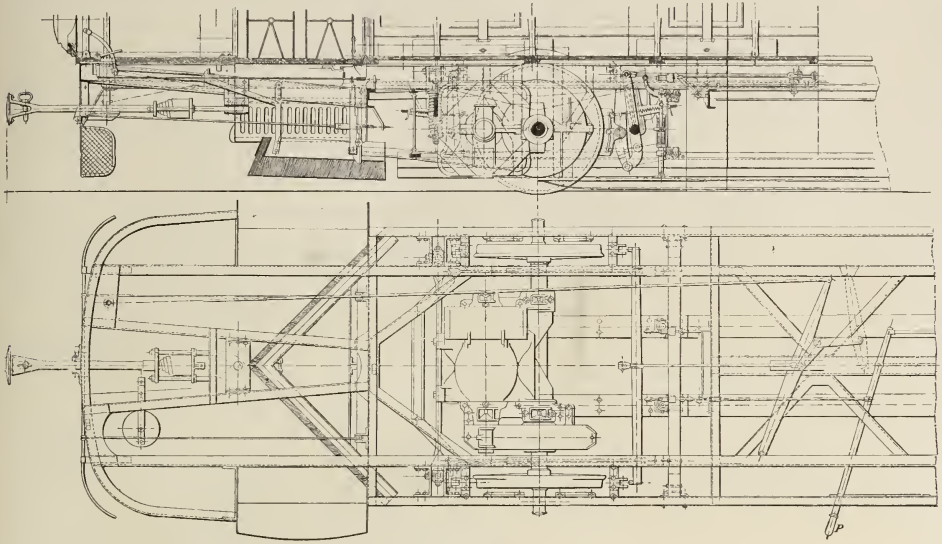
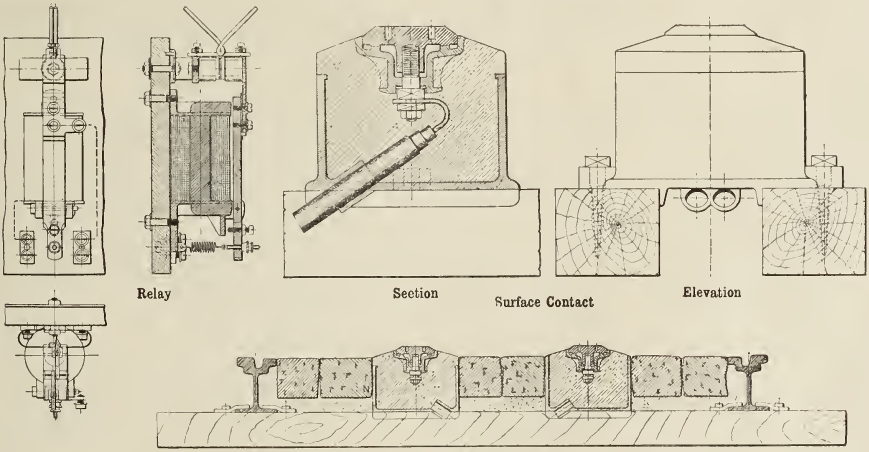


Fig. 2. Plan and Elevation of Car Truck.

The operation of the system may be explained in connection with the diagram given in Fig. 1. The main and auxiliary contacts K_1, k_1, K_2, k_2, &c., are shown arranged along the centre of the track, and the car is shown in outline in such a position that its collecting shoes L and l are touching the contacts K_2 and k_2. The diagram also shows a small accumulator, consisting of four cells, carried on the car, and this is connected, as shown, between the collecting shoe, which touches the auxiliary contact k_2, and the rails; the motor, driving the car, is also shown to be connected between the two shoes. As soon as the car reaches the contacts, and the shoes have been lowered, a current passes from the battery through the auxiliary contact k_2 to the winding of the auxiliary relay R_2, which is placed in an iron cage on the parapet of the bridge; thence through the winding of the main relay R_0, and so to the rail and back to the battery. (The iron cases are mounted on a parapet on each side of the track; each case contains six auxiliary relays and one main relay. In point of fact, each auxiliary relay is connected to two contacts, and these successive contacts are joined by a cable, though this is not shown in Fig. 1, which is only intended to explain the system in its simplest form. Seeing that the contacts are 2·5 metres apart, it will be seen that the iron cases must be arranged at distances of 32·5 metres.) The armatures of the corresponding auxiliary and main relays are therefore attracted, and complete the circuit for the main current, which is carried by cables at the side of each track to the relay boxes, and connected through a fuse to the armature of the main relay, and thence to a



Relay

Section

Surface Contact

Elevation

Section of Track

Fig. 3.—Relay and Contact Studs.

distributing 'bus bar. From this 'bus bar, which is connected to the armatures of the auxiliary relays, the current passes through the armature of that auxiliary relay which happens to be in operation to the main surface contacts, and is then collected by the shoe beneath the car, passes through the motors and batteries (charging the latter), and finally reaches the rail which conveys it back to the station.

It will be seen from this description that the main contacts are only alive at the instant when they are passed by the car. The collecting shoes which are shown in Fig. 2 are 3·6 metres long, and the distances between the contacts 2·5 metres; consequently, for a moment, the shoe is in connection with two successive contacts, and in this way a steady movement of the car is assured. The contacts (see Fig. 3) consist of interchangeable metal knobs, which are screwed into holders; the whole being contained in cast-iron boxes, filled with asphalt, and mounted on a wooden base, so that the upper surface of the contact projects about 3 cm. above the roadway. As soon as the car or the shoe passes the contact, a spiral spring lifts the armature of the auxiliary relay, which now carries no current, and, in consequence, the main current ceases to flow, and the corresponding main contact ceases to be a danger to passing traffic.

The possibility, however, might arise of a contact remaining alive after the passage of the car. In this case, a brush which is carried on the back of the car, in passing over the contact causes a short-circuit with the consequent blowing of the fuse in the relay box; the main current therefore cases to flow through that section in consequence of the interruption of the circuit. The Government, however, require the use of some further protecting device in view of various objections to the existing method, and experiments are, therefore, being undertaken with this object in view.

It remains to be seen whether the system will work satisfactorily in all kinds of weather, and especially whether the leakages at the contacts are likely to be serious in wet weather. The cost of construction is more than double that of the overhead system. In any case, it is an interesting development of the surface contact system: as in all other experimental designs, it is likely to meet with difficulties; still it may confidently be expected to develop into a satisfactory solution of the traffic problem under the given conditions, and to allow of a continuous service in all weathers without personal risks from the contacts themselves.

ELECTRIC POWER IN THE PENNSYLVANIA RAILWAY SHOPS AT ALTOONA.*

BY W. R. LOVELESS.

A striking instance of the increasing use of electric power may be found in the shops of the Pennsylvania Railroad Co. at Altoona, Pa., which is one of the largest and best equipped railroad shops in the world. During the past eight years the system of belt-drive from the steam engine has been gradually replaced by the electric motor-drive, and, at the present time there are about 8,500 H.P. of motors in service as against less than 10 per cent. of that amount of steam engine power driving machinery direct.

The first electric motor used in these shops was installed in 1889 for driving an exhaust fan, followed by motors in travelling cranes in 1890. During the year 1899 the first stationary motor was installed to drive a machine tool. This was a 10 H.P. constant-speed motor geared to a cold saw, and is still in successful operation. The number of motors in service gradually increased from that time on, and at present there are 376 stationary motors and 285 motors on electric cranes and hoists, making a total of 661 electric motors, which range in size from $\frac{1}{6}$ H.P. to 85 H.P.

There are five distinct groups of shops at Altoona, each group having an individual power plant. This is necessary, as direct current is used by four groups and the distance prohibits transmission at the low voltage employed.

Direct current is generated at the machine shop, Juniata shop, South Altoona and East Altoona power plants, the voltage being 230 in each case At the car shop power plant alternating current alone is generated at 2,200 volts.

The power plant at the machine shops is equipped with three 300 kw. generators direct connected to cross-compound, non-condensing engines, and operate at 230 volts. One of these units is to be replaced in the near future by a 500 kw. set, an increase made necessary by the erection of new shops. There are also in the power plant one Brush arc generator belt-driven by a Westinghouse engine and one Thomson-Houston arc generator belt-driven by a 40 H.P. electric motor, which are used for lighting the shop yards. The switchboard is of slate, being equipped with two sets of 'bus bars. There are 11 panels, four for the generator circuits, four for power circuits and three for series arc-lighting circuits. Each of three of the generator panels contains a circuit breaker, ammeter and double throw switch for connecting to either of the two sets of 'bus bars. The fourth panel contains two ammeters connected into the 'bus bars to give the total load. Each of the power-circuit panels contains switches and ammeters for four circuits. giving 16 circuits for use to different parts of the shop. Of these circuits two are arranged to carry either alternating or direct current, the former being obtained from the car-shop power plant and used for lighting and testing purposes. The panels for the series lighting service contain 11 circuits, both direct and alternating, to which are connected 22 loops of arc lamps, and each circuit is equipped with an ammeter. With a few exceptions, all circuits are led from the power plant through a wire tower and are carried for about 600 ft. on supports built above an outdoor crane runway, and circuits are led from the power lines to buildings on either side. At the end of the crane runway the lines branch off to two pole lines, one running east through the railroad yards and the other extending west about 800 ft. to the end of the shop yard. The supports carrying the lines over the runway have 72 wires on them.

The power plant at the car shops contains four 250 kw. generators, each direct connected to tandem-compound, non-condensing engines, and one 625 kw. generator direct connected to a cross-compound non-condensing engine. These generators are all of the revolving-field type and generate two-phase alternating currents at 60 cycles and 2,200 volts. Each generator has its own exciter, those of the smaller sets being geared to the main shaft. The excitation for the large generator is obtained from a 20 kw. generator driven by a 30 H.P. 2,200 volt induction motor. This exciter set is connected so that it may be used on any of the other generators in emergency. There are also installed at this plant 12 constant-current transformers of 75 lights capacity at 7·5 amperes. These are used for lighting the shops and railroad yards.

The main switchboard is built of slate and contains 13 panels and carries two sets of 'bus bars. Five panels are used for the generators, one for the exciter set for the large generator, one panel for ground detector and recording voltmeters and the remainder for the distributing circuits. Each generator panel is equipped with two double-pole double-throw oil switches, two ammeters and synchronising lamps. In addition there are voltmeters for each phase on the two sets of 'bus bars and four ground detectors, two for each set of 'bus bars. The voltage regulation is accomplished by means of a Tirrill automatic regulator. Until recently all high-tension lines were carried from this plant on poles, but the wires are now being placed underground, and in the near future the conduit system will be used entirely.

At the Juniata shop power plant there are three 200 kw. generators, to which will soon be added a 300 kw. set. The generators are direct connected to non condensing cross-compound engines, and operate at 230 volts. The switchboard contains six panels, and is very similar to that at the machine shop plant, with the exception that it is supplied with two station watt-hour meters, which record the total energy generated at the plant. The wires are led from the building through a wire tower back of the switchboard, and carried on poles up and down the yard between the shops. This plant as yet only furnishes power for the shops, the lighting being furnished from the car shop plant.

At East Altoona there are two 100 kw. direct-connected sets, which generate direct current at 230 volts. The switchboard contains two generator panels and two panels for the power circuits, the wires all being run underground to the different shops.

The power plant at the new South Altoona foundries is the largest of the company's plants in Altoona. There are eight 350 H.P. boilers in four batteries equipped with Roney automatic stokers. A coal crusher and coal and ash conveyor, each driven by a 10 H.P. compound-wound motor, crush and convey to the bunkers 35 tons of coal per hour. The generating equipment consists of two 500 kw. and two 300 kw. generators, direct connected to non-condensing, cross compound Corliss engines; also one 50 kw. generator direct connected to a non-condensing high-speed engine—all generators furnishing direct current at 230 volts. The switchboard consists of five generator panels, five feeder panels and one fire-alarm panel. The generator panels contain the usual switches, circuit-breakers, ammeters, &c., and at the back of each panel there is a Thomson watt-hour meter. Each feeder panel contains switches and ammeters for four circuits, making a total of 20 circuits. All wires are led from the plant through an underground tunnel which branches off to each of the main buildings. Inside the buildings all mains are run open, while small branches are run in conduit.

The total rated capacity of the generators in the five power plants amounts to about 5,000 kw., and the average daily load may be judged from the load curves shown in the figure.

Where the old engine drive was replaced by electric motors, the existing conditions were changed very little. Machines of the same kind were, to a large extent, grouped together, and as there was no need to disturb this system, in the case of the small machines the main shafting was divided into sections and belted to motors of the proper size, usually placed on overhead supports. As new machines were added to the various groups, care was taken that the motor was not overloaded, it being replaced by one of larger capacity when the load warranted so doing. It has been the experience that better satisfaction in regard to both expense and shut-downs is obtained by not allowing the average load to go beyond the manufacturer's rating of the motor, for with groups of small machine tools the average load is usually less than one-half the maximum, and this maximum load occurs frequently and is of long enough duration to have a bad effect on a motor which is normally carrying about full load. Most of the larger tools, chiefly planers, boring mills, lathes, &c., were equipped with individual motors. In some places, notably with planers, these were simply belted to the counter-shaft, but more often the motor was geared directly to the machine.

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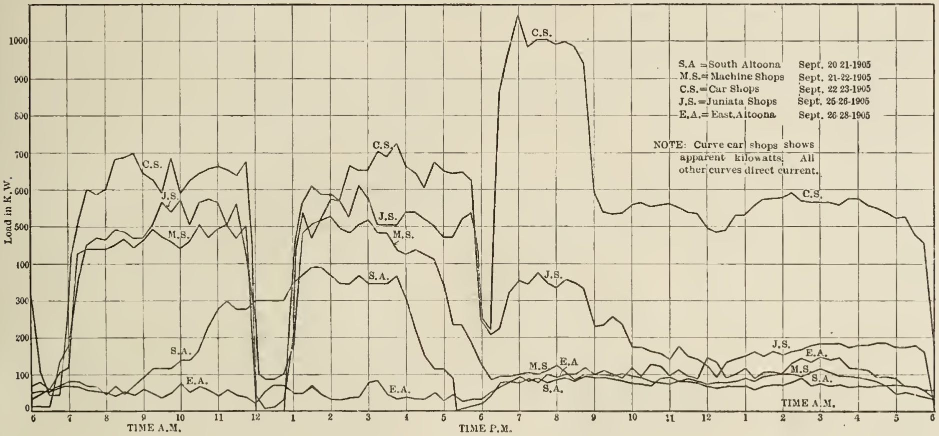
* Abstracted from the *Electrical World.*

As new machines have been added to the equipment of the shops, the individual drive has been largely used, and at present there are four motors connected singly to each motor driving a group. Individual motors are applied to practically every type of machine in use in the shops, and range in size from ½ H.P. to 80 H.P., although tools requiring less than 3 H.P. are belted to groups wherever it is possible to do so. Naturally a large variation in speed is required in most cases of individual drive, and each motor is equipped with either a controller or rheostat in the field circuit, the latter being used only when the required speed ratio is not more than from 3 or 2 to 1.

of a bevel gear which slides on a shaft running the length of the lathe. This is the most convenient form of controller mounting in use in the shops, as the handle is always directly in front of the operator.

There are two large gang milling machines which are each driven by a 25 H.P. and a 10 H.P. motor. The larger motor drives the cutter shaft and the smaller motor operates the feed. These machines will remove 10 cubic in. of steel per minute with a load on the motor of 21·8 H.P. and 7·6 H.P. respectively. Two double-headed slotters with 5 ft. by 45 ft. beds are driven by 10 H.P. motors at each head. The slotter moves lengthwise of the bed and a motor is bolted directly to the body and gear connected. Current for the motors is taken by trolleys from overhead wires. A double-headed drill for spacing holes in driving rods is driven by a 5 H.P motor connected to each head by means of chain belt. The pump on a 100 ton hydraulic jack is driven by a 5 H.P. motor mounted on the pump base and gear connected. A 10 spindle drill is geared to a 10 H.P. motor taking about 6·5 H.P. when drilling 1 $\frac{9}{16}$ in. holes in cast iron.

In the metal yard is a combination punch and shear driven by a 25 H.P. compound-wound motor mounted on the machine and connected by chain belt to the shaft. This machine will shear 16 sq. in. of steel and punch holes in 2 in. steel plate. There is also a bolt shear geared to a 10 H.P compound-wound motor mounted on the base of



Load Curves.

the machine. This shear is used for cutting bars up to a diameter of 2½ in. A machine for threading pipe up to 12 in in diameter is geared to a 5 H P. motor and equipped with a field rheostat for speed regulation

The largest motor required for individual work is rated at 80 H.P. This is used on a 72 in. by 72 in. by 36 ft. planer and is worked well up to its capacity. There is also a 5 H.P. motor on the planer for raising and lowering the tool post, and the reversing gear is equipped with an automatic magnetic clutch.

Among the other heavier machines there are two 90 in. wheel lathes equipped with 30 H.P. variable-speed motors, and six 90 in. lathes taking 20 H.P. motors. These lathes are designed for heavy cuts and high-cutting speed, using the full power of the motor. A test of one of the lathes equipped with a 30 H.P. motor gave the following results. The cut was made on the steel tyres of a pair of 56 in. engine driving wheels:—

Size of cut	$\frac{7}{16}$ in. by $\frac{7}{32}$ in.
Number of cuts	2
Cutting speed	13·3 ft. per min.
Metal removed	30·6 cubic in. per min.
Power delivered to motor	28 9 H.P.

Another test with the same material made on a 72 in. lathe, driven by a 25 H.P. motor, gave the following results:—

Size of cut	$\frac{7}{16}$ in. by $\frac{3}{16}$ in.
Number of cuts	2
Cutting speed	11 ft. per min.
Metal removed	21·6 cubic in. per min.
Power delivered to motor	27 H.P.

These machines are used for turning down tyres on old wheels, and require a wide range of speed on account of the hard spots which are often encountered, and which must be cut at a very low rate. The controller is placed convenient to the operator, so that he can handle it without taking his attention from his work.

A 30 in. by 18 ft. engine lathe is geared to a 15 H.P. variable-speed motor, and in this case the controller handle is mounted on the movable tool carriage and is connected to the controller by means

In the pattern shop there are numerous small machines direct-connected to motors. Three band saws are each geared to 5 H.P. motors; three small circular saws are driven by 5 H.P. motors connected by belt; two buzz planers are each belted to 5 H.P. motors, and a larger planer is driven by a 10 H.P. motor. A lathe capable of turning to a diameter of 8 ft. is belted to a 5 H.P. motor. All of the foregoing motors are enclosed to keep them free from dust, and the effective power is thus considerably less than the ratings given. A 20 H.P. motor drives a line shaft to which are connected several small lathes, a grindstone, a saw sharpener and other small machines.

In the foundry motors are used to drive casting shakers, sand sifters and mixers and a belt system for conveying sand to bunkers above the moulding machines. A small storage battery locomotive is used to haul dump cars for conveying sand, ashes, &c., to and from the foundry.

At the car shops two-phase induction motors are used, which run at constant speed. All speed variation is obtained by means of cone pulleys or change of gears, but as the greater part of the machinery is for wood-working purposes, where a speed variation is not required, the inconvenience of this is slight. The metal-working machinery is similar to that already described and takes approximately the same size motors, though the individual drive is not employed as extensively as in the other shops where direct current is used. In the lumber mill and cabinet shop, however, there are a number of heavy machines driven by separate motors. A four-headed timber planer is belted to a 50 H.P. motor. This machine will surface four sides of 12 in. by 16 in. timbers and make a cut of 13 sq. in. of wood at the rate of 40 ft per minute. A 4 in. band saw for cutting timbers up to 12 in. in thickness is driven by a 30 H.P. motor, and a 66 in. surface planer requires a 20 H.P. motor. Three circular saws for light work are driven by a 10 H.P. motor, and a small band saw is driven by a 5 H.P. motor. Several wood-carving machines are driven by 2 H.P. motors, and in the upholstering department a number of 1 H.P. and ½ H.P. motors are used to drive sewing machines. Also three large sanding machines are each belted to 10 H.P. motors.

One very important use to which motors are put in the shops is that of driving fans. There are in service 46 fans used for furnishing air blast, heating purposes, ventilating, and for removing dust, wood shavings, &c. These are driven by motors, the total capacity of which is 1,340 H.P.

A partial list of motors used for individual and group drive, not mentioned heretofore, is given below :—

3 planers, 36 in. by 36 in. by 10 ft., driven by 20 H P. motor.
1 duplex milling machine, 14 ft. table, driven by 20 H.P. motor.
1 bending roll, driven by 22 H.P. motor.
1 Sturtevant blast fan, driven by 40 H.P. motor.
5 planers, 5 ft. table, driven by 10 H.P. motor.
11 drill presses, driven by 10 H.P. motor.
2 wheel-boring mills and 1 drill press, driven by 10 H.P. motor.
1 milling machine, 6 ft. table, driven by 15 H.P. motor.
9 lathes, about 18 in. by 7½ ft., driven by 20 H.P. motor.
8 boring mills for driving wheel boxes, driven by 20 H.P. motor.
4 planers, 5 ft. table; 2 slotters, 22 in. stroke and 2 turret lathes, driven by 20 H.P. motor.
18 bolt-threading machines, driven by 20 H.P. motor.
15 lathes, about 18 in. by 6 ft., driven by 20 H.P. motor.
8 belt hammers, driven by 50 H.P. motor.
15 bolt lathes and bolt-threading machines, driven by 30 H.P. motor.
3 mortise machines and 4 drill presses for wood working, driven by 10 H.P. motor.
2 circular saws, 1 planer and 2 drill presses for wood working, driven by 7½ H.P. motor.
1 four-head flooring surfacer, driven by a 20 H.P. motor.

In wiring motors the insurance companies' rules are closely followed, and every precaution is taken to minimise the fire risks. The mains are run open through the building, but the wires from the mains to the motor switchboard are run in iron conduit, carried down the side walls and under the floor, thus avoiding any vertical wires which would interfere with the operation of cranes or hoists. From the switchboard to the motor the wires are placed in flexible conduit if the motor is close at hand, or in solid iron conduit if it is some distance away. The switchboards are made in standard sizes to carry switch, starting rheostat and fuse block or circuit-breaker. They are built three-ply, 1½ in. thick, of well-seasoned poplar, and are shellaced and painted black. Motors which are operated out of doors are covered with sheet-iron housings to protect them from the weather, and the switchboards are enclosed in wooden boxes.

A complete record is kept of each motor on a printed form, which gives the size, manufacturer's rating and specification, number of motor and of armature, date of purchase, date first put in service, department and machine for which motor is used, size of brushes and a record of all repairs and changes made on the motor. This information has proved to be of great value, especially in ordering spare parts, material for repairs and new motors, and also in comparing the merits of various motors. A similar record is kept of generators and transformers.

LIMITATIONS OF THE BALLISTIC METHOD FOR MAGNETIC INDUCTION.*

BY A. HOYT TAYLOR.

This investigation is incidental to a more extended inquiry into the magnetic properties of electrolytic iron—an inquiry made possible by a grant from the Carnegie Institution to Prof. C. F. Burgess, of the department of applied electrochemistry, and by the kindness of the latter in furnishing the samples of iron tested.

Very early in this investigation it became apparent that the step-by-step ballistic method applied to an electrolytic iron ring gave results which were very far from being in accord with those obtained by the method of reversals. It also developed that this discrepancy, although more pronounced in the case of pure electrolytic iron, was present, in varying degrees, in nearly all samples of iron and steel available for the test. It therefore seemed worth while to investigate these discrepancies, with a view to determining their possible quantitative effect on cyclic curves of magnetisation, and with the object of devising a means of eliminating them.

An examination of the literature concerning the magnetic properties of iron is too great an undertaking to be attempted in detail. It is quite evident, however, that this effect has not escaped notice. Ewing† notes that there are slow changes in the magnetic induction taking place some time after the field has reached a steady state, and remarks that these would cause an error where a ballistic method is used. E Wilson* working with "almost pure iron" found large discrepancies between the results obtained by the method of reversals and by the step by-step method.

He showed that the error came in principally in the steep parts of the hysteresis loop and that it was not a function of the time constant of his primary circuit, but was due rather to a viscous time lag of the magnetic induction behind the field. This time lag he showed was persistent and noticeable for as long as 10 seconds after the changes in field strength had been made, and was of such magnitude that it could not be accounted for on the basis of the retarding effect of eddy currents. He did not vary the time constant of his circuit within very wide limits, nor did he investigate the effect of changing the period of his galvanometer. His results can hardly be extended so as to find the distortion produced in the hysteresis loop by these errors.

R. Jouaust† found viscous hysteresis in many soft steels, the extent of viscosity depending somewhat on the dimensions of the rings tested. He suggests that the step-by-step method be so modified that in running a hysteresis loop the steps be always taken from low fields to comparatively strong ones. This would eliminate magnetic viscosity, which is not evident under strong fields, but would require a rather complicated cycle of operations between observations.

Fr. Rücker‡ notes magnetic viscosity in iron and steel, and states that the step-by step method gives values for the magnetic induction which are too low. I have not access to this Paper, but according to a brief review of the same, no remedy for the error is suggested.

In the present case, when discrepancies were observed between the method of reversals and the step-by-step method, the author was at first inclined to ascribe them to peculiarities of the electrolytic iron. An investigation of two samples of laminated soft iron rings, made from armature stampings showed the same effect, though not in so marked a degree. Then two solid iron rings which had been used in the laboratory for testing purposes were tried, both showing the effect to a considerable extent. In the case of one laminated iron ring, of 1 sq. in. cross-section, with a radius of 5 in., and having 1,009 turns on the primary, the method of reversals gave values for the maximum induction 47 per cent. higher than those obtained by the step-by-step method. This was found to be due to the fact that in certain portions of the cycle where the differential permeability was high and hence the self-induction of the primary circuit was large, the time constant of the primary circuit was so large that the primary current, and hence the field strength, did not attain to its maximum value until after the first throw of the galvanometer had taken place. The time constant of the circuit was unusually large because the resistance was low and constant, variations in primary current being made by varying the applied voltage over any desired range with a potentiometer device. This scheme was exceedingly convenient and easy of manipulation by one observer working alone, but was dropped for the reasons cited above. When a constant potential and a variable series resistance is used in the primary circuit, then at points where the differential permeability, and hence the inductance, of the primary circuit is high, the field is always low, the primary current small, and hence the series resistance large. This gives a small time constant, and an applied voltage (20 volts) was found such that any error due to slow rise of primary current was eliminated for all of the rings. This was shown by the fact that doubling the applied voltage and series resistance, hence halving the time constant, did not affect the results. In the case of all samples except one, which was hard iron with a rather large coercive force (4·00 dynes), there was still a very considerable discrepancy between the maximum induction as obtained by the two methods, the method of reversals giving invariably the greater value. In the case of the electrolytic iron, which after annealing behaves, as far as I can say at present, like any soft steel, the effect was most marked, the discrepancy amounting to 17 per cent. This is undoubtedly due to magnetic viscosity, and an attempt was made to eliminate it by increasing the galvanometer period from 5·5 to 15·0 seconds. By this means the maximum inductions, as determined by the two methods, were brought within 11·05 per cent of each other. From this one may infer that the viscous effect is of such long duration that no galvanometer of sufficiently short period to be workable would give results very nearly correct. An instrument of the fluxmeter type would be admirably suited to such cases.

However, the step-by-step method may be so modified as to prevent these errors from being additive, and to nearly eliminate them, even with a fairly short-period galvanometer. The arrangement of the apparatus is nearly the same as for the regular step-by step method. The secondary coil of the ring being tested is connected in series with the galvanometer G, a suitable high resistance, H, and a switch, S_4. A damping coil and commutator, not shown in the sketch, were also included in this circuit.

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* From the *Physical Review*.

† "Magnetic Induction in Iron and other Metals."

* *Proc.* Roy. Soc., LXII., 1898.

† *Comptes Rendus*, Vol. CXXXIX., p. 272, 1904. ‡ Diss. Halle, 1905.

The primary coil P is connected through a commutator, C, and switch, S_1, with a storage battery and an ammeter. The switches S_2 and S_3 allow more or less of the wire rheostat R to be put in circuit. If desired (as in the step-by-step method) one of the switches S_2 and S_3 may always be kept closed, and hence the current never broken. The rheostat R consists of I. A. wire, mostly No. 30, but with 5 or 6 ohms of No. 16 for the larger currents. The switches of S_2 and S_3 connect with the rheostat by means of flexible leads and spring clip terminals, provided with copper jaws for gripping the rheostat wire firmly.

For the determination of points on the upper branch of the hysteresis loop, from saturation point to retentivity point (zero field) the method is as follows: S_1 is closed and S_2 is connected to such a point on R that a current flows in the primary strong enough to produce a saturation field. In this case the current was 5·00 amperes and the field 100 dynes, which was in most cases far more than enough to cause saturation. Then S_3 is closed, connected to such a point on R that when S_2 is opened the current falls to any desired valve. Then S_4 is closed and the galvanometer brought to rest with the damping coil. Finally, on breaking S_1, one observes the deflection caused by the change in induction in passing from any desired point, such as A, for instance, in curve I., to O, the retentivity point.

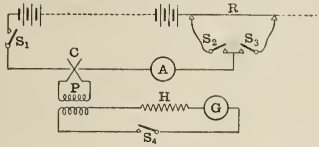

FIG. 1.

The observations may be repeated as often as desired, the cycle of operations being this: Open S_4, close S_1, close S_2, close and set on the rheostat S_3, open S_2, open S_1. Whatever viscous effect may be present will not cause a cumulative error as in the regular step-by-step method.

For the remainder of the cycle, from the retentivity point to the saturation point the change of induction is observed from the retentivity point to any point, such as A′, curve I. This requires a slightly more complicated cycle of operations, since the iron must be carried back to the first or upper saturation point, and down to the retentivity point before the observation is taken. S_3 is set on the rheostat for the current corresponding to the field strength at A′. The method is then as follows: Open S_4, reverse C, close S_2 close and set S_3, open S_2, open S_1, reverse C, close S_4 and close S_1,' observing the deflection.

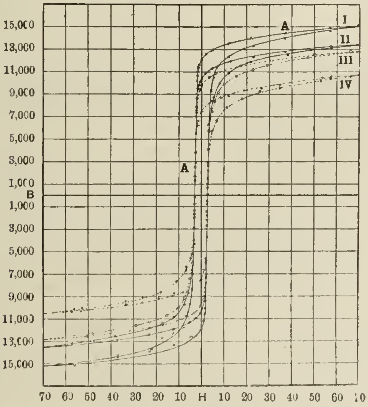

FIG. 2.

Curve I. was obtained in this manner, and represents what we may call the true hysteresis curve for a ring of annealed electrolytic iron of radius 4·12 cm. and area 0·7 cm.^{2}, primary winding 424, secondary 700. The period of the shielded ballistic galvanometer used was 15 seconds and the applied voltage in the primary circuit was 40 volts.

It required nearly twice as much time to run this test as it did to get curve II., using the same apparatus and the regular step-by-step method. The hysteresis area of curve II. is 18 per cent. smaller than that of curve I.; the retentivity point is 16 per cent. lower, and the maximum induction is 11·8 per cent. lower. The coercive force is practically the same for all four curves.

Curve III. was taken exactly as was curve II., except that the galvanometer period was 5·5 seconds and hence the viscosity causes a larger discrepancy.

Curve IV. was taken exactly as was curve III., except that the primary resistance was kept constant and the voltage varied by a potentiometer arrangement in order to vary the primary current. As explained earlier in the Paper, this gives a larger time constant and introduces another error besides the one due to viscosity.

These discrepancies are more marked as more and more steps are taken on the curves, because the errors are cumulative. They are not peculiar to electrolytic iron, but may occur in any soft steels, and in many samples of iron, even when laminated, although, perhaps, not to so marked a degree.

It seems clear, then, that the ring tests should be done with the modified ballistic method, or better still, if sufficient sensibility can be obtained, with an instrument of the fluxmeter type.

THE EXPERIMENTAL STUDY OF TELEGRAPHIC TRANSMISSION.*

BY M. DEVAUX-CHARBONNEL.

The study of the phenomena which accompany the propagation of the current is of the greatest importance to telegraphy. If the part played by the constants of the line and the apparatus were known, one could, by modifying them, improve the transmission in a rational manner. The question has indeed been solved mathematically in a general manner, but it has not yet been put into a shape which allows of its ready adaptation to the complicated cases of actual practice. In the present state of our knowledge, an experimental study would be equally useful to the practician who wishes to be acquainted with the part played by his apparatus and to the theoretician who wishes to know the order of importance of the different factors of the problem.

I have sought, by means of Blondel's oscillograph, to render an account of the different phases in the propagation of a current, and I here give the first results obtained.

Speed of Propagation.—The wave-front is propagated with the speed indicated by theory. Denoting by C and L the capacity and inductance per unit length, this speed is

$$V = \frac{1}{\sqrt{CL}}.$$

From the experimental values we obtain

	Copper lines.	Iron lines.
C	0·009 mf. per kilometre	0·009 mf. per kilometre.
L	0·002 henry per kilometre	0·006 henry per kilometre.
V	236,000 km. per second	136,000 km. per second.

This speed is that given by experiment. It is less than the speed of light, because the conductor is not alone in space. The capacity is increased by more than one-half on account of the surrounding conductors, and in the case of iron the inductance is tripled on account of the permeability of the metal.

Line Without Apparatus.—When there is no apparatus on the line, then, as soon as the wave-front arrives at the end, the current appears to have a great value, sometimes more than half that of permanency. The curve presents a maximum when the quantity

$$\delta = \frac{2\pi}{R}\sqrt{\frac{L}{C}}$$

is about 3.

The variable period appears to be terminated at a time

$$\theta = \sqrt{CL}.$$

Line with Apparatus.—Locally, on a circuit comprising only a cell and an apparatus, permanency is practically attained by a time

$$t = 4\frac{L_1}{R_1}$$

when R_1 and L_1 are the inductance and resistance of the apparatus.

When the apparatus is connected with an aerial line this time is considerably reduced. The duration of the variable condition appears to be represented by the formula

$$T = \sqrt{CL} + \frac{3}{4}\frac{L_1}{R_1}.$$

This formula, essentially empirical in character, has been verified for lines composed of aerial sections 200 km. to 1,000 km. in length, comprising an underground section at each end 7 km. to 8 km. long, and coupled to Morse and Baudot instruments.

It is of some importance, for experiment shows that, in order to be correctly received, the signals must succeed each other at intervals such that the variable period corresponding to one of them is over before the next appears. The time T therefore practically represents the shortest duration which can be given to any signal, and it therefore measures the maximum speed of transmission.

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* Translated from the *Comptes Rendus*, July 23, 1906.

In all the experiments the factor δ had a value above unity. Theory shows that this condition is necessary in order that the inductance should play a useful part and compensate the capacity. Within these limits, the speed of transmission will be the greater the smaller are the capacity and inductance. The capacity of aerial lines is practically independent of the nature and diameter of the wire, but the inductance is higher in iron lines. Copper lines have therefore a marked advantage over these.

In underground and submarine lines the high value of the capacity hinders the speed of transmission. It would be well to modify them and make them similar to aerial lines. It has already been proposed to increase their inductance artificially by inserting coils in the line or winding it with a ribbon of soft iron. If δ could be given a value approaching unity the efficiency of medium lines could be tripled, and that of great submarine cables could be doubled.

As regards resistance, it must be noted that it only plays a secondary part in the duration of the variable period, and only intervenes to fix the current of permanency.

As regards the receiver, its capacity, always feeble, appears negligible in practice. It intervenes by its time constant in the value of T, and usually constitutes its principal part. An ordinary Baudot relay introduces the value 0·0052 second, while a copper line 500 km. long only gives 0·0021. It is, therefore, of the greatest interest for rapid telegraphy to find receivers whose inductance shall be as small as possible.

ON THE APPLICATION OF ASYMMETRIC MAGNETISATION TO ALTERNATING-CURRENT APPARATUS.*

BY C. LÉONARD AND L. WEBER.

By making use of an asymmetric alternating magnetisation, the authors have devised a static frequency transformer by means of which the frequency may be doubled. The arrangement of apparatus is represented in Fig. 1. A and B are the cores of two transformers, whose primaries F and G are connected in series. The secondaries H and H′ are also connected in series. In addition to these windings, the transformers are provided with the windings D and D′ connected in series with the reactance coil E (which is intended to suppress fluctuations in the current due to the alternating E.M.F.s induced in D and D′) and supplied with continuous current from the battery C. The windings D and D′ are so arranged relatively to F and G that during the half-period when D and F assist one another, D′ and G oppose each other. The continuous current is chosen so that the M.M.F. (magnetomotive force) due to it is sufficient to produce saturation. If the alternating currents in F and G be such that their maximum M.M.F. is equal to twice that of D or D′, the fluxes through A and B will be as indicated by the full-line and chain-dotted curves of Fig. 2, the change of flux in either core during addition of the M.M.F.s being very small, owing to the fact that the core is already saturated by the continuous current, while, on the other hand, the change of flux during opposition of the M.M.F.s is relatively very large. By adding the ordinates of the two curves, we obtain a resultant curve which represents the algebraical sum of the fluxes through H and H′. This is easily seen to be a periodic curve whose period is *half* that of the alternating current in either primary, so that the resultant alternating E.M.F. in H and H′ will have *twice* the frequency of the primary currents.

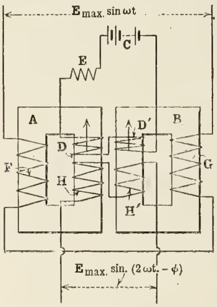

FIG. 1.

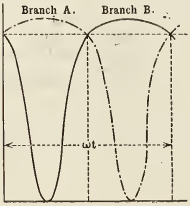

FIG. 2.

The windings DD′ and HH′ might be placed on a common limb, the entire core then resembling that of a three-phase transformer. The arrangement described is also directly applicable to polyphase circuits.

Another application of the principle of asymmetric magnetisation consists in varying the self-inductance of a choking coil by providing it with adjustable continuous-current excitation, fluctuations in the continuous current being prevented by suitable means. This method, however, involves a distortion of the alternating-current wave.

Although the arrangements described do not enable us to construct a static frequency transformer for commercial use, the authors have thought the matter of sufficient interest to warrant its publication.

RESISTANCE OF CONDUCTORS TO VARIABLE CURRENTS.*

BY M. BRYLINSKI.

The study of wireless telegraphy problems has concentrated attention upon the resistances experienced in the transmission of variable currents. Lord Kelvin and other authors have given a complete solution of this problem in the case of a cylindrical conductor traversed by simple periodic currents. The present Paper deals with cases of somewhat greater complexity.

The author deals at length with conductors of indefinite extent, like the earth's crust, and shows that the surface density of the current is the smaller the greater the damping of the current. But, though the depth of the conductor be infinite, the density of the surface current is a finite fraction of the total current. Whatever may be the finite value of the damping, the distribution of the current is practically always superficial. But the current density does not decrease uniformly, there being several zones of rapid decrease separated by zones of slow decrease, thus making the total conduction a phenomenon of considerable complexity.

The following table gives the comparative current densities at different depths for sine currents of frequencies 150, 4,000 and 10,000,000 ∼ per second respectively:—

Depth in metres.	150	4,000	10^7
1	0·999	0·994	0·73
5	0·994	0·97	0·21
10	0·99	0·94	0·04
50	0·94	0·73	10^{-7}
100	0·88	0·54	..
200	0·82	0·29	..
500	0·55	0·04	..
1,000	0·30	0·006	..
2,000	0·09	..	..
4,000	0·008	..	..

For salt water of resistivity 373×10^9 C.G.S., or 17·68 times feebler than that of the average soil, the same current densities would obtain at depths $\sqrt{17 \cdot 68}$, or 4·2 times less. Thus, for currents of frequency of 10^7, the density would be reduced to 0·04 of its surface value at a depth of 2·3 metres.

Copper, which has a conductivity 4×10^9 times greater than that of the soil, would have a layer of conduction 44,000 times thinner. Thus, a current of frequency 4,000 would have its density reduced to 0·04 of its surface value at a depth of 11 mm. In iron of permeability 3,500, the conducting layer would be 24 times thinner again. At depth of a millimetre the current density would be reduced to 0·3 of its surface value for currents of frequency 150, and to 0·006 for currents of frequency 4,000, while in the case of currents of frequency 10^7 the current density would be reduced to 0·04 of its surface value at a depth of $\frac{1}{11}$ mm.

The current finds itself in phase with the surface current at various depths below the surface. If a plane is drawn parallel to the surface and progressively deepened, the current comprised between the surface and the plane is progressively greater and smaller than the total current. The amplitude of these variations is the greater the greater the damping, but the variations cover layers of a thickness smaller in proportion as the damping is greater.

After a certain depth, which increases with the damping, these variations cease to be perceptible; and the current passing through the section differs from the total current by a quantity decreasing exponentially, which may be made as small as we please.

In spite of the infinite depth of the conductor it has a finite resistance which increases with the resistivity, the frequency, the permeability and the damping. The damping has this effect in spite of its action in increasing the thickness of the conducting layer, on account of the phase reversal which it brings about.

Practical wireless telegraphy has shown that transmission is easier across the sea than across the land, and that great ranges are best obtained with low frequencies and slight damping. This is explained by the above theory.

The various experiments made to determine the distribution of alternating currents through earth returns are considerably facilitated by the discovery that these currents are practically confined to a thin surface layer.

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* Abstracted from *L'Éclairage Électrique*, July 21, 1906.

* Abstracted from the *Bulletin* de la Société Internationale des Electriciens, June, 1906.

ELECTRIC MEASUREMENT OF TIME INTERVALS AND ITS APPLICATIONS.*

BY H. C. STEIDLE.

The method of measuring very small intervals of time devised by Prof. Radacowic, of Innsbruck, may be applied to testing the electrical and mechanical constants of the circuits and apparatus used in telegraphy. It enables us to measure intervals of $\frac{1}{10000}$th second within an error of 1 per cent.

In the circuit of a battery, E (Fig. 1), an inductionless resistance, R, and a condenser, C, are inserted in parallel. Two switches, S_1 and S_2, operated by the apparatus to be tested, have the effect of successively disconnecting the battery and the resistance. The condenser then retains a residual charge which depends in a definite manner upon the interval between the two breaks, and may be measured by a ballistic galvanometer in the ordinary way. If Q_0 is the original charge of the condenser, t the interval between the breaking of the two contacts, the residual charge of the condenser is given by the equation

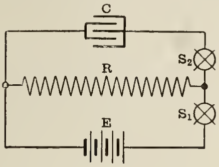

FIG. 1.

$$Q = Q_0 e^{-\frac{t}{RC}}$$

and $$t = CR \log \text{nat} (Q_0/Q).$$

This method has already been successfully applied to the measurement of the speed of projectiles over their whole path at intervals of 8 cm.

Rapidity of Relays.—Fig. 2 shows the arrangement adopted for testing the rapidity of a working relay. M is an electromagnet holding a falling weight, G, guided by a wire, which serves to break the contacts I. and II. in rapid succession.

What is to be measured is the time elapsing between the break and make of the line current and the break and make of the local current by the relay. The first test was carried out on a Siemens & Halske relay specially designed for rapid working. In this relay the proper vibrations of the armature are eliminated. To do this the current-making contacts are placed at the points where the magnetic forces act upon the armature. In consequence of the strong magnetic field, the favourable arrangement of the coils and the small inductance, the relay reacts upon very feeble and rapidly alternating currents.

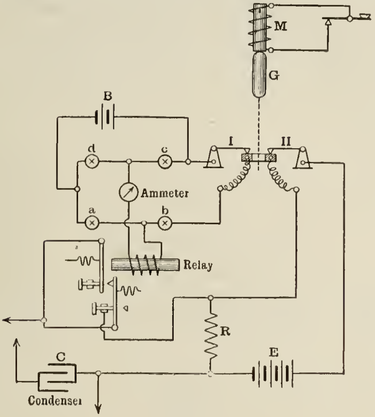

FIG. 2.

The test showed that the measured-time interval between the disappearance of the line current and the setting in motion of the armature is $2{\cdot}1 \times 10^{-4}$ second.

For comparison, an English-made relay, also designed for rapid working, was tested. The electromagnet cores of this relay are not, as is usual, joined by a cross-piece below, but each arm is independent of the other, and provided with pole-pieces above and below. The armature also consists of two pieces separated by brass partitions. The reaction interval in this case was $6{\cdot}9 \times 10^{-4}$ second, or about three times longer than that of the German relay.

Inductances.—The time-interval method may be used for the determination of the inductance of low-power circuits, and even for the calculation of the losses due to magnetic and dielectric hysteresis. For this calculation the following formula is used;—

$$L = \frac{\tau^2}{4\pi^2 C}\left(1 - \frac{C(R+r)^2}{4L}\right),$$

where τ is the vibration period as determined by means of a Helmholtz pendulum interrupter.

The author gives the result of the test of a small transformer used for telephone purposes. The inductance turned out to be 1·95 henry. The effective total resistance was 165 ohms. Since the continuous-current resistance was 20 ohms, there is a further resistance of 145 ohms generated in the circuit owing to the proper vibrations of the transformer.

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[*] Abstracted from the *Elektrotechnische Zeitschrift*, August 16, 1906.

REFLECTION OF KATHODE RAYS.*

BY S. R. WILLIAMS.

When kathode rays impinge upon a metallic surface they are either reflected, transmitted, or absorbed. But since they cannot be identified it is still an open question whether those apparently reflected or transmitted are identical with the incident electrons, or whether they are electrons out of the body of the metal. Another outstanding question is as to how thin the reflecting film may be before reflection gives way to transmission. Researches hitherto made have shown that the critical thickness increases with the potential, but that the reflection coefficients remain constant for potentials ranging from 4,000 volts upward, if the reflectors are 1 mm. or more thick. The author studied the critical thickness in the case of aluminium and copper, using a photometric method, in which the fluorescent brightness produced by the reflected rays is taken as a measure of the quantity reflected.

On plotting the thickness of aluminium film used as a function of the potential at which the reflection begins to diminish it is found that the curve rises quite rapidly to a point between 1·90μ and 2·44μ and then becomes more nearly parallel to the axis of abscissæ. It thus appears that for reflectors 1 mm. thick it would take an infinite potential before any of the reflected rays would be lost by transmission. In other words, this would be saying that, whatever the potential, the reflected rays are never from a depth greater than 1 mm.

The question as to whether the reflection of kathode rays from metals occurs at the surface or whether there is penetration and then reflection has been answered by the results in such a way as to leave no doubt but that the rays penetrate to various depths, depending on the potential, and are then reflected.

For a film 0·56 thick at a potential of 11,000 volts the reflection coefficients of the thin and the thick reflectors are the same. At 11,000 volts, then, the critical potential has not been reached. On increasing the potential, however, a difference occurs, and the only way the decrease in the amount reflected from the thin film can be accounted for is that a part has been lost by transmission. This indicates, then, that the reflection is not all taking place at the surface of the reflectors, but that there is penetration and then reflection for some of the rays. Although at 11,000 volts a thin film did reflect as much as a thick one, this is not saying that none of the kathode rays passed through the thin film, for behind the film a fluorescence on the walls of the tube showed that some of the rays were coming through. Thus some rays penetrate even farther than those reflected from the greatest depths. At the same potential—viz., 11,000 volts, with a film 1·8μ thick, Leithaüser[†] still found some transmission.

Again, the data and the curves show that there is a decrease in the quantity of rays reflected as one goes from rays of less to those of greater deflection in the magnetic spectrum; further, the difference in brightness of corresponding sections of the two spectra is greatest in the most deflected portions. This is as might be expected, considering that the most deflected particles are the lightest and therefore the most penetrating.

The critical potential depends both on the thickness and the nature of the film. For aluminium this critical potential for thicknesses 0·56μ, 1·90μ and 2·44μ is 11,000, 16,500 and 21,800 volts respectively. For a copper film of thickness 0·66μ the critical potential has a value greater than 27,750 volts.

Theories of the reflection of kathode rays have been furnished by Warburg, Stark and J. J. Thomson. Their agreement with observation is as yet only qualitative.

[*] Abstracted from the *Physical Review*, July, 1906.

[†] Leithaüser, *Ann. d. Physik*, XV., p. 305, 1904.

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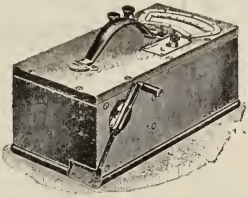

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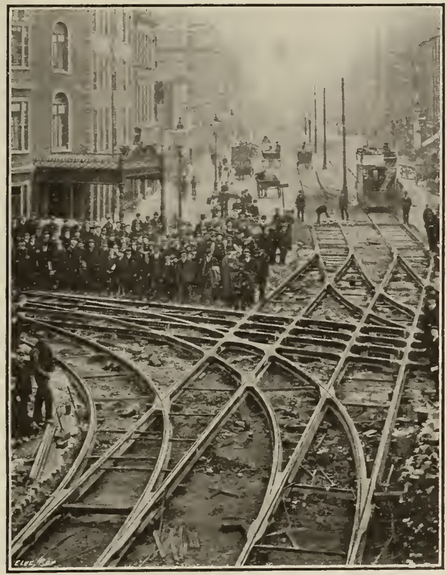

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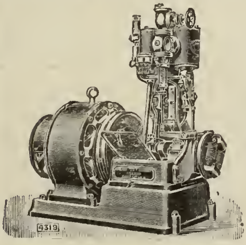

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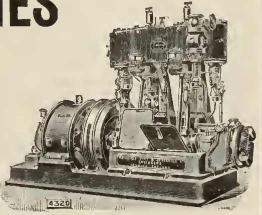

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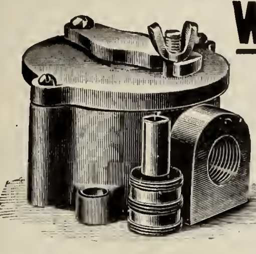

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The majority of the tables given througbout the book have been prepared specially for it, and great care has been taken in the selection of the remainder that only those likely to prove of actual service should be chosen. Particular attention has also been paid, in all cases, to matters that have suffered neglect hitherto in technical literature of the pocket-book and reference-book order. Thus a complete set of diagrams for the connection of motors to supply mains has been added to the House Wiring section in this edition, and it is hoped that this will save trouble and lessen the errors in connecting up continuous-current and single-, two- and three-phase motors. Among other additions in this section are the information with regard to Nernst Lamps, the illustrations in which have been drawn from the actual burners and resistances, and a page on Metallic Filament Lamps which has been kept back to the end of the section so as to embody the latest information available. The table of "flexibles" has been revised so as to include the standards of the Cable Makers' Association, and the Association's specification is appended to it. The new form of table issued in the first edition, connecting the fall of pressure, number of lamps and size of conductor has been retained with the addition of a column for currents.

Section **B**, Underground Mains, contains as before tables, instructions and other detailed information as to cables, ducts, junction boxes, &c., and a chapter briefly describing the various systems employed for public distributing networks. In this, the essential practical information is alone given; two- and three-phase systems are dealt with as well as continuous current and single phase, and the method of calculating the size of the conductors and the fall of pressure from the number of lamps or horse-power of motors is made clear without the elaboration of clock-face diagrams or algebraical exercises. A table of voltages on two-phase and three-phase systems, which has been added, is one which Mr. A. P. Trotter had worked out for his own use, and has kindly placed at my disposal. In this section, as in the others, all the tables have been recalculated to conform with the copper standards of the Engineering Standards Committee;—I am indebted to Mr. Robert S. Ball, jun., for the two tables of resistance and weight of single wires, in Section **A**, worked out from these standards. Unless otherwise stated all resistances are given for a temperature of 60°F.

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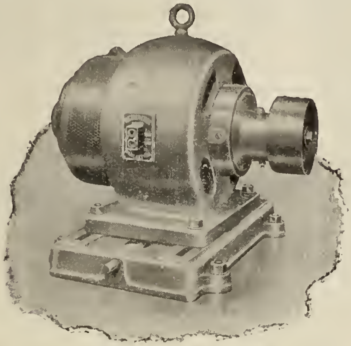

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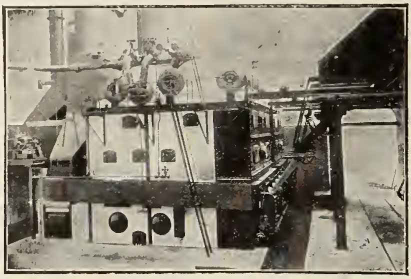

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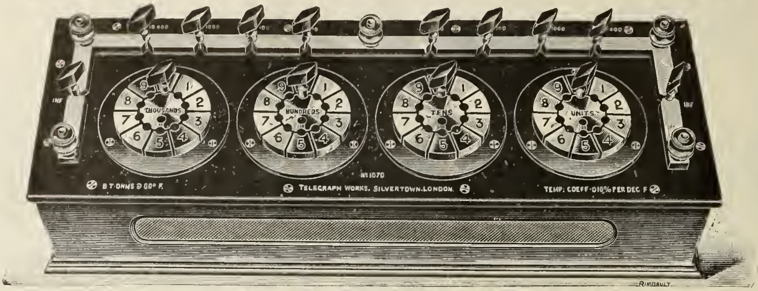
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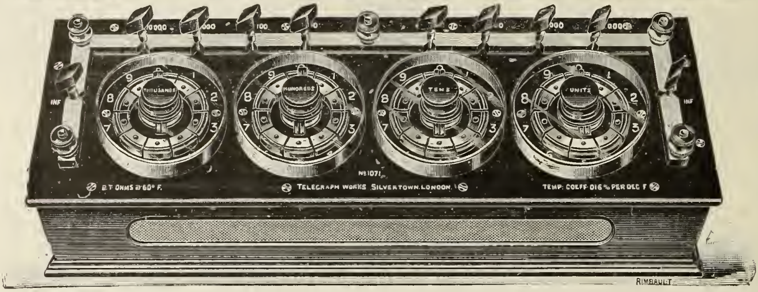
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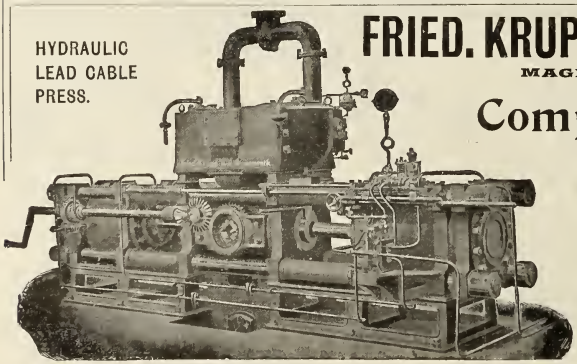

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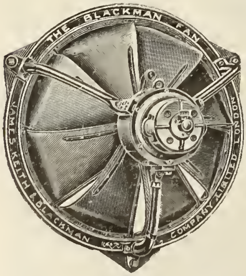
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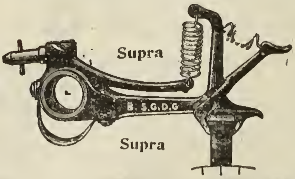

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it, is suitable. Thus wireless telegraphy was immediately an important subject, and radium is still a favourite. Of this we should have no reason to complain if the information were given with some knowledge of its value or the reverse, but unfortunately the "science" that is given is often rubbish and nothing more. If a lunatic were to patent a torpedo driven by radiobes, the halfpenny reader would soon know of it as one of the latest "marvels" of science.

An example of this kind of science is "The Four Just Men," by EDGAR WALLACE, the "£500 prize story." It came out under *Daily Mail* auspices, but it did not win a £500 prize itself; the point was that the work contained a deep mystery, and prizes were offered for the solution of the puzzle. And the so-called solution has now been published. We notice the book in these columns because the whole scheme exhibited such amusing ignorance and such impertinent incompetence.

The story is simple. The Foreign Secretary, Ramon, brought in an extradition bill which affected one Manuel Garcia, who was a Carlist, not a singing-master; so the three just men determined to give him due notice, and to murder Ramon if he persisted in his intention. Having decided on electrocution, they took in a fourth, a ruffian, Thery, who was, like most newspaper ruffians, an electrician. He had been stealing rubber, presumably from a cable works in Spain, where cable works are so common. He knew "everything there is to be known" about electricity, like the *Daily Mail*. The Four Just Men then took a place in Carnaby-street, over which the private telephone wire from the Foreign Office to Ramon's house ran. Then they did many sensational and wonderful things to frighten their victim. Ramon was not much terrified, but finally lives at his official residence, which must have been at the south corner of Downing and Parliament-streets. The four just men, however, had been making numerous preparations at Carnaby-street for electrocuting Ramon. They had rows of numbered bottles, or, as journalists call them, "phials," and a litter of graduated measures, test tubes and "condensors" with which they "oxydised and carbonated," but they may have been for making melodramatic explosive accessories. They had something, made by Thery, in a polished wood box which was the bait to lure Ramon to his death. One odd thing about this bait was that Thery had not yet been told how they were going to kill Ramon. Later on, however, there was much work to be done at Carnaby-street, "for in the killing of Sir Philip Ramon all the resources of" (*Daily Mail*) "science were to be pressed into the service of the four," and many calculations had to be made.

As the Foreign Secretary would not give way, even on receipt of the most dramatic of threats, the Four Just Men decided to give him till eight o'clock on one particular night, and then to kill him off. The police, however, closed the traffic in Westminster, and packed the streets, and the house, including roof and cellars, with the force. A bowl of mysterious flowers arrived, however. After seven, Ramon locked himself into his study. At Carnaby-street, just on eight, the Four Just Men tied a wire to the telephone circuit, and Thery stretched out his hand and evidently got a fatal shock. Ramon also died at the same moment. The telephone, as seen in the illustration, is apparently a real one, so Ramon could not have been killed through it. Moreover, he was on a carpeted floor. He had cleared all the light articles off the table, including the bowl of flowers, and had a rosebud—withered—between his fingers. Such is the potency of *Daily Mail* electricity administered by telephone. Where he held the rose there was a round black stain, which the eminent surgeon, Sir Francis Katling, thought might be formed by an acid, such as carbolic acid. In *Daily Mail* science phenol is a typical acid, of course, and it and other commercial acids make black stains. There were two sparrows found dead on the window sill. It is not within the editorial ambit for us to be intimate with the ways of sparrows, but a small boy informs us that real sparrows do not sit on telephone wires after dark. These, being *Daily Mail* sparrows, were no doubt sitting on the telephone wire, and were killed by the *Daily Mail* fluid. Whatever else inferior kinds of electricity may be, the newspaper article is invariably in the fluid phase. Now an interesting question arises: Will the *Daily Mail* liquor kill a sparrow with both legs on a wire? Shootists are annoyed by finding birds dead near telegraph lines, but they do not generally hold that grouse sit in rows on wires and get killed even by the unscrupulous mendacity of passing Press messages. Probably the sparrows, in this case, were sitting, for the purposes of fiction, with one leg on the wire and the other on the roof, or if the stretch was too long, no doubt one had a leg on the wire and the other had a leg on the roof, and they clasped their intermediate paws—or whatever it is *Daily Mail* sparrows have—so as to get a longer reach, and make a circuit.

Such is the story as told. The question was: How was Ramon killed, and who killed Thery? Over a thousand competitors gave a correct or nearly correct solution! Mr. EDGAR WALLACE had "underrated the astuteness of the reader," but had the reader underrated the colossal ignorance of the author? The solution is that they meant to electrocute Ramon by coupling the telephone wire and the electric light mains. This would have sent "a force of electricity" which should kill Ramon, but the four were wrong, for if "the full load" of electricity had been sent there must have been a "fusion." Whether Ramon or the sparrows would have been fused we are not told, but we are informed that this would not have killed Ramon. Thery, however, bungled and short-circuited so much of the current of the town mains through himself that Ramon was killed! "We are not told," as the curate says, what Thery had in the polished wood box, or what happened at the private house end of the wire. We are not told how Ramon got any shock at all. He would not be touching the telephone, as the bell had been taken off, and putting the lighting circuit on would not call him. Moreover, he had a flower in his hand, and the receiver was in its place. Even if he had had the telephone in his hand we should want to know how he could have been hurt. We are not told what the flowers had to do with the story. We are not told why the eminent surgeon could not recognise electric shock, even with a black stain on the victim's hand. We are not told how a little *Daily Mail* electricity is a dangerous thing, while drinking deep of that odd fluid merely causes a fusion.

We are not reviewing this work as a book; we are merely protesting against the preposterous ignorance of the untechnical press. To make a popular mistake, as DICKENS did over spontaneous combustion, is human; but to circulate a book with the attraction of a prize, and to sell many thousands of copies on the strength of a solution which does not exist, sounds almost like obtaining money under false pretences. We do not for a moment believe Mr. WALLACE was anything but perfectly sincere, though when he got the solutions in, some must have told him that his plot was nonsense. But we cannot help noticing the author's absolute contempt for knowledge. He might, at least, in dealing with a subject which he knew nothing about, have asked some competent friend to look through the manuscript. We would have said nothing, perhaps, if the matter were ended. But it is not; this string of nonsense is being dramatised, and is to be produced on the stage next week!

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Ueber den Gegenwärtigen Stand der Frage nach einer Mechanischen Erklärung der Elektrischen Erscheinungen. By Dr. Hans Witte. Naturwissenschaftliche Studien I. (Berlin: E. Ebering.) 7.50m.

A mechanical "explanation" of electric phenomena presupposes that mechanical phenomena, and our conception of the agencies that produce them, are simpler and more fundamental than electric phenomena. This is by no means evident at sight, and it is so difficult to prove that proposals have not been wanting for a reduction of mechanical phenomena to electromagnetic conceptions. Both mechanical and electrical theories are ultimately based upon certain fundamental assumptions, and both systems have much in common. The conservation of mass has its modern counterpart in the conservation of electricity, based upon its atomic structure. The conservation of energy is common to both. . Again, both systems admit forces apparently acting at a distance, and gravitational and molecular forces are as obscure as electric and magnetic forces.

It is only when we enter the more speculative regions of mechanical theory that further simplifications heave in sight. The successful explanation of pressure by the kinetic theory of gases, the reduction of a "force" to "concealed motions," and ultimately to collisions, gave a powerful impetus towards a mechanical "explanation" of all phenomena. But the zeal of the mechanicist has outrun his discretion. Of all known mechanical phenomena, those of collision are perhaps least capable of a rigid theory, and when we get down to molecular dimensions they become much more complex than, say, Newton's law of gravitative action at a distance. The denial of action at a distance has become a positive mania, and any absurdity, however complicated, is being welcomed in obedience to some dogmatic and unphilosophical denial of its possibility.

Dr. Witte's book places the various mechanical and semi-mechanical theories of electricity in a proper perspective. The main classification makes a division between distance actions and field actions. Weber's theory involves instantaneous action at a distance. Herein it resembles Newton's gravitational theory, but, unlike the latter, it has been shipwrecked on the facts discovered by Hertz. A theory involving an action at a distance propagated with the velocity of light has not yet been formulated, unless we interpret Bucherer's tentative denial of the ether in that sense.

Among field action theories we have a possible emission theory involving the passage of a stream of something from sources to sinks (not yet formulated) and the large class of wave-theories. The author enumerates 25 of these, two of which are not as yet worked out. In one main sub-division he places those theories in which the energy, whether electric or magnetic, is either altogether kinetic or altogether static. These, again, he sub-divides under the names of Mie, Kelvin, and Hertz. Mie's theory regards both electric and magnetic energies as potential, and is still far from approaching a complete mechanical solution. In the Kelvin group of theories one species of energy is potential and the other kinetic. These theories are connected with the names of Kelvin, Boltzmann, Voigt, Silberstein, Neumann, Sommerfeld, Reif, Larmor, Santer, Ebert, Glazebrook, Maxwell, Hankel, and Lorenz. Many of them are at once ruled out by their assumption that magnetism is characterised by a polar and electricity by an axial (rotational) vector. But the author shows that they are all impossible except on the assumption of an atomic ether, as against a continuous fluid. The "bubble" theory must be rejected on kinematical, mechanical, and electrical grounds.

An attempt to reduce all the electromagnetic energies to kinetics was inspired by Hertz, and made in a somewhat half-hearted manner by Lord Kelvin and Larmor. Here, again, only an atomic ether is admissible. If we assume that either of the energies may be partly kinetic and partly static, we get to the ideas of Graetz and Helm, which, like Mie's theory, admit a continuous ether. But the author proves that if the ether is discontinuous the assumptions concerning the size and properties of its discrete particles are quite arbitrary, and must remain so.

None of the theories advanced so far can be extended to solid conductors or to dispersion without utilising the conception of electrons. But the electrons can, as a rule, be introduced without much difficulty as conductors with a surface charge.

The book, written by one who has no axes to grind, maintains a welcome judicial impartiality. It gives a bird's eye view of all actual and possible theories and points out their difficulties. The author is evidently not committed to an eventual mechanical quasi-explanation of electrical phenomena, and therein he shows a due appreciation of the limits imposed by the laws of human cognition. E. E. F.

Lexikon der Elektrizität und Elektrotechnik. In 20 instalments. Edited by Fritz Hoppe. (Vienna: A. Hartleben.) Each instalment 60h.

This Austrian electrotechnical encyclopædia in instalments received a notice in these columns on its first appearance some time ago. It has recently been completed by the publication of the last five instalments, Nos. 16 to 20, which deal in alphabetical order with electrical and general technical subjects, ranging from "Rabatte" to "Zylindermaschine." As far as the mere collection of subjects goes this work appears fairly complete, but in most other respects it leaves much to be desired. The definitions advanced are not always quite accurate, and the tables of constants and collected data lack completeness, while the general text descends occasionally into trivialities, cardinal points being either entirely missed or hurriedly passed over. Many of the illustrations have been obviously chosen from makers' catalogues; others represent antiquated designs.

The following examples, culled at random from the first 15 pages of No. 16, fairly represent the spirit throughout the whole work :—

Reactance voltage, one of the most important quantities in dynamo design, is dealt with in 10 lines. It is defined as "diejenige elektromotorische Kraft, welche durch die Bürstenverschiebung in der mittleren Lage erzeugt wird." Whatever this may mean we are at a loss to understand, but it certainly is not the definition of the reactance voltage. Not one of the familiar and simple formulæ for calculating the reactance voltage is quoted—and this is a work which the editor proclaims, in the preface, to have been compiled for practical men! In dealing with the speed regulation of continuous-current motors, it is briefly stated that an increase in speed of about 20 per cent. above normal speed may be obtained by shunt control, and the compiler appears to be oblivious to the fact that numbers of motors having a speed regulation of 1 to 2 or more by shunt control are running daily in many kinds of industrial works. The table of friction coefficients in the article on this subject is incomplete. The coefficients pertaining to static friction between dry surfaces are given for a number of materials. In only two cases is this coefficient given for lubricated surfaces. But the coefficients of "running" friction—which are quite as important as the former—are only given for wrought iron running dry on cast iron and cast iron on bronze or cast iron with oil as a lubricant. Figures relating to the friction between steel and cast iron, bronze and some of the more important anti-friction metals with which bearings are lined, are conspicuous by their absence. Such figures are useful and so easily obtainable that there is no excuse for their omission.

Die Theorie, Berechnung und Konstruktion der Dampfturbinen. By Gabriel Zahikjanz. (Berlin: Verlag M. Krayn.) 1906. 6m.

This book of some 180 pages is based on a series of articles published by the author during the years 1904-5 in *Die Turbine*, a German monthly periodical devoted entirely to the subject of steam turbines and now in its second year.

The work is not of the kind where photographs of the casings of turbines and photographs of the interior of turbine stations are distributed through the book. It is of a much more businesslike character, and the 23 figures with which the text is illustrated have each a definite purpose. The author wastes no time on the historical part of the subject, but goes straight to the point, and in the first few pages shows how to calculate the pressure on a vane caused by a stream flow on to it. The next chapter contains the theory of the method of estimating the amount of work done by a moving vane and from this point onwards turbine theory is developed.

An interesting feature of the development is the method of expressing the various quantities, blade pressure, available work, entry and discharge angles, &c., in terms of the ratio between the circumferential velocity of the receiving rim to the circumferential velocity of the stream of fluid flowing to the turbine wheel. This quantity, which the author calls γ, is made the key to many problems. For instance, in the case of the single stage impulse turbine it is shown that γ may be chosen to give maximum efficiency, or to correspond to a given rim velocity, or to correspond to an efficiency determined by practical considerations to be the highest possible consistent with the possibilities of the materials used in the construction of the turbine. Once the value of γ is settled all the other quantities can be calculated from the expressions given. A pleasing feature of the book is the large number of worked-out numerical examples distributed through the text. In fact, all the important points are illustrated by a worked example. It should be understood that the author considers problems connected with both pressure and impulse turbines and also develops the principles concerned with the design of nozzles for the flow of steam. To a student with a competent knowledge of mathematics the book will be found useful and interesting.

FLAME ARC LAMPS.*

BY L. B. MARKS AND H. E. CLIFFORD.

It is only within a comparatively few years, and as a result of the scientific study of the arc, that it has come to be appreciated that the efficiency of such a light source is not dependent on temperature alone. The question of emissive power frequently plays an equal if not greater part in the determination of the ratio of watts to candle-power. It has long been realised that the light from the arc itself between pure carbon electrodes is of extremely low intensity, and more than 60 years ago experiments were carried on in substituting other electrodes in place of pure carbon. No systematic investigation of the whole question took place, however, until the recent work of Bremer, Auer, Nernst, Blondel, Whitney, Steinmetz, to mention the more noted of the workers in this field.

This work has resulted in marked improvements in two directions: First, the production of a luminous arc between electrodes whose rate of combustion is very much less than with ordinary carbons; and second, the evolution of the high-efficiency flame arc, in which the ordinary carbon electrodes are replaced by those impregnated with metallic salts. Although these impregnated carbons are to-day manufactured in many forms differing in construction detail, the purpose with all of them is to obtain a higher light efficiency. Up to the present time this gain in efficiency has been obtained at the expense of the life of the electrodes.

The colour of the light with these carbons is determined by the nature of the salts used and may therefore be controlled throughout a wide range. The efficiency, however, is very different for the different salts, the calcium compounds having given the best results. This difference in efficiency is well illustrated by the curves of Fig. 1, showing the distribution with flame carbons giving light designated as white, red and yellow, respectively. The tests here indicated were made with a 20 ampere Siemens-Halske alternating-current lamp without globe, operating with 32·5 volts at the arc and 34 volts at the terminals. The watt consumption at the terminals per spherical candle-power varied from 1·202 for the white light to 0·716 for the yellow. From the standpoint of efficiency, therefore, the carbons producing yellow light are distinctly superior.

Fig. 2 shows the results of tests made upon a 10 ampere Excello direct-current lamp operated with 55 volts at the terminals and 46·3 volts at the arc without a globe and 49·3 volts at the arc with a globe. A comparison of the two photometric curves of Fig. 2 shows the importance of a careful study of the optical properties of the glass used, since its selective absorption may bring about a considerable diminution of intensity for the very rays which are emitted by the arc.

In addition to the metallic salts for securing a longer and more brilliant arc, a flux is introduced to assist in the disposition of the slag formed. The presence of this slag makes it desirable in some cases to place the carbons parallel or slightly inclined to each other, rather than in line. In lamps where this arrangement is adopted, a magnetic blower coil maintains a longer arc under ordinary conditions of operation, and acts in addition to prevent the arc from climbing up the sides of the carbons. In a number of flame arc lamps, however, the carbons are placed one directly above the other.

The diameter of the carbons used varies from 8 mm. to 11 mm., the negative being as a rule 1 mm. less in diameter than the positive. The length varies from 325 mm. to 600 mm., whereas the life ranges from 7·25 to 17·5 hours. Lamps are now manufactured having a magazine to contain eight or nine pairs of carbons, thus giving a much increased time of burning.

Owing to the rapidity with which the carbons are consumed it has been found necessary to shield the tips as far as possible from "washing" of the air currents in the globe. For this purpose there is used an "economiser" or chamber of highly refractory material which surrounds the ends of the carbons (in lamps in which the carbons are arranged side by side) or encircles the upper carbon (in lamps in which the carbons are arranged one above the other).

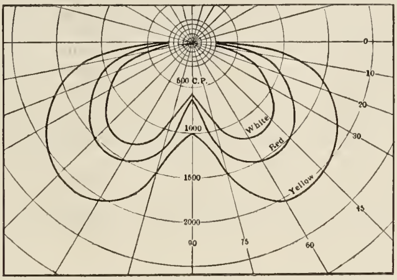

Fig. 1.—Flame Carbons. Distribution of Light in Vertical Plane.

The vapour which results from the burning of the mineralised carbons condenses for the most part on the economiser and contiguous portions of the lamp casing. Sometimes a special form of condenser is provided to receive the vapour deposits. As the colour of the condensed vapour is whitish the deposits above the arc assist in reflecting the light downward. The arc is extremely sensitive to currents of air in the globe and to variations in the magnetic field as well as to movements of the regulating mechanism of the lamp.

In the very nature of things the tendency of a long arc operated in the manner employed in flame arc lamps is toward unsteadiness. The variability of air currents in the globe, the lack of uniformity in the chemical constituency of the mineralised carbon, and the action of the magnetic field (where such is employed)—these and other difficulties conspire to produce unsteadiness in the light.

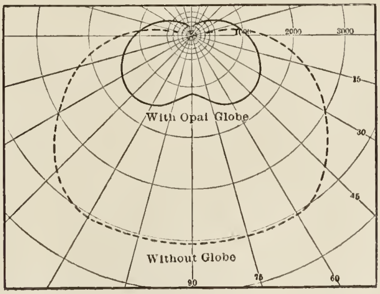

Fig. 2.—Excello Lamp. Distribution of Light in Vertical Plane.

For purposes of street illumination the highly efficient yellow light of the calcium carbon is in general suitable, but for interior illumination, where colour values are important, the yellow light flame carbon lamp is objectionable. Under the light of this lamp white material appears cream-coloured, the shades of yellow are intensified, and the colour values at the violet end of the spectrum are naturally distorted. It is quite impossible to distinguish different shades of dark blue from one another, all of them appearing black. With the white light flame carbons, however, most of the colours have approximately their correct daylight value.

The distribution of illumination of the type of flame arc lamps now in use is quite different from that of the enclosed arc lamp.

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* Abstract of a Paper read before the Atlantic City Convention of the American National Electric Light Association. From the *Electrical World.*

Most of the light of the flame arc lamp is thrown downward in a zone from 30 deg. to 90 deg. below the horizontal, the amount of illumination dropping off quickly towards the horizontal. The maximum illumination is at about 45 deg. below the horizontal, in which respect the distribution of its light resembles that of the old open arc. The flame arc, however, sends its rays with almost equal brilliancy through all the angles from 30 deg. to 75 deg. below the horizontal, whilst the old open arc quickly drops from its maximum on either side of the 45 deg. line of vision, and yields a comparatively small proportion of its total flux between zero and 15 deg. below the horizontal. In the enclosed arc lamp, on the other hand, the horizontal illumination is relatively very large, and at 15 deg. below the horizontal the illumination is not far from the maximum.

Fig. 3 shows the result of tests made upon enclosed and open direct-current arc lamps, flame arc and an alternating-current enclosed arc lamp. The voltage of the alternating-current arc was 70·7, the power factor being 0·85. The enclosed arc lamps were of the single globe type, the alternating-current arc being provided with a metallic shade. The globes were of opalescent glass, except for the open arc, which was bare. The flame arc lamp was of slightly opalescent glass.

Taking the 6·5 ampere direct-current enclosed arc, it will be noted that from the horizontal down to about 12 deg. below, the enclosed arc gives more illumination than the 9·5 ampere open arc consuming the same power. This means that if the lamps were mounted on poles 25 ft. above the ground they would give equal illumination at a distance of about 115 ft. from the pole; beyond this distance the advantage would be in favour of the enclosed arc. Now taking the case of the flame arc lamp consuming 360 watts, or four-fifths of the power of the enclosed arc, the illumination at a distance of 115 ft. from the pole will figure out 2 83 times that of the enclosed arc.

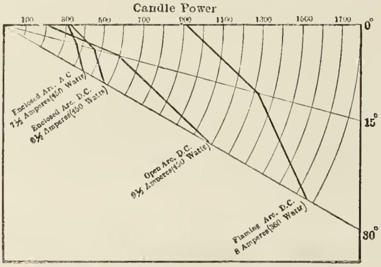

Fig. 3.—Distribution of Illumination.

From the distribution of illumination, as shown in the chart, it will be seen that this same proportion holds approximately for all distances from the pole greater than 45 ft., at which point the light strikes the ground at an angle of 30 deg. below the horizontal. At distances less than 45 ft. from the pole the proportion rapidly changes in favour of the flame arc and reaches approximately 10 to 1 at a distance of 7 ft. from the pole. With the 7·5 ampere alternating-current enclosed arc the amount of illumination distributed through the most effective zone for street illumination is considerably less than that of the direct-current enclosed arc with the same power consumption. The ratio of 2·83 to 1 cited above would, for the flame arc and the alternating-current enclosed arc, be 3·3 to 1 at 12 deg. below the horizontal, representing a distance of 115 ft. from the pole, 3·5 to 1 at 15 deg. below, representing a distance of 95 ft. from the pole, and 3 9 to 1 at 30 deg. below, representing a distance of 45 ft. from the pole. As in the last case, the proportion increases rapidly in favour of the flaming arc as the pole is approached. Hence, to obtain the most effective use of the remarkably high luminous efficiency of the flame lamp, it must be provided with a reflecting device that will materially modify the distribution of illumination of the arc. There is reason to believe that considerable improvement in this respect may be brought about, but the problem is not a simple one. With the present distribution of illumination the flame arc lamp, if mounted on a pole having the same height as the poles now in use for street lighting, would produce an illumination in the immediate neighbourhood of the pole entirely out of proportion to that given at a distance of 125 ft. to 250 ft., which is about one-half the distance that now obtains between poles in arc lighting practice in America.

To meet this difficulty it is apparent that unless the size of the unit can be materially decreased, the flame arc lamp must be placed very high above the ground, so high in fact that in most cases serious questions arise as to the practicability of such a procedure.

The units now commonly employed are 8, 10 and 12 amperes, with 45 to 50 volts at the arc. Owing to the special composition of the carbons and the peculiar nature of the arc, obstacles are encountered which make the practical operation of the lamp difficult when smaller currents are used. Moreover, in the small currents the luminous efficiency of the arc is very considerably reduced.

The concentration of the large amount of flux from the higher-current arcs in a single unit renders the lamp unsuitable for purposes of ordinary street illumination in the United States.

ON METHODS OF HIGH PRECISION FOR THE COMPARISON OF RESISTANCES.[*]

BY F. E. SMITH.

(From the National Physical Laboratory.)

The object of the author is to give a brief account of the high precision methods used at the National Physical Laboratory for measuring standard resistances. Up to and including the year 1903 the standard unit coils of the British Association were compared by Carey Foster's method, the Fleming circular wire bridge being used. The probable error of such comparisons is of the order 0·001 per cent. The build up of a 10-ohm coil from the unit was very conveniently effected by a process suggested by Lord Rayleigh.[†] Three 3-ohm coils are arranged in parallel, and their combination value determined by comparison with a unit resistance. They are then placed in series; by the addition of a unit coil to the series formation the "build-up" is complete. The probable error of this build-up is also small, but when combined with the error of comparison of nominally equal coils the observed value of a 1 to 10 ratio may be in error by 0·002 per cent. The use of this ratio for the evaluation of resistances of 10^n units results in a possible error of $n \times 0{\cdot}002$ per cent.

The resistance standards of the National Physical Laboratory are of three kinds—mercury, platinum-silver, and manganin. When comparing standards of mercury and of platinum-silver, comparatively small currents must be employed, because the temperature-coefficients of these materials are large and the resistances are surrounded by bad thermal conductors. The manganin coils are wound on brass cylinders, have small temperature coefficients, and may be immersed in oil; the maximum permissible current is therefore much greater. The accuracy of all methods of comparison is directly proportional to the current employed, from which it follows that for all building-up processes manganin coils are to be preferred. The question of preference for permanency is not discussed in this Paper.

In order to compare the various methods of measurement it is necessary to give the formulæ for sensitiveness. In presenting these latter I do not wish to suggest that they are new. The subject has been previously treated by Mr. O. Heaviside,[‡] Mr. T. Gray,[§] Lord Rayleigh,[||] Prof. Schuster,[¶] Prof. A. Gray,[**] Dr. Jaeger,[††] and others, and some of the formulæ are given in text-books. In the present Paper the considerations of many of these writers have been extended. Prof. Schuster first pointed out that it is the heating of the conductors which puts the limit to a measurement of resistance, and the formulæ derived by him are in terms of the current conveyed by the resistance to be measured. Dr. Jaeger has recently discussed the question of sensitiveness from the same point of view, and in this Paper the subject is similarly treated. The formulæ may be derived in several ways, as will be seen on reference to the authorities quoted. Many of these ways are long, and it may not be out of place to give a well-known rule, which, if applied to any system of conductors, will quickly give all the desired information.

"In any network of conductors the current in one arm due to an electromotive force in another arm is equal to the current in the latter when an equal E.M.F. is placed in the former."

(This rule results from an application of Kirchoff's laws.)

The most complicated system of conductors considered in the present Paper is that known as the Kelvin double bridge,[‡‡] and this is dealt with here by way of example. Let the current through

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[*] Appendix to the Report of the British Association Committee on Practical Standards for Electrical Measurements, issued during the meeting at York (see *The Electrician*, August 17, 1906, p. 706). The committee consists of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Profs. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Profs. A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar and Mr. George Matthey.

[†] *Phil. Trans.*, 1883, Vol. CLXXIV., 310. See also B.A. Report, 1883.

[‡] *Phil. Mag.*, 1873, Vol. XLV., p. 114.

[§] *Phil. Mag.*, 1881, Vol. XII., p. 283.

[||] *Proc.* Roy. Soc., 1891, Vol. XLIX., 203.

[¶] *Phil. Mag.*, 1894, p. 175.

[**] "Absolute Measurements," Vol. I., p. 331.

[††] *Zeitschr. Instrumentenk.*, March, 1906, Vol. XXVI., 69.

[‡‡] W. Thomson; *Phil. Mag.*, 1862, Vol. XXIV., 149.

P be i, and through R, i', and let $P/Q = R/S = \alpha/\beta$. Also let the applied E.M.F. remain constant. On completing the galvanometer circuit the distribution of the currents will remain unaltered. Let P be changed to $P + \delta P$. The current through it will change to $i - \delta i$, and the change in P.D. of P is $i\delta P - P\delta i$; of Q it is $Q\delta i$. If the galvanometer circuit is now completed the current through it will be equal to that produced by an E.M.F $i\delta P - P\delta i$ in P and an E.M.F. equal to $Q\delta i$ in Q. If an E.M.F. equal to the latter is placed in the galvanometer branch, the current through Q is $PQ\delta i/(P+Q)r$, where r is equal to

$$\frac{\alpha\beta}{\alpha+\beta} + \frac{(P+R)(Q+S)}{P+R+Q+S} + G,$$

i.e, the resistance of the "external galvanometer circuit" plus that of the galvanometer. Similarly, the current through P due to an E.M.F. $P\delta i$ in the galvanometer branch is equal to $QP\delta i/(P+Q)r$. Hence, by the rule, the current through the galvanometer, due to an E.M.F. $Q\delta i$ in Q, is equal to the current through the same due to an E.M.F. $P\delta i$ in P. As these must be in opposite directions through G, we have only to consider the current due to an E.M.F. $i\delta P$ in P. The current through G due to this E.M.F. is found in a similar manner and is equal to

$$\frac{i\delta P}{G + \frac{\alpha\beta}{\alpha+\beta} + \frac{(P+R)(Q+S)}{P+R+Q+S}} \cdot \frac{Q+S}{P+R+Q+S} \quad . \quad . \quad . \quad (A)$$

This, therefore, is the current through the galvanometer when the balance of the bridge is disturbed by an alteration in P of δP.

In galvanometers, the coils of which are wound in similar channels, and contain the same mass of wire, the E.M.F. on the needle, and hence the deflection, is proportional to $x\sqrt{G}$* where x is the current through G. In the case considered the deflection is proportional to

$$\frac{\sqrt{G}\, i\delta P}{G + \frac{\alpha\beta}{\alpha+\beta} + \frac{(P+R)(Q+S)}{P+R+Q+S}} \cdot \frac{Q+S}{P+R+Q+S} \quad . \quad . \quad . \quad (B)$$

This is a maximum when $G = \frac{\alpha\beta}{\alpha+\beta} + \frac{(P+R)(Q+S)}{P+R+Q+S}$, *i.e.*, the resistance of the "external galvanometer circuit," and the value of this is the most suitable galvanometer resistance. Substituting this value for G in (B), an expression is obtained which, from the conjugate condition of the arms of the bridge, may be reduced to the simple form

$$i\Delta\sqrt{P}/2\sqrt{\frac{(R+S)(P+R+\alpha)}{PS}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (C)$$

in which $\Delta = \delta P/P$.

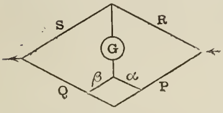

Fig. 1.

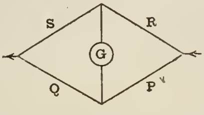

Fig. 2.

If in (B) we write g for the best galvanometer resistance and Ng for the resistance of the galvanometer used, the deflection is proportional to $\sqrt{Ng}/(N+1)\sqrt{g}$, and the ratio of this to the maximum $(N=1)$ is $2\sqrt{N}/(N+1)$. Prof. Schuster, in the Paper referred to, gives a table showing that if $N=20$ or $0{\cdot}05$, the sensitiveness is 0·426 times the maximum.

The derivation of the formulæ being so simple, the results alone are given for the other methods considered.

Wheatstone Bridge (Fig. 2).—If $\alpha = \beta = 0$ in the expressions obtained for the Kelvin double bridge, the values are those for the Wheatstone bridge.† In this case expression (C) may be written

$$i\Delta\sqrt{P}/2\sqrt{\left(1+\frac{R}{S}\right)\left(1+\frac{R}{P}\right)} \cdot \quad . \quad . \quad . \quad . \quad . \quad (D)$$

The best conditions for sensitiveness are here clearly indicated. The resistance R should be small compared with S and with P—*i.e.*, P should be connected to a comparatively large resistance, Q, and a small resistance, R. If i is the maximum permissible current through P, Q must be a resistance of large cooling surface and small temperature coefficient; if it is of the same type and dimensions as P, then it should be of the same nominal value. In the latter case, which is the general one for precision measurements, $P=Q=R=S$ and the sensitiveness is proportional to $i\Delta\sqrt{P}/4$. It is generally recognised that for coils of the same type and dimensions $i\sqrt{P}$ is constant.

The Potentiometer (Fig. 3).—Let the resistances of the two circuits be $P + R_1$ and $Q + R_2$. If i is the current through P, the current through the galvanometer is

$$\frac{i\Delta P}{G + PR_1/(P+R_1) + QR_2/(Q+R_2)},$$

and the best resistance for the galvanometer is $PR_1/(P+R_1) + QR_2/(Q+R_2)$. The sensitiveness is, therefore, proportional to

$$\frac{i\Delta\sqrt{P}}{2\sqrt{R_1/(P+R_1) + QR_2/P(Q+R_2)}}.$$

In the case of precision measurements, R_1 and R_2 may be made very great compared with P and Q respectively. If this is so, the sensitiveness is proportional to $i\Delta\sqrt{P}/2\sqrt{1+Q/P}$. If Q is small compared with P, this becomes $i\Delta\sqrt{P}/2$, and the best resistance for the galvanometer is P. Unless P and R are nominally equal the galvanometer resistance cannot be the most suitable for both observations, and the sensitiveness of one of the measurements must be less than that stated. If $P=R$ and $Q=S$, the latter being comparatively small, the sensitiveness is twice that of the Wheatstone bridge with equal arms. It has to be remembered, however, that the current in the potentiometer is continuous and the heating effects more marked than in the bridge in which a tapping current only is employed. A great practical advantage of the bridge method is the rapidity of measurement.

Differential Galvanometer Method (Fig. 4).—If G and g are the resistances of the galvanometer coils, the difference of the currents through them is $i(Pg - QG)/G(Q+g)$. If $P=Q$ and $G=g$, the difference of the currents is $i(P-Q)/(Q+G) = i\delta P/(Q+G)$, and the best galvanometer resistance is $G=P=Q$. The sensitiveness is then proportional to $i\Delta\sqrt{P}/2\sqrt{2}$. If the currents through the galvanometer are comparatively large, convection currents are produced in the space containing the suspended magnets; also, the resistance of the coils is subject to small but rapid changes. There is, therefore, a maximum permissible value for the currents through the galvanometer coils, and in general some ballast resistance must be added to the galvanometer arms. This reduces the sensitiveness.

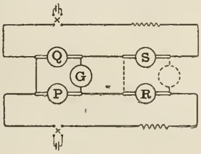

Fig. 3.

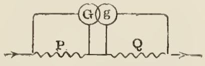

Fig. 4.

Mercury Standards of Resistance.—The Kohlrausch differential galvanometer, the Kelvin bridge, and the potentiometer have been employed* for the measurement of resistance of mercury standards with current and potential leads of comparatively high resistance. These methods are recommended in the Report of the Conference on Electric Units at Charlottenburg, 1905. The current used in the measurement of such resistances is limited by the condition that the mercury shall not be sufficiently warmed to produce appreciable error.

In the Standards Department of the National Physical Laboratory no favourable opportunity has arisen for an exhaustive test of the Kohlrausch method. As used at the Physikalisch-Technische Reichsanstalt it is very satisfactory; but, strictly speaking, it is not a null method, as observations of deflections have to be made. From particulars published,† a favourable arrangement for the measurement of mercury standards is when $G = g = 6$ ohms, $P = Q = 1$ ohm, and the ballast resistance in each galvanometer arm is 10 ohms. In this case the sensitiveness is proportional to $i\Delta\sqrt{12}/34 = 0{\cdot}098\, i\Delta$.

With the Kelvin double bridge, if $R = S = 1{,}000$, $P = Q = 1$, $\alpha = \beta = 100$, and $G = 1{,}000$, the sensitiveness is proportional to $0{\cdot}011\, i\Delta$. If $R = S = 100$, $P = Q = 1$, $\alpha = \beta = 100$, the sensitiveness is more than doubled, being equal to $0{\cdot}025\, i\Delta$. This latter case is convenient in practice.

In the potentiometer, if $P = Q$, and $G = P + Q$, the sensitiveness is proportional to $0{\cdot}35\, i\Delta$. The current is continuous, and hence the maximum permissible value of i is not so great as with the differential galvanometer and Kelvin bridge.

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* A. Gray: "Absolute Measurements," Vol. II.

† The values usually given for the Wheatstone bridge (see J. J. Thomson, *Elements of Elec. and Magnetism*, p. 305; Fleming, *Handbook of Elec. Laboratory*, Vol. I., p. 233; A. Gray, *Abs. Measurements*, Vol. I., p. 333) involve the resistance of the battery arm and the E.M.F. of the battery. If for the latter $i(P+Q)$ is substituted, the resistance of the battery may be taken as zero, and, on substituting, the value given in this Paper is obtained.

* *Wissenschaft. Abhand. Phys.-Tech. Reichsanstalt*, 414, Band II.; see also *Phil. Trans.*, 1904, A 373, 57.

† *Wissenschaft. Abhand. Phys.-Tech. Reichsanstalt*, Band III.

At the National Physical Laboratory the Kelvin bridge and the potentiometer were employed up to March of the present year. With the former method a tapping current of 0·2 ampere was necessary in order to measure a difference of 1×10^{-6} ohm with certainty. With the latter method the current used was 0·03 ampere, but the method was far less convenient. At the present time a modification of the Wheatstone bridge is used, and proves to be the most satisfactory and most sensitive of all the methods discussed. The arrangement is very similar to that suggested by R. H. Housman for the evaluation of small resistances.

In Fig. 5 P is the mercury standard, of which r and r' are the current leads. R principally consists of a 1 ohm manganin coil, which is shunted with a resistance X, usually of the order 30 to 50 ohms, and a resistance X′ of several thousands of ohms. The latter is varied in the final adjustment of this arm of the bridge so as to obtain a very accurate balance. Q and S are 1,000 ohm coils of manganin. R′ consists of two unit coils in series; the value of these in terms of other unit coils is known with great accuracy (*see* Build-up Method). B is a thick copper conductor in series with S. The current through P is 0 03 ampere. The operations are as follows: The bridge piece B is placed in position so that R′ is out of circuit, and the shunts X and X′ are adjusted until

$$R_1/P=(S+B)/(Q+r),$$

R_1 being the shunted value of R. The galvanometer lead at a is removed and connected to b, and the battery lead at c is placed at a. In practice this change is effected with a rocking commutator. The position of B is altered so as to include R′ as one of the arms of the bridge, and a balance is obtained by shunting R′, when, if R_1' represents the shunted value of R′,

$$R_1'/(P+R_1)=(S+B)/(Q+R).$$

Combining this with the previous equation, we have

$$R_1'=P[(S+B)\ (Q+S+r+B)/(Q+r)^2].$$

The value of r is obtained with considerable accuracy by moving the galvanometer lead at e to d and balancing. In an analogous manner the value of B may be obtained; the correction due to B is usually less than one part in 10,000,000. The ratio of S to Q may be eliminated from the last equation by interchanging Q and S in the bridge and repeating the operations indicated above. If Q and S are not very different from their nominal values, then

$$R_1'+R_2'=P[4-6(r-B)/Q],$$

where R_2' represents the second shunted value of R′.

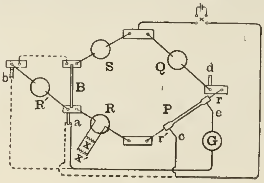

Fig. 5.

With a galvanometer resistance of 2 ohms, with P = R = 1, and Q = S = 1,000, the sensitiveness of the arrangement is proportional to 0·35 $i\Delta$. With P = R = 2, and Q = S = 1,000, this is increased to 0·47 $i\Delta$, the values for i being the same in the two cases. If a greater current value than 0·03 ampere is permissible, then Q = S may be made equal to 100 ohms, and the increase in sensitiveness is approximately proportional to the increase in the current.

The following observations were made on May 30, 1906, the mercury standard Y being used, and two coils in series (C.1) evaluated :—

1st observation, $P=Y=1{\cdot}00027_0$ int. ohms $Q=1{,}000{\cdot}18$ approx.
$S=1{,}000{\cdot}19$,,
$X=40{\cdot}1$
$X'=30{,}900$
Shunt on $R'=31{,}500$. $r=0{\cdot}033$. $B=0{\cdot}00007$

2nd observation, Q and S interchanged.
$X=40{\cdot}1$
$X'=28{,}400$
Shunt on $R'=16{,}400$.

Hence $R_1'+R_2'=1{\cdot}00027_0\ [4-6(0{\cdot}0000329)]$
$=4{\cdot}00088_{25}$
$\therefore\ 2R'=4{\cdot}00088_{25}+2(1/31{,}500+1/16{,}400)$
$\therefore C1=R'=2{\cdot}00053_4$ int. ohms. $t=17{\cdot}21^\circ$C.

Comparing the various methods as practically employed, the sensitivities are proportional to

0·025 $i\ \Delta$ for the Kelvin double bridge.
0·098 $i\ \Delta$,, Kohlrausch differential galvanometer.
0·35 $i\ \Delta$,, Wheatstone bridge.
0·35 $i\ \Delta$,, Potentiometer.

The maximum permissible values of i are the same for the first three methods. For the potentiometer a smaller current must be used. Possibly the arrangement considered for the differential galvanometer might be modified so as to make the method more sensitive.

(*To be continued.*)

THE DISRUPTIVE VOLTAGE OF THIN LIQUID FILMS BETWEEN IRIDIO-PLATINUM ELECTRODES.*

BY P. E. SHAW, D.SC.

PART I.—VOLTAGES 25-400.

Electric-touch measurements can readily be made under oil. If a telephone be included in the circuit, the sounds made in contact are sharp and clear for all the liquids mentioned below. They even excel air in this respect. This property of oils to render contact distinct has been used in potentiometers and other instruments. The whole instrument, or at least the slide-wire, is immersed in paraffin oil (see a Paper by R. A. Lehfeldt and discussion following, in Phys. Soc. *Proc.*, p. 479, 1901-03). This previous use of oils suggested the present research.

The relation of spark-length to small P.D. of the electrodes has been experimentally tested for gases by Earhart (*Phil. Mag.*, series 6, Vol. I., p. 147, 1901), Shaw (*Proc.* Roy. Soc., Vol. LXXIII., p. 337, 1903), Kinsley (*Phil. Mag.*, May, 1905, p. 692), and Hobbs (*Phil. Mag.*, series 6, Vol. X., December, 1905).

Earhart discovered the knee occurring in the curve at 350 volts. Shaw pushed the investigation further by using small P.D. down to $\frac{1}{2}$ volt. Kinsley threw doubt on the constancy of potential for a given gas and given electrodes. Hobbs, working more exhaustively than his predessors, has added much definite and useful information. The discharge in gases must bear a close relationship to the discharge in liquids, but little precise work has been done on the latter, though Hughes (*Proc.* Inst. Elec. Eng., 1892), Swinton (discussion on the above Paper), Steinmetz (*Trans.* Amer. Inst. Elec. Eng. 1893), before 1903, and recently, C. E. Skinner (Nat. Elec. Light Assoc., Boston, Mass., 1904), Przibram (*Akad. Wiss. Wien, Sitz.-Ber.*, November, 1904), and Voege (*Elektrotechn. Zeitschr.*, December, 1904) have tested the relationship for spark-lengths greater than $\frac{1}{20}$ mm. In the following Paper the P.D. varies from 25 to 400 volts, and the corresponding spark-lengths vary from $\frac{1}{10}$ micron (micron $=\frac{1}{1000}$ mm.) to about 10 microns.

Recently a book has been published giving useful information ("The Insulation of Electric Machines," by H. W. Turner and H. M. Hobart. It is made clear in this book that water, acids and alkalies are very destructive of the insulating powers of oils; thus Skinner has shown that $\frac{1}{50}$ per cent. of water reduces the dielectric strength of transformer oil to half its value when quite dry. In the present work all the commercial liquids used were shaken up and allowed to remain over potassium carbonate, filtered, and then heated to 110 deg. for several hours, then kept in a glass-stoppered bottle till used.

METHOD.

In a research by the present writer on the sparking distance in air (*loc. cit.*), the electric micrometer with levers was used to measure spark-length; in the present case the electric micrometer, without levers, is used. It has been already described (*Proc.* Roy. Soc., April, 1906) for measuring gauges; it has proved very convenient for the present experiments.

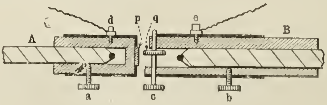

Fig. 1.

The only parts of the apparatus which need be here mentioned can be understood from Fig. 1. Two spindles, A and B, are in one line, and can be worked to or from one another by micrometer screws not shown, and their distance apart can be read and controlled to $\frac{1}{100}\ \mu$ (*i.e.*, $\frac{1}{100000}$ mm.). The divisions on the micrometer head show movements of 1 μ, and these, when viewed by a microscope, can be each subdivided into 100 parts.

On A and B are fitted two caps of ebonite clamped on by screws, a, b. Mounted on each ebonite is a sheath of steel. On the left cap is a plate of iridio-platinum, p, and on the right is a disc of iridio-platinum, q, set on a spindle turning on an axis in the plane of the paper and perpendicular to B. This disc projects, as shown, so that when B advances to A, the surfaces q and p are brought into contact. Since q is a diametral section of a sphere, its edge touches the plate p at a point. Discharge is made to occur between p and q. By causing p to rotate on a horizontal axis along A and q to rotate on a horizontal axis perpendicular to B, fresh surfaces of p and q can be presented to one another continually, since q touches p not at the centre.

The P.D. on surfaces p, q is maintained by connecting wires to terminals d c. The full circuit is shown in Fig. 2. Here a 400 volt lighting circuit is joined through key K_4 to a water resistance. Between the fixed zinc electrodes Z_1, Z_3 is the full P.D., while between the movable Z_2 and the fixed Z_1 is the P.D., say V, used in discharging the apparatus. The leads to the electrodes Z_2 and Z_3 are insulated from the liquids by being enclosed in glass tubing.

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* Paper read before the Physical Society June 22, 1906.

If switches K_2 and K_3 are put over to the right, the above voltage V will act through the voltmeter V_0 or on the discharge surfaces p, q according as the keys K_5 and K_6 are put over to the left or the right. It is easy to vary the P.D. used by moving Z_2.

Another circuit is on the left and is brought into action by putting switches K_2 and K_3 over to the left, whilst K_5 and K_6 are kept to the right. The single cell C has resistance r_1, say 100 ohms, and r_2, say 4,000 ohms, in circuit. The telephone T is in the circuit and sounds when p and q touch. This circuit is used to determine the position of contact of p and q, the P.D. between them being very small, in this case $\frac{1}{40}$ volt. The actual discharge for high potential experiments, say 100 volts, from the right circuit, takes place when p and q are separated by a small gap; but the discharge-distance for the small voltage $\frac{1}{40}$ volt of the left circuit is so minute that it can be ignored. The above apparatus can be used for discharge through gases, liquids or solids.

The modus operandi for liquids is as follows: The caps on spindles A B are removed from the spindles, the iridio-platinum surfaces ground with finest emery to remove the old surface, polished with rouge or leather, and cleaned. The caps are placed on A and B and p, q made to approach. One drop of the liquid to be tested is placed on q, and as p approaches q the liquid settles by capillarity between p and q. Then the spindle B is moved slightly away, the liquid being thus drawn out into a thread connecting the surfaces, and there is a guarantee that liquid without air-bubble connects the surfaces. The switches K_2 and K_3 are put to the left, and K_5 and K_6 put over to the right. If now p is advanced and touches q, the telephone T sounds; the reading of the divided head of the right micrometer-wheel is taken. This is the first reading. The surface q is drawn away from p about twice as far as the spark-length about to occur. Switches K_2 and K_3 are put to the right, and K_5 and K_6 put to the left. The position of Z_2 is arranged so that the voltmeter shows the desired P.D. Now K_5 and K_6 are put over to the right, and q is made *very slowly* to approach p, the micrometer-scale being watched so that at the moment when discharge occurs and is indicated by the sounding of telephone L.S.T., the scale is read a second time. The discharge-distance is the difference between the first and second readings. These distances are entered in the tables following in units which are $0{\cdot}01\mu$ (μ = micron = $\frac{1}{1000}$ mm.).

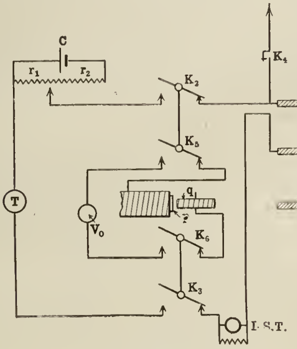


Fig. 2.

The surfaces of p, q presented to one another are renewed, as shown above, by rotations and another discharge is made.

Most of the liquids used are of commercial quality, and are purified as shown above; others were obtained specially pure. The following liquids were tested:—

Vegetable Oils.—Olive oil, castor oil, linseed oil, rape oil. Also turpentine, fusel oil, and oil of resin.

Animal Oils.—Cod-liver oil, neat's-foot oil.

Mineral Oils.—Paraffin, transformer oil.

A Homologous Series.—Pentane (C_5H_{12}); hexane (C_6H_{14}); heptane (C_7H_{16}); octane (C_8H_{18}). These were obtained from C. A. F. Kahlbaum, Berlin. Hexane and octane were specially pure, being derived from propyl iodide and octyl iodide respectively; while heptane and pentane were obtained from petroleum.

Varnishes.—Of these armacell and ohmaline are obtained from Griffiths Bros., Bermondsey, London; while Sterling varnish is made by the Sterling Varnish Co., Manchester. Though these are made to insulate when dry, they all have great dielectric strength when liquid, as shown in the curves (Fig. 5).

Table I.—*l = Spark-length stated in Units of 0·01μ.*

P.D. in volts.	*l.*						
	Olive oil.	Linseed oil.	Castor oil.	Rape oil.	Turpentine-	Fusel oil.	Air.
375	560	550	570	..	..	550	1,300
350	510	475	520	610	520	..	1,100
300	445	350	400	430	420	..	160.250 480.320
275	..	..	..	..	..	..	120
250	400	300	350	400	340	300	118
200	..	220	..	300	220	255	100
186	340	..	318	..	165	..	..
150	290	190	275	220	120	205	80
125	235	150	210	..	100	..	48
100	200	95	170	115	90	150	46
75	145	..	150	115	80	110	36
70	140	..	..	..	..	..	..
68	115	..	..	..	..	..	..
66	93	..	..	..	..	..	..
62	80	..	110	..	..	..	..
50	60	56	58	45	55	80	14
25	27	27	35	..	27	35	8
10	11	..	..	..	..	..	..

Table II.

P.D. in volts.	*l.*						
	Paraffin oil.	Transformer oil.	Cod-liver oil.	Pentane.	Hexane.	Heptane.	Octane.
390	breaks down readily	breaks down	450	..	..	..	..
345			395	400	260	320	350
300			350	250	..	260	310
250			290	220	220	275	..
200		350	..	170	220	235	240
175	350	..	..	..	..	..	..
150	300	210	175	145	170	140	180
125	220	170	150	..	..	..	..
100	180	110	120	90	150	100	105
75	155	80	..	..	..	..	..
62	125	..	..	..	..	..	..
56	95	..	..	..	..	..	..
50	75	70	50	50	80	50	..
25	38	..	..	..	..	..	..

As all experimenters on gaseous discharge have found, the discharge-distance is an uncertain measurement. The same order of error occurs for liquids. In the case of gases, dust or want of polish increases the distance of discharge for a given P.D. In liquids, solid or flocculent substances or minute air-bubbles may be floating, or the presence of water, acid, alkali or salts will set up electrolysis and change the discharge distance.

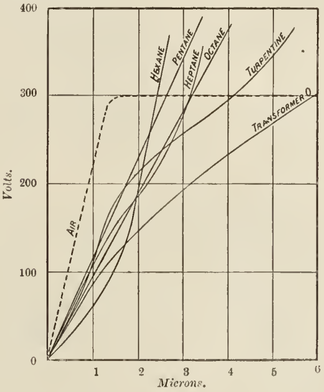


Fig. 3.

In the curves (Figs. 3, 4, 5) some liquids may be represented roughly by straight lines; other liquids certainly require irregular curves for proper representation. They may be classed as follows:—

Straight Curves.		*Irregular Curves.*	
Linseed oil	Octane	Paraffin oil	Turpentine
Rape ,, ...	Armacell varnish	Transformer oil	Hexane
Fusel ,, ...	Ohmaline ,,	Castor ,, ...	Heptane
Cod-liver ,, ...	Sterling ,,	Olive ,,	
Pentane			

Though this classification is convenient, there is no sharp demarcation between the two classes above. Only those liquids are placed in the second class for which it would be absurd to suppose the departure from a straight line could be due to experimental errors.

In the cases of castor oil, olive oil and paraffin there appears to be a distinct and similar variation in potential gradient for discharge distances between 1μ and 2μ (see Fig. 4). The air curve is given for reference.

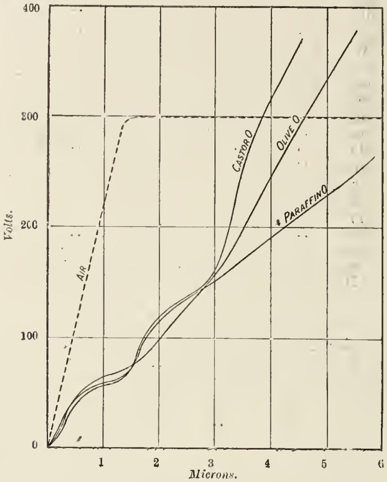


Fig. 4.

Hobbs (*loc. cit.*) has shown that potential gradient near the origin depends on the metal of which the electrodes are made, every metal having a different gradient from every other.

The electrodes used throughout these researches are iridio-platinum. The gradient for this alloy is steeper (220 volts per micron) than any found by Hobbs, though he found platinum to have a high gradient (160 volts per micron).

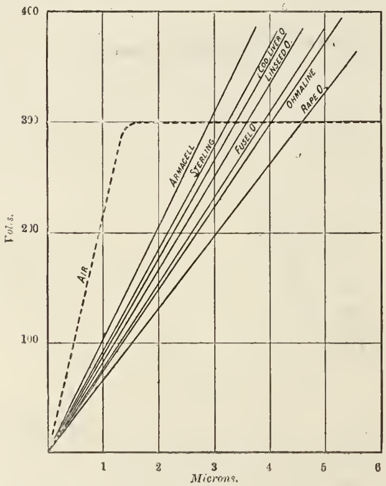


Fig. 5.

The "knee" occurs at 300 volts, the horizontal part extending to 8μ—*i.e.*, well to the right of the plotting shown. After 8μ the gradient is very small. Air has greater strength than any liquid for small distances; but the liquid curve in all cases crosses the air curve for discharge lengths varying between $2\frac{1}{2}\mu$ and 6μ. That is, for any great distances the liquids have much greater strength than air.

The order of strength for the higher voltages used is roughly: Hexane, heptane, armacell, pentane, octane, Sterling varnish, cod-liver oil, linseed oil, fusel oil, ohmaline, castor oil, turpentine, olive oil, rape oil. Paraffin and transformer oil are both weak. Resin oil gave very irregular results, not showing, as might be expected, great strength.

Notes and Precautions.

1. The voltmeter was carefully standardised.

2. The loud-speaking telephone in the discharge circuit was shunted with non-inductive resistance of a few ohms. Some experimenters in previous researches have kept the discharge surfaces shunted with a voltmeter, so that the discharge is shown by the fall of the voltmeter pointer. This seems faulty; for when discharge commences it will be at once violently retarded by an inductive rush from the voltmeter. In the present work the shunted telephone of low resistance indicates discharge, the voltmeter being then cut out and no inductive resistance left in circuit.

3. The members of the homologous series are very volatile; the method employed is to cause drops of them to fall slowly on the discharge surfaces, a fresh drop arriving before the last has evaporated.

4. The discharge is of the nature of a volcanic eruption, the cathode loses material and a distinct pit or crater forms there, while fine dust is scattered on both electrodes. The surfaces approach, but do not always meet on discharge. To avoid dust the surfaces are wiped after each discharge.

5. The discharge surfaces should be treated with care whilst the zero is being obtained. "Make" and "break" should be made as little as possible, and the zero should not be much overrun. The highly-polished surfaces, even of the very hard iridio-platinum, are easily damaged for discharge work.

6. If a contact is "wheezy," it is rejected at once; this indicates bad polish, and always produces electrolysis or premature discharge.

7. The contact sound is invariably clearer and sharper for liquids than for air, and discharge is more definite. Air discharge often occurs partially—*i.e.*, there is a rush of material from the cathode and the contacts approach one another, but do not touch. Discharge does not continue; in fact, this partial discharge seems to retain the tension and for a time stop the complete and final breakdown.

Theory.

Very short spark lengths in gases have now been studied by Earhart, Shaw, Kinsley and Hobbs. The accumulated results of these, and the present experiments on short spark lengths in liquids, should lead inductively to a theory of the conditions of matter at and between the discharge surfaces. Recently T. Schwedoff (*Ann. d. Physik*, pp. 918-934, April 1906) has propounded a ballistic theory of the spark discharge. The fundamental principle he uses is that the discharge between the surfaces is due to the shattering of the molecules of the gas into free ions; this occurs when the electric strength between the electrodes jointly with the kinetic energy of the ions already existing free, reaches sufficient magnitude. He uses the ballistic law of resistance, in which the frictional force opposing the passage of an ion depends on its speed and on the density of the gas. An expression is finally derived

$$v=\frac{300h_0 . 10^{-4} . l}{1+\frac{c}{\lambda}\left(1-e^{\frac{l\delta}{c}}\right)},$$

where v = P.D. on the surfaces, l = spark length, δ = density of the gas, h_0, c, λ are constants.

The values of these constants are derived from consideration of the experimental results of Earhart and Shaw. Putting in the constants and the density of the gas, the P.D. required for any given spark length is derived. Schwedoff thus obtains a curve which fairly closely follows that of Earhart, having a knee in the curve at voltage about 350.

At first sight the similarity between Earhart's experimental curve and Schwedoff's theoretical curve appears to be a striking confirmation of the theory; but careful comparison shows that the two curves are far from coincident near the "knee," one set at this important point being only 50 per cent. of the other set. Again, since Earhart's values are used to give the constants in the formula, there is, naturally, a certain degree of coincidence. But this is not all: the most recent results by Hobbs (*loc. cit.*) are opposed to Schwedoff's theory in each of the following particulars:—

1. The critical potential gradients for different gases are identical below the knee.

2. The critical potential gradients vary very greatly according to the metal used in the electrodes.

3. Although Earhart did not take note of the fact, his results indicate a short horizontal portion to the curve, the potential gradient there being nil. Hobbs has thoroughly established the horizontal portion for every gas and for every kind of electrode.

As Hobbs points out, his results, in conjunction with the previous work of Peace (*Proc.* Roy. Soc., p. 99, 1892), Strutt (*Phil. Trans.* p. 377, 1900), Carr (*Proc.* Roy. Soc. p. 374, 1903), which showed in every case minimum spark potential in a gas (unless the voltage is very small), seem to indicate that at atmospheric pressure the carriers of the discharge are the ions of the gas for distances greater than 6μ; while they are the ions of the metals of the electrodes for distances less than $2\frac{1}{2}\mu$; for distances between $2\frac{1}{2}\mu$ and 6μ the P.D. for discharge remains constant, and discharge occurs not at the extreme points of the opposing surfaces, but between points at the distance corresponding to the minimum sparking potential—*i.e.*, about 350 volts in air.

J. J. Thomson had previously suggested ("Conduction of Electricity through Gases," p. 386, Camb. Univ. Press) that the metal corpuscles might play a part in these effects. A corpuscle about to leave the electrode feels an electrostatic attraction towards the electrode; if the electric intensity between the electrodes exceeds this, the corpuscle escapes. This critical field works out, from the principle of electric images, to be 8×10^3, which is the order of field in Earhart's experiments. Thus Thomson accounts for the fact that the first part of the curve is straight. This theory, however, may need some modification or amplification in view of the fact, mentioned above, discovered by Hobbs that each metal has its own gradient. Hobbs' curves indicate that great gradient goes with great atomic weight—*i.e.*, the heavy metals lose their corpuscles with greatest reluctance.

RESULTS.

1. The insulating liquids do not differ very much from one another in power of resisting discharge, the strength lying between the limits 110 volts per micron and 70 volts per micron, though some liquids seem to have slightly less strength. The range of voltage here spoken of is between 25 and 400.
2. Some liquids have a peculiar variation in potential gradient for distances between 1μ and 2μ. Castor oil, olive oil and paraffin are cases in point.
3. All insulating liquids have greater strength than air for P.D. greater than 300 volts; for less P.D. liquids have much less strength than air.
4. The results for a homologous series of hydrocarbons do not indicate any simple connection between composition and power of resisting discharge; the differences found are as likely to be due to accidental impurities as to specific qualities of the liquids. But these simple substances have specially great dielectric strength. It may be that simplicity of composition makes for strength.
5. Whereas in the case of gases there is always a horizontal portion in the curve, in liquids there is no such distinct break in the curve between 25 and 400 volts, unless the region at about 60 volts in castor oil, olive oil and paraffin is of this nature.
6. No simple connection can be observed between power of resisting discharge and specific inductive capacity, in liquids.
7. The temperature throughout was from 15°C. to 18°C.

LEGAL INTELLIGENCE.

Hastings Tramways Co. v. Hastings and St. Leonards Gas Co. and Another.

This case came before Mr. Justice Bargrave Deane on Wednesday, on a motion to restrain defendants from proceeding with an arbitration.

Mr. ROSKILL, K.C., said that the plaintiffs' tramways were laid under the Hastings Tramways Extension Act, 1903. The Tramways Act of 1870 was incorporated in that act, and secs. 26 to 30 were the material sections. Under sec. 26 the promoters were bound to give to the road authority (the Town Council) at least seven days' notice before beginning work, and the work had to be done under the superintendence of the road authority. Under sec. 27 the promoters, when they had broken up any portion of the road, were under a penalty to put it right again within four weeks. The undertakers had to give seven days' notice to the road authority before they broke the soil, and unless the road authority consented to give an extension of time the Tramway Co. were under a penalty to have the whole thing replaced within one month. Sec. 30 enabled the company to alter the position of the gas mains, subject to giving seven days' notice to the Gas Co. and delivering a plan and section of the proposed work. That had been done. If it should appear to the Gas Co. that the construction of the tramways would endanger their main they could give notice to the Tramway Co. to alter the position of the mains and pipes, and any dispute or difference should be settled by arbitration in the manner appointed by sec. 33. Sec. 32 reserved to the Gas Co. their existing rights to open up roads. On June 1 the Tramway Co. gave the Gas Co. notice that the plans and sections rendered necessary were deposited. The Tramway Co. heard nothing from the Gas Co. until June 26, long after the seven days had expired. The promotors were under statutory obligation to restore the road for traffic within four weeks of the notice given to the Corporation and failure to do so rendered them liable to a penalty of £5 a day. It followed under the circumstances that there was an absolute obligation on the Gas Co. to serve the promoters with what he might call a counter notice requiring them to alter the position of the mains or pipes, and failure to do so within seven days put an end to their right to arbitration. They must then either alter the mains themselves or pursue the other remedies under the Gas Works Clauses Act at their own expense.

Mr. BRAMWELL DAVIS, K.C., for the Gas Co., contended that the Court had no jurisdiction to grant any interlocutory injunction, and

His LORDSHIP said he did not think it was a case in which he should make any order in the vacation.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The trustees of the Victoria Jubilee Technical Institute, Bombay, invite applications for the position of head of the department of physics and electrical engineering. Preference will be given to candidate with experience in works and in actual technical teaching in physics and electrical technology. Salary 600 rupees, rising to 800 rupees, per month. Applications to Prof. W. E. Ayrton, F.R.S., 41, Norfolk-square, London, W. See also an advertisement.

Bombay Electric Supply & Tramways Co., 30, Norfolk-street, London, W.C., require a car-shed superintendent; must be experienced in the repair and maintenance of rolling stock and be a qualified mechanic. Commencing salary £350, with three years' agreement. See an advertisement.

A thoroughly competent chief engineer, well up in rapid production and designing of d.-c. single-phase and polyphase machinery, is required for engineering works. See advertisement.

A superintendent of telephones and foreman of electric light service is required for Dominica, West Indies. Salary £240 per annum, with free passage out and home. Engagement for three years. Applications to the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Oct. 8.

Baker Street & Waterloo Railway Co. require a local superintendent for engineering and traffic operations. Applications to the secretary, Hamilton House, Victoria Embankment, London, E.C.

Mr. J. G. Griffin is vacating the position he has held for the last four years as borough electrical engineer and manager of the Corporation tramways at Swindon, and will proceed to India shortly to take up the post of resident engineer and manager to the Delhi Electric Tramways & Lighting Co. He will commence his duties at Delhi, as he did at Swindon, by superintending the equipment of the power station and the construction of the tramways.

Mr. T. W. Ellis, Swansea representative of Marples, Leach & Co., has been appointed, out of about 200 applicants, engineer and manager of Woolwich Borough Council electricity works.

The Council of the University College of North Wales, Bangor, have appointed Mr. W. E. Williams, B.Sc., late fellow of the University of Wales and recently private assistant to Prof. Rontgen, of the University of Munich, to the position of assistant lecturer in electrical engineering.

M. Th. Collmann has been appointed Director-General ad interim of Siamese Posts and Telegraphs in place of Phra Sakdissenie, who has been transferred to another administrative department of the Government.

Ilford Council have appointed Mr. W. E. Claret as shift engineer at £2. 5s. per week.

Halifax Tramways committee have promoted Mr. W. Drinkwater from inspector to tramway traffic superintendent.

Mr. W. Peyton has been appointed assistant electrical engineer at Bexley.

Mr. J. Nicol, B.A., B.Sc., and Mr. W. Wilson, Ph.D., have been appointed assistant lecturers in physics at King's College, London.

Mr. H. Brown, mains inspector at Walthamstow, has been appointed canvasser to the electricity department for six months on trial.

EDUCATIONAL NOTICES.

Merchant Venturers' Technical College, Bristol.—There are courses for electrical, civil, mechanical and mining engineers, chemists, architects and builders. The instruction includes preparation for the matriculation, B.Sc., and D.Sc. degrees (including engineering) of the University of London. Calendars (6d.) or short prospectus (free) from the Registrar.

King's College, London.—The 1906-7 session commenced on Wednesday last. In addition to the ordinary day courses in engineering and applied science, there are evening classes in electrical and mechanical engineering, architecture and building construction, drawing, mathematics, physics and all science subjects. Courses of instruction are arranged (in connection with the evening classes at the college) for the intermediate and final examinations for the B.A. and the B.Sc. degrees of the University of London. There are also classes in engineering and architectural subjects. Full information and prospectuses from the Dean (Mr. R. W. K. Edwards), or the Secretary.

Armstrong College, Newcastle-on-Tyne.—The 1906-7 session opened on Oct. 2. Particulars can be obtained of the secretary (Mr. F. H. Pruen) of curricula for University degrees and college diplomas in engineering, electrical engineering, naval architecture, mining, metallurgy, pure science, &c., as well as of fellowships, scholarships and exhibitions, facilities for residence, &c.

Finsbury Technical College.—The session for the evening departments in electrical and mechanical engineering, chemistry and applied art began on Oct. 1. Programmes containing particulars of courses of instruction may be obtained from the Registrar at the College, Leonard-street, Finsbury, E.C.

An introductory course of six lectures on the Calculus for Engineers is being given by Prof. Coker. These courses will serve as an introduction to the advanced course of lectures and laboratory work on steam and other heat engines, and will occupy the remainder of the session. The first lecture was given on Tuesday evening last.

City and Guilds of London Institute.—The 26th annual report of the Council (for 1905) has been issued and contains a great deal of interesting information concerning the technical colleges at Exhibition-road and Finsbury.

In September, 1905, there were 203 candidates for the matriculation or entrance examination at the Central Technical College (against 203 and 175 in 1904 and 1903 respectively), and 135 students were admitted (against 131 in the previous year). There were 372 students in the winter term taking diploma and special courses and 59 students from the Royal College of Science and School of Mines, making a total of 431 against 415 during the previous session. The fees are to be increased from £30 to £36 a session after the end of the present session. At the close of the 1905 session 48 students were awarded the diploma of associate of the Institute. The Siemens Memorial medal for the student of greatest merit in electrical engineering was awarded to W. H. Grinsted. The number of University students attending the college continues to increase, over 140 being in attendance during the 1905-6 session. The Old Students' Association has now over 500 members.

The new wing of the Finsbury Technical College has been completed, and part of it was in occupation at the date of the report. There were 214 day students against 206 and 210 in each of the two previous years. The evening department of the college was attended by 414 students, against 509 in the preceding session, the number of class entries being 521 against 619. The fees charged to day students have been increased from £15 to £20 per session.

The reports of the Central (Exhibition-road) and Finsbury Technical Colleges are printed separately as appendices to the report.

The number of technological subjects in which examinations were held by the institute in 1905 was 69, being the largest on record. The number of students in attendance at classes registered by the Education department increased to 41,618, the number of examinations to 19,782, and of passes to 11,838. The students registered in the 1906 session show an increase of 2,850. The number of candidates for examination show considerable increases in electrical engineering (from 1,984 to 2,070) and in mechanical engineering (from 1,129 to 1,250).

General Engineering College.—At this college individual coaching is given in engineering subjects, especially in preparation for the technical schools and London University examinations. Particulars from the principal, Mr. J. H. Reeves, M.A., 2, Penywern-road, Earl's Court, London, S.W.

Arc Works Extension.—Last week Chelmsford Council passed Messrs. Crompton & Co.'s plans for additions to the company's arc works, Chelmsford.

Aston.—An agreement between the Town Council and Erdington District Council for supply of electricity in the latter district is being prepared.

Barking.—The electrical engineer (Mr. Henley Howard) is organising an exhibition of electric motors, fittings, &c., which will be held at the public baths on Oct. 18, 19 and 20.

The Electricity and Tramways committee have authorised Mr. Howard to supply electricity in bulk to owners of groups of not less than 12 houses at 3d. per unit.

The chairman of the committee (Mr. Crow) said it was well known to the Council that the engineer was doing all he possibly could to push and extend the use of electricity, and although it seemed impossible to supply electricity to a small cottage, yet it did seem possible if they grouped the houses into about a dozen and the landlord supplied one meter, through which the Council supplied the power, and he, in his turn, distributed the current among the group of tenants. They thought that 3d. per unit would be a fair price where other private consumers were paying 4d.

Bath.—By agreement the assessment of the electricity works has been fixed at £1,500.

Belgium.—In a report upon the trade of Belgium for 1905 and the first half of 1906, Consul-General Sir Cecil Hertslet sets out a list of articles of British production which he considers would be likely to find a ready sale in Belgium. These include electric batteries, electric cables, electric measuring instruments, steel tubing for electric wiring, gas engines, and machinery of all kinds. The duty upon these goods is as under: Electric batteries 10 per cent. ad val., cables 12 per cent. ad val. or 12frs. per 100 kilos., measuring instruments free, tubing 1fr. per 100 kilos. for single tubes, or 4frs. per 100 kilos for divided tubes, and gas engines 4frs., per 100 kilos.

The report states that many of the coal mines in the Borinage district of Belgium are putting in electrical machinery for power purposes, including hauling, pumping, &c., as well as for lighting.

On the general subject of tendering for Belgian requirements, the report emphasises the abolute impartiality of the Belgian authorities in awarding public contracts to firms of any nationality provided the tender for the work or construction is sufficiently low to favourably compare with the offers of Belgian firms. Sir Cecil Hertslet comments upon the fact that upon only one occasion has it come to his knowledge that a British firm has competed for a Belgian contract. He ascribes this condition of affairs to the heavy import duties on finished manufactured goods and to the difficulty in obtaining labour to carry out contracts awarded to foreign firms, and points out how these disabilities can be partially or wholly overcome.

Birmingham.—The opening of the Summer-lane electricity works will take place on the 10th inst. and the station will be opened for public inspection on 13th, 15th, 16th and 17th inst. between 2 p.m. and 10 p.m.

A part of the works will be utilised for the exhibition of motors and electrical apparatus to give visitors ocular demonstration of the use of electrical energy for lighting, power, heating and medical purposes. A working exhibit will show the process of manufacture of incandescent electric lamps and the latest types of arc, incandescent and mercury vapour lamps will be exhibited.

The electricity supply department are endeavouring to create an extended demand for electricity for power and domestic purposes, and with this object in view a scheme has been adopted for letting out motors, &c., on hire.

Bournemouth.—Once again the ratepayers have rejected a proposal to run tramcars on Sunday. This time the voting was 2,703 for and 3,606 against.

Bray (Ireland).—The Bray electricity works are probably the oldest in Ireland, having been originally started by J. E. H. Gordon & Co. in 1891. The Council purchased the undertaking in 1896. It has recently been found necessary to carry out various extensions and renewals to bring the works up to date. Considerable additions to the generating plant and distribution system were carried out in 1894. The arc lamps in use for street lighting were until recently of the first Brockie-Pell type, manufactured by Johnson & Phillips, and fitted in lanterns similar to those erected in the City of London in 1891. These lamps, which had been in continuous use for 15 years, have now been replaced by Gilbert lamps. Swan neck brackets have been fitted to existing pillars in the principal thoroughfares and handsome carriers along the sea front. The new arc lamps were supplied by the Gilbert Arc Lamp Co., and are of their double-carbon type, burning 30 in series on an alternating 60 ∿ circuit. The work has been carried out to the specification and under the supervision of Mr. W J. U. Sowter, electrical engineer to the Council.

Bridlington.—For extra work in connection with the wiring of the Pavilion, café and shops on the Prince's-parade, the Council have made a grant of £20 to the electrical engineer (Mr. Beckett) and £10 to his assistant (Mr. Mott).

Brighouse.—A reduced scale of charges for electricity for lighting and power is to be introduced by the Council.

Brighton.—In future all electric lamps required for use at the Pavilion are to be obtained from the Corporation electricity department.

Cheltenham.—The borough electrical engineer (Mr. W. J. Bache) has been permitted to take an articled pupil at the electricity works, a condition being that half the premium is paid over to the Corporation.

Dudley.—Application has been made for sanction to a further loan of £3,000 for supply of distributor cables and for the laying of same by the Council's staff.

Edinburgh.—The city electrical engineer (Mr. F. A. Newington) reported to the electric lighting committee on Tuesday on a statement recently made in the course of debate in the Council that two alternating current machines, which had cost £7,000 each, were out of date and worthless.

Mr. Newington stated that he had not the least idea what the machinery in question was. They had not got any alternators worth £7,000 each. Two steam-driven alternators were put down at Dewar-place station in 1898 at a cost of £7,510 for the pair. Those machines had been in everyday use and they were as useful and fit for work to-day as when they were purchased. There was no alternating current machinery in the stations which was not in use, except the rectifiers. Those were discontinued at the end of 1899, but the Council (in January, 1903) authorised that machinery to be sold and that the balance of the original cost still unpaid should be paid out of that year's revenue. That sum, amounting to about £2,000, was repaid, so that the item had entirely disappeared from the capital account.

Motions by Treasurer Brown as to a reduction in the period of paying off capital sums borrowed for the electric light undertaking, and as to the apportionment between the capital and revenue accounts, have been remitted to a sub-committee for report.

Egypt.—Mr. C. M. Pepper, the U.S. special agent at Alexandria, has sent to the Department of Commerce and Labour (Washington) a report on trade conditions in Egypt, in which he states that the prospect for electric installations is a fair one, for though the Arab villages do not take to electric lighting with so much avidity as many other primitive communities, in the large towns electric railways are being extended, and telephone and telegraph lines are likely to be materially increased. Mr. Pepper suggests the advisability of establishing a permanent American exposition in Egypt for making American goods known. Machinery (and particularly agricultural machinery) should be the principal feature of such a display.

Electricity in Mining.—At the meeting of El Oro Mining & Railway Co. on Monday, Mr. R. T. Bayliss said the replacement of steam by electric power at the mines was commenced in February, and had now been applied throughout the company's property, except in the case of one or two pumps underground. Nothing could have been more satisfactory than the operation of the electric plant. It had resulted in a considerable saving in the cost of power heretofore incurred, and the fact of its having worked without any hitch or delay from the commencement reflected the greatest credit on the Mexican Light & Power Co., who supplied current, and upon those responsible for the installation of the plant and apparatus.

Erdington.—On Wednesday the Tramways and Electric Lighting committee reported to the Council that they had approved agreements between Aston Manor Corporation and the Council for the supply of electrical energy for tramway traction, and also for lighting in the district of Erdington, and the seal of the Council was ordered to be affixed to the agreements.

Exeter.—The work of laying electric light cables to Heavitree is about to be commenced.

Exhibition.—An electrical exhibition, organised by Hornsey (London) electricity department, was opened on Tuesday. There is a good display of motors, electric light fittings, &c.

Among the exhibitors are the Dowsing Radiant Heat Co., who display electric radiators, &c.; Harry W. Cox (Ltd.), who have X-ray apparatus on view; J. W. Carpenter (Ltd.), who show fans, bells and lamps; Hill & May, fittings. The Western Electric Co. exhibit fans, irons, turn-down lamps, and a Singer treadle sewing machine driven by an electric motor; Ellwood & Sledmere have an artistic display of oak and Chippendale fittings, and W. R. Webb has an exhibit of telephones, bells and lamps. J. A. Ritchie displays chandeliers and radiators, and F. C. Chase & Co. have beaded lights. E. Wight & Co. exhibit table lamps in brass and copper and standard and hall lamps, and an electric kettle. H. Southey & Co. show table and standard lamps, mantelpiece lamps, wall brackets and hanging lights. The chief exhibit of this firm is a complete installation for a six-roomed house for £5.

Hackney (London).—The Council have accepted the tenders for arc lamps, &c., recommended by the Electric Lighting committee and set out in our last issue (p. 947). The consulting engineers for the work are Messrs. Robert Hammond & Son.

Hanley.—At the meeting of the Council last week the question of street lighting was discussed.

The Electric Lighting committee reported that they had considered the steps to be taken to improve the electric street lighting and reduce the cost. A reduction had been made in the last 18 months in the price of electric current charged for private lighting and power. It was not correct to say that more efficient lighting could be obtained by gas than by any system of electricity supply, and as the supply of electricity increased and as economies were effected by the introduction of new plant, &c., the electric light could be increased in extent, and be supplied without loss at a considerable reduction upon the present cost. The cost depended to a large extent upon the number of lamps supplied and upon the cost of the mains, and many streets were at present provided with mains which were not fully utilised. The addition of a number of public lamps in streets already provided with mains would be of great advantage to a street lighting. The committee recommended (1) that the lighting of streets in which electric mains had been laid be carried out by electricity, and that no extra charge be made for the increased number of such lamps beyond the sum already received by the electricity department until the average price per post fell to £2. 13s. 4d., which price is charged by the Gas Company for a 5 cubic ft. batwing burner; and (2) that the Works committee be recommended to double the number of lamps in certain main thoroughfares, in which case the committee would light and maintain them without increasing the charge made for lighting those streets.

The chairman of the committee (Ald. Coates) said they were anxious to light by electricity as many of the streets as possible, and therefore suggested that lamps should be put wherever mains were laid. The committee were anxious, too, that tradesmen should use more arc lamps, and had made a quotation of £5 per lamp per annum, whatever the consumption of the lamp might be.

Considerable discussion arose on the report, and an amendment that a report be prepared by the committee on the relative cost and efficiency of the lighting by electricity and gas was moved.

The borough electrical engineer (Mr. C. H. Yeaman) was called upon to state his views, and said that when he came to Hanley he was surprised at the condition of the side street electric lighting. There had been improvement, however, and he suggested that they could go on giving increased light until they got as good a light, and later on a better light than they could obtain in any other way. The town owned its own works, and could afford to produce electricity for long hour consumption at the price at which people were supplied with current for power, 1d. per unit. They had spent their capital and could never get it back. Every improvement they made would reduce the cost of their light, and every increase of light would have the dual effect of increasing the consumption of electricity, while reducing the cost per unit. The reduction of the total consumption by changing the street lighting would in no wise assist the undertaking in keeping down its capital. There were in view some 200 additional kw. of power, which would probably be connected to the mains before the end of the current year, and new plant was required whether the street lighting was continued or not. The street lighting could eventually be done for practically nothing when one had a big undertaking. As to the instances of electricity being supplanted by gas which had been cited, anyone having, as he had had, 10 years' experience in London would know that the lighting discarded was lighting put up some 10 or 14 years ago, and which had remained unaltered since. In Hanley they were in the same condition to-day. The arc lamps in Piccadilly, Hanley, had been erected for years; they were not of the latest pattern, like the arc lamps at the Grand, the Theatre Royal and the Sewage Works. He hoped they would be able to have a flame arc lamp on Crown Bank shortly. The changes going on in London in places were dual, and in some places where the street lighting had not been improved naturally they went over to gas for a time. There was a sort of see-saw. The pendulum was going towards gas lighting at present, but it would surely swing back when flame lamps were more generally introduced. The other day he made a tour of Burslem and Stoke, and he could not see that the lighting there by incandescent gas was any better than the light Hanley could give. If an undertaking was to be run to the best advantage, street lighting, properly done, was the best advertisement it could possibly have. Street lighting could be done more cheaply than any other lighting, because of the long period for which the light was required. The trouble with electricity was the capital charges involved. The capital cost of mains, &c., was the same whether the lamps were run for 600 hours a year or for 4,000 hours.

Eventually the Council decided to add the words "in such cases as the Works committee so decide" to one of the resolutions, which made the carrying out of the work of a permissive character, and, as thus amended, the recommendations were carried.

Hull.—At the meeting of the Electric Lighting committee last week the city electrical engineer (Mr. H. Bell) reported on the breakdown which occurred on Sept. 1, at 7:25 p.m., at Sculcoates-lane generating station, causing an extinction of light in a large portion of the city. Mr. Bell did not see how it could have been avoided by any other means than those at present being adopted, the entire substitution of the old board by one of more modern and efficient design.

Ilford.—The electrical engineer (Mr. A. H. Shaw) and the surveyor (Mr. H Shaw) have been asked to present an estimate of the cost of extending the tramways.

Japan.—According to a report just issued on the trade of the district of Kobe by Mr. Consul Bonar, there has been talk of establishing electric tramways in the city to districts radiating to the west of it. Notwithstanding that the Osaka-Kobe tramway (or railway) has proved an immense success, the projects for electric lines within the city have not eventuated. Traffic began on the Osaka-Kobe line in April, 1905, and the satisfactory working and excellent traffic return led to a large appreciation of the company's shares, which has been justified by a declaration of a dividend of 8 per cent.

There is now under consideration an extensive scheme to furnish electricity to Osaka and Kioto. The power house is to be established at a village about 28 miles distant from Osaka and about 8 miles from Kioto, where, it is stated, water-power is available to the extent of over 45,000 H.P. Mr. Bonar hopes that British manufacturers and contractors are alive to the developments of electrical enterprise in Japan, in order that they may secure at least a share in these and similar undertakings.

The electrification of the Nankai railway connecting the cities of Osaka and Wakayama is in progress. The company own an inter-urban steam railway 40 miles long, 9½ miles being double track and 30½ miles single track. This line taps a number of popular resorts, and the traffic is increasing along with the completion of the electrification of the service, which is at present limited to the 9½ miles of double track. The company's generating station is situated at Sumiyoshi, some distance outside the city of Osaka.

Another extensive scheme of electric tramways has been considered and decided upon by the Osaka City authorities, who intend to spend £2,000,000 (22,000,000 yen) on a complete electric tramway service for the city and district.

A project for an electric railway between Osaka and Kioto is also contemplated, the capital being £200,000. The line will run through a fairly populous district not at present provided with railway facilities.

It is considered that the concessions recently granted to private enterprise for the construction of electric railways and tramways will be the last of such concessions, as the Japanese State Railway Department and the municipalities of the various cities are disposed to retain this branch of industrial enterprise in their own hands.

Labour Dispute at Loughborough.—At a meeting on Tuesday last at the Brush Co.'s works the managing director (Mr. W. L.

Madgen) stated that the Company had gone as far as they dared to meet the men's wishes without further prejudicing their home trade and crippling their foreign trade. Mr. Kinggate, president of the U.K. Society of Coachbuilders, said there was no question as to the men giving way. They intended to stand out until reasonable terms were granted.

Light Railways.—Cleckheaton Council on Tuesday considered a letter from the Yorkshire (Woollen District) Electric Tramways stating that the company would construct a tramway from Moorend (Cleckheaton) to Scholes, on a sleeper track at the side of the road, provided they obtained a lease for 42 years, and that the Council would not oppose their application for leave to abandon the completion of the projected line from Cleckheaton to Hightown, via Hartshead Moor. The Council have, however, decided not to entertain any other scheme until this latter line has been constructed.

London County Council Tramways.—The City Corporation have asked the County Council to contribute towards the cost of widening Bishopsgate-street, and the County Council have taken the opportunity to make a counter request for permission to bring their electric tramways into the City portion of Bishopsgate-street.

Lambeth Council have voted £3,433 towards the cost of widening Wandsworth-road preparatory to conversion of the L.C.C. tramways to electric traction and the doubling of the line. A request from the L.C.C. for a contribution of £10,000 for similar work in connection with the proposed extension of the Norwood line to the Crystal Palace was referred to committee.

London United Tramways.—The tramway deadlock in Wimbledon has ended, as the London United Tramways (1901), Ltd., have announced their intention to start the construction of the lines through Wimbledon to Tooting on Monday next. In April the company completed the extension from Malden to Raynes Park, and in July the section from Raynes Park to Wimbledon was also finished. Wimbledon Corporation, however, would not consent to the opening of the Raynes Park to Wimbledon section until the company gave an undertaking to proceed with the remaining section, linking up with the L.C.C. tramway system at Tooting.

Manchester.—On Wednesday the Corporation considered a recommendation of the Electricity committee to apply for sanction to a further loan of £64,000, mainly to carry out extensions of the generating plant, and also for motors and meters. The recommendation was adopted.

The proposed restricted scheme of parcel carrying in connection with the electric tramways, as mentioned in our last issue, was also adopted on Wednesday.

The Tramways committee recommended that, inasmuch as the present statutory powers of the Corporation were not sufficiently wide to enable the department to successfully carry on the parcel-carrying business, immediate steps be taken to confine the operations to the tramway area, so as to prevent a continuance of the loss which was at present being sustained.

Ald. Wainwright referred to the suggestion that the committee should get wider powers and become common carriers, but it was felt that in the present circumstances the ratepayers would not sanction the step, and that to employ further capital in the undertaking would lead to further loss. The committee had made up their minds to dispose immediately of the most expensive part of the parcels systems—the horses and vans. That, they considered, would do away with the loss almost immediately. The committee would establish small central receiving offices, where parcels could be taken by the public, stamped and handed to the first passing car, and at the tram office a messenger would take the parcel from the car to its destination. By that means he felt convinced that they would be able to deliver parcels as quickly, almost, as telegrams were delivered. The scheme, of course, would apply only to the Manchester tramway system, but the committee thought they would be able to arrange to carry through parcels, as well as passengers, to the Salford system. The scheme, he felt certain, could be worked profitably.

Mr. Hibbert moved an amendment in favour of discontinuing the entire parcel-carrying business, but, after a long discussion the committee's proposals were approved.

Menai Bridge.—The Council have approved the scheme of the Mona Electric Lighting Co. for the supply of electricity in this district. The company, which will apply for a provisional order in due course, proposes to erect a generating station at Pwllfenog.

Newcastle on-Tyne.—The Tramways committee on Tuesday decided to recommend the Council to include in any bill promoted by them provisions for carrying out two of the tramway extensions recently suggested by the tramways manager (Mr. E. Hatton), at a cost of £30,600. It was also decided to recommend the Council to proceed with another extension at once.

Newport (Dundee).—A special meeting of the Council is to consider a communication from Tayside Electric & Gas Light Co., Wormit, for permission to erect overhead wires for supplying electricity in Newport and Tayport.

Pembroke (Co. Dublin.)—The Council are recommended to extend the hours at which the lower rate of charge is made for electricity for power.

Plymouth.—Ald. Radford, chairman of the Electricity and Street Lighting committee, recently invited members of the council and other prominent townsmen to inspect the new coal-conveying apparatus installed at the electricity works by Babcock & Wilcox (Ltd.). The borough electrical engineer, Mr. E. G. Okell, conducted the party over the building and explained the operation of the plant. After the inspection Ald. Radford, who entertained the visitors at lunch, gave a sketch of the progress of the Corporation's electricity undertaking.

Poplar (London).—The Electricity committee report that during the five months ended Aug 31 the output of the electricity works was 1,269,922 units, an increase of 352,095 units over the corresponding period of 1905.

The system of manufacturing disinfectant by electrolysis of salt water is reported by the Public Health committee to be successfully established on a permanent basis.

Projected Electrical Legislation for London.—It is proposed to hold a conference of the owners of existing electrical undertakings in London with a view of considering the policy to be adopted next session. West Ham Corporation have appointed the chairman of the Electric Lighting committee (Councillor Littler) and the borough electrical engineer (Mr. A. Hugh Seabrook) to represent them.

Rotherham.—The charge for electric current for lighting has been fixed at 4d. per unit from Dec. 31, with a discount of 2½ per cent. for payment within one month.

The agreement between the Council and the Mexbro' and Swinton Tramways Co. with regard to through traffic between Rotherham and Rawmarsh has been completed.

Salford.—An alternative system of charging for electric current used for power (£1 per quarter per B.H.P demanded, and ⅓d. per unit) will be introduced on Jan 1.

Shoreditch (London).—A loan of £23,555 is to be taken up by the Council for electric lighting—viz., £20,689 for plant and mains (to be repaid in 42 years), and the balance, for meters, in 10 years.

South Lancashire Tramways.—The opening of the Worsley and Walkden tramway on Friday will enable passengers to travel by tramcar from Deansgate, Manchester, to the Pier Head at Liverpool. The journey can be accomplished in about five hours. The route is by way of Deansgate, Swinton, Walkden, Moses Gate, Great Moor-street, Bolton, Four Lane Ends, Bolton, Atherton, Hindley, Haydock, St. Helens; thence via Eccleston, Prescot, Huyton and Roby to Knotty Ash, where a car can be obtained to complete the journey to the Pier Head. The charges made on the various sections brings the total cost of the journey to about 2s. 6d.

South Shields.—The remaining section of the muncipal tramways was officially inspected and opened for traffic on Friday.

Stockton.—The Council have referred to a committee a letter from the Cleveland & Durham County Electric Power Co. asking the Council to consider the general question of the supply of electric energy for power within the borough by the company.

Stoke Newington (London).—Mr. Alderman W. H. Savery, J.P., will lecture on "Electricity: How Made and Stored" in the Library Hall, Edwards-lane, Church-street, to-morrow (Saturday) at 8 p.m.

Sutton Coldfield.—It was reported on Wednesday that there are now 437 consumers of the electricity department.

The chairman of the Electric Lighting committee (Ald. Seal), in moving the adoption of the committee's minutes, said that at an early date he would have to ask the Council to give the committee power to undertake the free wiring of houses, as Birmingham Corporation were laying in the gas services in every possible house they could in Sutton Coldfield free.

Walthamstow.—From Dec. 31 the following reduced charges for current for lighting and power will come into effect:—

Lighting.—1st 750 units 4d. per unit, 2nd 750 units 3½d., subsequent units 3d. *Power.*—Up to 250 units per quarter 2d. per unit, for the next 3,750 units 1½d., for all excess units 1d. Power consumers are to be allowed current for lighting up to 10 per cent. of the units used for power at 2d. per unit.

The question of establishing a showroom for motors and fittings has been referred to a special committee.

The Council have adopted a hire-purchase scheme for supply of arc lamps at £4 per lamp per annum for 500 hours' burning, including maintenance.

Tenders are to be invited for a small water-tube boiler, and the electrical engineer (Mr. G. R. Spurr) has been instructed to purchase a centrifugal pump for the artesian well. A dozen Nernst lamps are to be purchased for testing purposes. Various premises which have been free-wired are to be inspected, and if the fittings are not being used they are to be removed. Mr. Spurr is to report as to the supply of electricity to Highams Park.

Notices have been received by the Council (1) from Brecknell, Munro & Rogers stating that in consequence of the increased market prices they were compelled to increase their prices for the supply of overhead equipment accessories; and (2) from the London Lamp Works increasing their price for the same cause for the supply of arc lamp carbons to 70s. per thousand pairs. It was resolved to pay the increased price in both cases.

West Ham.—The borough electrical engineer and manager of the electricity departmen. (Mr. At H. Seabrook) and his staff are doing their utmost to convince the ratepayers of the great advantages of electricity for lighting and power. As already announced, offices have been opened at 84, Romford-road, Stratford. Huge posters have been placed throughout the district stating the extremely cheap prices at which electric energy for power and lighting can be obtained. It is also proposed to open a perfectly fitted up show room, at which everything of the latest in the way of motors, fittings, stoves, and heating and lighting apparatus will be exhibited for inspection by intending customers.

It was reported to the Council on Tuesday that the agreement with the Dock Co. for laying cables through their property for supplying current to Silvertown had been arranged.

Wimbledon.—Application is to be made for sanction to borrow £1,000 for 43 arc lamps for street lighting.

York.—During the recent visit of the British Association the Exhibition building was supplied with a temporary electric light installation, and the Electricity committee are of opinion that the installation should be made permanent, not only on the ground of convenience, but also on the grounds of greater safety and cleanliness of the building and its contents.

Electro-Harmonic Society.—The first smoking concert of the season will be held at the Holborn Restaurant (King's Hall) this (Friday) evening, commencing at 8 o'clock.

ELECTRICITY SUPPLY ACCOUNTS.

Ayr.—The accounts of the Corporation tramways department for the year ended May 15 show capital expenditure £79,362, an increase of £824.

Revenue was £15,253. Working expenses were £8,360 (5·39d. per car-mile). Gross profit was £6,892 (4·44d. per car-mile). After meeting capital charges, placing £1,430 to reserve and allowing £2,371 for depreciation, the net profit (£940) has been handed over to the Burgh general fund, &c. 3,551,538 passengers were carried, 372,062 car-miles run and 372,597 units used. Total receipts per car-mile 9·97d.

Cheltenham.—The accounts of the electricity department for the year ended March 31 show capital expenditure £154,075, an increase of £1,808.

The revenue was £23,576 (compared with £21,034), including £3,836 for current for the tramways (at 1·6d. per unit). Working expenses were £10,189 (against £9,730). Gross profit was £13,387 (£11,304), and after meeting capital charges the net profit was £2,573. 2,161,108 units were generated (compared with 1,718,665 in previous year), 623,362 (622,255) supplied to public lamps, 495,261 (477,065) supplied by meter, 7,290 (7,190) by contract and 575,456 (283,081) to tramways. The maximum supply demanded was 1,316 kw. (1,090 kw.), and the load factor was 14·73 (14·39) per cent. There are 865 private consumers (increase 50). Working costs (including fuel, which came to 0·402d., against 0·445d.) were 0·986d. per unit sold (against 1·022d.) and the total costs were 1·276d., against 1·407d.

TELEGRAPH AND TELEPHONE NOTES.

Municipal Telephony.—There is a growing feeling among Hull ratepayers that the Corporation should dispose of their municipal telephone undertaking, and at the meeting of the Council yesterday (Thursday) Councillor Wheatley moved that it be an instruction to the Telephone committee to at once further consider and report upon the recommendation of the committee for the sale of the Corporation telephone undertaking, contained in their proceedings of March 9 last.

We learn (by telegram) that Councillor Wheatley's motion was adjourned.

TRADE NOTES AND NOTICES.

"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

The demand for the first issue of "The Electrician" INDUSTRIAL SUPPLEMENT (published gratis with *The Electrician* for Sept. 14) has necessitated an additional printing. We have now a small further supply of copies available.

In answer to numerous requests for filing cases for the Supplement, the Publisher begs to announce that these are ready. The filing cases are made to hold twelve copies of the Supplement.

TENDERS INVITED.

Manchester Electricity committee invite tenders for supply, delivery and erection at Stuart-street generating station of one 500 kw. turbo-alternator, complete with condensing plant. Specifications, &c., from the chief engineer (Mr. S. L. Pearce), Electricity Works, Dickinson-street, Manchester. Tenders (addressed to the Chairman of the committee) to the Town Hall by 10 a.m. 31st inst. See also an advertisement.

Wigan Corporation invite tenders for the supply and erection of air and circulating pumps with necessary pipework for the condensing plant at their Pemberton electricity station. Specification, &c., from the borough electrical engineer (Mr. Jas. Slevin), Bradford-place, Wigan. Tenders to the town clerk (Mr. Harold Jevons) by Oct. 15. See also an advertisement.

The directors of the *Metropolitan Railway Co.* invite tenders for supply of general stores during the 12 months ended Oct. 31, 1907, including electric lamps, carbons, fuses, ebonite, &c., electric wires and cables, telegraph fittings, battery jars, zinc, insulators, &c. Forms of tender, &c., from the secretary, Mr. R. H. Selbie, 32, Westbourne terrace, London, W. Samples and patterns may be seen at the office of the company's storekeeper, adjoining Neasden station, N.W., up to Oct. 6. Tenders to the Secretary not later than 10 a.m. Oct. 8.

Newport (Mon.) Borough Council invite tenders for supply of the following apparatus for their electricity and tramways department: (1) Three feeder boosters, one balancer, one electrically-driven feed pump and one two-throw pump; and (2) switchboards and instruments. Tenders to the Town Clerk by Oct. 13.

Tenders will be opened at the Italian Royal Arsenals, *Spezia* and *Naples*, at 11 a.m. on 23rd inst. for supply of electric cable and insulated wire to the estimated value of 40,000 lire (£1,600). Conditions of contract may be seen at the Ministry of Marine, Rome, the Royal Arsenals at Spezia and Naples, the Technical offices of the Navy, Genoa, and the principal Chambers of Commerce in Italy. Local representation is necessary. A deposit of 4,000 lire (£160) is required.

TENDERS RECEIVED AND ACCEPTED.

Correction.—We are asked to state that the order recently placed by St. Pancras (London) Council with Bruce Peebles & Co. covers two 500 kw. and one 1,000 kw. *motor converters*, constructed under the Peebles-La Cour patents, and not two 500 and one 1,000 kw. *motors* only, as previously announced.

Walthamstow Council have accepted the following tenders: British Electric Equipment Co., alterations and additions to permanent way of light railways; Chamberlain & Hookham, annual supply of meters; W. T Glover & Co., fireproof cables; and Tudor Accumulator Co., renewal of positive plates of storage battery at the Sanatorium.

Derby Corporation have accepted the tender of the British Thomson-Houston Co. for a Terrill regulator at £63. 7s. 6d. and re-winding four armatures at £55. 10s., and that of the British Electric Transformer Co. for a new transformer at £35 and the old transformer in exchange.

Gloucester Council have accepted the following tenders for 15 months' supplies to the tramways:—

Alger & Blackmore, twist drills, bolts and nuts, screws, &c.; L. Andrews & Co., oil tape, ebonite and red fibre sheet; Callender's Co., cables; Cryselco Limited, lamps; Conway, Jones & Co., paints, oils, &c.; J. L. Duguid & Co., metal polish; Glacier Anti-Friction Metal Co., anti-friction metal; W. T. Henley's Co., para strip; Hadfield's Steel Foundry Co., tyres; Johnson & Phillips, grey dynamo tape, superfine tape, micanite plate; Jones & Son, sulphur and paraffin wax; London Electric Wire Co., press-spahn; T. B. Powell, light car oils; C. D. Phillips, iron, brass and gun-metal castings, brake blocks; Ruberoid Co., P. & B. insulating tape and electrical compound; Clifford Stanley, screws, cotter pins and hack saw blades; H. E. Thorne, washers and nuts.

Charrington, Sells, Dale & Co., whose tender was recently accepted for the supply of coal to Islington electricity department, have struck out of the contract the conditions laid down with regard to the calorific value, and the Lighting committee have now accepted the tender of Blackmore & Co. to supply 2,000 tons of coal at 9s. 3d., the price quoted in Charrington & Co.'s tender.

Stoke-on-Trent Council have accepted the tender of Babcock & Wilcox for a water-tube boiler at £1,330, and that of Callender's Co. for 1,370 yds. of 0·2 sq. in. single vulcanised bitumen cable at £249. 11s. 6d.

West Ham Guardians have accepted the tender of Pryke & Palmer for light electric light wire at £10. 10s. per mile, and receiver cords at 2s. per dozen, and that of Troup, Curtis & Co. for contact hinges at 1s. per dozen.

Johnson & Phillips have received a contract from Dartford Council for supply of feeder, pilot and distributor cable, together with feeder pillar, boxes and fittings.

Aston Electricity committee have accepted the tender of Callender's Co. for supply and laying of tramway cables at Erdington at £5,808. 18s. 6d.

Meldrum Bros. have received an order for Koker stokers, combined with the Meldrum system of air supply, for four Babcock & Wilcox marine boilers at Avonbank electricity works, Bristol.

Dudley Town Council have accepted the tender of Callender's Co. for the supply of distributor cables, but the laying is to be done by the staff at the power station.

Wrexham Council have accepted the tender of the Triplex Electrical Engineering Co. for the supply of electric light fittings for the library.

Wimbledon Council have accepted the tender of G. & J. Weir at £125 for a steam feed pump.

D. Santoni & Co. have secured the contract for the exclusive supply of their flame arc lamps to the Irish International Exhibition.

Bexley Council have accepted the tender of Friday & Ling for the erection of car sheds, of Measures Bros for steel work, and that of C. P. Kinnell & Co. for heating the sheds.

Eccles Council have accepted the tender of W. A. Shaw & Co. for maintaining the electric fire-alarms at £12 a year.

York Electricity committee have accepted the tender of the Pulsometer Engineering Co for water softening and filtering apparatus.

Dudley Tramways committee have accepted the tender of Callender's Co. for distributor cables.

Todmorden Council have accepted the tender of W. T. Glover & Co. for supplying and laying distributor cable at £459.

BUSINESS NOTICES.

The address of the offices, factory and warehouse of the Union Cable Co. (Ltd.) will in future be Eagle Wharf-road, London, N.

The Sloan Electrical Co. (Ltd.) have made a further extension of their premises at 11, Fore-street-avenue, London, E.C.

The River Plate Electricity Co. (Ltd.) is removing to 79, Coleman-street, London, E.C.

Mr. Henry F. Joel has changed his address from 31, Wilson-street, E.C., to 110, Strand, W.C., London, where he will practise as a consulting electrical engineer and specialist on electric motor vehicles. Mr. Joel has had a long and extensive experience, having been associated with the electrical profession and industry from its earliest days. Telegrams: "Bipolarity London," telephone 8372 Gerrard.

Mr. J. D. F. Andrews, who has established himself as a specialist in the interior electrical equipment of buildings at 47, Victoria-street, Westminster, S.W. (telephone 835 Victoria), announces that he has disposed of all his trading and commercial interests. He is one of the oldest specialists in the interior electrical equipment of buildings, and for several years has devoted particular attention to ventilation and other mechanical appointments of buildings, also to the production of greater economy of fuel consumption in steam plant installations.

Johnson & Phillips, Old Charlton, have started a motor van department, and will specialise in the construction of delivery vans suitable for railway and other work. Mr. W. Hemingway, who resigned the position of chief draughtsman of the Daimler Co. in 1902, has joined the firm, and will be responsible for the new design. Contracts have been placed by Johnson & Phillips for extensions of their works as follows: Extensions of the V.I.R. department, Kirk & Randall at £6,000; for a new paper-insulated, lead-covered factory, G. Bollom at £8,500, and the new machine shop, Redpath, Brown & Co. (steelwork only) at £3,200.

Wm. Wharam and Fredk. John Borland, mechanical and electrical engineers, Grove Engineering Works, Claypit-lane, Leeds, have dissolved partnership. Debts by Mr. A. Hutley, 53, Albion-street, Leeds.

Messrs. Moores, Martin & Co are continuing the wholesale electrical supply business as recently carried on by the late firm of Moores, Farrell & Co., Mynshulls House, Victoria-street, Manchester.

BANKRUPTCIES, LIQUIDATIONS, &c.

The first meetings of creditors and shareholders of the Empire Electric Light & Power Co (Ltd.) were held on Tuesday.

Mr. H. E. Burgess, O.R., reported that the company was formed in November, 1902, to promote the Romford electric tramways and other electrical undertakings. Mr. Alfred Slatter had entered into arrangements with Chesham and Romford Councils to supply electricity for lighting and to construct tramways, and the company was formed to take over the contracts, the consideration being £3,500, payable in cash and shares. The nominal capital was £100,000, of which £14,626 had been issued. Shortly after formation the company took steps to acquire from public bodies the right to supply them with electricity, and in so doing expended large sums. The only work actually entered upon was at Chesham, on which the company had expended £24,173. It had disbursed nearly £9,000 to obtain the Romford Tramways Act, £1,115 over the Romford provisional order, and £518 upon a similar order for Halesowen. The £14,612 subscribed in cash for shares had been exhausted, and the company now owed nearly £20,000 to unsecured creditors, in addition to £7,300 to debenture bondholders. The company's assets chiefly consisted of buildings, land, machinery, mains, &c., at Chesham, valued at over £20,000, and £1,301 deposited with the Paymaster-General, in connection with the Romford Tramway Bill. Mr. Walter Allnutt, 5, Lime-street, London E.C., the receiver for the first debenture holders, was appointed liquidator, with a committee of inspection.

It was intimated that steps would be taken to form a new company.

At Blackburn Bankruptcy Court on Wednesday, Charles Chadwell, civil engineer, was publicly examined.

Debtor attributed his failure to losses in business. Gross liabilities £27,524, expected to rank £25,207, assets estimated at £2,712. Debtor started business about 1889 without capital, and of his many large contracts since that time some had paid and others had not. He was contractor for the Blackpool, St. Annes and Lytham tramway, the amount of the contract being £104,000 for the whole of the work. At the time he was perfectly solvent. In respect of that contract he received £74,000 in cash and the balance in shares. There was a verbal arrangement that he was afterwards to receive cash for those shares from the underwriter, but he did not get it. He did not take the precaution of seeing what the capital of the company was, and when he had completed the line the company at once reduced the capital and his shares were worthless. The present liabilities in respect of the contract were about £25,000. He paid over the £74,000 received in cash to the sub-contractor. He had shares in three or four tramways, in respect of which provisional orders had been obtained, and if he had been able at the time of the assignment to negotiate them he would have been able to pay 20s. in the £.

Examination adjourned.

Electrical Turnery (Ltd.), 10, Wind-street, Tottenham Court-road, London, W., is being wound up voluntarily. Mr. T. M. Gordon, 1, Kenway-road, Earl's Court, S.W., is liquidator.

A meeting will be held on Nov. 9 at the offices of Hall, Son & Hawkins, Northern Assurance-buildings, Manchester, to receive an account of the winding up of the International Electric Traction & Power Synd. (Ltd.)

Mr. F. S. Salaman, 1, Oxford-court, London, E.C., is trustee in the bankruptcy of Ernest Rosenberg, patent broker, 465 and 466, Birkbeck Bank-chambers, London, W.C.

The examination of W. J. Charlesworth and Harry Jones, formerly trading as H. Jones & Co., electrical engineers, Longton, took place at Stoke last week. Liabilities £116, assets nil. As Jones could not file a satisfactory deficiency account his examination was adjourned, but that of Charlesworth was closed.

The trustee (Mr. C. H. Plant, 14, Chapel-street, Preston) in the bankruptcy of Jas. W. Smith, electrical engineer and contractor, 55, Bolton-road, Darwen, has been released.

The trustee (Mr. A. B. Davies, 58, Wind-street, Swansea) in the failure of Hector D. McIntyre, electrical engineer, &c., 15, Werter-road, London, S.W., and Glanamman Colliery, Carmarthenshire, has been released.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the receiver for the debenture holder of the Thames Electric & Motor Boats (Ltd.) to sell by public auction in one lot, upon the works premises, Eel Pie Island, Twickenham, on Tuesday, Oct. 16, at 10 a.m. (for 11 a.m. prompt), the freehold works and land, containing about $1\frac{1}{4}$ acres, with a frontage to the river Thames of approximately 300 ft., together with substantially-built boat-building shops, engine and battery house, machine shop, stores, &c.

Messrs. Wheatley Kirk, Price & Co. will also sell by public auction, piecemeal, in the lots of the catalogue, immediately after offering the freehold, the contents of the works, including sliding, surfacing, screw-cutting and other lathes (by well-known makers), wood-working machinery, planing, drilling, bending and other machines, engine, boiler, dynamo and switchboards, electric motors and accessories, loose tools, utensils, &c. Catalogues (gratis) from the auctioneers, 46, Watling-street, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester.

During the sale of the above plant the newly-built electric launch "Victory" (capable of accommodating 350 passengers) will be offered at auction. Further particulars are set out in an advertisement.

Plant, &c., for Sale.—Barber & Coleman (Ltd.), 38, King-street West, Manchester, advertise for sale two electric motors ($2\frac{1}{2}$ H.P. and $\frac{1}{2}$ H.P.).

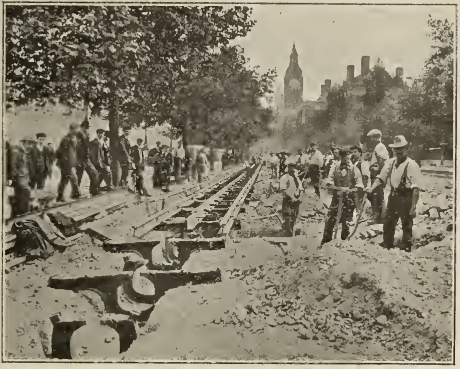
Plant Required.—A d.-c. motor-generator, from 100 kw. to 150 kw., suitable for traction (500-660 v.) and lighting mains (440-480 v.) is wanted by the Liverpool Electric Supply Co., 12, St. John's-lane, Liverpool. See an advertisement.

The British Electric Equipment Co. (Ltd.), 265, Strand, London, W.C., require one 150 kw. (about) d.c. generator (440-500 volts); also two 40 H.P., one 30 H.P. and one 20 H.P. d.c. motors (500 volts). See an advertisement.

Works Site for Sale.—Messrs. R. Heber Radford, Son & Squire, 15, St. James's-row, Sheffield, advertise some conveniently situated land (over 20 acres) in Sheffield, suitable for large works.

Factory Premises to Let.—Messrs. E. & T. Pink, Staple-street, Borough, S.E., have factory premises (with power) to let. See an advertisement.

The Embankment Tramways.—One of the most interesting sections of the London County Council tramways now under construction is that which is being carried out by Messrs. Dick, Kerr & Co. on the Thames Embankment between Westminster and Blackfriars Bridges. The work is being done under somewhat difficult conditions, for, contrary to general expectations, the roadway below the surface is found to be practically as solid as concrete, and almost immediately below the level of the roadway is the arch of the Metropolitan District Railway. Despite these and other obstacles, excellent progress is being made and the contractors expect that the track work will be completed in three to four weeks from this date. The method of construction employed by Messrs. Dick, Kerr is shown in the accompanying illustration. Large gangs of men are engaged in this work, and their operations are followed with interest by crowds of onlookers. Considering that the total length of line is about 3¼ miles of single track, and that work has been only proceeding some four weeks this rate of progress is very satisfactory. The width of the Embankment thoroughfare is generally about 66 ft. from kerb to kerb, and the effective width occupied by the new lines is from 18 ft. to 19 ft., which leaves a width of about 47 ft. available for ordinary vehicular traffic. This is about 10 ft. in excess of the width of an ordinary principal thoroughfare.



Conduit Construction by Dick, Kerr & Co., on the Victoria Embankment.

CATALOGUES, &c.

Robertson Lamps.—Three neat pamphlets and two bold show cards on Robertson lamps have just been issued by the General Electric Co. One of the pamphlets is a useful test chart showing the degrees of blackening in a Robertson incandescent lamp. It should form a useful guide to consumers in the economical use of their lamps. The show card is most effective and quite typical of G.E.C. productions.

A.C. Generators and Motors.—Messrs. Crompton's standard list D 27 has just reached us. It deals exhaustively with the standard makes of A.C. generators and motors manufactured by the firm. The illustrations include views of motors coupled to pumps and haulage gears and of generators driven by high speed engines. There is a page of useful formulæ at the end, which should often be consulted. The booklet is the company's standard size and will fit their regular file.

"*Century*" *Testing Set.*—Pamphlet D.C. 94 issued by Elliott Bros. describes their new Century testing set as re designed and brought up to date. The ranges deal with up to 750 volts and 600 amperes in six and four steps respectively, and measurements can be made of current, voltage, power, resistance and insulation. Full instructions for the use of the set are given.

Care of Accumulators.—The operation and care of the "Chloride Accumulator" in stationary service forms the subject of a useful publication issued by the Chloride Electrical Storage Co, Clifton Junction, near Manchester, and 39, Victoria-street, London, S.W. It comprises a series of loose leaflets giving concise instructions for the care and operation of the company's batteries. The copy sent to us is priced at 5s. net, and presumably copies of the pamphlet will be forwarded on receipt of this sum.

New "Wireless" Electric Sign.—The Efandem Co. are placing on the market an electric sign of entirely new construction. It is claimed to possess many points of advantage over other signs, as it is portable, cheap and consumes a small amount of current. The wording is interchangeable at will, and it can be used either as an indoor sign for shop windows, &c., or, being weather proof, it can be used in exposed positions. It can be made in any shape or design, the lettering ranging in size from 4 in. in height upwards. Each whole letter takes on an average one-third ampere. The same sign can be constructed with a double face so as to read both sides without adding to the amount of current consumed. The fixing is effected by simply hanging the sign up by a cord or other means of suspension. No wiring is required other than that already existing. The sign has depending from it a flexible cord with a plug, or adapter, at the end, and the adapter is inserted in the nearest lamp socket. In appearance the design is much like a marking board in a billiard room. The lamps can be moved much in the same way as the markers to form any word required. Each board contains about 20 letters.

A Unique Publicity Scheme.—The manager of the General Electric Co.'s publicity department, Mr. H. C. Palmer, is to be congratulated upon putting into practice a useful publicity scheme for central stations. Manufacturers are awakening to the fact that the consumer of electrical energy can be reached through the medium of the central station engineer. The General Electric Co. is, so far as we know, the first in the field with an organised method of supplying prospective customers of electricity departments with concisely-written and well-illustrated information regarding the electrical devices commonly used in trade and domestic circles. The company have prepared an attractive booklet, "Electricity in the Household," besides half a dozen leaflets depicting and describing various uses of electric motors; all or any of these will be sent in quantities to station engineers for distribution in their respective districts. Blank panels are left on the booklet and leaflets for filling in the name and address of the local electricity department. The literature is well printed and copiously illustrated, so that the story of electric heating, cooking and power is told rather by pictures than by letterpress. Although this printed matter is ostensibly compiled to push G.E C. goods, the name of the firm is not unduly obtruded, and would not at any time pall upon the reader. We understand the scheme is being well received, and from the details, which have been explained to us, it should do much to popularise the uses of electrical energy.

Picture Post Cards.—Mr. C. Rockley, of the West Ham Electricity Department, has initiated several good business "lines" in connection with electricity supply, and among these a set of really artistic and effective picture post cards may be given a front place. Series I. of these business-getters are designed to interest the private house type of consumer of electrical energy, and right well, we think, will they serve that purpose. The cards are published by J. Curwen & Sons, 24, Berners-street, London, W.

Mirrlees-Diesel Oil Engine.—"Power with Economy" is the title of an artistic brochure issued by the Mirrlees Watson Co. It contains a complete description of the Mirrlees-Diesel oil engine, together with photo illustrations and curves of performances.

Exports of Electrical Goods and Apparatus.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Sept. 26 to Oct. 2 with the ports of destination :—

Africa—Alexandria, £713 (including £61 telegraph material); Cape Town, £90 (telegraph material); Delagoa Bay, £1,832 (including £133 telegraph material); Durban, £291; East London, £310; Mombasa, £298 (including £74 telegraph material); Port Elizabeth, £716; Port Said, £37; Sekondi, £32; Suez, £79 (telegraph material). *Argentina*—Buenos Ayres, £1,711 (including £1,427 telegraph material). *Australasia*—Adelaide, £131 (including £75 telegraph cable); Auckland, £49; Brisbane, £95 (including £17 telegraph material); Christchurch, £61; Fremantle, £846; Hobart, £21; Lyttelton, £26; Melbourne, £2,175 (including £1,663 telegraph material); Napier, £8; Perth, £87 (including £34 telegraph material); Sydney, £2,813; Wellington, £956 (including £187 telegraph material). *Belgium*—Antwerp, £10; Brussels, £9; Ghent, £49; Ostend, £68. *Burma*—Rangoon, £563. *Canada*—Montreal, £132; Quebec, £57; Toronto, £176. *Ceylon*—Colombo, £9. *Chili*—Punta Arenas, £27. *China*—Hankow, £228; Shanghai, £394; Tientsin, £276. *France*—Boulogne, £81; Paris, £100. *Gibraltar*, £46. *Greece*—Piræus, £44. *Holland*—Amsterdam, £343 (including £258 telegraph material); Rotterdam, £17 (telegraph material). *Hong Kong*, £18. *India*—Bombay, £447; Calcutta, £975 (including £110 telegraph material); Madras, £153. *Japan*—Kobe, £65; Moji, £18; Nagasaki, £865; Tokyo, £300 (telegraph material); Yokohama, £122. *Malta*, £249. *Mexico*—Vera Cruz, £60. *Peru*—Callas, £64. *Siam*—Bangkok, £106. *Spain*—Malaga, £30. *Straits Settlements*—Penang, £214; Singapore, £87 (including £21 telegraph material). *Sweden*—Stockholm, £283 (including £87 telegraph material). *Uruguay*—Monte Video, £30. *U.S.A.*—New York, £141. *West Indies*—St. Lucia, £10; Trinidad, £12. *Zanzibar*, £6 (telegraph material). Total £20,212, against £13,232 in the corresponding week last year (Sept. 27 to Oct. 3).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"'The Electrician' Wireman's, Linesman's and Mains Superintendent's Pocket Book." By F. Charles Raphael. New edition. (London: "The Electrician" Printing & Publishing Co.) 5s. net.

"Manual of Wireless Telegraphy." By A. Frederick Collins. (London: Chapman & Hall.) 6s. 6d. net.

"Management of Electrical Machinery." A revised and enlarged edition of "The Practical Management of Dynamos and Motors." By F. B. Crocker and S. S. Wheeler. 6th edition. (London: E. & F. N. Spon.) 4s. 6d.

"Care and Management of Electric Power Plants." By Norman H. Schneider. New edition. (London: E. & F. N. Spon.) 5s.

"Experimenting with Induction Coils." By H. S. Norrie. (London: E. & F. N. Spon.) 1s. 6d.

"The Grouping of Electric Cells." By W. F. Dunton. (London: E. & F. N. Spon.) 1s. 6d.

"Science Abstracts," September. Section A, Physics. Section B, Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Continuous-Current Dynamo Design." By H. M. Hobart. (London: Whittaker & Co.) 7s. 6d. net.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

August 13, 1906.

18,186 B.T.-H. Co. (G.E. Co., U.S.) Systems of electric motor control.
18,187 Alloemeine Elektricitäts Gesellschaft. Electric resistance regulators. (Date applied for, Aug. 14, 1905.)*†

August 14, 1906.

18,211 Hinton. Trolley finders. (Date applied for, Aug. 16, 1905.)*†
18,212 Hall. Telegraphic and telephonic communication between signal boxes and trains.
18,220 Brouohall. Utilisation of wind power for generating electricity for lighting or other purposes.
18,227 Volk. Electric controllers. (Date applied for, Sept. 12, 1905.)*†
18,229 Miller. Cap for use with telephones.
18,255 Kleinsteuber. High-tension section insulator for electric tramways or railways. (Date applied for, Aug. 14, 1905.)*†
18,278 B.T.-H. Co. (Kintner, U.S.) Electric railways systems.
18,289, 18,290 & 18,291 Justice (Melms & Pfenninger G.m.b.H., Germany.) Turbines.*

August 15, 1906.

18,304 Berry. Preventing breaking of conducting wires of electric lamps and fittings.
18,308 Thomson. Automatic dry seats.
18,309 Thomson. Reversible seats for trains, tramcars, &c.
18,317 Justice (Melms & Pfenninger G.m.b.H., Germany.) Turbines.*
18,329 Fuller & Fuller. Electric conductors.
18,330 Nehmer. Electrical apparatus for lighting gas.
18,343 Mavor & Mavor & Coulson. Cores of dynamo-electric machines, transformers, &c., having ventilating spaces.
18,348 Curtis. Turbines. (Date applied for, Aug. 24, 1905.)*†

August 16, 1906.

18,365 Brook & Hirst. Metallic cases for motor starters, switches, fuses, and like electrical apparatus.
18,376 Grant. Ships' and analagous telegraphic apparatus.
18,378 Perrin. Side lever brakes for railway and tramway waggons, &c.
18,387 Geall. Automatic clock switch for controlling electric circuits, taps, valves, &c.
18,408 Lake (Semenza, Italy.) Insulators for high-tension conductors.*
18,413 Ferranti. Turbines.
18,421 Anger. Railway or tramway vehicles.
18,428 Deutsche Telephonwerke G.m.b.H. Devices for adjusting or operating from a distance signalling pointers' indicators, contact arms, &c. (Date applied for, Nov. 10, 1905.)*†
18,435 Pauling. Processes for producing electric discharges. (Date applied for, Aug. 18, 1905.)*†

August 17, 1906.

15,200a Segnitz & Parkes. Supporting the plates of secondary batteries. (Date applied for, July 4, 1906.)
18,445 Waterhouse. Electric glow lamp holders.
18,458 Phipps. Splicing-grips for electric tramways overhead construction and repairing.
18,464 Breoknell, Munro & Rogers & Monro. Bow trolleys.
18,479 Parsons. Cooling of electric appliances.
18,485 Allgemeine Elektricitäts-Ges. Incandescing bodies for electric lighting and heating purposes. (Date applied for, Aug. 29, 1905.)*†
18,486 Alloemeine Elektricitäts-Ges. Time and like switches especially for electric metering apparatus. (Date applied for, Aug. 19, 1905.)*†
18,487 & 18,488 B.T.-H. Co. (G.E. Co., U.S.) Filaments.
18,489 B.T.-H. Co. (G.E. Co., U.S.) Purifying metallic compounds,
18,490 B.T.-H. Co. (G.E. Co., U.S.) Systems of motor control.

August 18, 1906.

18,516 Smith. Starting switches.
18,524 Collins. Revolving electrode holder.
18,531 Bruce Peebles & Co. & La Cour. Ventilating dynamo-electric machines.
18,532 Bruce Peebles & Co. & La Cour. Field magnets for dynamo-electric machines.
18,561 Prested. Electric current indicator.*
18,565 Schneider. Secondary batteries or accumulators.*
18,573 McHardy & Bowell. Electric clocks and like mechanisms.
18,575 Heywood. Apparatus for signalling or displaying advertisements by electric lamps.

August 20, 1906.

18,588 Vasey & Stokes. Brake mechanism for vehicles.
18,591 Nitzsche. Wire insulators.
18,592 Nitzsche. Means for placing wires into wire insulators.
18,599 Pauling. Production of voltaic strong-current arcs.*
18,600 Pauling. Electrodes.*
18,607 Chesterfield. Holders for cards for electricity meters.
18,608 Romer. Condensers for electrical purposes.
18,610 Société Anonyme des Anciens Etablissements Panhard et Levassor. Current interrupter. (Date applied for, 18/11/05.)*†
18,621 Torda Dynamo-electric machines and the like.
18,622 Justice. (Deutsche Gasgluhlicht Aktienges., Auerges, Germany.) Producing metallic incandescence bodies for glow lamps.*
18,624 Fry. Producing electricity by steam.
18,628 Boult. (Burroughs Adding Machine Co., U.S.) Electric driving attachments for adding machines.
18,629 Goriainoff Generating motive power and apparatus therefor.
18,641 Cronsioe. Contact head for electric apparatus.*
18,649 Marks. (Federal Electric Co., U.S.) Insulated bushings for circuit wires.*
18,660 Hoyt & Sinsabaugh. Motors.*
18,666 Peacock. Prepayment attachments for electricity meters.

August 21, 1906.

18,687 Croft. Splicing ear for trolley wires and the like.
18,693 Von Lepel. Detectors of electric oscillations.*
18,704 Hosch. Attention sparking plugs.
17,714 Imray. (Pintsch, Germany. Ventilating fan for railway and other vehicles.
18,716 Siemens Bros. & Co. (Siemens & Halske, A.G.. Germany.) Central battery telephone systems.*
18,724 Park. Conduits or casings for conductors.*
18,725 Strouse. Mechanical stokers.*
18,729 Wingren. Electric furnaces. (Date applied for, 21/8/05.)*†
18,738 Lederer. Manufacture of filaments of metallic tungsten or molybdenum.
18,739 Mendelson. Electric motors.*
18,745, 18,747, 18,748 & 18,749 B.T.-H. Co. (G.E. Co., U.S.) Manufacturing filaments.
18,746 B.T.-H. Co. (G.E. Co., U.S.) Boron and boron compounds and the production of incandescing bodies therefrom.
18,750, 18,751 & 18,752 B.T.-H. Co. (G.E. Co., U.S.) Manufacture of electric conductors applicable as incandescing bodies in electric lamps.
18,754 Pringle. Brakes for tramways and railways.

August 22, 1906.

18,762 Davey. Electric alarm clocks.
18,808 B.T.-H. Co. (G.E. Co., U.S.) Internal combustion engines.
18,811 Lederer. Incandescent bodies of metallic tungsten or molybdenum for incandescent lamps.
18,812 Lederer. Supports for metallic filaments for incandescent lamps.
18,816 Parsons, Stoney & Law. Electromagnetic coupling devices.
18,817 Scherbius. Dynamo-electric machinery.*
18,826 Lovell. Street fire alarms.
18,829 Reithoffer & Morawetz. The operation of electric clocks by electrical waves.*
18,835 Wynne. Heating molten or semi-molten materials by electricity.*

August 23, 1906.

18,840 Somerville. Permanent magnet generators.
18,841 Goldschmidt. Microphones for microtelephones for central battery system.
18,842 Kneen. Tramway and the like points.
18,874 & 18,875 Lederer. Incandescent lamps.
18,877 B.T.-H. Co. (G.E. Co., U.S.) System of electric motor control.
18,886 Joel. Electrodes for secondary batteries.
18,889 Weman. Switches for telephones.*
18,905 Richmond & Co., Burnett & Lyon. Switch for automatic electric lifts.

August 24, 1906.

18,944 Holmoren & Brahm. Compound telephones. (Date applied for, 9/3/06.)*†
18,956 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors and systems of operating same.
18,957 Euker. Electric motor control apparatus. (Date applied for, 31/8/05.)*†
18,965 Graham. Telephonic apparatus.

August 25, 1906.

18,982 Snelling. Disease-preventing safety cap for telephone receivers.
18,996 Lee. Prepayment device for combination with electricity meter.
19,002 Segnitz & Parkes. Covers of electric cells.
19,005 Eckstein, Heap & Mellis. Oil break switches.
19,009 Warwick Machinery Co. (G.E. Co., U.S.) Buckets for turbines.
19,037 Boult. (Louis de Loma, France.) Electric ignition for explosion engines.

SPECIFICATIONS PUBLISHED.

1905 Specifications.

10,298 Vera & Vera. Switches or relays. (Date applied for, 17/5/04.)
12,953 Kottmair & Zwack. Electrically-operating railway points, signals, &c.
14,256 Voelker. Electric heating cartridges.
14,898 Crawford. Filaments for incandescent lamps.
16,479 Lattig & Goodrum. Telephone systems.
16,479a Lattig & Goodrum. Telephone systems. (Date applied for, Aug. 14, 1905.)
16,491 Quincey & Harrison. Coiling apparatus for hollow or solid flexible conductors.
17,106 Grote & Ely. Arc lamps.
17,257 Hildebrand. Automatic switches for telephone istallations.
17,372 & 17,373 Belliss & Morcom & Jude. Turbine motors.
17,699 Field & Ferranti Limited. Electromagnetic mechanism.
17,742 Howgrth. (Maschinenfabrik Oerlikon.) Artificially-cooled electrical Machines.
17,791 Nesbit, & Ashwell & Nesbit. Radiators and fittings.
17,826 Parsons & Ball. Electric clock systems.
18,375 Brooks & Read. Connecting tubular conduits and fittings.
18,504 Kerr. Automatic governors for elastic fluid turbines.
19,015 Berry. Apparatus for distribution of electric current.
19,504 Prentiss. Trolley poles.
19,968 Mensing & Bruce, Peebles & Co. Switch.
20,683 Atkinson. Joints the rails of railways, tramways, &c.
20,155 Trippe & Staniland. Automatic device for the automatic control of arc and incandescent lighting circuits.
20,990 B.T.-H. Co. (G.E. Co., U.S.) Dynamoelectric machines.
21,259 Chilton & Brush Electrical Engineering Co. Throttle valves for governing steam engines, turbines, &c.
22,005 W. T. Henley's Telegraph Works Co. & Savage. Insulated electric conductors.
22,821 Löh. Turbines. (Date applied for, Nov. 7, 1904.)
23,751 Scott. Electric switches.
23,778 Johnson. Turbines.
23,889 Cooper. (Klewe & Co.) Automatically cutting off current from electric furnaces, stoves or other apparatus at desired temperature.
24,794 Wilson. Brush-holders for dynamo-electric machines.
25,193 Crosta & Bidder. Tramway points.
26,689 Bragstad. Distribution and supply of current in electric railway systems. (Date claimed, Dec. 21, 1904.)
26,713 Routin. Controlling electric current distributing systems.

1906 Specifications.

516 Benson & Co. & Leaver. Electro-plating.
1,707 Davis, Davis & Davis. Pulling-through rods for electrical conduits.
2,739 Aldworth, Crosta & Boot. Trolley wheel with renewable centre.
3,509 Iseki. Filament for incandescent lamps.
6,218 Elektrizitäts A.-G., vorm. W. Lahmeyer & Co. Starting compensated monophase commutator motors. (Date applied for, March 16, 1905.)
8,457 Rivers. Electrical heating "element" or resistance.
10,172 Conrad. Overload and reverse current relay devices. (Date applied for, May 8, 1905.)
11,458 Cooper. Controlling systems for electric motors. (Date applied for, May 22, 1905.)
11,648 Stewart. Mounting or supporting of electric motors on electrically-propelled vehicles.
11,803 Siemens Schuckertwerke Akt.-Ges. Overhead conductors of electric railways and tramways. (Date applied for, June 29, 1905.)
11,995 Vidal. Brush-holders for electro-motors.
12,055 Cruyt. Gas-explosion and like apparatus for use with turbines, &c. (Date applied for, June 3, 1905.)
12,420 Imray. (Washington Licht Ges.) Vapour incandescence lamps.
15,053 Chaulin. Electrical apparatus for protection against insects. (Date applied for, July 18, 1905.)

COMPANIES' MEETINGS AND REPORTS.

Willans & Robinson (Ltd.)

The ordinary general meeting was held at the Cannon Street Hotel, on Wednesday, under the presidency of Mr. Mark Robinson, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) having read the notice calling the meeting,

The CHAIRMAN said : Gentlemen, I am able to congratulate you on the progress of the company's business, and on the fact that we have at last reached that long-expected point, the turning of the corner at Rugby. The one matter which is of supreme importance to us is the ability of the Rugby business to earn good profits in the future. It is unnecessary to prophesy about this, for anyone can see from the last two accounts how things are moving, but let me say now, very definitely, that so far as concerns the work now going on, and that which appears to be lying before us, and apart from the clearing up of old troubles or of new troubles which have developed out of old transactions, we do not think that shareholders could desire a wholesomer, or sounder, or more promising business. Even its volume gives no cause for complaint, for the number of men employed at Rugby is now considerably larger than it was in our best days, and the volume of our work shows no diminution in our ability to make profits in the future. The losses to face are indeed great, but they have been given due prominence alike in the report and in the accounts. For reasons you will probably see are valid, we desire to deal with these losses through a suspense account until the hoped-for disposal of the Queen's Ferry works enables the whole losses of the company to be dealt with at one time. The Queen's Ferry loss is now no more than about £2,300 in excess of the depreciation written off, and even this excess is less than the amounts charged to Queen's Ferry as its proportion of debenture interest and directors' salaries. Depreciation is an equally necessary charge, whether the works are closed or open ; it is clear that we are losing less money by running them than we should lose by closing them. It is equally clear that by keeping them open, and by showing that one section at least (the steel works) is capable of profitable business, we are adding to our chances of finding a buyer and of getting a better price. The most serious single item loss is one which is plainly coming upon us in regard to one of the large electric power companies, whose debt to us we must treat as bad, though there is a suggestion to pay it in shares, for which a future value is claimed. We hold a few of this company's shares (not many), and these we must for safety write down to a nominal value. This is one of the cases where we took important contracts under the condition that we would accept payment of a certain proportion of the purchase money in shares. This arrangement has been unfavourably commented upon at our meetings, and loss has been freely predicted from it. It will interest you to know, therefore, that, except to a small amount, we have lost nothing upon the shares received in payment from this company. Nearly all those shares were sold and they were all sold at even a higher price than was put on them in our accounts. The loss we shall suffer arises upon the cash part of the contract, in respect of payments which fell into arrear, and which the power company is now unable to make. The circumstances are complicated, and it would be impossible to lay them fully before you, but I may tell you that a year ago we sold a large number of the shares on advantageous terms, and so we had little reason to fear that our debt would not be paid. All the power companies are by no means in the same position, but we have written down to nominal values all shares which we hold in other undertakings. It will be seen, therefore, that the amounts are not in all cases realised or ascertained losses. There are two other points about these losses. One is that, so far as they arise from contracts with power companies, large as the losses are, there has been no loss over the contracts as a whole, if we deal with past periods as well as with the current half-year. The contracts were originally for very large amounts, and as they were reasonably profitable contracts, the profits on the earlier portions exceeded the losses which have since arisen only in the final winding-up of the accounts. And I would say further that these contracts, by largely filling our shops with work, helped us to meet our standing charges during some of the worst years of our troubles. Another point is that much of the loss has no effect upon the financial strength of the company. So far as it represents outlay in the past, upon patents and experiments and the like, the only change is that this outlay will no longer figure as an "asset," and the amount of available cash in the business (so far as these items are concerned) is exactly as before. To some extent the same remarks apply to the writing down of stocks of engine parts. As regards the shares written down, only a portion were shares taken in payment under contracts.

As regard expected losses under "Debtors," the case is different ; were these amounts paid to us they would, of course, be available for the general purposes of the company. But the precautions which have been taken throughout these difficult times to keep the company in a financially strong position enable us to bear this added trouble. It may surprise some shareholders to learn that for over two years—the years in which some of our friends suppose we have been sinking into rapid ruin—we have never had an overdraft at our bankers. Perhaps another rough test of our strength is given by the taking of cash discounts. Well, we never miss a single discount which can possibly be gained by prompt payment. I do not think that is usually the position of an undertaking which is either in extremis or near it. And it may further interest you to know that not only is the number of men at work at Rugby nearly the largest we have ever employed, but that the horse-power ordered during the nine months of this year—of course mainly in turbines, not engines—is not greatly below the best figure of the past five years, while there is, I am glad to say, an amount of miscellaneous work in our shops of which we have no experience.

Reference is made in the report to our intention not to proceed with the once contemplated business of building large gas engines ; this is, of course, the reason for writing off as an immediate loss a good deal of expenditure which it would otherwise be reasonable to write off over a term of years. In the steam turbine business we have a more promising employment for our capital and our plant than could ever be supplied by gas-engine construction. But there is another reason—in the manufacture of the Diesel oil engine—which, as we have stated before, has been undertaken by this company, and which we think is likely to employ us so fully that we shall have no wish, or need, to think further about gas engines. The first batch of Diesel engines should be completed before the end of the year. We believe this will prove to be one of the most valuable developments of the internal combustion engine.

The CHAIRMAN then referred to depreciation at Rugby, and said they had written off on freehold premises and buildings (at Rugby only), on plant and machinery, and on patents and experiments £120,009. They had fully maintained their buildings and plant in perfect condition out of revenue by the expenditure of no less than £69,420 in the $9\frac{1}{2}$ years they had been there. Their freehold included about 40 acres of land, which cost on an average £260 per acre. Land adjoining their works had sold for building (after roads and drains had been provided) for nearer £1,200 per acre, and this alone suggested that Rugby was worth a good deal more than the balance-sheet showed. He then moved the adoption of the report and accounts.

The DEPUTY-CHAIRMAN (Sir Gilbert A. Clayton East, Bart.) seconded the motion, which, after the Chairman had replied to several shareholders, was carried by 32 to 17.

The proceedings then terminated.

DEVONPORT & DISTRICT TRAMWAYS CO.—At the meeting on Friday it was reported that the total revenue for the past half-year was £11,566, and after deducting expenses the profit was £29. 9s., which, with £149. 7s. brought forward, made £178. 16s. to be carried forward. The chairman (Mr. W. G. Bond) said, as compared with the corresponding half of 1905, the receipts showed a decrease of over £439, although the only new adverse factor affecting the company's traffic during the half-year had been the prolonged and complete mobilisation of the fleet, which denuded Devonport of its sailor population for several weeks. The rail motor service had become increasingly popular, making serious inroads into their long-distance traffic. To meet present conditions the car-mileage had been reduced, and the traffic arrangements reorganised, with the result that there had been an appreciable reduction in expenses. With regard to the question of power supply they were entitled, under the terms of the original arbitration award, to a revision of the prices charged by Devonport Corporation as from July 1 last. The Corporation and the company having failed to come to an agreement as to the price to be charged for the ensuing five years, application had been made to the Board of Trade to appoint an arbitrator, and the arbitration would be held on Oct. 20.

DIRECT WEST INDIA CABLE CO. (LTD.)—At the meeting last week the directors' report for the year ended June 30 was adopted. The net result of the year's working was a profit of £3,113. 7s. 7d., compared with £4,182. 1s. 2d. for the previous year. An interim dividend of 3 per cent. (tax free) had already been paid, and it was proposed to make a further equal payment (tax free), leaving £1,313. 7s. 7d. to be carried forward.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—At the meeting on Monday the chairman (ex-Provost Brownlee) said they must congratulate themselves on the successful work of the company. Their gross income for the seven months had been £7,482. 3s. 3d. Their expenses were £3,463. 2s. 2d., leaving £4,029. 1s. 1d. They had carried 1,170,700 passengers, and their drawings per car-mile for July had been 10 3d. Their operating cost per car-mile was much lower than in Dundee or in any large city, for the reason that the Board of Trade gave them higher speeds, and consequently each car did a great deal more work than in Dundee. They went over a greater number of miles, and while the drawings were less the miles run were greater, and so the working cost per car-mile was much less. The cost of energy was also considerably less, for the reason that their working expenses were so much lower. The cost of energy was 0·85d. per car-mile, while in Dundee and other places it was as high as $2\frac{1}{3}$d. It had become patent that the company was to be a paying concern. The service had become popular. They had ordered two additional cars with covered tops, which they expected to have for the winter.

EDISON & SWAN UNITED ELECTRIC LIGHT CO. (LTD.)—The directors report for the year ended June 30 states that the net revenue shows that £53,709. 19s. 1d. has been brought forward from profit and loss account. Debenture interest absorbed £16,730. 4s. 8d., £11,000 has been set aside as depreciation on freehold and leasehold property, plant, machinery and tools; £1,507. 11s. has been applied in writing down values of stocks, and £1,321. 14s. 7d. has been reserved on account of bad and doubtful debts. £5,000 has been placed to a reserve fund. The result is a credit balance of £18,150. 8s. 10d., added to £6,834. 14s. 1d. brought forward, making £24,985. 2s. 11d. Out of this the directors recommend payment of a dividend for the year on the A shares at the rate of $4\frac{1}{6}$ per cent. (4s. 2d. per fully-paid A share and 2s. 6d. per part-paid A share) absorbing £15,978. 5s., leaving £9,006. 17s. 11d. to be carried forward. During the year £8,381 of debenture stock was purchased and cancelled, resulting in a profit of £1,069. 1s. 1d. beyond that shown in the profit and loss account. This has been appropriated as a reserve against stock depreciation. Cost of establishing the business, goodwill, &c., £443,451. 8s. 1d., has been reduced by £53,019, being the amount written off the B shares during the year. Freehold and leasehold property, plant and machinery have been brought forward at the value stated in the last balance sheet, with the addition of the amount expended to June 30 less depreciation charged in net revenue account. There has been expended on capital during the year £7,439. 18s. 3d.

The shares of the Altrincham Electric Supply (Ltd.) have been taken at par, as in previous years. This concern continues to show satisfactory progress, having this year for the first time paid a dividend on its shares. Its indebtedness to this company had been reduced by £1,864. 12s. 5d.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The report for the year ended June 30 was adopted at the meeting last week. The net profit was £3,273. 18s. 3d., compared with £2,698. 8s. 5d. for the previous year. An interim dividend of $2\frac{1}{2}$ per cent. (tax free) had already been paid, and it was proposed to make a further equal payment (tax free), leaving £773. 18s. 3d. to be carried forward.

NEW ST. HELENS & DISTRICT TRAMWAYS CO.—The report for the year ended June 30 states that there was a loss of £37, increasing the debit to £2,054. The amount of preference dividend unpaid at June 30 was £21,972.

STIRLING & BRIDGE OF ALLAN TRAMWAYS CO.—At a meeting on Monday the shareholders agreed to accept an amended offer by the National Electric Construction Co. of £15,000 in cash for the whole undertaking. The Construction Co. will convert the lines to electric traction.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANY.

GENERAL ELECTRIC SIGN & ENGINEERING CO. (LTD.) (90,297.)—Reg. Sept. 29, capital £2,000 in £1 shares, to carry on the business of general engineers and contractors, manufacturers of signs and electrical apparatus, machinery, tools, mechanical and other appliances, &c.

STATUTORY RETURNS.

ACCESSORIES MFG. CO. (LTD.)—In return to Aug. 8 capital is £10,000 in £1 shares (5,000 preference), of which 2,443 preference and 1,064 ordinary have been taken up. £7 has been received and £3,500 is considered as paid. Mortgages and charges, £2,500.

ALTRINCHAM ELECTRIC SUPPLY (LTD.)—Return to Aug. 2 gives capital as £50,000 in £1 shares, of which 25,000 have been taken up and paid for in full. Mortgages and charges £25,000.

MALAGA ELECTRICITY CO. (LTD.)—The capital in return to Aug 27 is £57,000 in 10,000 ordinary and 7,000 deferred shares of £5 each, of which 10,000 ordinary and 7,000 deferred have been taken up. £5 per share has been called up on the ordinary and £50,000 has been received. £7,000 is considered as paid on the deferred shares. Mortgages and charges, £44,738.

MORTGAGES AND CHARGES.

FLEETWOOD & DISTRICT ELECTRIC LIGHT & POWER SYND. (LTD.)—A charge securing not more than £1,360 was created by the receiver (pursuant to three orders of Court) on Sept 12. Property charged, company's undertaking and assets (ranking in priority to trust deed dated Oct. 31, 1899). Holder, W. C. Johnson.

MORRIS-HAWKINS ELECTRICAL CO. (LTD.)—A board resolution (under seal) dated Sept. 19, 1906, creating £11,000 5 per cent. debenture stock, has been registered. Property charged, company's freehold and leasehold properties, patent rights, buildings, works, undertaking and uncalled and unpaid capital.

PRIVATE WIRE & TELEPHONE INSTALLATION CO. (LTD.)—£1,000 5 per cent. debentures, created Aug. 24 and dated Sept. 19, 1906, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. Holders, Consolidated Electrical Co.

CITY NOTES.

MEMORANDA (Oct. 4).—Bank rate 4 per cent. (since Sept. 13, 1906). Price of silver $31\frac{7}{8}$d. per oz. Consols $86\frac{5}{16}$—$86\frac{7}{16}$ for money, $86\frac{9}{16}$—$86\frac{11}{16}$ for account; $2\frac{1}{2}$ per cent. annuities 85—$85\frac{1}{2}$. Consols Pay Day, Nov. 2; Stocks and Shares Continuation Days, Oct. 10 and 24; Ticket Days, Oct. 11 and 25; Pay Days, Oct. 12 and 26; Mining Share Carry-over Day, Oct. 9.

BERGMANN ELECTRICITATS WERKE A.G. (BERLIN).—An extraordinary meeting has been called for 22nd inst. to authorise an increase of the capital, owing to the extension of the company's business.

BRUCE PEEBLES & CO. (LTD.)—An interim dividend at the rate of 6 per cent. on the preference shares has been declared for the half-year ended June 30, and the warrants have been posted.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The directors recommend a dividend on the ordinary shares at the rate of 5 per cent. (tax free) for the half-year ended June 30.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—Mr. J. Cecil Bull, who has acted as secretary to this company since its formation in 1890, has been appointed a director of the company. Mr. R. S. Shaw has been appointed secretary pro tem.

MEXICO ELECTRIC TRAMWAYS (LTD.) At an extraordinary meeting on Tuesday a resolution altering the articles of association was passed.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—This company is inviting applications for an issue of £187,500 $4\frac{1}{2}$ per cent. second mortgage debentures of £100 each at par.

RAND CENTRAL ELECTRIC WORKS.—During September 943,000 units were generated, yielding gross revenue £9,450, against 930,000 units and £8,700 in the corresponding period last year.

REUTER'S TELEGRAM CO. (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. (tax free) for the half-year ended June 30.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to allow a further issue of 30,000 £1 fully-paid ordinary shares of *Babcock & Wilcox (Ltd.)* to be quoted.

SUBMARINE CABLES TRUST. The coupon due Oct. 15 will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C., on that date.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 26	2,206	+ 655	17	27,566	+ 1,116
Airdrie	,, 21	232	- 4	38	8,413	+ 686
Anglo-Argentine	,, 30	15,352	+ 1,863	39	579,793	+ 64,466
Ashton-under-Lyne Corp.	,, 29	375	+ 79	27	9,807	+ 1,235
Ayr Corporation	,, 29	363	+ 29	20	8,440	+ 137
Baker St. & Waterloo Ry.	,, 29	1,580	...	13	17,820	...
Barnsley	,, 21	163	+ 3	38	6,231	+ 81
Barrow	,, 21	281	+ 4	38	10,003	+ 626
Bath Electric Trams, Ltd.	,, 26	959	+ 168	39	32,956	+ 5,994
Birkenhead Corporation	,, 30	1,152	+ 63	...	...	...
*Birmingham Corporation	,, 29	1,551	+ 1,169	26	25,981	+ 16,651
Birmingham & Mid.	,, 21	9,462	- 945	38	386,366	+ 16,834
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 27	1,803	+ 328	25	42,821	+ 2,833
Blackpool and Fleetwood	,, 29	1,122	+ 307	...	...	...
Blackp'l, St. Anne's & Lytham	...	..	...	...	...	...
Bolton Corporation	,, 30	2,146	+ 315	25	57,242	+ 4,270
Bournemouth Corporation	,, 26	1,842	+ 352	†26	48,150	+ 9,651
Bradford Corporation	,, 29	4,645	+ 257	26	123,144	+ 5,003
Brighton Corporation	,, 30	1,031	+ 33	26	29,267	- 877
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 28	5,132	+ 318	7	21,486	+ 1,957
Buenos Ayres & Belgrano	,, 23	3,920	+ 114	38	136,564	+ 6,516
Buenos Ayres Elec. Trms.	,, 1	1,366	+ 91	36	47,400	+ 7,521
Burnley Corporation	,, 29	1,214	+ 75	26	31,242	+ 1,829
Burton Corporation	,, 30	278	+ 11	§26	8,160	- 461
Bury Corporation	,, 23	1,100	...	25	25,667	...
Calcutta Tramways Co.	,, 29	R50,589	+ R6,596	13	R585,794	+ R24,634
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 22	2,240	+ 57	25	54,471	+ 33
Cavehill	,, 21	118	+ 68	38	3,594	+ 1,578
Central London Railway	,, 29	6,265	- 98	13	72,152	- 2,983
Chatham & Dist. Lt. Rys.	,, 27	853	+ 229	†39	26,753	+ 514
City & South London Rly.	,, 30	2,955	+ 420	13	32,578	+ 2,184
Colchester Corporation	,, 27	226	+ 28	...	...	...
Cork Electric Trams Co.	,, 27	555	...	39	19,128	- 207
Croydon Corporation	,, 28	1,477	+ 227	17	27,504	+ 2,134
Devonport & Dist. Trams	,, 21	502	- 6	38	17,603	- 165
Dover Corporation	,, 29	268	+ 37	26	7,537	+ 1,108
Dublin & Lucan Railway	,, 28	134	+ 2	§13	1 880	- 49
Dublin United	,, 28	4,968	+ 190	‡13	74,441	+ 4,092
Dundee Corporation	,, 26	1,170	+ 127	§19	21,775	+ 4,331
East Ham Council	,, 29	898	+ 63	26	24,842	+ 2,231
Exeter Corporation	,, 28	335	+ 81	26	8,150	- 242
Falkirk and District	,, 26	316	...	...	...	...
Gateshead & Dist. Trams	,, 21	1,012	+ 74	38	36,860	+ 2 046
Glasgow Corporation	,, 29	18,793	+ 1,417	18	296,773	+ 26,039
Glossop	,, 22	150	+ 11	40	5,235	+ 452
	,, 29	134	+ 7			
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	,, 21	264	+ 4	38	9,396	+ 414
Gt. Northern & City Rly.	,, 29	1,736	+ 136	13	20,556	+ 1,499
Greenock & Port Glasgow	,, 21	731	- 8	38	25,925	+ 1,274
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 21	311	+ 15	38	11,723	+ 1,494
Hastings Elec. Trams Co.	,, 27	1,047	...	13	15,002	...
Huddersfield	...	...	...	...	...	...
Hull Corporation	,, 29	2,226	+ 89	26	59,297	+ 1,430
Ilford Dist. Coun.	...	...	...	...	...	...
Ilkeston Dist. Council	,, 26	131	+ 18	26	3 634	+ 400
Ipswich Corporation	,, 29	444	+ 6	26	12,521	- 122
Isle of Thanet Co.	,, 29	680	+ 117	51	32,164	+ 103
Keighley Corporation	,, 27	157	+ 23	13	2,074	+ 156
Kidderminster & District	,, 21	116	- 21	38	4,786	+ 15
Kilmarnock Corporation	,, 29	167	+ 4	20	3,300	- 57
Kirkcaldy Corporation	,, 26	296	+ 85	13	3,587	+ 537
Lanarkshire Trams Co.	,, 27	1,024	+ 67	†39	34,405	+ 5,906
Leamington	,, 21	200	- 28	38	6,865	+ 2,634
Leeds Corporation	,, 29	6,310	+ 467	26	167,579	+ 9,654
Leicester Corporation	,, 29	2,123	+ 3	39	86,153	+ 5,059
Leith Corporation	,, 22	549	- 32	‡20	10,831	+ 4,754
	,, 29	521	+ 136			
Lincoln Corporation	,, 29	107	..	26	3,118	...
Liverpool Overhead Rly.	,, 30	1,417	- 16	13	20,149	- 591
Liverpool Corporation	,, 22	10,868	+ 180	34	409,901	+ 7,063
*London County Council	,, 22	24,738	+ 9,541	25	661,799	+ 280,685
London United	,, 28	6,350	+ 1,058	†39	247,166	+ 17,603
Lowestoft	,, 29	242	+ 38	52	9,901	- 416
Maidstone Corporation	,, 29	123	- 15	26	3,415	- 327
Manchester Corporation	,, 29	14,526	+ 1,711	26	364,689	+ 23,727
Mersey Railway	,, 29	1,718	+ 161	13	21,365	+ 1,621
Merthyr	,, 21	206	+ 10	38	7,489	+ 211
Metropolitan Dist. Railway	,, 30	7,916	+ 364	13	94,710	+ 9,348
*Metropolitan Elec. Trams	,, 21	3,369	+ 2	38	131 314	+ 30,047
Middleton	,, 21	355	- 30	38	13,770	+ 538
Nelson Corporation	,, 29	137	+ 6	1	137	+ 6
Newcastle-on-Tyne Corp.	,, 29	4,037	+ 246	26	107,035	+ 6,799
Newport (Mon.)	,, 29	650	+ 90	26	17,149	+ 1,093
Northampton Corporation	,, 28	461	+ 28	26	12,263	+ 2 6
Oldham, Ashton & Hyde	,, 21	581	- 26	38	21,769	+ 592
Oldham Corporation	,, 30	1,919	+ 312	27	49,874	+ 4,937
Perth (N.B.) Corporation	,, 26	174	...	19	3 324	...
Perth (W. A.) Elec. Trams	,, 28	1,362	+ 28	39	56,800	+ 3,387
Peterborough	,, 21	130	- 12	38	5,065	- 313
Pontypridd District Coun.	...	...	...	..	...	...
Portsmouth Corporation	,, 29	2,005	+ 268	26	59,017	- 403
Potteries	,, 21	1,878	+ 34	38	67,372	+ 3,247
Preston Corporation	,, 19	742	+ 95	..	...	...
	,, 26	725	+ 98			
Reading Corporation	,, 27	641	+ 18	...	...	..
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 27	487	+ 8	26	13,181	+ 1,217
Rothesay	,, 21	309	+ 39	38	10,033	+ 1,593
Salford Corporation	Oct. 1	4,613	+ 152	26	120,923	+ 3,280
Sheerness	Sept. 19	66	- 9	38	2,330	- 455
Sheffield Corporation	,, 30	5.337	+ 329	27	144,079	+ 9,274
Singapore Trams	,, 29	$3,288	...	14	$103,600	...
Southampton Corporation	...	...	...	...	...	...

(a) These comparisons are with the corresponding period last year. ¶ Plus 3 days. † Minus 3 days. ‡ Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate.		
				No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Southend Corporation	Sept. 26	425	+ 60	26	12,550	+ 618
Southport Tramways	,, 21	364	+ 30	38	12,800	+ 346
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	,, 30	1,336	+ 100	26	38,477	+ 2,082
Sunderland & District	,, 26	431	...	39	15,721	...
Swansea Trams	,, 21	869	- 7	38	32,053	+ 4,955
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 21	49	+ 49	38	1,780	- 87
Tynemouth and District	,, 21	273	+ 8	38	10,543	+ 63
Tyneside Trams Co.	,, 26	494	+ 102	39	17,948	+ 1,501
Wallasey District Council	,, 29	839	+ 88	26	22,682	+ 1,063
Walsall Corporation	,, 29	518	- 12	39	20,154	+ 995
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 27	2,300	+ 265	26	60,467	+ 15,286
Weston-super-Mare	,, 19	231	+ 4	38	6,699	+ 481
Wolverhampton Corpn.	,, 26	840	...	13	11,479	...
*Worcester	,, 21	324	- 30	38	11,072	- 837
Wrexham	,, 21	118	+ 10	38	3,996	+ 83
Yorkshire W.R. Trams	,, 30	817	+ 42	39	32,642	...
Yorkshire Woollen District	,, 21	1,008	+ 198	38	34,607	+ 9,850

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Oct. 3.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Oct. 3.	
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.		Highest.	Lowest.
5	4/0	† Anglo-Argentine Ord. Shs.	$7\frac{1}{16}-7\frac{5}{16}$	5 8 0	Ap, Oct	$7\frac{3}{32}$	$7\frac{1}{16}$
5	2/9	Do. 5½% Cum. Pref.	$5\frac{13}{16}-6\frac{1}{16}$	4 11 6	—	$5\frac{31}{32}$	$5\frac{7}{8}$
St.	6%	Do. Permanent 6% Deb. Stock	139 —141	4 7 0	—	..	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103 —105	4 15 0	—	..	..
5	—	Brisbane Electric Trams. Invest. Ord.	$1\frac{1}{2}-1\frac{3}{4}$	..	..	$1\frac{5}{8}$	$1\frac{9}{16}$
5	2/6	Do. 5 per Cent. Cum. Pref.	$4\frac{1}{2}-4\frac{3}{4}$	5 5 0	—	$4\frac{3}{4}$	$4\frac{5}{8}$
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	99 —104	4 6 6	—	$101\frac{3}{4}$	$101\frac{1}{2}$
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	122 —125	4 16 0	—	$124\frac{3}{4}$	120
St.	5%	Do. Pref. Ord. Stk	110 —113	4 8 6	—	$112\frac{1}{4}$	$108\frac{7}{8}$
10	5%	Do. 5% Cum. Perp. Pref. Stock.	107 —110	4 11 0	—	$109\frac{1}{2}$	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	104—106%	4 5 0	—	—	—
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 6	—	..	..
5	3/0	Buenos Ayres and Belgrano Ord.	$3-3\frac{1}{2}$	5 0 0	—	$3\frac{1}{4}$	$3\frac{7}{32}$
5	3/0	† Do. 6 per Cent. "A" Cm. Pref	$5\frac{1}{8}-5\frac{3}{8}$	5 6 0	—	..	..
5	3/0	Do. "B"	$4\frac{7}{8}-5\frac{3}{8}$	5 2 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —107	4 13 6	—	106	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —101	4 19 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	—	—	—
100	6%	† Do. 6% 1st Deb. Bonds	100 —105	5 14 0	..	..	—
5	4/6	† Calcutta Tramways (Nos. 1 to 105)	$8-8\frac{1}{2}$	4 14 0	—	..	..
5	2/6	Do. Nos. 105,001 to 137,610	$7\frac{7}{8}-8\frac{3}{8}$	4 14 6	—	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	105	$103\frac{1}{2}$
1	0/6	Cape Electric Tram Shares	$\frac{1}{2}-\frac{3}{4}$	3 6 6	—	..	..
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —103	4 18 0	—	..	—
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	$95\frac{1}{2}$	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —93	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	83 —87	6 18 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	$1\frac{3}{8}-1\frac{9}{16}$	3 4 0	..	..	..
1	0/7½	Do. 6% Cum. Pref.	$1\frac{1}{8}-1\frac{3}{8}$	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 —103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	103 —105	4 5 6	—	$104\frac{1}{2}$	—
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	..	..
..	$2	† Sao Paulo Tramway, Light and Power Co. $100 Stock	137 —139	5 11 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	98%—100%	5 0 0	—	100	99
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	$5\frac{1}{4}-5\frac{3}{4}$	4 17 0	..	..	..
5	5/3	Calcutta Elec. (1-50,000)	$8\frac{1}{8}-8\frac{5}{8}$	4 12 9	..	..	..
50	5%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbr.	48 —50	5 0 0	..	..	..
—	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	$2\frac{1}{2}-3$	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 8 6	—	..	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108 —111	5 8 0	—	$109\frac{5}{8}$	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}-\frac{27}{32}$	7 8 6	—	—	..
1	1/6	Rand Electric	$1-1\frac{1}{8}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}-\frac{11}{16}$	—	..	$\frac{5}{8}$	..
1	1/2⅖	Do. 6% Non. Cum. Pref	$\frac{7}{8}-1$	6 0 0	—	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	—	..
5	3/0	† Rosario Elec. Co. 6% Pref. (1-20,000)	$5-5\frac{1}{2}$	5 9 6	—	..	..
100	4½%	*† Royal Elec., Montreal 4½% 1st Mort. Deb	97 —101	4 9 0	Ap, Oct	—	...
—	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101%	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., Oct. 3.	Rate % Yielded. £ s. d	Dividend Due.	Business, Week to Oct. 8. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	10 –11	6 7 0	..	10⅜	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9¾–10¾	4 8 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10¾–11¼	5 6 6	..	..	–
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –105	4 5 6	..	104½	104
5	2 0	†Bromley (Kent) El. Lt. & Power Shares	5 –5½	5 0 0	..	..	..
St.	4½%	Do. Do. 1st Debs	101 –104	4 7 6	–	..	..
5	4/6	Brompton & Kensington Elec. Sup. Ord	8¼–8¾	5 14 0	–	..	..
5	3/6	Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	101 –104	3 17 0	–	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4⅜–4⅞	5 2 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4½–5	4 10 0	Feb, Aug	..	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	3 17 0	–	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 –4½	5 0 0	–	..	..
5	2/3	Chelsea Electric Supply Ord.	5⅜–5⅞	5 2 2	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec ..	..	..
10	5/0	City of London Electric Lighting Ord.	10 –11	5 9 0	Feb, Aug	..	–
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	–	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	123 –126	3 19 4	Jn, Dec ..	..	..
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	100 –103	4 7 6	..	102½	102
5	4%	County of Durham Elec. P.D. Ord. £3 pd.	2⅞–3	4 0 0	April, Oct	..	–
5	5%	Do. Do. 5% non cum. pref.	5¼–5½	4 13 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	8⅜–8⅞	5 6 0	–	8¾	8 9/16
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 4 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	103	..
5	3/6	†Folkestone Electricity Supply Co. Ord.	5 –5½	5 5 0	..	–	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4⅞–5⅜	4 12 6	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	–	–	..
5	5/0	Hove Electric Lighting Ord.	8¼–8¾	5 5 0	–	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	–	..	–
5	5/0	Kensingtn. & Kngtsbdg. Ord	9¾–10¾	4 13 0	–	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	–	–
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 –102	3 18 6	..	..	..
St	4%	†Kensingtn. & Kngtbg. Co & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	99 –101	3 19 0	–	..	..
3	2/4½	London Electric Supply Ord.	1⅞–2⅜	4 4 0	–	–	..
5	3/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	–	–	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	..	..
5	4 0	Metropolitan Electric Sup. Ord.	8 –8½	5 6 0	April, Oct	8¼	8 1/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅜	4 8 6	Jan. July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec ..	–	..
St.	3½%	Do. 3½ per Cent. Mrt. Db. Stock (red.)	95 –97	3 12 0	–	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	–	..	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11 –11½	3 18 3	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	102½–103½	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7½–7⅝	5 5 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾–6	4 6 11	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	98 –100	4 0 10	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	1 3/16–1¼	2 8 0	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	–	–
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	† Do. 4 per Cent. 1st Mt. Debs.	96 –98	4 1 6	..	..	–
5	2/6	Oxford Electric Ord.	6⅛–6⅝	5 0 0	March ..	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	–	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	9¾–10¾	5 16 0	Feb, Aug	10	..
5	3/6	Do. 7 per Cent. Pref.	7 – 8	4 7 0	Feb, Aug	..	–
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	95 –97	3 12 2	–	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	1 –2	10 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	–	..	..
5	4/0	South London Electric Supply Ord	2⅝–3⅛	6 5 0	..	2 29/32	2⅝
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	11/16–⅞	–	..	..	–
1	0/8⅖	Do. 7% Cum. Pref.	1⅛–1⅜	4 14 0	..	..	..
St.	4½%	† Do. 4½ 1st Db. Stk. Red.	102 –105	4 5 6	–	..	–
5	2/6	Urban Electric Supply Ord.	3¼–3¾	6 15 0	–	..	..
5	2/6	Do. 5% Cum. Pref.	4¼–4¾	5 2 6	–	..	..
St.	4½%	Do. 4½% 1st Mort. Deb.	97 –100	4 10 0	..	99	97¾
5	5/6	Westminster Elec. Sup. Ord.	9½–10¼	6 12 0	Mar, Sept	10 1/16	9 15/16
5	2/3	Do. 5 per Cent. Cum. Pref.	5¼–5½	4 11 0	..	–	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	–	..	..
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	..	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	..	..
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	102 –105	4 5 6	–	–	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 –100	4 10 0	..	..	..
10	2½%	Bristol Tramways and Carriage Ord.	14¾–15¼	6 2 0	Feb, Aug	–	–
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	–	–
St.	4%	Do. 4 per Cent. Debs.	101 –103	3 17 6	Feb, Aug	..	..
10	6/0	British Electric Traction Ord.	4½–5½	5 9 0	–	5⅜	4¾
10	6/0	Do. 6 per Cent. Cum. Pref.	8 –9	6 13 0	Feb, Aug	8⅝	8½
St.	5%	† Do. 5 per Cent. Perpetual Debs	109 –113	4 8 6	..	111½	110½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	92½–95½	4 14 0	..	94	..
St.	4%	Central London Ordinary Stock	83 –85	4 14 0	June, Dec	84½	83¼
St.	4%	Do. 4 per Cent. Pref. Stock	97 –99	4 1 0	..	99	–
St.	4%	Do. Deferred Stock	73 –76	5 5 0	..	73¾	..
100	4%	Do. 4 per Cent. Debs.	108 –110	3 12 8	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	84 –89	4 10 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5 –5¼	4 15 0	..	..	–
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	3 17 6	..	..	..
St.	2½%	City and South London Rly. Con. Ord.	42 –44	4 11 0	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 –122	4 2 0	Feb, Aug	..	..
St.	5%	Do. (1896)	115 –118	4 4 8	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	–	115	114¾
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	3 14 8	May, Nov	104½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½–4	10 0 0	..	..	..
St.	4½%	†Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	99 –102	4 8 0	..	..	..
10	9%	‡ Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	–	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	102½–104½	4 6 0	Jan, July	–	–
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	–	..	–
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	–	..	..
10	1½%	Liverpool Overhead Railway Ord	8 1/16–8 5/16	3 18 0	Feb, Aug	..	–
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	3 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9⅛–9⅝	5 7 0	–	9¼	9 3/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	93 –96	4 3 0	–	–	..
St.	..	Mersey Con. Ord. Stock	5 –7	–	–	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	7 –10	–	–	..	..
1	–	Metropolitan Elec. Trams Def.	⅛–3/16	..	–	..	..
1	0/6	Do. 5% Cum. Pref.	13/16–15/16	5 9 0	–	29/32	..
St.	4½%	Do. 4½% Deb. Stock	98½–100½	4 9 6	–	..	–
5	–	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May – –	1 1/16	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¼	5 10 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7½–8½	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 3	–	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	86 –91	5 10 0	–	..	..
..	5%	Und. Elec. Rys. Co. of Lond.	90 – 92	5 8 8	–	90 9/16	..
St.	3%	Waterloo and City Ord.	101 –104	2 17 6	June, Dec	102	101½
5	..	Yorkshire W.R. El. Trs. Ord.	1¼–1½	..	..	–	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	–	–	..
St.	4½%	Do. 4½% 1st Debs.	91 –94	4 15	–	..	–

Shre.	Last Dividend	Name.	Price Wed., Oct. 3.	Rate % Yielded. £ s. d.	Dividend Due.	Business, Week to Oct. Highest.
		ELECTRIC MANUFACTURING, &c.				
1	10½d.	Aron El. Met. 6% Cm. Pf.	½–⅝	..	–	½
1	1/7½	†Babcock & Wilcox Ord	3⅞–4⅛	4 12 6	..	4
1	7½d.	† Do. Pref	1 7/16–1 9/16	3 17 0	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6½–6¾	5 10 0	July, Feb	..
5	5/0	Do. 6 per Cent. Pref.	5⅞–6⅛	4 18 0	Jan, July	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94 –98	4 12 3	..	..
5	..	British Westinghouse 6% Pref.	1¼–1¾	..	..	1 9/16
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	78
2	1/0	Brush Electrical Engineering	¾–1	–	March ..	..
2	2/4½	Do. 6 per Cent. Pref. Non-Cum.	1¼–1¾	6 16 6	Mar, Sept	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –98	4 11 9	Mar, Sept	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 –84	5 7 2	Jan, July	..
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	11
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5⅝
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	..
1	9⅜d.	Castner-Kellner Alkali Co.	1 15/32–1 17/32	5 4 6	..	..
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	–	..
1	9½d.	†Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	–	–
1	7½d.	† Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..
2	1/6	Crompton and Co. (Nos. 1 to 54,000)	1⅝–1⅞	3 13 6	Jan, July	..
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%–97%	5 2 0	Jan, July	97
5	10/0	Dick, Kerr & Co. Ord.	1⅝–1⅞	5 11 0	Sept – –	1 21/32
5	7½d.	† Do. 6% Cum. Pref.	1 3/16–1 5/16	4 11 6	Sept – –	..
St.	4½%	Do. 4½% Deb. Stock	103 –106	4 5 0	..	..
5	1/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1¾–2	3 15 0	Feb, Aug	1⅞
5	2/6	Do. (£5 paid)	2½–3	4 4 0	Feb, Aug	2⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	85 –87	4 12 0	June, Dec	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	89 –94	5 6 0	–	..
5	1/6	Edmundson's Elec. Corp. Ord.	3⅜–3⅞	9 6 0	H'lf-yearly	..
5	3/0	Do. 6 per Cent. Cum. Pref.	4⅞–5⅜	5 11 6	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 –103	4 7 4	–	..
2	1/7½	Electric Construction Co.	¼–½	14 0 0	July – –	..
2	2/2⅘	Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	84 –87	4 12 0	Jan, July	..
10	5/0	General Electric (1900) 5% Cum. Pref.	9 –9½	5 5 3	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	91 –94	4 5 0	–	..
5	5/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	12⅛
5	2/3	Do. 4½ per Cent. Pref.	5¼–5½	4 2 0	Feb, Aug	..
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½–109½	4 2 0	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	17 –18	2 17 2	Feb, Aug	..
100	4%	† Do. 4% Debs. Red.	99 –101	3 19 0	..	..
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 3 4	Mar, Sept	..
1	1/2⅖	Richardsons, Westgarth & Co., Ltd. Ord.	29/32–31/32	6 3 0	..	1
1	7½d.	Do. 6% Cum. Pref.	1 –1⅛	5 7 0	–	1 1/16
St.	4½%	Do. 4½% Perp. Deb. Stock	97 –100	4 10 0	..	97
1	..	Simplex Conduits Ord.	1½	..	–	..
5	..	Do. 6% Cum. Pref.	5¼	..	..	..
12	12/0	Telegraph Construction & Mainten'ce.	33½–35½	5 12 6	Mar, July	35
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2 5/16–2 7/16	6 2 6	..	2 5/16
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1 3/16	4 2 6	..	1 5/32
St.	5%	Do. 5% Non-Cum. Preferred	113 –116	4 6 0	–	..
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	104¾
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	103 –105	4 5 6	–	104¾
5	–	Willans and Robinson Ord.	½–1	..	Apr, Oct	–
5	–	Do. 6 per Cent. Cum. Pref.	2 –2½	..	Apr, Oct	–
	4%	Do. 4 per Cent. 1st Mort. Debs.	77 –82	4 17 6	May Nov	78
		TELEGRAPHS.				
10	–	Amazon Telegraph	1¾–4¼	–	Jn, Dec ..	3 29/32
100	5%	Do. 5% Debs. (red.)	88 –93	5 7 0	..	..
St.	15/0	Anglo-American	66½–68½	4 15 0	F, My, Ag, N	68
St.	30/0	Do. Preferred	113 –114	5 5 6	F, My, Ag, N	113⅞
St.	10/0	Do. Deferred	24⅜–24⅝	2 2 6	F, My Ag, N	24 9/16
St.	4%	†Commercial Cable 4 per Cent. Deb. Stk	95 –98	4 1 6	Jn, Ap, Jy, O	97¾
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	..
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..
5	2/0	Direct Spanish Ord	3⅜–3⅝	5 6 6	April, Oct	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	3 19 0	Jan, July	..
20	6/6	Direct United States Cable	15⅜–15⅝	4 14 6	Ja, Ap, Jy, O	15⅝
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec ..	..
St.	65/0	Eastern Ordinary	144½–147½	5 8 0	Ja, Ap, Jy, O	146½
St.	17/6	Do. 3½ per Cent. Pref. Stock	90½–92½	3 17 3	Ja, Ap, Jy, O	91½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108½
10	2/6	Eastern Extension	14¼–14¾	4 10 3	Ja, Ap, Jy, O	14½
St.	4%	Do. 4 per Cent. Deb. Stock	105½–107½	3 14 3	Feb, Aug	..
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	3 19 0	Feb, Aug	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–103%	3 17 6	May, Nov	..
10	5/0	G. N. (of Copenhagen) with coupon 68	26 –28	6 5 0	Jan, July	[illegible]
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..
25	52/6	Indo-European	59 – 61	5 6 6	May, Nov	59¾
100	4%	Mackay Companies Common	73 11/16–74 11/16	5 7 0	Jan, July	–
100	4%	Do. Preference	73 3/16–73 9/16	5 9 0	Ja, Ap, Jy, O	..
1	..	Marconi's Wireless Teleg. Co.	1 –1¼	..	..	1⅛
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	3 18 5	June, Dec	..
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..
2½	–	West Coast of America	¾–⅞	..	–	..
100	4%	Do. 4 per Cent. Debs.	100½–103½	3 17 3	Jan, July	..
10	–	West India and Panama	⅜–½	–	May, Nov	..
10	4/0	Do. 6% 1st Pref.	6½–6¾	3 18 0	May, Nov	..
10	–	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..
10	3/0	Western Telegraph	14⅜–14⅞	4 14 6	Mr, Jn, O, D	14 11/16
100	5%	* Do. 5% Debs. (2nd Series, 1906)	–	4 17 0	June, Dec	..
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	3 15 6	–	..
		TELEPHONES				
–	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 3 4	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..
5	5/0	Chili Telephone (fully paid)	6¾–7¼	5 11 0	August –	..
1	0/4½	Monte Video Telephone Ord.	15/16–1 1/16	3 15 3	–	..
1	0/6	Do. 5% Pref.	⅞–1	5 0 0	..	..
St.	6%	National Co. Pref. Stock	109½–111½	5 7 6	–	110⅝
St.	5%	Do. Def. Stock	109 –111	4 10 0	–	110⅝
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12 –13	4 13 6	Feb, Aug	12⅛
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11½–12½	4 16 0	Feb, Aug	..
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5 9/16–5 13/16	4 7 6	Feb, Aug	5 11/16
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	99¾
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	3 17 0	–	103¾
1	0/9⅜	Oriental	1 5/16–1 7/16	4 3 6	April, Oct	1⅜
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16–1 5/16	4 11 0	–	..
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	–	97
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	..
5	5/0	United River Plate	7 –7½	5 0 8	July – –	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 2 0	June, Dec	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 0 8	June, Dec	..
		FINANCIAL, INVESTMENT, &c.				
5	3/0	Elec. & Gen. Investment 5% Cum. Pref.	4½–5½	5 10 0	–	..
10	2/0	Globe Telegraph and Trust	10⅞–11⅜	4 10 0	Ja, Ap, Jy, O	11⅛
10	3/0	Do. 6 per Cent. Pref	14⅝–14⅞	4 0 6	Ja, Ap, Jy, O	14¾
10	6%	Submarine Cables Trust (Cert.)	159 – 162	4 11 0	April, Oct	..

* In calculating the yields, allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

The formal inauguration on Wednesday last of the new Summer-lane electricity station by the Lord Mayor of Birmingham, of which we commence a full description in another column, adds a fine example to the long list of municipal power houses. The result of Mr. CHATTOCK's labours presents a number of points of interest to engineers. Critics will no doubt carp at the use of reciprocating engines for a size of unit which is now frequently associated with the steam turbine, but we doubt not that the decision to adopt the more old-fashioned style of plant was founded on good reasons. The chief characteristic of the equipment is its diversity and its elaborate nature. The buildings themselves are evidence that no money has been spared in matters of detail, and the conditions of supply involve plant of some variety. The switch gear, which we hope to describe at some length in our next issue, is more than usually intricate. Owing to the peculiar position of the station, practically in the centre of the area of the supply, and the existence of two other plants of considerable output, there have been introduced into the controlling arrangements, on the continuous-current switch gear especially, a series of interconnecting and boosting panels which probably have no parallel in any other station of similar output. For instance, one of the two distant stations which must be run in conjunction with the Summer-lane plant is further away than the other, the extra distance representing on full load a drop of 20 volts over and above that on the trunk main to the other station. This necessitates a special trunk booster for this particular feeder. Again, the use of both alternating and continuous-current plant for traction and lighting almost naturally introduces the desire, if not the actual need, for the supply of both systems from any one set of generating plant. The Summer-lane station is probably unique in that it is a very large plant in the centre of an extensive district supplying energy for lighting, power and traction from both alternating and continuous-current machines, and operating in parallel with two other steam stations and a number of sub-stations simultaneously.

◆

The question of charging accumulators off an alternating-current supply is one of some importance, and during the last few years several rectifying devices have made their appearance. Of the rotary type of rectifier the permutator is one of the most recent, but has certain peculiarities. In this connection the article by Mr. A. C. JOLLEY in the present issue will be read with interest. It appears that the permutator is very inefficient if used directly on a charging load, the form factor for the direct current being very high; but if the charging is effected through an inductance in series with the battery the efficiency is much improved, and the form factor is reduced to 1·1 by proper adjustment, so that the result compares favourably with the rotary converter. The Nodon valve, on the other hand, is quite efficient, even in small sizes, when coupled up so as to use both sides of the wave, and has the very great advantage that it is without moving parts. But the efficiency falls off rapidly if the temperature rises above 40°C., so that artificial cooling must be resorted to, or the valve must not be heavily worked.

◆

Very different points of view are taken by different sections of the Press as to the Wireless Telegraph Conference. Some of our contemporaries appear to regard the maritime supremacy of Great Britain as almost entirely due to Mr. MARCONI, and the other extreme is reached by a widely-read halfpenny paper, which speaks of the "un-British, unenlightened attitude to which the Admiralty's foolish bargain with the Marconi Company seems to have committed the British delegation." Of the actual progress made by the Conference towards the elaboration of a workable convention, no reliable information can as yet be given, as the proceedings are taking place with closed doors.

The chief bone of contention is contained in Article 3 of the draft Convention, put forward by the German Government, and which reads as follows: "Coast stations and stations on board ship are bound to exchange telegrams between themselves without distinction of the radiographic system adopted by such stations." But it is impossible to predict at present whether this article will be finally passed entirely without modification.

On another page we reproduce at some length Mr. Esson's Presidential Address to the Civil and Mechanical Engineers' Society, and elsewhere we deal with some of the points which are raised. The address will be read with interest; but we have a complaint to make. Why does Mr. Esson deal in electrical horse-power? Kilowatts and kilowatt-hours are in general use; they have some of the advantages of the decimal system, and they are simply connected with other quantities, whereas the electrical horse-power-hour requires something of a mental effort to connect it with the Board of Trade unit, and forms a trap for the unwary. Is it that civil and mechanical engineers in this day of grace are unfamiliar with the kilowatt? We can scarcely think so; yet there seems to be no other reason for adopting a unit which we do not doubt annoyed Mr. Esson himself in the writing, as much as other people in the reading, of his address.

The connection between art and engineering is but slight and indefinite, for the inartistic is generally the cheaper, and we have a reputation, rather undeservedly perhaps, for being an inartistic nation. This in itself, however, is scarcely a valid excuse for the County Council to damage the trees along the Embankment in extending the tramway service between the bridges at Westminster and Blackfriars. The Embankment is one of the few London thoroughfares that can make a serious claim to any beauty, and from this point of view it should be respected. By leaving a margin of only about 4 ft. between the trams and the trees, it will be necessary to convert the latter into a glorified hedge on one side. We do not advocate the sacrifice of utilitarian ends to the æsthetic taste, but with a thoroughfare so wide as the Embankment we think that something better might have been done.

Much regret will be felt at the disastrous fire which has taken place at the Merchant Venturers' Technical College at Bristol. We understand that the damage is covered by insurance; but records and manuscripts cannot be replaced by such means, and there is probably no more unfortunate time for such an occurrence than the beginning of a session. We trust, however, that the successful work of this institution, which is one of our oldest technical colleges, will not be very seriously impaired, and that Principal Wertheimer and his staff may be enabled to resume the essential part of their technical courses in a comparatively short time.

Cable Interruptions and Repairs.

	Date of Interruption.		Date of Repair.
Tarifa—Tangier	Jan. 18, 1904	..	—
Garachico (Teneriffe)—Santa Cruz de la Palma	July 12, 1906	..	—
Môle St. Nicholas—Port au Prince	Aug. 16, 1906	..	—
Grand Canary—Lanzarote ..	Sept. 18, 1906	..	—
Gibraltar—Tangier..........	Oct. 3, 1906	..	Oct. 10, 1906

Wireless Telegraph Notes.—It is stated that the Argentine Government has granted a licence to the President of the River Plate Wireless Telegraphy Co. to establish wireless telegraph stations in Argentine territory and on board Argentine ships. The stations are to be subject to the ordinary telegraphic laws and regulations and the tariffs are to be fixed by the Government.

It is announced that wireless telegraph communication was established from the "Telefunken" station at Nauen, near Berlin, with the steamship "Bremen," of the North German Lloyd, every day for four days after sailing from Bremen up to a distance of 1,550 miles.

Wireless Telegraph Patent Litigation.—The Lodge-Muirhead Wireless & General Telegraphy Synd. have commenced an action against Marconi's Wireless Telegraph Co. for an injunction to restrain defendants from threatening plaintiffs and their customers with legal proceedings or liability for infringement of defendants' letters patent, and for a declaration that plaintiffs' system of wireless telegraphy is not an infringement of any patent rights of defendants.

London County Council Tramways.—The London County Council added another 7 or 8 miles to its system on Monday, October 1st, when the lines from Vauxhall to Norwood and Camberwell, formerly worked by the London Southern Tramways Co., were formally taken over. Powers will be sought during the coming Parliamentary session to convert the lines to electric traction.

It is anticipated that the Embankment tramways will be ready for running before the completion of the Holborn substation, so arrangements are being made with the Underground Electric Railways Co. for a temporary supply at 1d. per unit.

Errata.—Messrs. Armstrong, Whitworth & Co. have called our attention to a slight inaccuracy in our description of the heavy electrically-driven lathe on their stand (*The Electrician*, September 21st, p. 889.) The lathe is driven by a six-pole motor fitted with interpoles and not by a four-pole motor, and the dimensions of the cut which was being taken should have been given as 1¼ in. deep by ¼ in. traverse.

Mr. V. A. Fynn has kindly called our attention to a slight error which occurred in the reproduction of the diagram forming Fig. 1 of his letter on the above subject on p. 941 of *The Electrician* of September 28th. The angle α should be the angle comprised between ϕ and P_1, and not that between ϕ and $-E_1$ as there shown.

Electric Traction on the Great Western Railway.—Considerable progress has been made in the electrification of the Great Western and Hammersmith and City lines from Bishop's-road to Hammersmith, the principal details of which were described in *The Electrician* of June 22nd (p. 362) and June 29th (p. 406). A number of trial runs have already taken place, and it is anticipated that steam working will be discontinued in November. This and the adoption of electric locomotives for hauling the Great Western main line trains which run through Bishop's-road will finally complete the electrification of the portion of the Inner Circle belonging to the Metropolitan Railway and enable the full benefits of the new working to be felt, which should result in greatly improved service on all parts of the circle. The new Great Western trains will be similar to the newer trains of the Metropolitan Railway, which were described in *The Electrician* of June 1st, p. 248.

Holborn Fire.—The cause of this fire, which occurred on September 12th last in Holborn, was recently made the subject of an inquest held by Dr. F. J. Waldo, the City coroner, under the provisions of the City of London Fire Inquest Act of 1880, which empowers the coroner, if he thinks fit, to hold inquests on fires taking place in the City, even if, as in this case, they are unattended by loss of life. The leading circumstances of the fire will doubtless be remembered. It seems to have originated at a wooden partition on the stairs, behind which passed an electric light cable, and, as is usual, one of the witnesses suggested that this was in some way responsible for the outbreak. The evidence of Lieut. Sladen, third officer of the Fire Brigade, however, directly contradicted this, and the verdict of the jury was eventually to the effect that the cause of the fire was unknown. The evidence of the telephone operator that five minutes delay occurred before telephonic communication could be established with the Fire Brigade points to a most unsatisfactory state of affairs, and we wonder that more attention was not paid by the jury to this statement.

Engineering and Machinery Exhibition at Olympia.—A successful "Patrons' dinner" was given by the Executive committee of the Engineering and Machinery Exhibition at Olympia on Saturday last. Sir William White was in the chair, and about 100 persons were present, including Admiral Sir Eardley Wilmot, Sir George Bartley, Sir J. W. Swan, Sir Edwin Cornwall, M.P., Hon. J. W. Taverner (Agent-General for Victoria), Hon. C. A. Duff (Agent-General for New Brunswick), Hon. W. H. James (Agent-General for W. Australia), Hon. J. G. Jenkins (Agent-General for S. Australia), Profs. W. C. Unwin, E. G. Coker and J. Perry, Dr. R. T. Glazebrook, Mr. Edgar Worthington, Col. Sir E. Raban, K.C.B., and many others. Several interesting speeches were made. In replying to the toast of "The Army, the Navy and the Reserve Forces," proposed by Sir George Bartley, Admiral Sir Eardley Wilmot recalled the time when dynamos were first used in the navy. He was then a lieutenant on a ship stationed at Portsmouth, and an old powder hulk asked permission to go alongside. "What have you got?" he asked, and the reply was, "One of Mr. Dynam's machines." Since then things had changed, and now, on board ship, everything was done by electricity, from the ringing of bells to the firing of the guns. Col. Sir E. Raban replied for the army. The toast of the evening, "Success to the Engineering Industry and continued Success to the Engineering and Machinery Exhibition," was given by Sir Edwin Cornwall, M.P., who paid a warm tribute to the work of engineers, upon whom the community depend so much, both in the arts of war and peace. Sir William White responded, and was able to give a very gratifying account of the success of the exhibition. Other toasts were "The Colonies and British Dominions beyond the Seas," proposed by Sir William White and responded to by the Hon. J. G. Jenkins (Agent-General for S. Australia); "The Rising Generation of Engineers," proposed by Dr. R. T. Glazebrook and responded to by Prof. J. Perry; "Patrons and Visitors," proposed by Mr. Edgar Worthington; and "The Chairman," proposed by the Hon. J. W. Taverner.

Electric Launch on Lake Vyrnwy.—The Liverpool Corporation have recently replaced the petroleum-driven launch which has been in use on Lake Vyrnwy, whence the city water supply is obtained, for the last 11 years, by an electric launch. According to the *Liverpool Courier*, the new launch has been specially designed for the purpose of towing barges laden with stone and other materials, as well as for ordinary use in inspection and transportation of workmen. It has an overall length of 31 ft., an extreme beam of 6 ft. 8 in., with a draft of 2 ft. 3 in. There is seating accommodation for 25 persons, and a large awning is provided. The propeller is driven by a two-pole motor rated at 6 H.P., situated amidships, and is supplied at 150 volts. The controller and steering wheel are placed forward, and an ammeter and a voltmeter are provided. The battery consists of 88 Faure-King cells carried in acid-proof lockers under the seats, and is of sufficient capacity for a run of about 45 miles. Charging is effected through a flexible cable from a charging station on shore which contains a switchboard provided with regulating resistance, switches and instruments, and supplied with current from the small generating plant recently laid down by the Corporation for local lighting purposes, and worked by the flow of the compensation water into the river Vyrnwy. The propeller, shaft and stern tube are of manganese bronze, and the steering is effected by a rudder of the suspended balance type. A portable electric masthead light is fitted, which can also be utilised for general inspection and lighting purposes in any part of the boat. During the official trials, with 20 persons on board, the mean speed obtained on the measured mile on consecutive runs, with and against the wind, was 7·75 miles per hour, this being $\frac{3}{4}$ mile in excess of the contract speed. On a continuous run of three hours an average speed of 7·8 miles per hour was developed.

A New Traction System with Rectified Single-phase Currents.—A long article in the *Bulletin* of the Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore describes a proposed system of electric traction for main lines of railway which is being developed by Messrs. Auvert & Ferrand. The method involves the employment of a special design of "regulating rectifier," which takes single-phase current from the line and supplies continuous current at varying voltage to the motors driving the train, its function being similar to the motor-generator of the Ward-Leonard system. The apparatus is somewhat similar in principle to some forms of "permutator," and consists of a group of commutators connected to sections of a revolving ring winding, and driven by a synchronous motor. The arrangement differs from the usual forms of permutator in that the commutators revolve and not the brushes, but, like the permutator, does not involve a driving motor capable of handling the total power, as the rotation is only required for collecting and not for inducing the transformed current. The apparatus is, therefore, considerably lighter than a motor-generator of corresponding output. The sections of the rotating winding may, roughly speaking, be compared to auto-transformers, the steps of which are so connected to the commutator segments that the alteration of the relative position of the two sets of brushes controls the mean voltage of the "continuous" current side of the apparatus. Thus, all regulation of the voltage supplied to the motors driving the train, and consequently of the speed of the train, can be effected by shifting the brushes of the rectifier entirely without the use of rheostats. The resulting rectified current is, of course, pulsating, but the introduction of an impedance coil into the circuit to some extent improves its wave form. The system has not as yet been tried under actual traction conditions, but the P.L.M. Railway has carried out a series of tests at their workshops in Paris, with a 400 kw. set, consisting of two regulating rectifiers each having two commutators with four lines of brushes. In order to approximate as nearly as possible to traction conditions, the load consisted of four series-wound traction motors which were belted to generators, so that their output could be easily measured. The rectifiers were geared together and driven by a small synchronous motor at 750 revs. per min., the input current being supplied from a single-phase transformer at 160 volts, 25 cycles. The voltage on the continuous-current side could be varied from 20 to about 250 volts and the overall efficiency of the converting system was found to be 93 per cent. at the latter and 68 per cent. at the former voltage. Some further tests have been carried out at the Alioth Company's works near Basle, where the reversibility of the apparatus was demonstrated, indicating not only the possibility of regenerative braking but the use through the medium of similar appliances of sub-station batteries on single-phase systems. It should be added that in neither of these tests was the slightest trouble experienced with sparking.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, October 13th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7:30 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham. Paper by W. Langdon-Davies and F. B. O. Hawes, on "Some Points about Single-phase Motors."

JUNIOR INSTITUTION OF ENGINEERS.

3 p.m. Visit to Engineering and Machinery Exhibition, Olympia.

TUESDAY, October 16th.

JUNIOR INSTITUTION OF ENGINEERS.

7 p.m. Annual General Meeting, at Westminster Palace Hotel. Election of officers and council for ensuing session. Paper by R. E. B. Dunbar Kilburn, on "The Protection of Inventions." Annual General Meeting on Benevolent Fund.

FRIDAY, October 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

8 p.m. General Meeting. Adjourned discussion on Paper by T. H. Riches and S. B. Haslam, on "Railway Motor-Car Traffic." Paper by E. M. Hann, on "Some Notes on the Mechanical Equipment of Collieries."

CALCULATION OF THE CHARACTERISTIC CURVES OF SINGLE-PHASE SERIES COMMUTATOR MOTORS.

BY PROF. O. S. BRAGSTAD AND STANLEY P. SMITH, B.SC.

To predetermine the load curves of electromagnetic machines, in which the magnetic saturation of the path of the main flux has to be considered, it is necessary to first calculate the magnetisation curve of the machine, and from it deduce the characteristic curves by means of the "point-by-point" method. Moreover, in the case of the single-phase commutator motor there is another reason which makes a point-by-point method essential—viz., on account of the currents which are induced in the armature short-circuited coils by transformer action, since these currents are strongly affected by the main flux in the machine, and bear no known algebraic relation to the E.M.F.s induced in these coils. In the present Paper, therefore, the authors propose to show how a point-by-point method has been used to determine the characteristics of a motor when both the saturation of the iron and the effect of the currents in the short-circuited sections are taken into account.

It will be convenient to divide the Paper into three parts :—

1. Effect of magnetic saturation.
2. Effect of the currents in the armature coils short-circuited by the brushes.
3. An illustrative example.

1.—EFFECT OF MAGNETIC SATURATION.

The *main* flux is defined as that flux which is interlinked with both the short-circuited and the field coils. The curve showing the relation between the instantaneous values of the main flux and of the current in the exciting coils is called the *magnetisation* curve. This is determined in precisely the same way as the magnetisation curve of a continuous-current machine. The assumption of a sine wave for the impressed E.M.F. curve is quite justifiable, since most alternating-current machines are designed either to yield, or to work on, a sinusoidal wave shape. We can now examine what shape the flux, current and counter E.M.F. curves will assume under various conditions of saturation when such an E.M.F. curve is applied at the motor terminals.

(*a*) *The Fundamental Wave.*—The counter E.M.F. will have the same wave shape as the impressed E.M.F., except in so far as it is distorted by ohmic resistance and leakage reactance. Neglecting, for a moment, the effect of the latter, we can consider the applied E.M.F. to be consumed by the counter E.M.F., wherefore the latter must follow a sine wave in the same way as the former. This counter E.M.F., which is produced by the main flux, has two components. The one, a static E.M.F., is due to the transformer action of the exciting coils ; the other, a dynamic E.M.F., is due to the rotation of the armature coils in the magnetic field. Since these two E.M.F.s must together form a sine wave, neglecting losses, to counterbalance the impressed sine E.M.F. wave, we can write:

$$T_r \omega_r \Phi + T_s \frac{d\Phi}{dt} = E_{max.} \sin(\omega t + \phi),$$

where Φ = momentary value of the main flux,

ω_r = angular velocity of rotation,

T_r and T_s = number of turns in series on armature and field respectively,

whence $$T_r \omega_r \Phi dt + T_s d\Phi = E_{max.} \sin(\omega t + \phi) dt.$$

This differential equation is satisfied if we put

$$\Phi = \Phi_{max.} \sin \omega t,$$

for we then get

$$E_{max.} \sin(\omega t + \phi) = \Phi_{max.}(T_r \omega_r \sin \omega t + T_s \omega \cos \omega t)$$
$$= \Phi_{max.} \sqrt{(T_r \omega_r)^2 + (T_s \omega)^2} \sin(\omega t + \phi),$$

where $$\phi = \tan^{-1} \frac{T_s \omega}{T_r \omega_r}.$$

From this we see that the main flux Φ must vary after a sine curve, when the impressed wave is sinusoidal and the losses are neglected. This sinusoidal flux curve which produces the counter E.M.F. will be referred to as the *fundamental* wave of the flux curve, since we shall afterwards show that the resultant flux curve will be somewhat distorted by the losses.

We must now find the shape of the current wave which is necessary to produce this fundamental wave in the flux curve. For this purpose we must have the curve of magnetisation, which shows the relation between instantaneous values of flux and current. This is shown in Fig. 1 (A, B and C). Fig. 1A represents the magnetisation curve of the machine, whilst Fig. 1B shows a simple construction for obtaining the current wave under the assumption of a particular wave shape (in this case, the first harmonic) of the flux curve. It is seen that the current wave, which is necessary to produce the first harmonic of the flux curve, is considerably peaked at high saturations. Two such current waves are shown in Fig. 1B for different values of flux. The curve I′ represents the current when the amplitude of the fundamental flux wave is $4 \cdot 75 \times 10^6$ which corresponds to a very large overload on the machine in question, whilst curve I″ is drawn for the fundamental flux wave whose maximum value is 4×10^6, corresponding to about 25 per cent. overload. The current waves I′ and I″ have been analysed and their fundamental waves are shown dotted I_1' and I_1''. It will be seen that these latter are the only current harmonics which contain a watt component, since the higher harmonics, having no corresponding terms in the applied pressure wave, must be wattless. By subtracting the first harmonics I_1' and I_1'' from their respective current waves I′ and II″, we obtain these higher harmonics, which must be present in the current curve in order to produce the fundamental flux wave. These higher harmonics are shown in Fig. 1C.

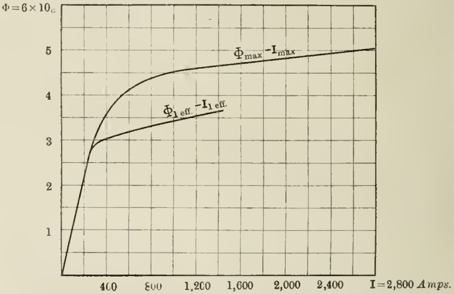

FIG. 1A.—MAGNETISATION CURVE OF 75 H.P. MOTOR.

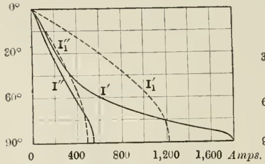

FIG. 1B.—CONSTRUCTION FOR FINDING CURRENT CURVE REQUIRED TO PRODUCE THE FUNDAMENTAL FLUX WAVE.

Curve I′ = very large overload.
Curve I″ = 1¼ full load.

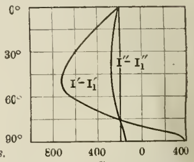

FIG. 1C. — SHOWING THE HARMONICS IN THE CURRENT CURVES OF FIG. 11B.

The diagram for the fundamental wave can now be drawn. This is shown in Fig. 2, where the impressed E.M.F. E is a sine wave and I_1 is the fundamental wave of the current curve which is required to produce the fundamental flux wave. The vector I_1 is displaced from the flux vector Φ_1 by an angle α, the so-called hysteretic angle of advance.*

The vector I_1R is drawn parallel (in phase) with the current I_1 and represents the total pressure drop due to ohmic resistance in the motor ; whilst I_1X, representing the pressure drop due to stray reactance, is displaced 90 deg. from the current. The stray reactance is the reactance of the path of that flux which is not mutually associated with stator and rotor windings, and thus includes all reactances due to leakage flux.

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* The angle $\alpha = \sin^{-1} \frac{W_i}{E_{s_1} I_1}$, where W_i = iron losses when motor is at rest,

and E_{s_1} = E.M.F. induced in field coils,

$$= \frac{1}{\sqrt{2}} \omega T_s \Phi_1 10^{-8} = 4 \cdot 44 c T_s \Phi_1 10^{-8},$$

T_s = number of stator coils in series.

The E.M.F. due to rotation is directly opposed to the main flux and is represented by

$$E_m = \frac{1}{\sqrt{2}}\frac{p}{a}\frac{n}{60}N_1\Phi 10^{-8}$$
$$= \frac{1}{\sqrt{2}}\omega_r T_r \Phi_1 10^{-8} \text{ volts,}$$

where

p = half the number of poles,
a = half the number of armature paths,
N = total number of armature conductors,
n = revs. per min.,
$\omega_r = \frac{pn}{60}$ = electrical angular velocity of rotor,
$T_r = \left(\frac{2}{\pi}\right)\frac{N}{4a}$ = effective number of rotor turns in series between two brushes $\left(\frac{2}{\pi} = \text{winding factor}\right)$.

Then E_m, the E.M.F. consumed by the counter E.M.F. of rotation, is the closing vector of the diagram.

It will be noted that the effect of the iron losses is not only to increase the effective resistance of the motor, but produces also a slight phase displacement α between the E.M.F. due to rotation and the current, causing the former to lag, thus improving the power-factor somewhat (see Fig. 1).

(*b*) *The Harmonics.*—Since the applied pressure has been taken as a sine wave, we must regard the machine terminals as being short-circuited in respect of the harmonics of the motor current; that is to say, the geometrical sum of all the E.M.F.s of each of the harmonics must equal zero in the motor itself, or, in other words, any E.M.F.s needed to drive the current harmonics cannot come from the sinusoidal impressed E.M.F. wave. Of course, if the current harmonics encountered neither resistance nor reactance, then no E.M.F. would be necessary to drive them, but in reality both ohmic resistance and leakage reactance have to be overcome, in consequence of which corresponding E.M.F.s will have to be present. Now these latter cannot, as we have seen, come from the impressed wave, hence they must be induced by the flux wave, and, since an E.M.F. curve has the same shape as its flux curve, it at once follows that, owing to losses, the flux curve cannot any longer be a pure sine wave, whilst its deviation from such will increase with the magnitude of the current harmonics. We thus see that the harmonics in the current curve give no power to the motor, since they find no corresponding pressure harmonics in the applied curve at the terminals, the only E.M.F. harmonics present being induced in the motor solely to overcome resistance and reactance, and thus adding to the motor losses. Coming, then, to Fig. 2 the curve Φ_1 represents the fundamental flux wave, whilst I is the current curve required to produce Φ_1 (as found from the magnetisation curve).

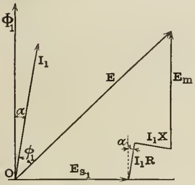

FIG. 1.—DIAGRAM OF FUNDAMENTAL WAVE.

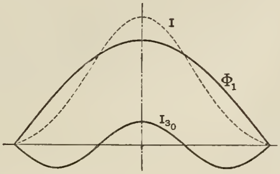

FIG. 2.—SHOWING THIRD HARMONIC.

Now the curve I (Fig. 2) has a strong third harmonic, I_{3_0}, and, in order that I_{3_0} could exist as shown, it would be essential to assume that no impedance in the motor was offered to it. Actually, however, the third harmonic encounters both resistance and reactance, and, in consequence, assumes a value I_3. Corresponding to this third harmonic, I_3, there must be a third harmonic, Φ_3, in the flux curve which generates the necessary third harmonic of E.M.F. required to drive I_3. Now, since the effect of flux harmonics on a flux curve is to flatten it, it is obvious that the third flux harmonic Φ_3 will be displaced about 180 deg. in phase from the curve I_{3_0}.

Denoting the symbolic expressions for I_{3_0}, I_3 and Φ_3 by I_{3_0}, I_3 and Φ_3, we can thus write—

$$\Phi_3 = k\,(I_3 - I_{3_0}),$$

where the geometrical difference of I_3 and I_{3_0} is taken and k is a constant depending on the magnetic reluctance of the machine.

The diagram for the third harmonic will thus be as in Fig. 3, where

$$\overline{OA} = I_{3_0},\ \overline{OB} = I_3,$$
$$\overline{OC} = \Phi_3 = k\,.\,\overline{AB} = k(I_3 - I_{3_0}) \text{ and is parallel to } \overline{AB}.$$

The pressure component consumed by resistance is $\overline{OD} = I_3R$, and that consumed by stray reactance is $\overline{DF} = I_3\,(3X)$. These must be overcome by the third E.M.F. harmonic, which is the geometrical sum of (i.) the dynamic E.M.F. due to the rotation of the armature coils in field Φ_3,

$$\overline{OE} = E_{r_3} = \frac{1}{\sqrt{2}}\frac{p}{a}\frac{n}{60}N\Phi_3 10^{-8}$$
$$= \frac{1}{\sqrt{2}}\omega_r T_r \Phi_3 10^{-8} \text{ volts,}$$

and (ii.) the static E.M.F. induced by transformer action of the third flux harmonic Φ_3 in the field coils,

$$\overline{EF} = E_{s_3} = 4{\cdot}44\,.\,3c\,.\,T_s\,.\,\Phi_3\,.\,10^{-8}$$
$$= \frac{1}{\sqrt{2}}3\omega T_s \Phi_3 10^{-8} \text{ volts.}$$

Regarding these two latter components of E.M.F., $\overline{OE}$ and $\overline{EF}$, generated by the flux Φ_3, as counter E.M.F.s, and those absorbed by ohmic resistance and stray reactance—$\overline{OD}$ and $\overline{DF}$—as consumed E.M.F.s, it is obvious that an alternating-current series motor acts as a generator, or short-circuited brake, in respect to the harmonics, when the impressed E.M.F. follows a sine wave. At first sight this result might appear to be strange when compared with the continuous-current series motor, for the latter cannot work as generator with the same direction of motion unless either the armature current or the field current be reversed. But the actual conditions in the two cases are different. The flux Φ_3, as seen in Fig. 3, is not in phase with the current I_3, but is displaced almost 180 deg. from it. Moreover, this flux is not simply proportional to the current I_3 but, as we have seen, to the vectorial difference between I_3 and I_{3_0}.

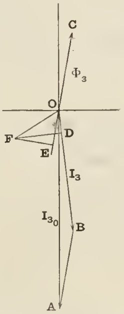

FIG. 3.—DIAGRAM FOR THIRD HARMONIC.

The components of the E.M.F. produced by flux Φ_3 (see above E_{r_3} and E_{s_3}) can be re-written as resistance and reactance pressures. Thus:—

$$E_{r_3} = -R_3(I_3 - I_{3_0}),$$
$$E_{s_3} = -j3X_3(I_3 - I_{3_0}),$$

where $R_3 = \frac{1}{\sqrt{2}}\omega_r T_r k 10^{-8}$

and $X_3 = \frac{1}{\sqrt{2}}\omega T_s k 10^{-8}$;

whence we get $ZI_3 = -Z_3(I_3 - I_{3_0})$.

By transposing $Z_3 I_{3_0} = (Z_3 + Z)I_3$

thus $I_3 = \frac{Z_3}{Z_3 + Z} I_{3_0}$.

Hence, converting to absolute values,

$$I_3 = I_{3_0}\sqrt{\frac{R_3^2 + 9X_3^2}{(R_3 + R)^2 + 9(X_3 + X)^2}}$$

and $\tan\phi_3 = \frac{3(X_3R - R_3X)}{R_3(R_3 + R) + 9X_3(X_3 + X)}$,

where ϕ_3 is the phase displacement between I_3 and I_{3_0}.

Both R and X can be determined from the magnetisation and speed curves of the motor, and are found to be very small compared with R_3 and X_3, which means that the actual phase position of the third harmonic I_3 does not differ very much from I_{3_0}, as obtained from the curve of magnetisation. For example, if the pressure drop in the ohmic resistance R is 10 per cent. of the pressure IR_3, induced by rotation in main field, and likewise the pressure consumed by leakage reactance X is 10 per cent. of the pressure IX_3, induced statically in the field winding by main flux, then I_3 is about 90 per cent. of I_{3_0}.

It will be quite allowable, therefore, to assume that the current harmonics—of which the third is the only important one—as found in the current curve required to produce the fundamental flux wave are actually the current harmonics present, the magnitude being that obtained by subtracting the fundamental current wave I_1 from the current wave I.

Moreover, the losses due to these wattless harmonics have been examined, and it has been found (see Fig. 1C) that until full load has been considerably exceeded, these harmonics do not make their appearance to any extent, although the iron may be fairly well saturated at full load. Hence, provided we do not work at extremely high saturations, it will be quite permissible to assume the current, flux and counter E.M.F. waves are sinusoidal, when the wave of applied pressure is also a sine curve. In such a case, therefore, the diagram in Fig. 1 is to be regarded as correct as far as these magnitudes are concerned.

We must now see the effect of the currents in the short-circuited coils on the motor diagram.

(To be continued.)

SOME OBSERVATIONS ON ALTERNATING-CURRENT RECTIFIERS.

BY A. C. JOLLEY.

The conversion of alternate into direct-current power is a problem which has long occupied the attention of electrical engineers. Where power is required in considerable quantity the use of motor-generators or synchronous converters has become universal. Such apparatus, however, necessarily involves the attention of skilled operators and is uneconomical in floor space.

In order to meet these disadvantages, and yet at the same time retain the electrical characteristics of the above plant, machines of the permutator type have been evolved. In this class of machine the rectified current is collected from a stationary commutator by synchronously rotating brushes, which are automatically started and run up into synchronism by simply closing the main switch. In a recent article Dr. Drysdale fully described this type of machine.*

Our early experiments with a 10 kw. Rougé and Faget permutator at the Northampton Institute gave very disappointing results when the machine was used for battery charging. To obtain a charging current of 20 mean amperes (as read on an ammeter of the permanent magnet type), 51 r.m.s. amperes had to be carried by the leads, indicating a form factor for the direct-current wave of 2·55. Figs. 1 and 1A are the oscillograph records of the machine under these conditions, and it will be observed that there is considerable reversal of the charging current. The efficiency of the machine working under these conditions was found to be 54 per cent., or 5 per cent. lower than the efficiency when loaded to a similar extent on non-inductive resistance. To improve the performance of the machine under these conditions Dr. Drysdale suggested the employment of an inductance in series with the battery. Figs. 2 and 2A are the oscillograph records when charging through a coil of about 4·5 m.h. having a completely closed iron circuit.* The form factor has fallen to 1·667 for the direct-current wave, but the efficiency is practically unaffected.

In Figs. 3 and 3A the inductance has been increased to 6 m.h.; the form factor has now reached 1·43, and the efficiency has improved to the extent that it is now only 1·5 per cent. below the equivalent on a non-inductive load. Still further improvements were effected by the use of greater inductance, the form factor being brought down to 1·25 and eventually to 1·1 by the use of choking coils. It is, therefore, obvious that by this means the performance of the permutator may be made quite satisfactory when charging cells. The reversal of the charging current may be suppressed, the root mean square value of the charging current brought within reasonable limits, together with an improvement of the efficiency of the machine and an entire suppression of sparking at the commutator and heating of the commutating resistances. The behaviour of the machine is in all respects as good as when non-inductively loaded, and thus its performance as a whole can be made to compare very favourably with that of the equivalent synchronous rotary converter.

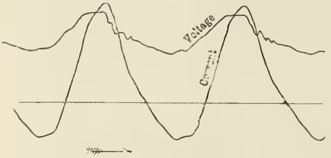

FIG. 1.—R.F. PERMUTATOR CHARGING CELLS WITHOUT SERIES INDUCTANCE.
D.C. voltage and current wave forms.

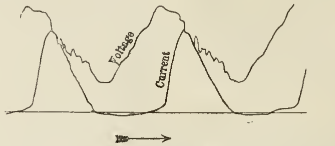

FIG. 2.—R.F. PERMUTATOR CHARGING CELLS THROUGH INDUCTANCE.
D.C. voltage and current wave forms.

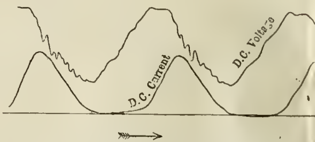

FIG. 3.—R.F. PERMUTATOR CHARGING CELLS THROUGH INDUCTANCE.
D.C. voltage and current wave forms.

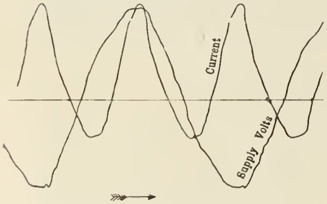

FIG. 1A.—R.F. PERMUTATOR CHARGING CELLS WITHOUT SERIES INDUCTANCE.
Primary A.C. voltage and secondary D.C. current wave forms.

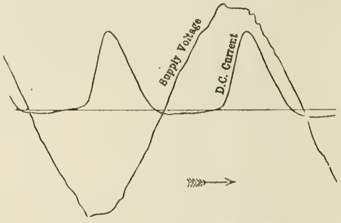

FIG. 2A.—R.F. PERMUTATOR CHARGING CELLS THROUGH INDUCTANCE.
Primary A.C. voltage and secondary D.C. current wave forms.

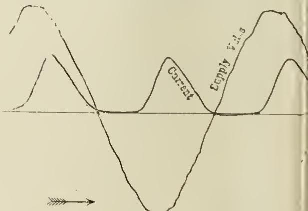

FIG. 3A.—R.F. PERMUTATOR CHARGING CELLS THROUGH INDUCTANCE.
Primary A.C. voltage and secondary D.C. current wave forms.

The production of rectified current may, however, be effected without the employment of rotary machinery at all, the electrolytic and mercury vapour rectifiers of Nodon and Cooper-Hewitt respectively being now upon the market in a commercial form.

By the courtesy of Messrs. H. Snowdon we have recently been able to test a small electrolytic rectifier of the Nodon type which has been generously lent for the purpose. The valve consists of a group of four cells each having a central rod electrode of an aluminium alloy, the other electrode being the lead-containing vessel.

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* *The Electrician*, Vol. LVI., p. 305, December 8, 1905.

* This inductance corresponds to a magnetising current in the choking coil equal to the root mean square value of the charging current. When this current approaches reversal, and the iron is therefore much less saturated, the inductance is considerably increased; thus at 0·5 ampere magnetising current the inductance has risen to 94 m.h.

The exact reasons for the curious action of this type of valve are still under discussion; but it would seem they depend for their action upon the formation at the aluminium electrode of a highly resistant film which has the property of suppressing currents from aluminium to lead, but is inactive for currents in the reverse direction. Thus a single cell supplied with single-phase alternating current will give an interrupted unidirectional current; and, by connecting the four cells according to the method of Leo Gratz, both semi-phases may be utilised, when a pulsating unidirectional current, as shown in Figs. 4 and 4A, results.

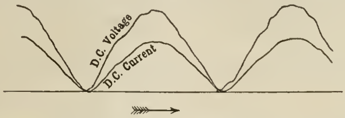


FIG. 4.—5 AMPERE NODON VALVE.
D.C. voltage and current wave forms for valve on non-inductive load.

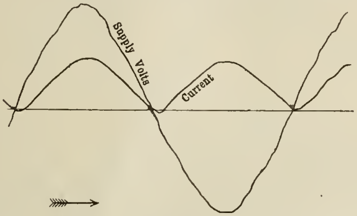


FIG. 4A.—5 AMPERE NODON VALVE.
Primary A.C. voltage and secondary D.C. current wave forms for valve on non-inductive load.

The performance of the 5 ampere valve on non-inductive load, when giving a constant direct-current voltage of 100 volts at all loads, is shown in Fig. 5. Supply was in all cases taken direct from the alternator without the use of any boosting device and specially calibrated wattmeters were used in both direct-current and alternating-current circuits for measuring the output and input of the valve.

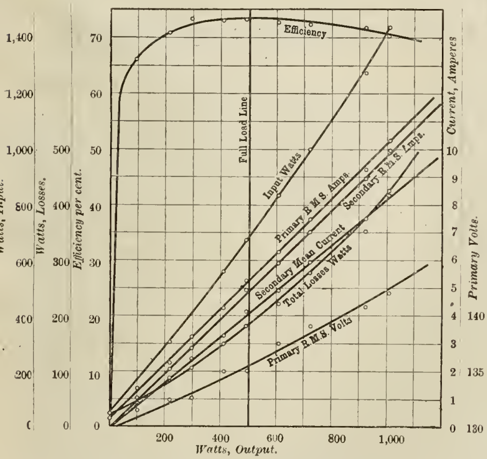


FIG. 5.—PERFORMANCE CURVES OF 5 AMPERE NODON VALVE. CONSTANT SECONDARY VOLTAGE TEST. LOADED ON NON-INDUCTIVE RESISTANCES.
Frequency 50 ∾. Maximum power factor on valve 0·98. Minimum power factor on valve 0·70.

From the curves it will be seen that the full-load efficiency even in this small size of valve is well above 70 per cent., and that it is capable of giving considerable overloads without great reduction of efficiency. The effect of temperature, however, is serious, and is shown in Fig. 7. These are the observations taken during a full-load heating run under the same conditions as above. It will be observed that except for the initial drop the efficiency is but little affected until the mean temperature of the electrolyte has risen 16·5°C. above the temperature of the air, or has reached a temperature of about 40°C.

This corresponds to a two-hour run on the 5 ampere valve. After this point is past the temperature and supply current rise with great rapidity; the direct-current output is but little affected, but the efficiency rapidly falls.

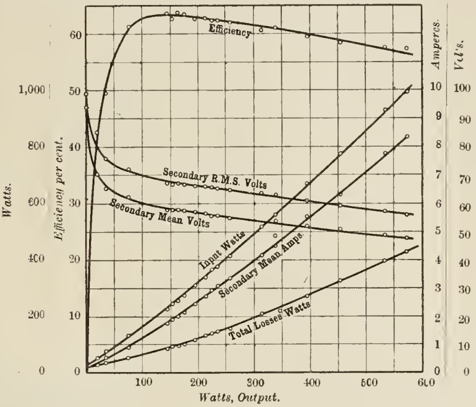


FIG. 6.—PERFORMANCE CURVES OF 5 AMPERE NODON VALVE. CONSTANT PRIMARY VOLTAGE TEST.
Frequency 50∾.

In Fig. 6 is given a set of observations on the same valve with a constant supply voltage of 105 volts. The efficiency under these conditions is lower, but the regulation curve for direct-current voltage is interesting. For apparatus such as incandescent lamps, or constant speed motors, &c., requiring close regulation, this property of the valve would be unsatisfactory; but for battery charging and cases demanding constant current supply it is eminently suitable, and tends to automatically keep the conditions right. As a further inte

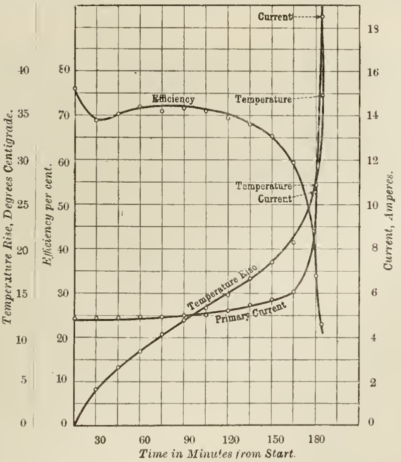


FIG. 7.—HEATING TEST ON 5 AMPERE NODON VALVE.

resting point it is found that if the valve under these conditions be loaded so that it is giving its full 500 watts output direct current it may be run for a considerably longer period without undue rise of temperature and consequent loss of efficiency.

In order to observe the behaviour of the valve on various voltages the supply voltage was varied by adjusting the exciting current of the alternator supplying the valve, whose direct-current load was maintained constant at 500 watts.

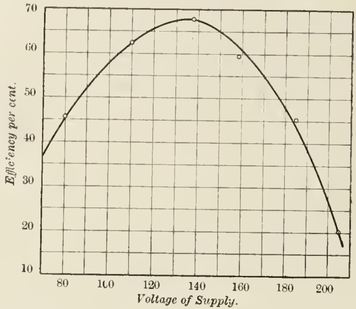


Fig. 8.—5 ampere Nodon Valve. Curve illustrating the Variation of Efficiency with Voltage.

Mean temperature of electrolyte in valve during test=33°C.

The curve (Fig. 8) gives the relation between the voltage and full-load efficiency, which reaches a maximum at 135 volts. At the higher voltages the valve heats very rapidly.

Changes in frequency have but little effect between the limits of 40 and 200 ~ per second. The tendency is to lower the efficiency as the frequency rises. The whole effect at 200 ~ is a reduction of full-load efficiency of about 3 per cent. When fully loaded on accumulator the efficiency is 5 per cent. lower than when equally loaded on non-inductive resistance, and the introduction of inductance into the battery circuit assists the efficiency. Thus, with the previous 6 m.h. in series the efficiency is only 2 per cent. lower than with the equivalent non-inductive load.

The introduction of inductance does not in this case influence the form factor, which is constant at 1·44 Fig. 9 shows the direct-current wave forms when charging directly, and Fig. 10 the wave forms when charging through the inductance.

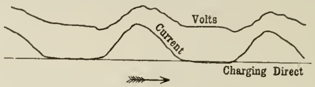


Fig. 9.—5 ampere Nodon Valve charging Cells without Series Inductance.

D.C. voltage and current wave forms.

Although in every other respect the valve is satisfactory, the temperature characteristic when good secondary regulation is demanded is a serious drawback, and makes it compare unfavourably with rotating machinery of the same output, which will take a load practically indefinitely without overheating or serious loss of efficiency, while in the case of the valve, the temperature limit is critical and cannot be overstepped. It should be noted that the valve tested had no auxiliary cooling device, and relied simply on its own radiating surface, which was such as to allow of about 0·25 watts per square inch at full rated output. In the larger sizes artificial cooling by means of a motor-driven fan is resorted to, and the temperature thus kept below 40°C.; but the power taken by the fan necessarily lowers the efficiency of the valve. The simplicity of operation and the little attention required when once set to work are, however, great points in its favour.

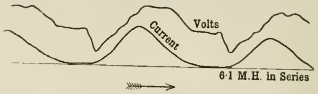


Fig. 10.—5 ampere Nodon Valve charging Cells through Series Inductance.

D.C. voltage and current wave forms.

THE NEW SUMMER-LANE STATION OF THE BIRMINGHAM CORPORATION.

Before commencing a detailed description of the new generating station at Summer-lane, Birmingham, which was opened on Wednesday by the Lord Mayor of Birmingham, a brief sketch of the history and development of electric supply in Birmingham will not be out of place. As far back as 1882 a provisional order for lighting a portion of the city was obtained by the Incandescent Electric Lighting Co., and a small plant was set to work near Paradise-street to supply the Town Hall and a few adjoining shops, Col. R. E. Crompton and Mr. Henry Lea being the engineers to the scheme. The operation of this system was not of long duration, however, as in 1886 the order was cancelled by the Board of Trade on account of certain obligations not having been fulfilled. The next step was the acquisition in 1889 of a new provisional order by Messrs. Chamberlain & Hookham, which was subsequently purchased by Messrs. Holmes & Vaudrey, of Liverpool. At the end of the same year the Birmingham Electric Supply Co. was formed to work the order, Mr. J. C. Vaudrey acting as engineer and managing director. A non-condensing station was erected at Dale End, and later on, in 1896, a second condensing station was built at Water-street, and a sub-station established in Parker-street, Edgbaston, to deal with the supply to that residential district.

The undertaking of the Birmingham Electric Supply Co., whose business consisted entirely of lighting supplied from these two generating stations and the one substation, was purchased in 1900 by the Corporation, and Mr. Vaudrey occupied the post of city electrical engineer until his resignation in 1903, when the present city electrical engineer, Mr. R. A. Chattock, to whom the design of the new station at Summer-lane is due, was appointed.

It was in the same year that the Corporation decided on the municipalisation of the Birmingham tramways and their conversion to electric traction. The present capacity of the Dale End station being only 1,520 kw. and of the Water-street station 3,456 kw., a considerable amount of new plant was essential to supply the power for the tramways and at the same time to keep pace with the rapid development of lighting and power supply, and it was to meet these requirements that the Summer-lane station and the new sub-stations were projected.

In addition to supplying current for the tramways, the output for which is estimated at from 10 to 12 million units per annum when the whole of the lines are in operation, the Corporation anticipate a large increase in the lighting and private power load consequent on the reduced charges which have now been introduced and the further encouragement of a motor-hiring scheme. The ordinary charge for lighting is now 5d. per unit for the first 300 units per quarter and 3½d. per unit for any further quantity, these figures being reduced to 3d. and 2d. for special "long-hour" consumers. Power is supplied at rates varying from 2d. to 1¼d. per unit, and a 5 per cent. discount is allowed for prompt payment. It is interesting to compare these rates with the price of 8d. per unit charged at the commencement of electricity supply in Birmingham. The total horse-power of motors connected to the mains now exceeds 3,200, as against 1,770 about a year ago.

The general distribution of the generating stations about the town is shown in the sketch map in Fig. 1. The original supply was given at a pressure of 110 volts through a two-wire network, and this was gradually changed over to a three-wire system with 220 volts across the outers, the consumers' lamps being still supplied at 110 volts. About the year 1899, 220 volt lamps were adopted and the pressure across the outers raised to 440 volts, its present value. The traction supply is, as usual, at 550 volts.

It is thus easy to understand the considerations which governed the choice of plant to be installed in the new station.

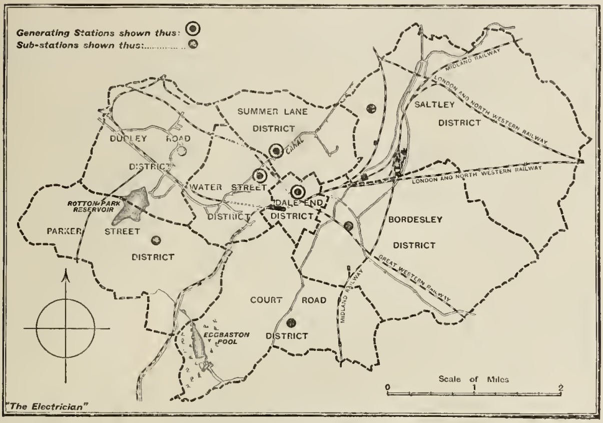


Fig. 1.—Sketch Map showing Positions of Stations.

Four classes of supply are dealt with which are enumerated below:—

(1) A continuous current supply for lighting and private power purposes in the neighbourhood of the station at a pressure of 220 and 440 volts.

(2) A continuous-current supply through a system of trunk mains, to the distributing switchboards at Dale End and Water street generating stations at a pressure of 440 volts, in order to deal with the increase in the demand for private lighting and power supply.

(3) A continuous-current supply to the tramway system within a radius of about 2 miles from the generating station at 550 volts.

(4) An extra high-pressure three-phase supply to the sub-stations which have been erected in the outlying districts at a pressure of 5,000 volts.

Accommodation has therefore been provided in the engine room for continuous-current plant to the extent of 13,000 kw., and alternating current plant for 13,500 kw., of which 7,000 kw. for continuous current and 4,500 kw. for alternating current form the capacities of the first equipment.

The site of the station is shown in Fig. 2. It was formerly occupied by the old General Hospital, and adjoins the Birmingham and Fazely Canal, by means of which coal is brought to the station. The architectural details of the building which are on a somewhat more elaborate and imposing scale than is usually associated with electric supply stations, are due to Messrs. Ewen Harper & Brother, and the building contractors were Messrs. William Sapcote & Sons, of Birmingham. A general plan of the station is given in Fig. 3. The engine room is 275 ft. long by 100 ft. wide; the boiler room is of the same length, 80 ft. wide, and a third parallel bay, 47 ft. in width, forms the economiser house. The workshops, part of the switch galleries, and the battery room occupy an extension of the Summer-lane front, and a small separate building by the canal contains the circulating water pumping plant.

The chief feature of the engine room is the arrangement of the two rows of generating sets on either side, the continuous-current plant being on one side and entirely separated from the alternating-current plant on the other side. The switchboards are divided in a similar manner. As the boiler house only runs down one side of the engine room, this arrangement of double rows of both boilers and engines involves a considerable length of steam piping, which is taken across the engine room under the floor.

The greater part of the sets are driven by reciprocating engines, but two small turbo sets have also been put down in this station, and were removed from Dale End. The first instalment of continuous-current plant consists of four Belliss engines, each driving a 1,500 kw. generator by Messrs. Dick, Kerr & Co., three of which are already erected, and the two 500 kw. turbo-generators by Messrs. C. A. Parsons & Co., referred to above. The alternating-current sets comprise two Belliss engines driving 1,500 kw. alternators by the British Westinghouse Co., one of which is now running, and three similar sets for 500 kw. each. The exciters for these alternators are independently driven, also by Belliss engines, and consist of 100 kw. machines by the General Electric Co.

The large engines for the continuous and alternating current sets are exactly alike, except that the alternators run at $166\frac{2}{3}$ revs. per min. to correspond to a frequency of 25 ~, while the continuous-current machines run at 160 revs. per min. One of the continuous-current sets is illustrated in Fig. 4. The engines are of the three-crank enclosed vertical triple-expansion double acting forced lubrication type with cylinders 25 in., $36\frac{1}{2}$ in. and 55 in. diameter respectively, by 33 in. stroke. Steam is supplied at 180 lb. per square inch, with a superheat of 100° to 150°F. The engines normally run condensing, but provision is made for exhausting into the atmosphere by automatic emergency valves. Specially large flywheels have been provided, the total amount of stored energy in the revolving parts being 3,400 and 4,600 ft.-tons for the continuous and alternating current sets respectively. The governors are arranged vertically at the high-pressure end of each engine and are designed to keep the speed within 2 per cent. of the normal from no load to 25 per cent. overload.

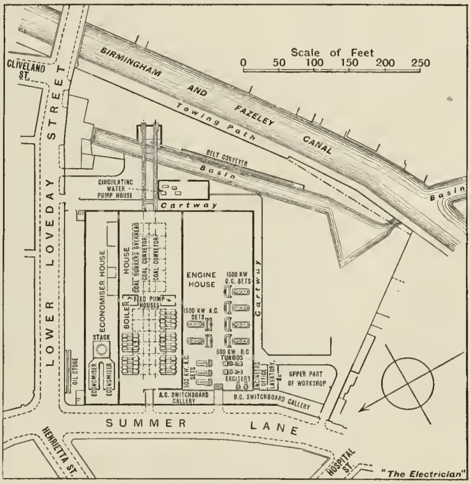
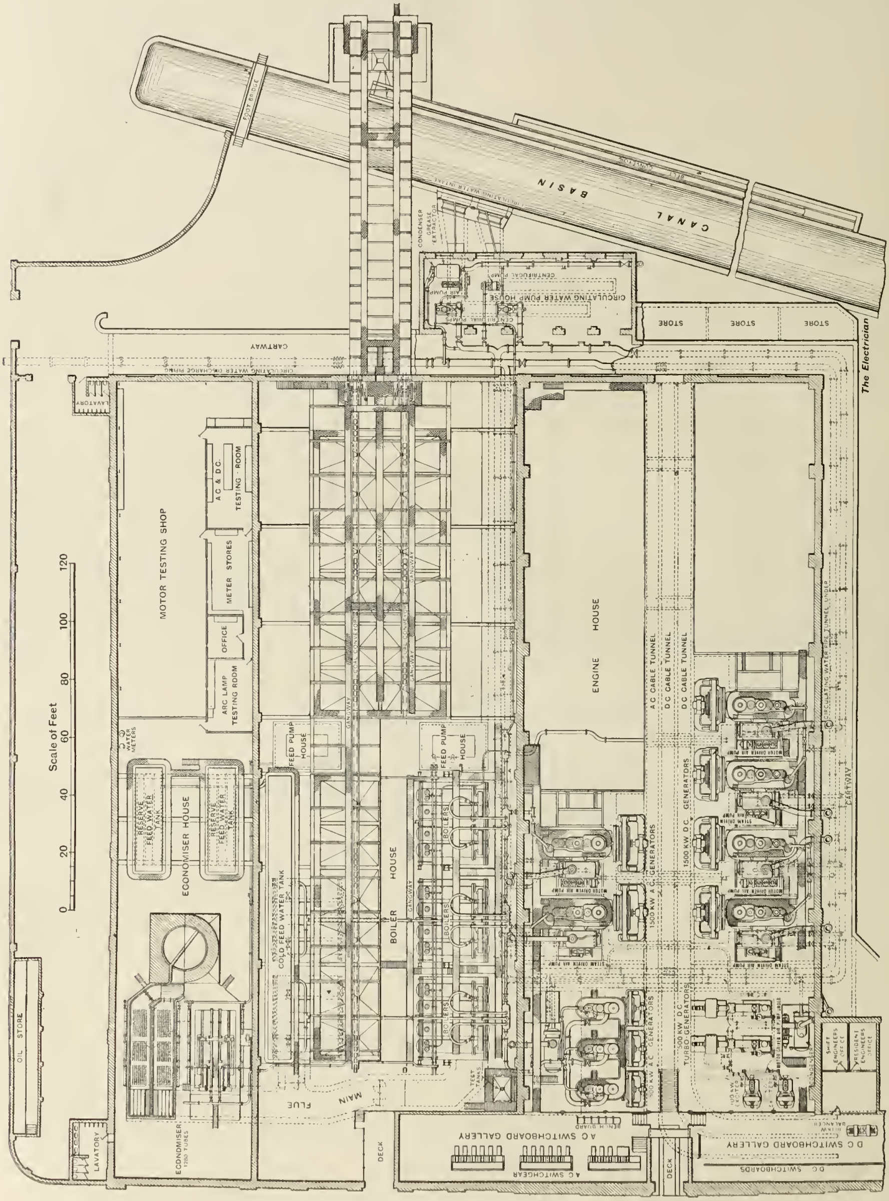


Fig. 2.—General Plan of Site of Summer-lane Station.

A variable expansion gear is fitted, the cut-off of the high-pressure slide valve being varied by means of a special relay cylinder operated from the governor. By this arrangement the power is regulated at the higher loads by automatically varying the cut-off and at the lower loads by throttling. A bye-pass valve is provided so that high-pressure steam may be blown through the intermediate and low-pressure cylinders for warming up, and to enable the engine to be started with the cranks in any position. There is also a bye-pass of ample size at the main stop valve, so that by opening this valve the engine can be started and got up to speed, the main stop valve being subsequently opened when the pressure on each side of it has been equilibrated. Each engine has its own surface condensing plant arranged alongside. The exhaust steam



The Electrician

Fig. 3.—Plan of Station.

before entering the condenser passes through a Baker grease extractor, and a sluice valve is fitted to the oil separator and the condenser, so that the latter may be shut off for cleaning while the engine exhausts to the atmosphere; the steam, however, in this case, still passes through the separator, which acts as a silencer. Each condenser has an aggregate length of 4 miles of tubing, presenting a cooling surface of 4,200 sq. ft. Edwards' three-throw air pumps are used, with cylinders 18 in. diameter by 12 in. stroke, running normally at 80 revs. per min. but capable of being speeded up to 120 revs. per min. if necessary. Arrangements are made for connecting up any air pump to any condenser in case of breakdowns, and alternate pumps are steam and electrically driven. A very complete system of cooling, storage and treating tanks is installed for dealing with the crank chamber oil, and auxiliary motor-driven oil pumps are provided, in addition to the ordinary oil pumps of each engine, by means of which the bearings of any engine can be flooded with oil at starting, or the pressure of oil augmented at times of maximum load. The 500 kw. sets are driven by standard triple-expansion engines running at 250 revs. per min. and exhaust into a common condenser, which is a duplicate of the condensers for the larger engines. The 100 kw. exciters are driven by two-crank compound Belliss engines running at 450 revs. per min. These two engines, together with the two 500 kw. steam turbines, are coupled to a surface condenser, with a set of motor-driven air pumps supplied by Messrs. W. H. Allen, Son & Co.

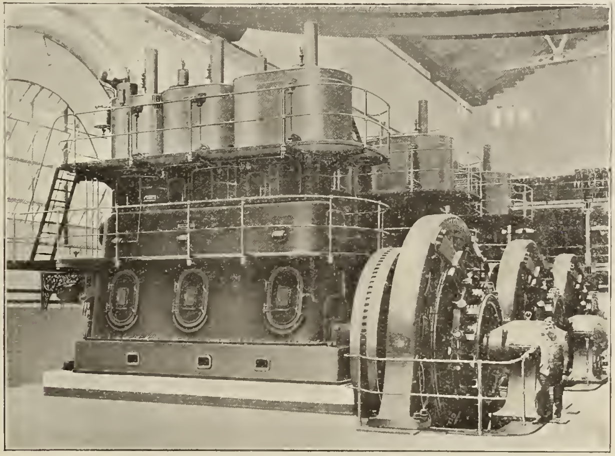


Fig. 4.—1,500 kw. Continuous-current Sets.

The chief point of interest in the continuous-current generators is their size and the large number of poles necessitated by the comparatively slow speed. Each machine has 16 poles cast into the frame and is rated at 1,500 kw. with an overload capacity of 25 per cent. They are compound-wound for 550 volts on the traction load, and can also be used as shunt machines for lighting at 460 to 520 volts. These generators are of Messrs. Dick, Kerr's standard type and their armature spiders are extended and bolted direct to the flywheels of the engines. The two 1,500 kw. and the three 500 kw. alternators were manufactured by the British Westinghouse Company and are of their standard revolving field type for 5,000 volts at 25 ~, and all are capable of an overload of 25 per cent. The independently-driven exciters have a capacity of 100 kw. each at 440 to 480 volts at 450 revs. per min. and can deal with overloads up to 10 per cent. They are of the General Electric Co.'s standard four pole shunt-wound type with steel poles and laminated pole shoes. The two 500 kw. Parsons turbo-generators are shunt-wound for 460 to 520 volts.

The auxiliary plant in the station, as might be expected from the varied conditions of supply, consists of several motor-generator sets for various different purposes. Two 100 kw. balancers by the Phœnix Dynamo Co. deal with the out-of-balance current of the local lighting network. Each of these sets consists of two open type machines on one base, with three bearings. Each machine is capable of an output of 435 amperes at 230 volts and a speed of 500, with an overload capacity of 25 per cent. for one hour and 50 per cent. for a few minutes; auxiliary poles are fitted. A pair of motor-driven three-wire double-ended booster sets by the same makers are installed for raising the voltage on the trunk feeders providing the additional supply to the Dale End and Water-street stations. Each of these sets consists of one motor and two boosters. Each booster machine has two commutators and gives 2,500 amperes at 10 to 17 volts, and is separately excited off 260 volts. The sets run at 450 revs. per min. Arrangements are made so that the brushes of both commutators on each booster machine can be adjusted together. Speed limiting governors are provided which short-circuit the booster armatures when the speed reaches 750 revs. per min. The motors are fitted with auxiliary poles and run off the 460 to 520 volt circuit. It is proposed, later, to instal two additional similar sets and four three-wire balancer-boosters, each for 75 volts at 200 amperes for the local lighting feeders. A 200 kw. motor-generator, consisting of a shunt-wound motor driving a compound-wound generator, both with auxiliary poles, enables the traction system to be run off the lighting bars at times of light load at night, and later on the alternating and continuous current systems will be linked together by a 200 kw. rotary converter and bank of transformers, so that at times of light load both sides of the station need not be run under steam. Further proposals for the future include a large traction battery controlled by a reversible booster set.

The engine room is spanned by a large electric travelling four-motor crane built by Messrs. Jessop & Appleby. The span between the rails is 97 ft. 6 in. and the crane can handle loads up to 40 tons on the main lift at a speed of 18 in. per min. or 10 tons at 12 ft. per min. The motors for operating the heavy and light hoists and the longitudinal travel are each of 12 B.H.P., and run at 460 revs. per min., and the cross traverse, the speed of which is 80 ft. per min., is driven by a 7 B.H.P. motor running at 630 revs. per min. All the motors are of the British Westinghouse Company's series-wound crane type and are operated by liquid controllers with screw reversing gear. Powerful automatic magnetic brakes are provided on the various motions, and in addition auxiliary brakes are fitted on each of the hoisting motions, these latter being so arranged that should the lowering become too rapid these brakes come immediately into operation and effectually check the speed. A mechanical foot-brake is also provided on the longitudinal travelling motion. As an additional means of control, to prevent any possibility of overrunning, a time-limit switch with catch is provided which is set in operation by the lift ropes at the desired point, one switch being used both for the main and the auxiliary hoist.

(To be continued.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Matriculation Directory, with Articles on Text Books." (Cambridge and London: University Tutorial Press.) 1s. net.

"Five-figure Mathematical Tables." By A. du Pré Denning. (London: Longmans, Green & Co.) 2s. net.

CONVERTED COACHES ON THE METROPOLITAN RAILWAY.

The change from steam to electric traction on any railway is bound to render obsolete a large quantity of rolling stock, much of which may be in a perfectly satisfactory condition and still fit for many years' service. An example of a way in which this difficulty has been met is found in the case of the Metropolitan Railway Co., who at the time when electric traction was inaugurated on its lines found themselves possessed of nine trains, built as recently as 1900, and which, having been designed for steam haulage, were now practically useless. It was determined to make the experiment of electrifying these trains and thus again bring into service rolling stock which would otherwise have to be written off or disposed of at a loss.

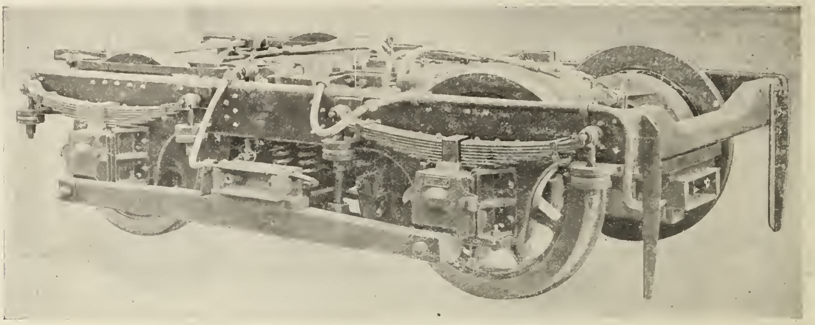


Fig. 1.—New Bogie for Motor Coach.

The length over buffers of the complete seven-coach train, coupled, is 289 ft. 7 in. The height to top of roof from surface of running rails is 11 ft. 6 in. The underside of floor of the coach is 14 in. above the centre plate of the bogie trucks. The original bogies, which are of the Fox pressed-steel type with 7 ft. wheel base, 5 in. axles and $40\frac{5}{8}$ in. Mansel wheels, have been retained under the trailer coaches. New bogie trucks, also of the Fox pressed-steel type, as shown in Fig. 1, with 7 ft. wheel base, $6\frac{1}{2}$ in. axles and 38 in. wrought centre steel-tyred wheels, each carrying two motors, have been provided for the motor coaches of these trains. A view of the complete converted train is shown in Fig. 2 and of a single motor coach in Fig. 3.

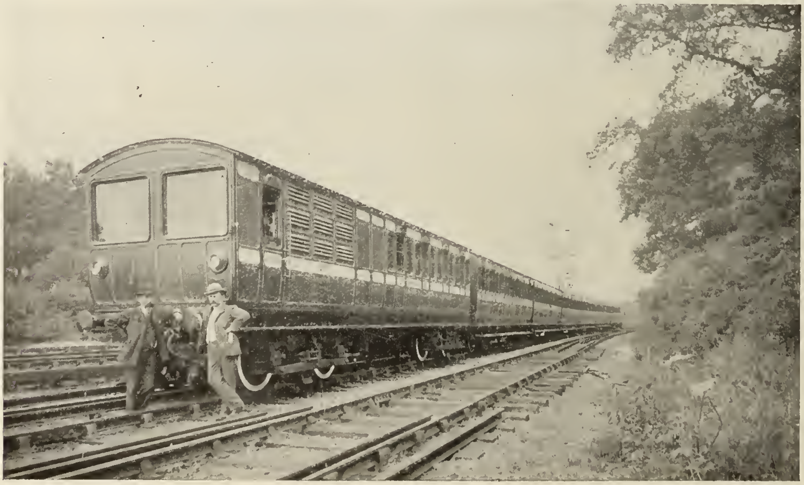


Fig. 2.—Complete Train.

A preliminary experiment was made with two of these trains, and the contract for their conversion was given to the British Thomson-Houston Co. The trains at present contain seven coaches, consisting of two motor coaches and five trailers. An extra trailer may be added later when the platforms at the stations have been lengthened sufficiently to accommodate the extra length of train.

The underframes of all the coaches are identical, being made up of 9 in. × 3 in. × $\frac{1}{2}$ in. steel channels in the usual way. No change has been made in the underframes of the trailer coaches, but in those for the motor coaches 7 in. × 3 in. × $\frac{1}{2}$ in. longitudinal channels have been substituted for the diagonals on either side of the bolsters over the centre of the bogies in order to facilitate the inspection of the motors and to allow of a better arrangement of the wiring. The motor bogies are generally similar in design to those used on the trains originally designed for electric working, the latest form of which were described in *The Electrician* of June 1st, p. 245. The way in which the motor leads are protected by flexible metallic tubing is particularly noticeable. The motors themselves, which are of the G.E. 69 type, as illustrated in Fig. 5, are similar to those in use on the Metropolitan trains referred to above, and those of the District and Baker Street & Waterloo railways. Two are placed on each driving bogie, and each is rated at 200 H.P. on the usual traction rating, giving a total of 1,600 H.P. per train, a power which is capable of driving the complete train at a maximum speed of 45 miles per hour, and maintaining an average speed of 16 miles per hour, including stops, under service conditions. The weights of the train unloaded are as follows:—

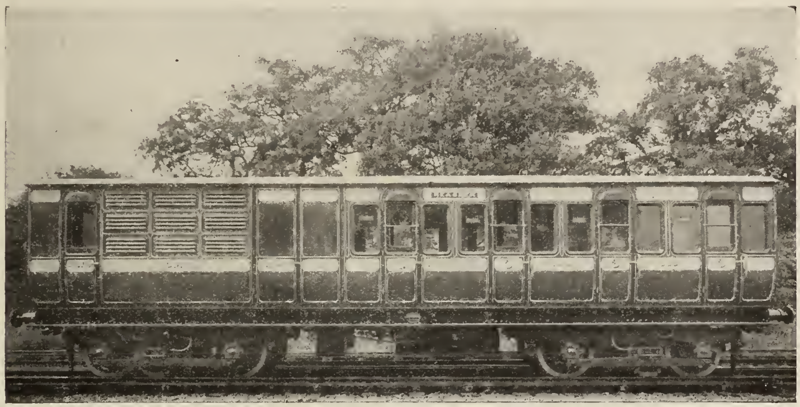


Fig. 3.—Motor Coach.

	Tons.	cwt.	qr.
Complete seven-coach train.........	171	16	1
Single motor coach	38	2	2
Single trailer coach	19	2	1

Each train has a seating capacity for 400 passengers, being 280 third-class passengers and 120 first-class. In each motor coach there are four third-class compartments, providing seating accommodation for 40 passengers, and there is also a luggage compartment. The two trailer coaches attached immediately to the motor coaches each contain seven third-class compartments, with seating capacity for 70 passengers. The middle trailer coach contains six first-class compartments, with seating accommodation for 60 persons. The two trailer coaches, on either side of the middle coach, each contain three first-class and three third-class compartments, with seats for 60 persons.

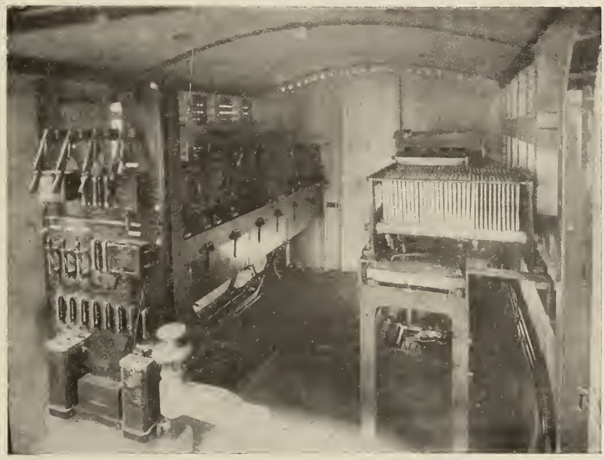


Fig. 4.—Interior of Driver's Compartment, showing Control Apparatus.

The method of control is by the Sprague-Thomson-Houston multiple unit system, similar to that in use on the Central London, North-Eastern, District, and Baker Street & Waterloo Railways and some of the other trains of the Metropolitan Railway Co.

In the converted trains, however, the whole of the control equipment, comprising the switch panel, contactors, reverser, main circuit-breaker, and also the motor resistances, are placed in what was formerly the guard's compartment, but which has been lined with fireproof material and converted into the driver's cab.

A view of the interior of the driver's compartment is given in Fig. 4. The arrangement is very similar to that adopted on the Central London and Baker Street & Waterloo Railways, except for the number of circuits to be controlled. The collection of the whole of the apparatus together inside the driver's compartment is much more convenient for examination and inspection than the disposition of the contactors, resistances, &c., under the cars, as is often done in rolling stock other than that intended for tube railways, but involves a somewhat greater amount of heavy wiring, and occupies rather more space which might otherwise be devoted to passengers or luggage. Master controllers are placed at both ends of the train so that they can be driven from either end, but provision has not been thought necessary for dividing the train into two parts in the middle and driving the sections from either end, as can be done in the Metropolitan trains described in *The Electrician*, June 1st, p. 248.

The wiring is of the most substantial nature. All wires and cables are enclosed in cold-drawn solid steel tubing with standard thread and fittings, and all connections and joints in the wiring are made by means of special connection boxes containing connectors mounted on slate bases. The entire undersides of the floors of the motor coaches are sheeted over with ½ in. uralite, whilst the upper surface is provided with a ¾ in. layer of paris cement, such as is used for flooring surface in steel car construction. The surfaces of the floors of the trailer coaches are similarly treated, and that portion of the underside directly above the steel tubes containing the train line wires is also protected by uralite sheeting.

The train is, of course, lighted throughout by electricity.

Automatic quick-acting air brakes have been substituted for the vacuum brakes formerly in use on these trains, and a hand brake is also provided in each driving compartment. The air compressors used are of what is known as the B.T.-H. C.P. 22 type. One of these compressors is shown in Fig. 6.

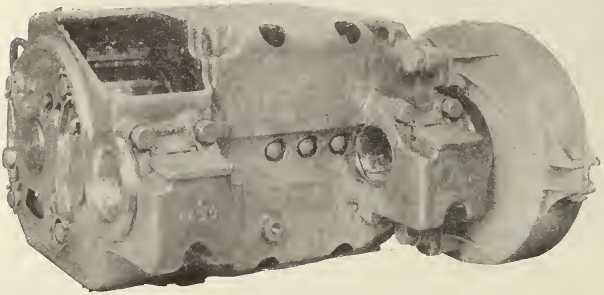


Fig. 5.—Motor and Gear Case.

They have two single-acting cylinders, and have a capacity of 25 cubic ft. of free air per minute. They are driven by enclosed series motors through double helical gearing, and the bearing boxes are protected by tight-fitting doors to prevent the entrance of dirt and to afford easy and immediate access for inspection and oiling. The motor frame being bolted directly to the compressor frame by body-bound bolts insures perfect alignment and mesh of the gears and makes it possible to remove and replace a motor without elaborate adjustment. Ample provision has been made for the lubrication of all the bearings, and complete protection of the machine from dust and water is afforded by the enclosed construction.

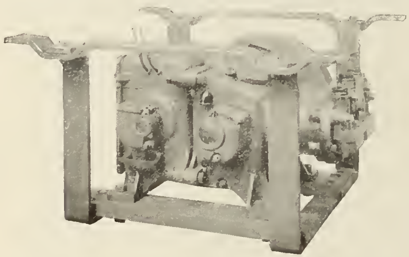


Fig. 6.—Electrically Driven Compressor.

The two trains have been re-painted and newly upholstered, and are intended for use on the Baker-street, Harrow and Uxbridge line. It is expected that the other seven trains of this stock will be similarly equipped.

We are informed that the first of these two trains went into service on July 11th, and has been making an average of about 200 miles daily, entirely without mishap.

The refitting of these trains has been carried out by the British Thomson-Houston Co., to whom we are indebted for the illustrations accompanying this article, and much of the information embodied therein. The work of conversion was entirely accomplished by the contractors under the personal direction of their engineer, Mr. J. B. Cox, at the Metropolitan Railway's erecting shops at Neasden.

THE INDUSTRIAL POWER PROBLEM.[*]

BY W. B. ESSON.

Everyone is interested directly or indirectly in the cost of power, because the lower the price at which it can be obtained the cheaper can articles of daily use be produced and the cheaper can they be bought. To us as engineers the subject of producing and distributing power at the lowest cost should have special interest, and in this Paper an attempt will be made to discuss within a short space the present position in power affairs.

Before dealing with the distribution of power from a general power house, let us consider the simple case of a factory having to be furnished with power from power-producing plant located on the premises. We have the choice of steam, gas, or oil engines, and we shall assume that the driving requirements will be met by an engine of 500 B.H.P. For the more economical distribution of the power throughout the works electricity will be employed, so in each case an electric generator will have to be coupled direct to the engine shaft. This generator will give a maximum of about 470 E.H.P., and, running for 2,800 hours per annum, we will take the electrical output as 1,000,000 E.H.P.-hours yearly.

A triple expansion steam engine of the size mentioned running condensing at 300 revs. per min. with 150 lb. pressure, and, say, 100 deg. superheat, will require no more than 14 lb. of steam per electrical horse-power per hour at full load, or 16 lb. at half load, or working non-condensing 20 lb. and 24 lb. respectively. As a general rule from 20 to 30 per cent. of the heat in the fuel cannot be utilised as it passes up the chimney in the waste gases, and is dissipated by radiation from the furnaces and flues. Accordingly, from 70 to 80 per cent. only of the heat in the fuel reaches the water, though it is claimed that with water-tube boilers, economiser, chain grate stokers and superheaters as much as 85 per cent. of the thermal units in a high-class coal has been returned in steam. As in different types of engine the disparity between the fuel consumption at full and reduced load is not the same, we will take in all cases the mean consumption between full load and half load, and there is no doubt that under this assumption, with the power producing plant carefully designed throughout, we can easily get when working condensing and with superheat an electrical horse-power-hour for every 2·25 lb. of bituminous slack consumed in the furnaces. This makes ample allowance for the steam used in the auxiliary plant and for the coal used in lighting up, &c. As this class of fuel can be obtained in the manufacturing districts at a cost of 7s. 6d. per ton delivered in the boiler house, or about 25 lb. for 1d., it will be seen that for steam plant the cost of an electrical horse-power, so far as the fuel is concerned, works out at 0·09d. per hour.

Let us see now what we can do with a gas engine using producer gas. In the early forms of producer for making power gas only anthracite coal or coke could be used, both of which consist almost wholly of pure carbon. For suction gas these are still the only fuels which can be employed, and, needless to say, they are very expensive as compared with bituminous slack. But the problem of using this latter fuel for power gas manufacture has been completely solved in the Mond producer. When working this system on a large scale it pays to recover the ammonia which is washed out of the gas before it is suitable for burning in engines.

We can gasify then for working our engines the dearer anthracite or the cheaper slack. Taking the former, which produces gas having a calorific value of about 150 B.Th.U. per cubic foot, the makers of the plant will guarantee that the consumption of anthracite coal in the suction gas installation per hour shall not exceed 0·8 lb. per electrical horse-power at full load, or 1·2 lb. per electrical horse-power at half load. Taking the average of these figures, if we reckon that anthracite peas can be purchased in the manufacturing districts at 24s. per ton, it will be seen that the fuel cost per electrical horse-power is about 0·129d. per hour. If the power happens to be wanted where Scotch anthracite peas can be delivered at 9s. 3d. per ton, the figure will of course be much lower.

Dealing now with slack, we will assume that this can be delivered at a cost of 7s. 6d. per ton at the works. The Mond gas made from it has a calorific value of about 150 B.Th.U. per cubic foot A good engine will give an electrical horse-power for every 75 cubic feet of gas consumed per hour, and as the gasification of a ton of slack produces about 150,000 cubic feet of gas, calculation shows that the cost per electrical horse-power per hour for fuel amounts at full load to about 0·045d. At half load this becomes 0·057d., the mean being 0·051d. As confirming this, the test of a 500 H.P. engine coupled to a generator has shown when running on two-thirds load a consumption of 1·26 lb. of slack per electrical horse-power. As it does not pay to recover ammonia in a plant of less than 20,000 H.P., we can in the present instance get no credit on this account.

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[*] Presidential Address to the Civil and Mechanical Engineers' Society, delivered on October 4, 1906.—Abstract.

Coming to oil engines, we shall choose the one invented by Rudolph Diesel as representing the latest advance. Oil suitable for Diesel engines now costs in London 42s. 6d. per ton, and carriage added will bring the price up to, say, 45s. The Diesel Engine Co. will guarantee that for an engine of the size we are considering the consumption of this oil which has a calorific value of 18,000 B.Th.U. per pound shall not exceed 0·48 lb. per electrical horse-power per hour at full load, or 0·56 lb. at half load. Taking the mean between these two figures, the fuel cost for the engine works out at 0·125d. per electrical horse-power.

The Mond gas plant, on the assumptions made as regards the cost of fuel per ton, easily distances its competitors in economy. The figures are :—

Mond gas	0·051	of a penny per H.H.P. per hour.
Suction gas	0·129	,, ,, ,,
Steam (condensing)	0·090	,, ,, ,,
Steam (non-condensing)...	0·120	,, ,, ,,
Oil	0·125	,, ,, ,,

These figures have been obtained under usual test conditions, and are just as valuable in giving an indication of what may be expected from the different plants as any figures can be. In taking the consumption in all cases as the mean between full load and half load, allowance has been made for the underloading likely to occur in works, while the fuel wasted in lighting up has been kept in mind. Obviously it depends upon locality as to which plant leads. When we have to use for the steam plant smokeless Welsh coal at double the price of slack, notwithstanding the higher calorific value of the former, the steam plant is then badly beaten by all the others. If we go to the East, where good oil is cheap and bad coal dear, the order of merit is again altered.

I have dealt with the cost of fuel first because it generally constitutes the most important item of running expenses, but the other running charges are shown below :—

—	Mond gas.	Suction gas.	Steam (cond.).	Steam (non-cond.).	Oil.
Fuel	0·051d.	0·129d.	0·090d.	0·120d.	0·125d.
Oil, water and stores ..	0·030d.	0·030d.	0·025d.	0 026d.	0 025d.
Wages	0·070d.	0·070d.	0 070d.	0·070d.	0·065d.
Maintenance & repairs	0·075d.	0 070d.	0·070d.	0 068d.	0·065d.
Works cost	0·226d.	0·299d.	0·255d.	0·284d.	0·280d.

The capital which would be expended on the various plants, including the electric generator and main switchboard, but excluding everything outside the power house, is set out as below :—

Mond gas.	Suction gas.	Steam (condensing)	Steam (non-condensing).	Oil.
£6,710	£5,150	£5,400	£4,900	£6,850

Adding to the figures of works costs, for interest on the capital outlay and depreciation, 10 per cent. per annum, we have, on the basis of 1,000,000 E.H.P.-hours per annum, to charge each electrical horse-power-hour with an amount as under:—

—	Mond gas.	Suction gas.	Steam (cond.).	Steam (non-cond.).	Oil.
Works cost	0·226d.	0·299d.	0 255d.	0 284d.	0·280d.
Capital charges......	0·161d.	0·124d.	0·130d·	0 118d.	0·164d.
Total cost	0·387d.	0·423d.	0·385d.	0·402d.	0·444d.

From these figures it will be seen that when any considerable amount of power is required it can be produced on the consumers' premises at a cost between 0·385d. and 0·444d. per electrical horse-power-hour, according to the plant employed. The question is, can the companies who undertake to deliver power from a general power house beat this ?

Let us consider the circumstances affecting supply of power from a general power house, premising at the outset that electricity furnishes the only means by which such distribution can be successfully carried out. The price at which the power can be profitably sold is, of course, influenced very largely by the expenditure on the power-producing plant. The difference between the cost of generation and distribution and the amount paid by the customers for power constitutes the gross profit on the undertaking, and if the business is to be profitable this must be sufficient to pay administration charges and interest on capital, while making ample contribution to a depreciation fund. It is manifest that, other things being equal, the less the outlay per horse-power the less need be the difference between the prime cost and the cost to customers, and the cheaper, therefore, will be the supply.

The amount which should be set aside to meet renewals—or, in other words, to form a depreciation fund—has been a matter of some controversy. We will take it that 2½ per cent. on the capital outlay represents a fair annual contribution to depreciation, and it will be assumed that, when the undertaking has reached its ultimate capacity, there is the same amount of share and loan capital. Calculating on a dividend to shareholders of 10 per cent. per annum, and on interest to debenture holders at 5 per cent., this amounts to paying on the whole capital interest at the rate of 7½ per cent., and with 2½ per cent. for depreciation the annual obligation in respect of capital amounts to 10 per cent. As a rule shareholders do not get 10 per cent. But an estimate giving scope to the consulting engineers' imagination is found to be very useful for getting money in. The number of incidents which occur to prevent prospective dividends from being realised is perfectly appalling, and if the price to be charged to the power users is fixed at such a figure as will return a prospective 10 per cent. to cover interest and depreciation, I am sure it will be found none too high in the end.

The percentage charges in respect of capital being taken as above, the amount actually assignable to each horse-power-hour depends, of course, upon the amount of capital invested and on the number of horse-power-hours sold. The expenditure on each horse-power of plant capacity depends upon many conditions. Beginning with the site on which the works are erected, the difference between land values in different localities is enormous. The next thing influencing capital expenditure is the cost of the buildings in which the power generating plant is housed. The last and most important factor influencing the outlay is the cost of the generating machinery and equipment. If steam turbines are used the cost per horse power installed is less for large generating sets than for small ones, and the capital cost with regard to plant capacity is correspondingly reduced. In addition to the saving on the sets themselves, as these become larger the cost per horse-power in foundations, steam pipes, switching gear, and all that appertains to the generating plant goes down. Working on a large scale makes large sets possible, and as these take up much less space for the power installed, the buildings can be made relatively smaller and the capital cost reduced all round. With respect to fuel economy, with increase in size the steam used per horse-power per hour diminishes, and at partial load large sets may actually use less steam for the same power than smaller sets running at full load There is also economy in labour, as large sets require no more attention in running than small ones

There are in London no less than sixty-two electricity supply works, the average capacity of each being under 4,000 E.H.P. None of these were erected with the object of distributing power. Though incidentally they have come to distribute a large amount, they were really put up to supply current for lighting, and, having been started on a comparatively small scale, they all cost more per horse power than what is now regarded as a proper figure. Taking all these works, the cost, including buildings, averages out at £38 per electrical horse-power installed, some costing more, some less. Roughly, it may be taken that the distribution system costs, on the average, another £32 per electrical horse-power, making the total capital expenditure £70.

Recently several estimates have been published showing what large power houses should cost with turbo-generating plant installed and everything carried out on the most up-to-date lines. The power house of the London County Council at Greenwich will have a capacity of 45,000 E.H.P., and is estimated to cost, when completed, £19·8 per electrical horse-power. The portion already finished has reciprocating engines, and as the plant will consist of these as well as turbines, it cannot be considered as quite the latest thing in power houses. The new power house proposed in their 1905 Bill by the County of London Company was to have a capacity of 13,000 E.H.P., and was to cost £14·7 per electrical horse power. The Carville powerhouse of the Newcastle-on-Tyne Company has a capacity of 13,000 E.H.P., and cost £12 per electrical horse-power. The Lots road power house of the Underground Electric Railways Co., with a capacity of 100,000 E.H.P., is said to have cost £13 per electrical horse power. The power house proposed by the Administrative Company's Bill of 1905 was to have a capacity of 120,000 E.H.P., and at that rating the cost worked out at about £7 per electrical horse-power. But there seems to be a special rating for Parliamentary Committees of which no man has grasped the sense, and, rated in accordance with the usual practice, this figure would probably be nearer £12. The latest figures of all are for the power house proposed to be erected at Battersea according to the London County Council's 1906 Bill, which was to have a capacity of 107,000 E.H.P., and was estimated to cost £11·25 per electrical horse-power. From these figures it looks as if the outlay per electrical horse-power for a modern power house can be reduced to about one-third of what now constitutes the average for the London supply stations. As regards the cost of the distributing system, this depends upon many circumstances, such as the number, size, and length of feeding and distributing mains, the route they have to take, the number of sub-stations required, &c., all of which vary according to the scheme and the district for which it is devised.

To get at the cost at which power can be supplied to customers, let us assume that we put down a power house having a capacity of 20,000 E.H.P. From the foregoing figures it would appear that £12 per electrical horse-power is a fair estimate for the cost of generating plant and buildings, including incidental changes, while the distributing system may also be taken as costing £12 per electrical horse-power. Of course, to get an exact figure for the latter, one should consider in detail a scheme for some particular locality; but for the general argument the figure seems a fair one, the total for generating and distributing plant amounting to £24. Needless to say, this is a much lower figure than has yet been found possible for the all-round cost of any undertaking. If we assume that the horse power-hours per annum reach 40,000,000, which, taking into account the loss in distributing, corresponds to a load factor of nearly 0·29, this means that the capital charge to cover interest and depreciation, reckoned at 10 per cent. on the outlay, will amount, in respect of each horse-power-hour, to 0·288d. The capital cost of the power house and distribution system is £480,000.

With respect to the running costs, we must give due weight to the figures obtained from existing undertakings, and to the cost of generating there must be added the cost of distribution and the cost of attendance at sub-stations. Then there is the loss in distribution to be reckoned with—first from the power house to the sub-stations, then from the latter to the consumer. Taking everything into account, and with the experience to hand, it would, I consider, be unwise to assume that the cost of generating and distributing could, for a power house of this size, be brought under ¼d. per horse power-hour sold, and this is taking coal at 7s. 6d per ton. After works cost come rent, rates and taxes, then directors' fees, cost of administration, and all the miscellaneous items which make up the head office charges in the engineering and business departments. As regards rents, rates and taxes, these items vary with the locality, but at 0·03d. per horse-power-hour we are putting them at a low figure. In London the undertaking with the greatest output pays more than four times this. At Newcastle-on-Tyne the figure is about 0·07d., and at Manchester and Liverpool it is 0·10d. Then we have the cost of administration, and here let me say that to find customers for the output of a large power station requires constant and unremitting effort and a staff to correspond. In putting the cost of this last item and the items not yet accounted for at 0·06d., we have, I consider, got down to bedrock. In the Newcastle-on-Tyne concern, where the amount of power sold is the same, and where the management is particularly energetic in pushing business, the figure reaches no less than 0·14d. Our cost per electrical horse-power is, therefore: Generating, 0·25d.; rent, rates, &c., 0·03d.; administration, 0·06d.; capital charges, 0·288d.; total, 0·628d. The conclusion is that, unless the undertaking can secure an all-round price of about ⅝d. per horse-power-hour, it will not, under the conditions we have assumed, pay the dividends it set out to earn, and if it has to supply below this price the dividend will shrink to correspond. If shareholders would be content with 6 per cent. on their investment, and lenders with 4, presuming all our figures are correct, the price might possibly be brought down to $\frac{9}{16}$d.

Several of the London undertakings supply power at ¾d. per electrical horse-power-hour, and seeing that the total cost of production, excluding capital charges, amounts to something over 1d., it is only natural to wonder how it is done. Well, it is just because they are not power undertakings that they can supply power so cheaply, just because a large portion of the output is sold at a comparatively high price for lighting can the power portion be supplied at a price which carries no administration or capital charges. Dumping units to fill in the valleys in the load curves is a good thing but when, owing to the loads overlapping, the generators must be set aside to supply power *or* lighting, but not both, obviously lighting pays better. At 4d. per unit for lighting and 1d. for power, the machinery, to produce the same revenue, must, when supplying power, run four times as many hours as when supplying light. To produce that revenue nearly four times the amount of coal and oil is consumed, to say nothing of extra wear and tear, all of which goes to show that for a purely power undertaking to be successful it must be conceived on a scale such that the capital cost per horse-power is as low as possible, and the running charges are brought down to the irreducible minimum.

Though our figures show that it will pay the large consumer better to use home-made power than to purchase companies' power, there are thousands of small consumers to whom a cheap supply from the companies must prove an inestimable boon.

Though it may pay to generate the power on site, considered from the purely investment point of view, the margin is not large, and if the companies can come within reasonable distance of the price I have mentioned they will be sure to secure a goodly number of large consumers. The reason is that, to compete with the power companies, the equipment in the factory must be of the highest efficiency, and to get up-to-date equipment the power user would have to spend money. That, needless to say, is precisely what he doesn't want to do, and often he hasn't the money lying by to spend. As a rule, a manufacturer will do anything rather than put down hard cash to improve his plant, and the companies, knowing this, must be ready to put it down for him. He may know that his power plant is old and inefficient, that years ago it should have been thrown on the scrap heap, and yet he will hesitate. Trade may be uncertain, times may be bad, and he feels that when money is spent on new plant it is irrevocably sunk whether trade revives or not. There is a good deal to be said for his view, and here is the companies' opportunity for coming in.

I have endeavoured in this address to let you know how matters stand and how things are tending, though it must be observed that an undertaking that manages to live by power alone, at present lives only on paper. But that there will be established in London at no distant date an undertaking for the supply of power only, appears to be pretty certain. A great many promises have been made as to the price at which power can be supplied, but the figures on which they are based are necessarily somewhat hypothetical, and are, I fear, in some cases illusory. That is, perhaps, unavoidable, for the reason that the power houses proposed differ both in magnitude and design from those which have furnished our experience. Consequently it is not known for certain how the price will come out, and the figures which have been given have certainly not been pessimistic. It has been suggested that the power house should not be in London at all, but that the power should be transmitted to London from the coalfields. The proper *kind* of fuel to use, say the advocates of this scheme, is cheap slack, the proper *place* to use it is at the pit's mouth, and the proper *way* to use it is to gasify it in Mond producers, and then burn the product in gas engines. An ammonia recovery plant would constitute part of the equipment, and it must be admitted that such a scheme has for the power engineer great fascination. Whether it would be commercially successful is another matter, however, and one which I will not discuss this evening.

ELECTRICAL INSTALLATION AT THE WILHELMINA MINE, HEERLEN, HOLLAND.*

BY W. PHILIPPI.

A special advantage of centrifugal pumps lies in the fact that they are easily applied to electric driving, especially on account of their high speed. The faster they run the more economical they become and the lower their price. They are, therefore, specially suitable for coupling to polyphase motors, which, at the ordinary frequency of 50 cycles, can be built even in large sizes for speeds of 1,500 revs. per min., and even for 3,000 revs. per min., being in this respect superior to continuous-current machines. There is the further advantage that a centrifugal pump only requires a small turning moment at the start, and can be consequently coupled to polyphase motors without slip rings. Short-circuited rotors in connection with starting transformers are all that is required, which allows of the use of motors of simple and yet thoroughly substantial construction.

It is highly important with mining pumps that they should have as little tendency as possible to heat the air of the mine, as this interferes with the work in a variety of ways. So long as steam pumps are used with long ranges of steam piping, a considerable degree of heating is unavoidable, especially when a large amount of water has to be raised to a great height; and one great advantage of electric pumps is at once apparent. Consequently the many incidental advantages of this form of pumping have led to its more or less general adoption in mines, which are organised on progressive lines. The main reason why steam pumps still continue in some places for this type of work seems to be that there is a difficulty in getting the necessary current from a power station, and the erection of a power station for the mine could only be done slowly; whereas steam pumps are always to be had from stock, and boilers already exist on the mine, so that, from these points of view, steam seems to be the simplest solution. In sinking a mine the usual plan seems to be to start by using any makeshift machines that can be found, and later to set to work to install something of a permanent nature. This is precisely the opposite of a good policy. Some good polyphase machines should be installed which are capable of doing all the various kinds of work needed in a mine, bearing in mind the fact that the nature of mining work seems to point distinctly to the choice of polyphase as opposed to any other kind of current.

These facts were borne in mind in sinking the Wilhelmina mine at Heerlen, in Holland, which was done by the department for the control of the Dutch mines. It was known from the experience of neighbouring mines that water was likely to be met with in fair quantities; and Messrs. Siemens-Schuckert, of Berlin, were entrusted with the work of supplying high-pressure centrifugal pumps. A voltage of 2,000 was chosen as being most suitable to the likely needs of the undertaking, and in the central station there were installed

* Abstracted from the *Elektrotechnische Zeitschrift*, August 30, 1906.

two machines of 235 kw. capacity at 125 revs. per min., driven by horizontal tandem engines. The continuous-current machines for excitation are also directly coupled to the alternators, and are of sufficient size to furnish current as well for the lighting of the station, so that the lighting circuits are free from the variations of voltage which are associated with motor work. There is also a 33 kw. turbine-driven continuous-current set, which is for use when the main generators are not being driven. Ordinarily this latter machine does the lighting work, whereas the former are confined to the excitation, the two being connected to separate 'bus bars, which can be connected, if necessary. The resistances in the fields of the excitation circuits are automatically adjusted, an arrangement which avoids complications on the switchboard; and the main alternators are connected to auxiliary 'bus bars, which are connected to the main bars by connecting links, the main bars themselves being divisible into sections by similar means.

The most interesting part of the machinery is that used for sinking the mine. This includes the pumps, the winding machinery for raising and lowering the same and similar machinery for removing or lowering other things. The pumps, made by Sulzer, were three in number; two raise 1 cubic metre (220 gallons) per minute, and the third 2 cubic metres (440 gallons) per minute against a head of 225 metres (739 ft.). These are all connected by flexible couplings to polyphase motors. A voltage of 2,000 was considered to be too high to be safe for this work, seeing that the pumps are always running in dripping water, and transformers were therefore used to lower the voltage to 500. These were housed in a closed room, as was the case with all high-tension switches, fuses and measuring apparatus. The starting of the motors is controlled by transformers, which are actually little more than choking coils, inserted between the three phases. By means of a controller it is possible to feed the motors with voltages of 250, 375, or 500. The pumps are hung from ropes that pass over pullies at the top of the shaft, and are coiled round the winding drum. A special form of rubber cable is used for making the connection to the motors driving the pumps, and this cable is similarly wound round the drum, being uncoiled as the pump is lowered. The motors are completely enclosed, but arrangements are made for the circulation of water through the casing in order to keep the windings cool, and a small fan inside the motor serves to keep the air in circulation. The winding machinery for raising and lowering these pumps is driven by a 2,000-volt motor through triple-reduction gearing, each pump being connected by its rope to a separate drum, and these drums are connected through a coupling to the motor. As the pumps are slowly lowered and carefully adjusted in position they are controlled by a brake worked by hand and foot levers, which are operated from the driver's seat, together with the switches for starting and reversing the motors connected to the pumps. A liquid resistance is used for starting the winding machinery for the pumps; this consists of three porcelain troughs, filled with soda solution, in which crescent-shaped metal plates are immersed. The specification provided that the speed with which the pump is raised is not to exceed 0·13 metre (0·42 ft.) per second. With the present gearing, at full speed of the motor, this speed would be 0·5 metre (1·6 ft.) per second, so that the starting resistances are inserted during this operation for the purpose of lowering the speed to the desired extent. It was considered that too much gearing would be required if the speed were to be reduced sufficiently by mechanical means alone, and the use of resistances of ample proportions seemed at once a simpler and better solution of the problem. The whole of this part of the installation has been so designed that after the mine has been sunk the winding machines can be used for raising the coal or for lowering the cage containing the miners. In this case the speed of the rope is to attain 2 metres (6·5 ft.) per second, and this will necessitate a slight re-arrangement of the existing gearing. The working load in this case will be 2 tons, for which the motor, starting resistances, &c., have been designed. A second winding motor has been connected to its drum for the purpose of raising the excavated material. Its maximum load is 1 ton, with a rope speed of 1·8 metres (6 ft.) per second. This motor, which is directly connected to 2,000 volts, is of 50 H.P. The details of its design are very similar to that of the larger motor, except that metallic resistances will be used for starting.

The whole installation has been carried out in accordance with the requirements of the specification drawn up by the Dutch Government, who have determined the sizes and arrangements of the various motors, &c. Thus, for instance, it was considered that it would be an advantage to be able to clear the shaft of any sudden inrush of water, and not to proportion the pumps to the average inflow. Consequently, although the average amount of water to be raised is only about 500 litres (110 gallons) per minute, pumps capable of dealing with 2 cubic metres (440 gallons) per minute are almost continually used, and the saving in time which arises when any emergency has to be met is so great a gain that the closing of the intake valve which is necessary for ordinary working is regarded as a disproportionate loss. This policy is adopted in spite of the existence of pumps which have been designed to raise 1 cubic metre (220 gallons) per minute, which would obviously work more economically with an average load of 500 litres (110 gallons) per minute. The various safety devices are of a very complete nature, and interruptions in working seem very unlikely to occur. Of course, it would be impossible to work the pump-motors under water, seeing that it is impossible to make the casing absolutely watertight; but it may be pointed out that steam pumps would similarly be unable to work under such conditions. The efficiency of the large pumps, together with their motors at full load, is 64 per cent., and that of the smaller ones is about 59 per cent. The possibility of driving these pumps by motors is a great advantage as compared with the long range of steam piping which would otherwise be necessary, and which would certainly entail many leaky joints. And further, the absence of any reciprocating parts removes the danger inseparable from continual vibration in work of this kind.

ON METHODS OF HIGH PRECISION FOR THE COMPARISON OF RESISTANCES.*

BY F. E. SMITH.

(From the National Physical Laboratory.)

(Concluded from page 976.)

Comparison of Unit Coils.—Manganin coils with potential points are alone considered. Platinum-silver coils without such points are compared with manganin ones by substitution in one of the arms of the bridge.

The method adopted is analogous to that of Carey Foster. The coils are exchanged in position, but the difference of values is given by the shunts applied to the two ratio coils. Thermal E.M.F.s are small and produce no disturbing effect as the galvanometer circuit is continually closed. The self-induction of the coils is very small indeed.

For coils having potential leads the Kelvin double bridge is used. $P=Q$ are the coils to be compared, P_R, P_L, Q_R and Q_L being the resistances of the current leads of these coils. R and S are 1 ohm standards. $\alpha=\beta=1$ ohm and $Q_R+P_L=d$. The galvanometer is permanently connected as shown in Fig. 6, but the battery leads are successively joined to the junctions of $P{\cdot}P_R$ and $Q{\cdot}Q_L$, $P{\cdot}P_R$ and $S{\cdot}Q_L$, $R{\cdot}P_R$ and $Q{\cdot}Q_L$. The coils R and S are shunted to effect a balance. Representing the shunted values of R and S by R_1 R_2 R_3, S_1 S_2 S_3, &c., we have

$$(1)\quad P=\frac{Q(R_1+P_R)}{S_1+Q_L}+\frac{d\beta}{\alpha+\beta+d}\left(\frac{R_1+P_R}{S_1+Q_L}-\frac{\alpha}{\beta}\right).$$

$$(2)\quad P=\frac{(Q+Q_L)(R_2+P_R)}{S_2}+\frac{d\beta}{\alpha+\beta+d}\left(\frac{R_2+P_R}{S_2}+\frac{\alpha}{\beta}\right).$$

$$(3)\quad P=\frac{QR_3}{S_3+Q_L}-P_R+\frac{d\beta}{\alpha+\beta+d}\left(\frac{R_3}{S_3+Q_L}-\frac{\alpha}{\beta}\right).$$

In practice, the value of $d\beta/(\alpha+\beta+d)$ does not exceed 0·00006 ohm, and the expression accompanying this is normally of the order 0·00005 ohm, so that the last term in the above equations is negligible. From (1) and (2) $Q_L=(R_1/S_1-R_2/S_2)/2$, and from (1) and (3) $P_R=(-R_3/S_3R_1/S_1)/2$.

P and Q are now exchanged in position, when $Q=P(R_4+Q_L)/(S_4+P_R)$, the values of Q_L and P_R being determined as before. If the coils are not very different from their nominal values we may now write

$$P-Q=\tfrac{1}{2}[(R_1-R_4)+(S_4-S_1)+2(P_R-Q_L)],$$

a difference readily determined from the shunts employed. With a galvanometer resistance of 3 ohms the sensitiveness is proportional to $0{\cdot}20 i\Delta\sqrt{P}$. For coils without potential leads, in which case the method of comparison is simplified, the sensitiveness is $0{\cdot}25 i\Delta\sqrt{P}$, the same as for the Carey-Foster bridge employing equal coils and a galvanometer resistance of 2 ohms. The latter method is, however, inapplicable to coils with potential leads, necessitates a calibration and standardisation of the bridge wire, is more troublesome in practice and the accuracy is limited, not by the general arrangement of the bridge arms but by the openness of the bridge wire and the accuracy of the scale and vernier.

The following table gives the difference in values of four coils with potential leads, every possible combination being taken. The differences in the first column result from the exchanging of the coils in the bridge arms; the differences in the second and third columns are deduced from observations of the two coils with a common standard. Thus, from the first and second recorded observations, the difference 2,206–2,205 is 130×10^{-7} ohms. The probable error is of the order of 1 part in 10,000,000. The temperature coefficients of these four coils are not very different and average 0·001 per cent. per 1°C. The bath used for the comparison is that described in the *Phil. Trans.*, A 373, p. 87, 1904.

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* Appendix to the Report of the British Association Committee on Practical Standards for Electrical Measurements, issued during the meeting at York (see *The Electrician*, August 17, 1906, p. 706). The committee consists of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Lord Kelvin, Profs. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Profs. A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar and Mr. George Matthey.

Date.	Coils.	Temperature of observation.	Difference at 17°C. 1×10^{-7} ohm.			Mean.
July 21, 1905	2,351—2,205	17·01°C.	492	493	492	492
,,	2,351—2,206	16·96 ,,	425	424	426	425
,,	2,483—2,351	16·86 ,,	143	143	144	143
,,	2,483—2,205	17·10 ,,	635	635	637	636
,,	2,483—2,206	17·12 ,,	569	568	567	568
,,	2,206—2,205	17·06 ,,	068	067	066	067
Sept. 8, 1905	2,351—2,205	17·25 ,,	475	474	476	475
,,	2,351—2,206	17·22 ,,	345	344	344	344
,,	2,483—2,351	17·19 ,,	357	356	356	356
,,	2,483—2,205	17·33 ,,	831	832	832	832
,,	2,483—2,206	17·38 ,,	701	702	700	701
,,	2,206—2,205	17·30 ,,	131	130	130	130

The differences recorded above indicate that at least three of the four coils changed between the dates of the observations. In a similar manner, very small changes have been observed in a few coils in an interval of 24 hours. Such changes are very interesting, but cannot be discussed here.

Ten, 100, and 1,000 ohm Coils and Resistances of a Higher Value.—By the bridge method the probable error in the evaluation of a resistance of 10^n ohm is n times the error of the 10 ohms built up from the unit. This latter error must, therefore, be made as small as possible. The "build-up" should contain no variable contacts, and the lines of flow in the coils when these latter are evaluated singly should be practically identical with the lines of flow when the coils are in series. At the National Physical Laboratory three special build-up boxes have been constructed. The 10 ohm build-up is here described. In this the coils are of nominal value, 1, 1, 2, 2, 5 ohms, and may be described as 1α, 1β, 2α, 2β, and 5. Each coil is of manganin, is immersed in oil, and connected by two copper posts to massive copper blocks, the blocks being provided with side terminals and mercury contacts. The coils 1α and 1β are evaluated by the Kelvin double bridge as described for standard unit coils. The leads to the bridge are from the mercury contacts, and the connections with the shunt coils α and β are from the side terminals. The resistance thus measured is that between two points lying centrally under the mercury contacts in the copper blocks. The value of the 5, 2β, 2α, and 1β in series will, therefore, be exactly equal to the sum of their individual values. The coils 1α and 1β; 1α, 1β and 2α; 2α and 2β; and 1β, 2α, 2β and 5 are compared by forming a simple bridge, the coils in the other arms being of 10 ohms resistance. A reversal in position of the two coils enables the difference to be accurately found. Finally, the 5, 2β, 2α and 1β are employed to evaluate a 10-ohm coil. 100 and 1,000 ohms are built up in a similar manner.

Let the constructional errors of the 10, 100 and 1,000 ohms build-up boxes be a, b and c respectively. Then, if we neglect the errors of observation, which are small, the error of a 10 ohm is a, of a 100 ohm $(a+b)$ and of a 1,000 ohm $(a+b+c)$. If the 100 and 1,000 ohm coils are evaluated by a Wheatstone bridge using the 10 to 1 ratio, then the error of the 100 ohm is $2a$, and of the 1,000 ohm $3a$. Hence, if in practice $a=b$, and $2a=b+c$, the probable error of the built-up values must be very small. Observations show that the differences $2a-(b+c)$, $3a-3b$, &c., are not measurable with certainty, for not only are the observed differences very small, but often the sign changes. The differences resulting in one set of observations is given in the following table.

June 11, 1906. *Observed Values in Int. Ohms at* 17°*C.*

	L·19	2,450	2,449
From build-up boxes....	$9{\cdot}9997_{97}$	$100{\cdot}008_{7}$	$1{,}000{\cdot}53_{0}$
From 1 to 10 ratio by use of Wheatstone bridge	—	$100{\cdot}008_{6}$	$1{,}000{\cdot}52_{7}$
	—	—	$1{,}000{\cdot}52_{8}$
From build-up boxes....	$9{\cdot}9997_{93}$	$100{\cdot}008_{6}$	$1{,}000{\cdot}52_{9}$

The values given on the first and fourth lines are from the three build-up boxes. The second values of 2,450 and 2,449 are obtained by the bridge, using the 1 to 10 ratio from the first build-up. The third value of 2,449 results from the 1 to 10 ratio from the second buid-up, and the probable error is therefore $3b$.

Low Resistance Standards.—A large number of methods have been suggested for the measurement of small resistances, and as many of these are known to be in use, it may be of service to point out the advantages and disadvantages of each

(*a*) *Matthiessen and Hockin's Method* (Fig. 7). By adjusting the resistances R and S a balance is obtained with the galvanometer arm connecting R/S with each of the potential points of P and Q in succession. The value of R + S is kept constant. The ratio of R to S is necessarily very great in one of the observations, and the sensitiveness is, therefore, very small (see expression (D)). The method is unsuited for accurate work.

(*b*) *Method suggested by Lord Rayleigh* (Fig. 8).—As an alternative to the previous method the following process was suggested by Lord Rayleigh in 1884.* P is the low resistance whose value is required. Q is a one or tenth-ohm standard which is shunted by the resistances b and c, the ratio of c to b being approximately equal to Q/P if the resistance of the galvanometer is comparatively great. When the galvanometer is connected across b, c is adjusted until the combination gives the same effect upon it as P does. Then, supposing the resistance of the galvanometer branch to remain constant,

$$P=\frac{Qb}{Q+b+c+bc/G}.$$

The method may be made a null one by using a differential galvanometer and an additional resistance, S (approximately equal to P), in the main circuit. One coil of the galvanometer is connected across P and the other across S, the resistance of the galvanometer arm of S being adjusted until there is no deflection. The P galvanometer coil is then joined across b, and c adjusted to obtain a balance. Small variations in current strength have no effect, but the current must be reversed and the combination readjusted in order to eliminate thermal E.M.F.s. The resistance of the galvanometer branch is not constant unless the potential leads of P are equal in resistance to those of b. In order to neglect the resistance of these leads, and to make bc/G comparatively small, G must be great. This diminishes the sensitiveness. If Q is made greater than 1 the maximum permissible current in the main circuit is reduced, and the sensitiveness is again diminished. Suppose that $P=0{\cdot}01$, $Q=1$, $b=1$, $c=97$, and $G=100+x$ where x is small. Then $P=1/(99+0{\cdot}96-0{\cdot}97\,x)$. Hence, if the value of P is desired to be correct to 0·001 per cent., the value of the galvanometer resistance must be known to 1 part in 1,000. Although not so sensitive as other methods described hereafter, the process is interesting. The combination of resistances Q, b and c was used by Lord Rayleigh in the determination of the ohm by Lorenz's method.

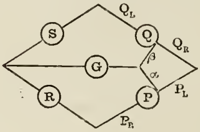

Fig. 6.

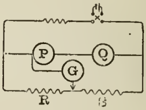

Fig. 7.

(*c*) *Housman's Method*† (Fig. 9).—The first stage in the process is to measure the ratio of P to Q by shunting R or (S + Q′). The second is to shift one galvanometer lead and one battery lead and measure the ratio of (P + Q) to Q′. Q′ is a 1-ohm coil. For precision work the leads connecting Q′ to S and P to R must be known. The greatest disadvantage of this method is that the current through P in the second measurement must be comparatively small. Thus, if $P=0{\cdot}0001$, $Q=0{\cdot}01$ and $Q'=1$, the maximum permissible current through P (if P is the usual type and size of standard resistance) is 100 amperes; through T and Q in series 10 amperes, and through $P+Q+Q'$ in series, 1 ampere. The necessary ratio of the arms S and R is also unsuited for accurate work.

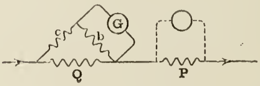

Fig. 8.

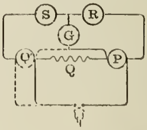

Fig 9.

(*d*) *Two-step Method*‡ (A. Campbell) (Fig. 10).—A suitable small resistance, whose value need not be accurately known, is inserted at U, and is adjusted by shunting until the galvanometer balances in position a. The galvanometer is then brought into position b and balance obtained by another shunt at R or S. By repeating this process a few times the balance is good in both positions. The method is about 50 per cent. more sensitive than the Kelvin double bridge if equally favourable arrangements are made, but it is much less convenient in practice. The leads connecting P to R and Q to S have to be evaluated by changing the position of the battery leads.

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* Camb. *Phil. Soc. Proc.*, 1884, Vol. V., p. 133.
† *The Electrician*, 1897, Vol. XL., p. 300.
‡ *Phil. Mag.*, July, 1903.

(*e*) *Potentiometer.*—With very small resistances, if great sensitiveness is required, two currents of large value have to be maintained in a steady state. As the probable error is proportional to the variation in the current strengths this necessitates great care. In practice the sensitiveness may be made greater than that of any other method. If P = 0·0001, R = 0·001, Q = 0·001, S = 0·01 (see Fig. 3), and if we suppose the resistance of the other portions of the circuits to be comparatively great, then, with G = 1 ohm, the sensitiveness for one position of balance is proportional to 0·01 $i\Delta\sqrt{P}$, and for the second position of balance 0·031 $i\Delta\sqrt{R}$. If Q = 1, S = 10, the sensitivities corresponding are proportional to 0·005 $i\Delta\sqrt{P}$ and 0·0029 $i\Delta\sqrt{R}$.

(*f*) *Kelvin Double Bridge*[*] (Fig. 11).—For measurements of precision this method is used at the National Physical Laboratory. Balance is first obtained by shunting R or S, when

$$P=\frac{QR'}{S'}+\frac{\beta d}{\alpha+\beta+d}\left(\frac{R'}{S'}-\frac{\alpha}{\beta}\right),$$

R′ and S′ representing the shunted values of R + L and S + L′ + L″. To obtain the value of L the battery lead at P·L is disconnected and joined to L·R and the bridge again balanced. L′ + L″ is similarly evaluated (see example which follows). For *d*, *α* and *β* are disconnected and the galvanometer circuit completed by connecting to the junction of Q and *d* and balancing. The ratio of *α* to *β* must be known with considerable accuracy if *d* is comparatively great. *α* consists of a resistance coil plus a potential lead of P, and *β* of another coil plus a potential lead of Q; hence the ratio must be determined with *α* and *β* in position in the bridge. The bridge is first balanced in the ordinary way by shunting R or S. The connector which joins P to Q through the arm *d* is then removed and balance restored by shunting *α* or *β*. The original arrangement is restored and the bridge balanced again. Thus by successive approximations we have

$$\frac{P}{Q}=\frac{P+\alpha}{Q+\beta}=\frac{\alpha}{\beta}=\frac{R'}{S'},$$

where R′ and S′ are the shunted values of R and S. Thus R′/S′ is equal to *α*/*β* within the limits of the errors of measurement. It does not follow, however, that $d\beta/(\alpha+\beta+d)\times(R'/S'-\alpha/\beta)$ is negligibly small. It is only so if the value of $d\beta/(\alpha+\beta+d)$ does not exceed the value of P. If the value be NP and the probable error of an observation is 1×10^{-n}, then the error of the final result is not less than $N\times10^{-n}$. It will be seen from this that the current leads of standard resistances intended for measurement on the Kelvin double bridge should have a resistance not greater than the standard itself. In some commercial standards the resistance of the current leads plus the connectors necessary for their measurement *is* greater than that of the standard strip. In such cases the potentiometer or Kohlrausch differential galvanometer should be employed. In the department of electrotechnics at the National Physical Laboratory the potentiometer is used. The sensitiveness of the Kelvin bridge is less than that of the potentiometer, but it is more convenient in practice. In the bridge, if P = 0·0001, Q = 0·001, R = 1, S = 10, *α* = 1, *β* = 10, the sensitiveness is proportional to 0·0034 $i\Delta\sqrt{P}$. The galvanometer resistance is supposed to be 2 ohms. An example follows. For simplicity P = 0·1 ohm.

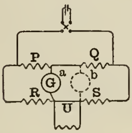

Fig. 10.

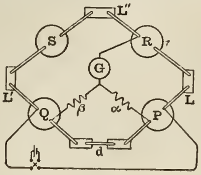

Fig. 11.

P = No. 2,484 = 0·1 ohm with potential leads. Value desired.
Q = No. 2,351 = 1·0 ,, ,, ,, ,, Value = 1·00000$_5$ at 17·0°C.
R = No. 2,483 = 1·0 ,, ,, ,, ,, Value = 1·00002$_4$,,
S = No. 1,693 = 10·0 ohms. No potential leads. Value = 10·0001$_8$,,
α = 1 *β* = 10 *t* = 17·0°C.

Balance was effected by shunting R with 122·000 ohms. The connector completing the branch *d* was then removed and balance again established by shunting *α* with 6,500 ohms. The balance still held good when the connector was restored in position. Hence, if R′ and *α*′ represent the shunted values of R and *α*,

$$\frac{P}{Q}=\frac{P+\alpha'}{Q+\beta}=\frac{\alpha'}{\beta}=\frac{R'+L}{S+L'+L''},$$

the probable error of these ratios being of the order 0·0001 per cent. in the present instance. The value of *d* (for measurement see the following table) is equal to 0·00012$_8$ ohm, and is less than P. Hence

$$P=\frac{Q(R'+L)}{S+L'+L''}=\frac{1{\cdot}00000_5\times(1{\cdot}00001_6+0{\cdot}00011_9)}{10{\cdot}0001_8+0{\cdot}0001_2}=0{\cdot}100011_0 \text{ at } 17{\cdot}0^\circ\text{C}.$$

The manner in which *d*, L, and (L′ + L″) were evaluated will be seen from the accompanying table. This is a good instance of a measurement involving a number of connecting pieces which must be evaluated in position.

	Position of galvanometer leads.	Position of battery leads.	Balancing condition.		Ohm.
(1)	L″·R *α*.*β*	P·L Q·L′	Shunt on R = 122,000	Equiv. change	= 0·00000$_{82}$
(2)	,, ,,	L·R Q·L′	,, ,, S = 8,150	,, ,,	= 0·00122$_6$
(3)	L″·S ,,	P·L S·L′	,, ,, R = 7,100	,, ,,	= 0·00014$_1$
(4)	L″·R Q·*d*	P·L Q·L′	,, ,, S = 8,370	,, ,,	= 0·00119$_5$

From (1) and (2) L = 10(0·000130$_8$)/11 = 0·00011$_9$
,, (1) ,, (3) L′ + L″ = 10(0·000133)/11 = 0·00012$_1$
,, (1) ,, (4) *d* = 0·00012$_8$.

(*g*) *The Differential Galvanometer.*[*]—This method is usually used for comparing resistances which are nominally equal. It is not convenient for their evaluation from the unit by means of a ratio of 1 to 10.

The difference of the currents through the galvanometer coils is $i(Pg-QG)/G(Q+g)$, where G and *g* are the resistances of the galvanometer circuits (see Fig. 4). This is equal to zero when P/Q = G/*g*. When this latter condition holds there will, in general, be a deflection owing to want of symmetry of the galvanometer coils. If P = 1 and Q = 10, then the ballast resistance in circuit with *g* or G may be adjusted until there is no deflection. In such a case, if two other coils, P′ = 0·1 and Q′ = 1·0, are substituted for P and Q (G and *g* remaining as before), and 10 times the previous current sent through them, there will be no deflection when P/Q = P′/Q′. In general, however, the maximum permissible current is $\sqrt{10}$ times that previously employed, and any want of symmetry in the galvanometer coils does, therefore, introduce an error. In addition, the substitution of P′ and Q′ for P and Q changes the values of G and *g*, because these latter include the potential leads of the resistances and also the contact resistances introduced. If G and *g* are comparatively large, the error is reduced, but so also is the sensitiveness. In the same way errors are introduced in the comparison of nominally equal resistances. In this latter case, if P and Q are exchanged, P is equal to Q when there is no change in the deflection, and no error is introduced by want of symmetry in the galvanometer coils or inequality of the resistances of the galvanometer circuits, always supposing that these latter remain constant throughout the observations. Unfortunately, the resistances of these circuits do change, for the reason previously given, and the error introduced may be considerable. Let P = Q = 0·1 ohm and let the resistance of the leads of P = 0·0001 ohm, and of Q = 0·0002 ohm. (In some low resistances the potential leads are of the order 0·01 ohm.) Then, if G = 1, and no correction is applied for the inequality of the leads, the error of measurement is 0·01 per cent. If G = 100 ohms, the error is 0·0001 per cent., but the sensitiveness is reduced to one-fifth of its former value. Such errors are abolished if the Kohlrausch method of overlapping shunts[†] is used, of which a diagram of connections is given in Fig. 13. In Fig. 12 let P = Q. Then, unless there is symmetry of the galvanometer coils and equality of resistance of their arms, there will be a deflection. Supposing that G and *g* can be exchanged in position by substituting for X a resistance practically identical with it, then the deflection will be of the same magnitude and of the same sign as before. In practice P is made equal to Q by shunting one of them, the equality being determined by the equality in magnitude and sign of the deflection before and after interchanging G and *g*. The exchange is effected by a six-pole switch, as shown in Fig. 13. The resistance of the galvanometer circuits is thus constant, and it is apparent that the Kohlrausch method of using the differential galvanometer is the only one so far suggested that can be used for precision measurements.

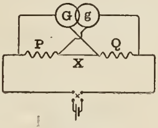

Fig. 12.

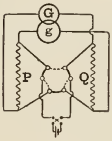

Fig. 13.

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[*] W. Thomson, *Phil. Mag.*, 1862, Vol. XXIV., p. 149. See also Jaeger, St. Lindeck, and Diesselhorst, *Zeitschr. Instrumentenk.*, 1903, 33.

[*] See "Heaviside's Papers," Vol. I. Also C. W. S. Crawley, *Journal* Institution of Electrical Engineers, April, 1904.

[†] *Wied. Ann.*, 1883, Vol. XX., p. 76. See also article by Jaeger, *Zeitschr. Instrumentenkunde*, 1904, 288.

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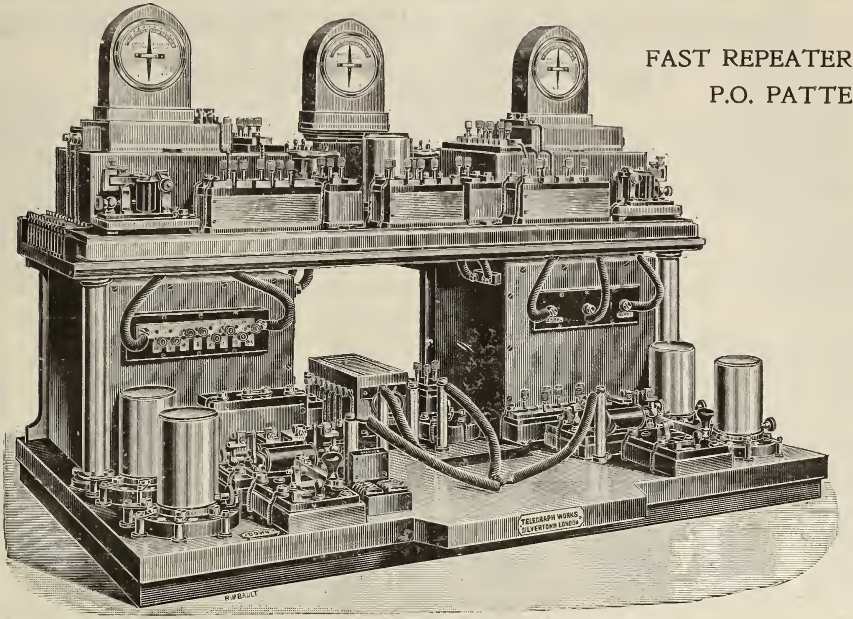

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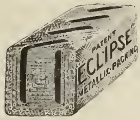

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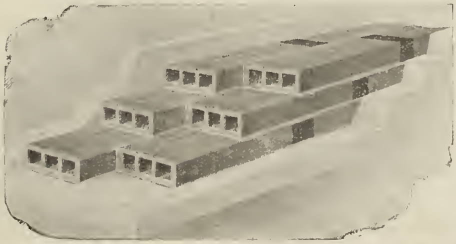

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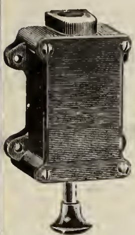

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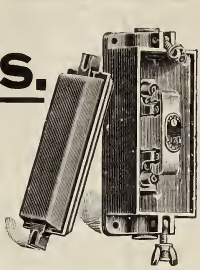

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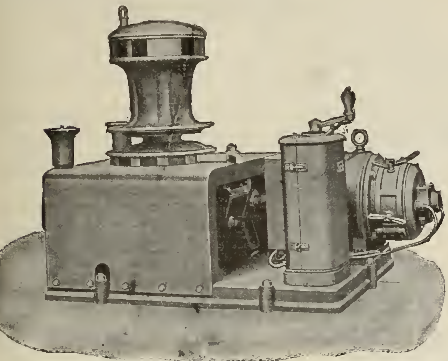

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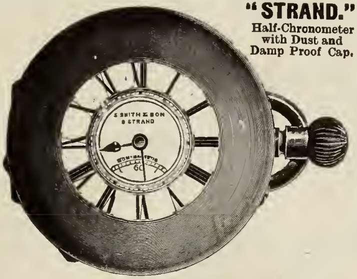

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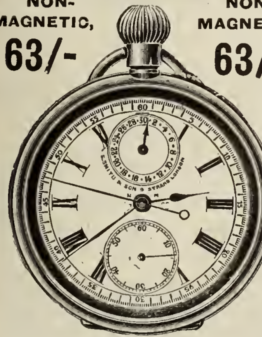

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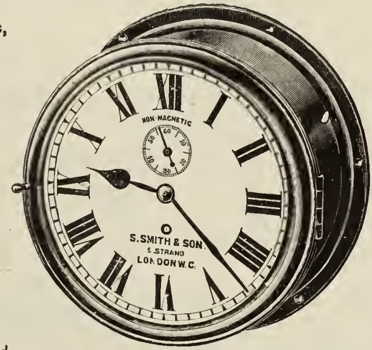

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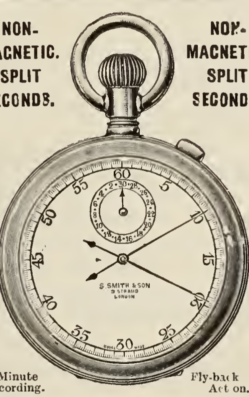

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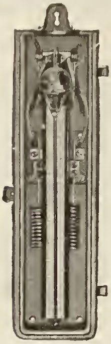

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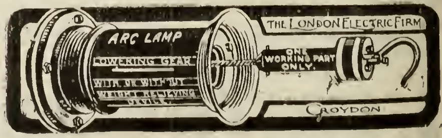

At one time it was a question of steam power, or nothing; but now there is the ordinary producer working by suction or pressure with anthracite coal, the more recently developed producers using bituminous coal (such as the Mond and the Duff-Whitfield, though the recovery of ammonia with the former would not be practised in a plant so small), and there is the Diesel oil engine. With this choice, economical working is not difficult to reach. We think, however, that Mr. ESSON is putting too rosy a light on the subject from the private station point of view when he puts the cost of fuel for condensing steam plant at 0·09d. per electrical horse-power-hour, and that most engineers would consider that steam plant in average working, condensing or non-condensing, is more costly, on a fuel basis, than suction gas or Diesel oil engines, instead of the reverse. Buildings have not been included, so that the cost of £15 to £16 per kilowatt for the generating plant installed may seem low, and the final figure of 0·385d. to 0·44d. per electrical horse-power-hour (0·51d. to 0·59d. per unit) for the total cost of private generation, including interest and depreciation combined at 10 per cent., but excluding any management charges, seems somewhat lower than can be expected for an output of a million E.H.P. hours per annum, unless the conditions are very exceptional.

In some respects the power company is not so favourably placed. Although many of its costs may be very low, it is saddled with an expensive distributing network, so that the capital cost of the whole is comparatively high. Mr. ESSON puts it at £32 per kilowatt for the whole undertaking, the network being responsible for half this amount, and he arrives at the figure 0·628d. for the cost per electrical horse-power-hour sold, including 10 per cent. for depreciation and dividends. The conclusion is that power cannot be sold at less than ⅝d. per electrical horse-power-hour—or, say, 0·84d. per unit—and that when London companies sell power at 1d. per unit, they are selling at a price which is lower than the total cost of production, even excluding capital charges; and it is only because they are selling a large portion of their output at a comparatively high price that they can supply power so cheaply. This criticism, however, is scarcely justifiable; for the cost per unit is an average, and the cost of producing the power portion of the load, assuming that it has a good load-factor, is less per unit than that of the lighting load. A lower charge, within limits, than the average cost is therefore permissible.

Although it may not be generally agreed that there is such a large difference in favour of the private generating station as that shown by Mr. ESSON, there is no doubt a difference which may make it quite worth while for a manufacturer erecting a new works to put in his own generating plant. There is, however, the other and more general class of private user of power—namely, the manufacturer who has a factory already driven by line shafting and steam plant. This plant may be very inefficient and comparatively costly to run: the manufacturer may recognise the advantages of electric driving; but he may not care to change from the bad that he knows to the good that is unfamiliar to him, and to take such a drastic step as the reconstruction of his power house. And there is, further, the important point that it may be very inconvenient to him to raise the necessary capital. Here it is that the power company is at an advantage. Possibly the cost of power to the private user may be a little more, but it is a great advantage not to have capital locked up in what, to the manufacturer, is a business that is foreign to him—namely, the production of power. If possible, the power company should be prepared to go further, and to supply not only power but motors also. In other words, it should be prepared to place its capital at the disposal of the user, so that motors can be hired, or purchased on the hire system when the success of the electrical working in any particular case is proved. Such a system would appeal not only to the large manufacturer, but to the numerous firms requiring less power than that just considered, and who are likely to form the bulk of the customers of many companies, since private generation is much less attractive to them than to those requiring power on a large scale.

REVIEW.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Principles of Electric Wave Telegraphy. By J. A. FLEMING. (Longmans, Green & Co.) 24s. net.

This large book of 600 pages, though modestly described in the preface as an expansion of the author's series of lectures on subjects allied to wireless telegraphy, is indisputably the most complete treatise yet published on the subject. It is written neither from a popular point of view, nor as an introductory text book, but is such a treatise as will prove invaluable to every worker and thinker in this subject.

The work is divided into three approximately equal parts. The first part deals with the generation, measurement and properties of electrical oscillations; the second with the production, propagation, measurement and detection of electromagnetic waves; the third with practical wireless telegraphy and apparatus. Of the first part the most valuable portion is that dealing with the measurement of capacity, inductance and damping factor of an oscillation circuit. Here are collected most known methods of merit, together with a vast amount of solid information, plentifully be-diagrammed, drawn from the most recent research. Naturally, as the author is himself a leader in the devising of instruments for the measurement of high-frequency constants, a number of those described are of his own design.

In the second part of the volume theory goes hand in hand with experimental work. While treating the subject of waves mainly by consideration of the movements of lines of force, the author has not shrunk from applying the equations of the electromagnetic field to the problem of the Hertzian oscillator. Here, too, are generously set forth the valuable diagrams of the field of an oscillator, due to Pearson and to Love. The chapter on detectors—coherers, thermal, magnetic and other detectors—is very good, though, we think, not so much credit is given as might be given to Marconi for his production of the magnetic detector. On the other hand, the treatment of wave-length measuring devices deals principally with the author's own appliances, only small space being given to other instruments.

The third section of the volume, namely, that treating of wireless telegraph engineering, possesses three chapters. The first of these, curiously entitled "The Inception of Electric Wave Telegraphy," is a eulogy, biographical in character, of Mr. Marconi's work from 1895 up to the present moment, wherein is drawn a vivid picture of that distinguished inventor plodding in isolation in an empty (wireless telegraph) world. The second chapter is headed "The Development" and begins thus: "Contributions to Electric Wave Telegraphy by various workers. Although the practical achievements of electric wave wireless telegraphy are in a very remarkable degree the work of one man—viz., Guglielmo Marconi, yet valuable contributions have been made to it by other investigators." Then is described the work of Lodge, Muirhead, Slaby, Arco, Braun, Fessenden, de Forest, Stone and others, during the same period as is covered by the preceding chapter. It is true that in the preceding chapter one or two of Marconi's rivals are mentioned, but merely to be castigated; and, correspondingly, in the "Development" chapter Marconi's work is referred to now and again, but only in efforts to belittle the achievements of Lodge and Braun and Slaby. As, however, facts and dates are correctly given, it is still possible for the reader to gather a fair estimate of the deserts of the various workers.

In his office of biographer the author has not drawn attention to one of Mr. Marconi's chief qualities as a leader in wireless telegraphy: no allusion is made to Mr. Marconi's very great business ability, a characteristic that has assured him all the irresistible impetus of great financial resources, and enabled him to expend vast sums on expert assistance and on experiments. Again, no mention is made of Mr. Marconi's great faculty—most valuable in any branch of engineering—of perceiving quickly the useful parts of other people's incomplete conceptions and of pushing them rapidly forward to a practical conclusion. This is, however, all excellently borne out by Prof. Fleming's two chapters; for here can be seen how Marconi improved the Branly coherer, the Lodge tapper, the Popoff air-wire, the magnetic detector often attributed to Rutherford, the Tesla and Braun oscillation transformer for sending, and the Lodge oscillation transformer or "jigger" for receiving. The "jigger," by the way, is not clearly treated by Prof. Fleming. The idea of this instrument belongs undoubtedly to Lodge; but Marconi's assistants wound hundreds of these instruments (see Marconi's Royal Institution Discourse, Feb. 2, 1900, *The Electrician*, p. 555, Vol. XLIV.) before hitting upon the best length of secondary—viz., about the length of the air-wire. Success was attributed, it would appear, to the *mode* of winding, which, by mere chance, was a peculiar bunching of the secondary wire into a kind of doubly-coned winding. Now Prof. Fleming quite omits to point out that this bundled winding is of no importance—that it was, in fact, either a mistake or a joke; nor does he mention that this mode of winding jiggers was discarded by the Marconi Company years ago. In fact, the taper winding is described in great detail, and the modern jigger is described on a later page under another name and in a few hurried words.

The last chapter of the book is valuable on account of the very full abstracts of the work of Chant, Pierce, Duddell and Taylor, and Jackson. But we cannot endorse the author's account of directed wireless telegraphy. From the nine pages devoted to this matter the reader might gather quite a false view of the relative magnitude of Marconi's contributions to this subject. In a leading article in *The Electrician* of May 25th last it was pointed out that several others, notably Braun in 1902, had used the horizontal antenna with accuracy as great as did Marconi in 1905. But of Braun and other workers with horizontal antennæ Prof. Fleming says not a word, and Mr. Marconi is set forth as the sole originator. We feel sure that Mr. Marconi himself would be the last to state such a proposition. Here, as in so many instances, Mr. Marconi's real merit lies in the making practical, the standardising and the advertising, of a method whose material value was, perhaps, not fully appreciated by its parents; and it is unfortunate that our author does not grasp and assert this reason for praising his hero.

The volume closes with useful appendices, giving the British Wireless Telegraph Acts and a list of important British patents. Another appendix, having for its object a list of important books and Papers on wireless telegraphy, is not complete, for it omits mention of, for example, Branly's classical Paper and the Institution Paper of Duddell and Taylor.

As it stands, the book is, notwithstanding its bias, incomparably the most complete in the English, or any other, language. It is, in its most scientific sections, altogether admirable, and is sure to rank for some years to come as a standard work on the subject. W. H. Eccles.

The North Magnetic Pole.—According to the *Electrical World* Capt. Amundsen, who recently made the North-West Passage, is believed to have located the north magnetic pole. He has proceeded to the magnetic observatory at Sitka and declares that until the results of his observations have been fully worked out he cannot say positively what has been accomplished. He believes that he has found the north magnetic pole, but cannot say as yet whether it is a shifting point or extends over a large area. Careful observations of the aurora borealis were taken with a view to tracing its connection with effects on the compass.

INSURANCE AND INSPECTION OF ELECTRICAL MACHINERY.

The report of Mr. Michael Longridge, chief engineer to the British Engine, Boiler & Electrical Insurance Co. (Ltd.), for the year 1905, contains some interesting remarks on the inspection and insurance of electrical machinery. Considerable increase is noticeable in the ratio of increase of business, but unfortunately the increase in the amount paid in claims is slightly greater. One explanation suggested is the deterioration of electrical machinery by age and use. At the same time, it is thought that the heavier fuses which the company has been compelled to allow to meet the heavy starting currents required by motors in so many cases are not without influence on the rate of breakdown. This rate among dynamos is decreasing, but among motors, particularly small motors, it is increasing. The rate among continuous-current motors exceeded the rate among alternating-current motors by 40 per cent., while the rate among alternating-current dynamos exceeded the rate among continuous-current dynamos by 29 per cent. The proportions in which the various parts of the machines are thought to have given way are set out in the following tables:—

	Dynamos.		*Motors.*
Armatures and rotors	53 per cent.	..	48 per cent.
Magnet coils and stators	6 ,,	..	13 ,,
Commutators and brush gear ..	25 ,,	..	28 ,,
Miscellaneous	16 ,,	..	11 ,,
	100		100

Starting Switches and Controllers.

Resistance coils	48 per cent.
Contacts or switch arms	15 ,,
Automatic apparatus	13 ,,
Miscellaneous........................	24 ,,
	100

And the causes of the breakdowns were probably the following:—

	Dynamos.		*Motors.*
Accident	15 per cent.	..	9 per cent.
Dirt and neglect.............	14 ,,	..	19 ,,
Age and deterioration	21 ,,	..	25 ,,
Bad workmanship and design..	23 ,,	..	18 ,,
Overloading	—	..	2 ,,
Unascertained	27 ,,	..	27 ,,
	100		100

Starting Switches and Controllers.

Accident	22 per cent.
Dirt and neglect	11 ,,
Age and deterioration	23 ,,
Bad workmanship and design..........	9 ,,
Improper use	7 ,,
Unascertained	28 ,,
	100

Examples of each class are given below, and in selecting them an endeavour has been made to choose, as far as possible, cases which are representative of large numbers of like cases.

1. Continuous-current compound-wound two-pole dynamo, giving 30 amperes at 250 volts when running at 1,030 revs. per min. Several of the armature conductors were burnt. When the armature was taken out the lid of a vaseline tin was found between it and the magnets. This had cut the insulation and short-circuited the conductors.

2. Continuous-current shunt-wound motor, taking 20 amperes at 230 volts for driving a passenger hoist. The motor was controlled by a double-break switch actuated by a horizontal shaft carrying a sprocket wheel, which was driven by a chain from another sprocket wheel on a countershaft, which in its turn was moved by a third sprocket wheel and a chain attached to the lower end of the hand rope running through the cage. By pulling the hand rope in one direction the attendant closed the switches, and at the same time liberated the plunger of a dashpot, which, in descending, cut out the coils of the starting resistance automatically. By pulling in the other direction he opened the switches, stopped the motor, raised the plunger in the dashpot, and threw the starting resistance into circuit. The dashpot consisted of two concentric cylinders, one within the other, with an annular space between. Through the wall of the internal cylinder several $\frac{3}{16}$ in. holes were bored, through which the oil escaped as the plunger descended by its own weight. On the occasion of the breakdown the cage was at the top of the well. The attendant pulled the rope to close the starting switch, and the cage began to descend, but at a slower speed than usual. It is uncertain what happened next, but probably he tried to accelerate the descent by a violent pull at the hand rope. At all events, he pulled it hard enough to twist the countershaft and break the chain and sprocket wheel on the shaft which moved the switches, leaving the latter closed. The motor therefore went on running, the cage went to the bottom of the well, and the balance weights were wound up till they jammed at the top, when the

fuse melted. After examining the broken parts without finding anything to account for the accident the inspector, noticing that more than half the resistance in the starter was still in circuit, was led to investigate the inside of the dashpot. In it he found the cause of the mishap, a small piece of silver or German silver watch chain, $\frac{3}{8}$ in. long by $\frac{1}{8}$ in. diameter, sticking through one of the $\frac{3}{16}$ in. holes sufficiently far to jam the plunger of the dashpot near the top of its stroke. How the piece could have got into such a position is a mystery. The breakdown shows the need for limit switches at the top and bottom of hoist wells to cut off the current automatically in the event of accident to the controlling gear.

3. Shunt-wound motor, 12 H.P., running at 1,200 revs. per min., with continuous current at 220 volts. When the installation was inspected in April the inspector found the positive supply cable "earthed," and the fault was duly reported to the owners, who were advised to rectify it. Evidently no notice was taken of the advice, for about a month afterwards the "no-load release" coil on the starting switch, and several of the resistance coils in connection with the same, were "burnt out" by a man driving a nail through the casing containing the shunt lead between the motor and the starting switch. The nail came into contact with the wire and with the frame of the machine, to which the casing was attached. This established a circuit from the earthed positive supply cable, through the machine, the nail, the no-load release coil, the resistance coils and the motor armature to the negative.

4. Series-wound motor, 54 amperes, 340 volts, driving a coal cutter. Owing to accumulation of oil and dust on the insulating ring at the outer end of the commutator one of the segments got into electrical contact with the frame. As the fault did not interfere with the use of the machine, and as the coal face was too dry to allow the pitman to receive shocks of any severity, no attempt was made to restore the insulation at the faulty part. Soon after, a second fault occurred through the same cause on another of the segments, short-circuiting a portion of the armature and burning the conductors. The armature, owing to its construction, had to be entirely re-wound. Had the frame of the machine been earthed effectively the development of the first fault would have been indicated by the earth lamp or other instrument on the dynamo switchboard, and on putting one of the mains to earth, the fuse at the motor would have melted, the fault would have been located, and it could then have been remedied. Thus the burning of the armature which followed the development of the second fault would have been saved, and the risk of shock to anyone touching metal in connection with the motor would have been removed. One of the special rules for the installation and use of electricity in mines provides that "all metallic coverings, armouring of cables, *other than trailing cables*, and the frames of generators, transformers and motors, *other than portable motors*, shall, as far as is reasonably possible, be efficiently earthed where the pressure at the terminals where the electricity is used exceeds the limit of low pressure," which is 250 volts. The words in italics exclude motors of coal cutters and their trailing cables. It is, of course, difficult to get a reliable earth near the coal face in a dry mine. Armoured cables cannot always be depended on, as the continuity of the armour is often broken by rough usage or at junction boxes. It would almost seem as if the only satisfactory plan would be to carry a third wire from bank, or from some other place where a reliable "earth" could be obtained, to the distribution board supplying the coal cutter, and to incorporate a third wire with the trailing cable, which would automatically connect the earthed wire at the distribution board to the motor frame. This system might be applied to other portable motors, such as those attached to movable pumps and drills.

5. Continuous-current 48 kw. motor-transformer, with double-wound armature receiving current at 1,000 volts and generating at 115 volts; one of several placed in different sub-stations to feed a low-tension network. In ordinary working the field magnets were excited by current shunted from the low-tension brush leads, but for starting purposes there were also a fairly large number of coils in series with the high-tension circuit, which were automatically cut out by a "stray-field" switch, when the excitation was complete. There was also an automatic single-pole switch on the low-tension side for connecting to and disconnecting from the low-tension cables. The high-tension cables were protected by double-pole fuses at the generating station. One day these fuses melted, indicating some fault in the system, which was afterwards found to be a short-circuit on the mains supplying the transformer. A man was at once sent to the sub-station. He found the transformer running at an excessive speed and stopped it, but not before the binding wires had been broken and the end connections to the armature spread by the centrifugal force, so that the armature had to be entirely re-wound. There was some uncertainty as to the cause of the mishap, but after getting all the information obtainable the company came to the conclusion that when the high-tension current was cut off by the melting of the fuses and the machine began to run as a motor with current from the other transformers, in connection with the low-tension network, and to deliver current to the short circuit created by the fault, the current taken from the low-tension mains would be so great as to cause a heavy momentary fall of potential in these mains, and in the shunt, which would demagnetise the field sufficiently to throw out the "stray-field" switch and throw in the series windings. These opposing the effect of the current in the shunt would permanently weaken the field, and allow the armature to attain a speed sufficient to cause the damage above described. This conclusion was supported by a very important fact not hitherto mentioned. The automatic switch on the low-tension side was out of order, and failed to fall out at the moment the current was reversed. Had it acted as was intended, the machine would have been switched off the low-tension mains when the fuses on the high-tension cables melted

6. Semi-enclosed three-phase alternating current motor, taking 85 amperes per phase at 350 volts, driving shafting in an ironworks. In consequence of persistent melting of the fuses the inspector was sent for to ascertain the cause. On testing for insulation he found the stator windings earthed. As far as could be seen through the openings in the front cover of the casing everything appeared to be in order, but on taking off the cover at the pulley end, which was unprovided with inspection holes, and taking out the rotor, the cause of the trouble became evident. That end of the machine was saturated with oil and covered with dust, and the stator windings were burnt in many places by arcs caused by temporary short-circuits. Their condition was so bad that the stator had to be entirely rewound. The oil had come from the bearing at the pulley end of the rotor shaft. This bearing was partly inside the casing, and the mouth of its overflow pipe was placed so high that the oil well could be almost filled with oil. This, combined with an inefficient guard over the oil thrower and the high speed of the shaft, 750 revs. per min., allowed the oil to creep along the shaft and to be thrown on to the windings of the motor. There seems to be a somewhat widely-held impression that alternating-current motors cannot be damaged by oil or dirt. As regards the rotors there is some excuse for the belief, because the difference of potential between the windings themselves and between the windings and the frames is low, and therefore imperfect insulation may be sufficient to confine the current; but as regards stators the only advantage they have over the armatures of continuous-current machines is this, that they are stationary, and therefore their insulation is less liable to disintegration and will hold out longer in a deteriorated state than if it were subject to the vibration of a moving part.

The above is quite a typical example, 23 per cent. of the failures of alternating-current motors in 1905 being due to this same cause.

7. Continuous-current series-wound four-pole motor, rated at 4 H.P. when running at 600 revs. per min. with current at 220 volts. The motor drove the longitudinal travelling motion of a 10-ton crane. It was placed below one end of the girder, which had a span of about 30 ft., and was coupled to the driving shaft by gearing. The armature shaft broke at an abrupt change of diameter. The armature dropped upon the pole-pieces, which tore off the binders and damaged the insulation of the conductors. As a previous shaft had been broken in an exactly similar way a year before, the owner decided to alter the design. The breakage of the shaft must be attributed to the weakening effect of the abrupt change of diameter, for with the highest starting current the stress would not have exceeded 3,400 lb. per square inch.

8. Continuous-current motor, 9 H.P., 110 volts, running at 600 revs. per min. The armature core, 8 in. long, was made up of soft-iron discs, No. 24 S.W.G. 0·022 in. thick and 14 in. diameter, threaded on the spindle and secured by nuts, and winding drums 12 in. diameter at each end. The conductors were laid in slots $\frac{7}{8}$ in. deep, lined with micanite about 0·05 in. thick, and further insulated by thin layers of presspahn. Owing to the absence of proper end plates or slotted flanges on the winding drums there was nothing to hold the core plates together at their periphery, and in some way, possibly in putting in or taking out the armature, they had been separated slightly from each other, and the length of the armature measured parallel to its axis had been increased from 8 in. at the bottom of the slots to $8\frac{1}{2}$ in. at the circumference. The slots in which the conductors were carried were, therefore, $\frac{1}{2}$ in. longer at the top than at the bottom, and as the insulating troughs were little more than 8 in. long (the length of the core at the bottom of the slots), it followed that the upper edges of the teeth at the ends of the core plates extended up to or beyond the insulating lining, and were in contact with the cotton covering of the conductors, which their sharp edges easily cut through. Several conductors were in consequence short-circuited and burnt. This case is representative of many others which justify a general statement that sufficient attention is not paid by many makers to the protection of armature conductors at the points where they leave the cores. The same insufficient insulation is frequently found at the edges of winding drums.

9. A common cause of damage to the field coils of shunt-wound motors and to the no-volt release coils of starting switches is high voltage generated by induction on breaking shunt circuits.

Many starting switches are so designed that in the off position of the starter it is possible to make the motor field by closing the double-pole main switch and break it again by closing the main switch with the starting resistance not in parallel with the field coil.

10. Continuous-current shunt-wound 40 H.P. motor, taking current at 400 volts. The commutator was 12 in. diameter by 5 in. long. The bars, 147 in number, were insulated from each other by compressed mica, sometimes called micanite, a substance which seems to be composed of small flakes of mica cemented together with shellac and consolidated by hydraulic pressure. Constant trouble was experienced from short-circuiting of adjacent bars causing heating and melting of the solder at the joints of the armature conductors to the commutator. Finally, the armature had to be sent back to the makers for repair. The inspector who saw it found the cement between the flakes of mica had worked out and been replaced by dust from the carbon brushes. To this the short-circuiting of the bars was due. The company advised the owner to have the commutator entirely reinsulated with pure mica, carefully chosen to wear down equally with the copper bars, but to save a little time he preferred to have it repaired with the original material. This was done twice at short intervals, and then the company's advice was taken. The commutator had not failed since.

11. Shunt-wound continuous-current motor, 15 H.P., 400 volts, 700 revs. per min. After repeated breakages of the end connections to the armature, the latter was sent to the makers' works to be thoroughly examined and repaired. As was surmised, the armature was found to be loose upon the shaft. There was no spider, but the core plates were threaded quite loosely on the spindle and held more or less rigidly by a key $\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. deep, sunk half in the shaft and half in the core. The core plates, as usual, had been stamped, and the keyways, as they often are, were a very poor mechanical fit upon the keys. The result was, the whole armature began working, and as the wear increased the movement became

greater. The commutator, as it happened, for it does not always so happen, held fast, and therefore the connection between the spokes and the ends of the armature conductors were subjected to slight but oft-repeated bending, which finally broke them. Many similar cases might be cited, for the fastenings of both armatures and commutators to their shafts are often of very poor design, and often, too, of very slipshod workmanship. This is certainly one of the points to which makers ought to give more thought and care.

12. Continuous-current enclosed motor, 12 H.P., 480 volts, 700 revs. per min. The motor had four poles shod with soft-iron shoes, each secured by a single setscrew. The screw in one of the top pole-pieces "slacked back," and allowed the shoe to come in contact with the armature, short-circuiting and fusing some of the conductors. The cause of the "slacking back" was not ascertained. There were several other cases of the same kind in 1905, which point to the necessity of riveting over the heads of the screws.

ON THE POLARISATION OF RÖNTGEN RAYS.*

BY PROF. H. HAGA.

In Vol. CCIV. of the *Phil. Trans.* Roy. Soc. of London, p. 467, 1905, Barkla communicates experiments which he considers as a decisive proof that the rays emitted by a Röntgen bulb are partially polarised, in agreement with a prediction of Blondlot founded upon the way in which these rays are generated.

In these experiments Barkla examined the secondary rays emitted by air or by some solids: paper, aluminium, copper, tin, by means of the rate of discharge of electroscopes. In two directions perpendicular to one another and both of them perpendicular to the direction of the primary rays, he found a maximum and a minimum for the action of the secondary rays emitted by air, paper and aluminium. The difference between the maximum and minimum amounted to about 20 per cent.

I had tried to examine the same question by a somewhat different method. A pencil of Röntgen rays passed through a tube in the direction of its axis, without touching the wall of the tube. A photographic film, bent cylindrically, covered the inner wall of the tube in order to investigate whether the secondary rays emitted by the air particles showed a greater action in one direction than in another. I obtained a negative result and communicated this fact to Barkla, who advised me to take carbon as a very strong radiator for secondary rays. I then made the following arrangement:—

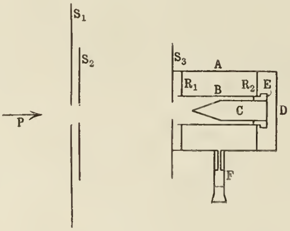

FIG. 1.

Let S_1 (Fig. 1) be the front side of a thick-walled leaden box in which the Röntgen bulb is placed; S_2 and S_3 brass plates 10 cm. by 10 cm. large and 4 mm. thick. Their distance is 15 cm. and they are immovably fastened to the upper side of an iron beam. In the middle of these plates apertures of 12 mm. diameter were made. A metal cylinder, A, is fastened to the back side of S_3; a brass tube, B, provided with two rings, R_1 and R_2, slides into it.†

An ebonite disc, E, in which a carbon bar is fastened fits in tube B. This bar is 6 cm. long and has a diameter of 14 mm. At one end it has been turned off conically over a length of 2 cm. The aperture in S_3 was closed by a disc of black paper; the back side of A was closed by a metal cover, which might be screwed off.

The dimensions were chosen in such a way that the boundary of the beam of Röntgen rays, which passed through the apertures in S_1, S_2 and S_3, lay between the outer side of the carbon bar and the inner side of the tube B. The photographic film covering the inside of B was therefore protected against the direct Röntgen rays.

If we accept Barkla's supposition on the way in which the secondary beams are generated in bodies of small atomic weight, and if the axis of the primary beam perfectly coincided with that of the carbon bar, then a total or partial polarisation of the Röntgen rays would give rise to two maxima of photographic action on diametrically opposite parts of the film and between them two minima would be found. From the direction of the axis of the cathode rays the place of these maxima and minima might be deduced.

A very easy method proved to exist for testing whether the primary beam passed symmetrically through the tube B or not. If, namely, the inner surface of cover D was coated by a photographic plate or film, which therefore is perpendicular to the axis of the carbon bar, then we see after developing a sharply-defined bright ring between the dark images of the carbon bar and of the ebonite disc. This ring could also be observed on the fluorescent screen—but in this case, of course, as a dark one—and the Röntgen bulb could easily be placed in such a way that this ring was concentric with the images of the carbon bar and of the ebonite disc.

This ring proved to be due to the rays that diverged from the anticathode but did not pass through the carbon bar perfectly parallel to the axis and left it again on the sides; these rays proved to be incapable of penetrating the ebonite, but were totally absorbed by this substance; when the ebonite disc was replaced by a carbon one, then the ring disappeared; it is, therefore, a very interesting instance of the selective absorption of Röntgen rays.*

When in this way the symmetrical passage of the Röntgen rays had been obtained, then the two maxima and minima never appeared, neither with short nor with long duration of the experiment, though a strong photographic action was often perceptible on the film. Such an action could, for instance, already be observed after one hour's exposure, if an induction coil of 30 cm. striking distance was used with a turbine interruptor. A storage battery of 65 volts was used; the current strength amounted to 7 amperes; the Röntgen bulb was "soft."

Sometimes I obtained one maximum only or an irregular action on the film, but this was only the case with an asymmetric position of the apparatus.

From these experiments we may deduce, first, that the primary Röntgen rays are polarised at the utmost only to a very slight amount; and, second, that *possibly* an asymmetry in the arrangement caused the maxima and minima observed in the experiments of Barkla, who did not observe at the same time in two diametrical opposite directions.

With nearly the same arrangement I repeated Barkla's experiments on the polarisation of secondary rays, which he has shown also by means of electroscopes and described, *Proc.* Roy. Soc., Series A, Vol. LXXVII., p. 247, 1906.

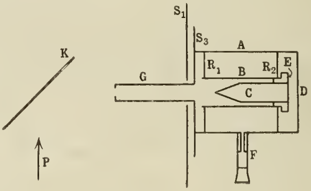

FIG. 2.

Let the arrow (Fig. 2) indicate the direction of incidence of the Röntgen rays on the carbon plate K large 8 cm. × 8 cm. and thick 12 mm. The secondary rays emitted by this plate could pass through the brass tube G, which was fastened to S_3. This tube was 6 cm. long and on the frontside it was provided with a brass plate with an aperture of 5 mm. It was placed within the leaden case at 8 cm. distance from the middle of the carbon plate; leaden screens protected the tube against the direct action of the primary rays. In these experiments the above-mentioned induction coil was used with a Wehnelt interruptor; the voltage of the battery amounted to 65 volts and the current to 7 amperes. A very good photo was obtained in 30 hours, and it shows very clearly two maxima and two minima; the distance between the centres of the maxima is exactly half the inner circumference of the tube, and it may be deduced from their position that they are caused by the tertiary rays emitted by the conic surface of the carbon bar.

In this experiment the centre of the anticathode, the axis of the carbon bar and the centre of the carbon plate lay in one horizontal plane, and the axis of the cathode rays was in one vertical plane with the centre of the carbon plate; the axes of the primary and the secondary beams were perpendicular to one another. According to Barkla's supposition we must expect that with this arrangement the maximum of the action of the tertiary rays will be found in the horizontal plane above mentioned. In my experiment this supposition really proved to be confirmed. In order to know what part of the photographic film lay in this plane, a small side-tube, F, was adjusted to the outside of cylinder A, and this tube F was placed in an horizontal position during the experiment. A metal tube with a narrow axial hole fitted in tube F, so that in the dark room, after taking away a small caoutchouc stopper which closed F, I could prick a small hole in the film with a long needle through this metal tube and through small apertures in the walls of A and B. This hole was found exactly in the middle of one of the maxima.

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* From the *Proceedings* of the Koninklijke Akademie van Wetenschappen te Amsterdam.

† Figs. 1 and 2 are drawn at about half their real size.

* Take for this experiment the above described arrangement, but a carbon bar of 1 cm. diameter and 4 cm. long.

So this experiment confirms by a photographic method exactly what Barkla had found by means of his electroscopes and it proves that the secondary rays emitted by the carbon are polarised.

In some of his experiments Barkla pointed out the close agreement in character of primary and secondary Röntgen rays; in my experiments also this agreement was proved by the radiogram obtained on the film placed in cover D. Not only did the secondary rays act on the film after having passed through the carbon bar of 6 cm., but also the bright ring was clearly to be seen, which proves that ebonite absorbs all secondary rays which have passed through carbon).* The ring was not so sharply defined as in the experiments with primary rays; this fact finds a natural explanation in the different size of the sources of the radiation: in the case of the primary rays the source is a very small part of the anticathode, in the case of the secondary rays it is the rather large part of the carbon plate which emits rays through the apertures in G and S_3.

This agreement makes it already very probable that the Röntgen rays also consist in *transversal* vibrations; these experiments, however, yield a firmer proof of this thesis. If, namely, we accept the supposition of Barkla as to the way of generation of secondary rays in bodies with a small atomic weight, then it may easily be shown that the supposition of a *longitudinal* vibration of the primary Röntgen rays would, in the experiment discussed here, lead to a maximum action of the tertiary rays in a *vertical* plane and not in an *horizontal* plane, as was the case.

A NEW METHOD OF CONTROLLING THE VOLTAGE AND INSULATION OF A NETWORK †

BY DR. M. KALLMANN.

The new principle employed by the author depends on the use of combinations of resistances having a small or negligible temperature coefficient with resistances having an extremely high coefficient. The latter are represented by the resistances used in connection with Nernst lamps, which consist of spirals of very fine iron wire sealed into bulbs filled with hydrogen. Within a certain limited range of voltage, the resistance of such iron wire spirals is found to increase in practically direct proportion to the voltage, so that the current will, within the limits considered, remain constant. If such a resistance be connected in series with a constant resistance, and a variable P.D. be applied across the extreme terminals, then the variations in the P.D. will, within certain limits, be taken up by the Nernst lamp resistance, the current and hence, also, the P.D. across the constant resistance remaining unaltered. Owing to this property of absorbing voltage fluctuations possessed by a Nernst lamp resistance, the author proposes to call a resistance of this type a *variator*. The typical behaviour of a variator is shown by the curves in the left-hand half of Fig. 1, the full-line curve connecting voltage, and the dotted one resistance, with current.

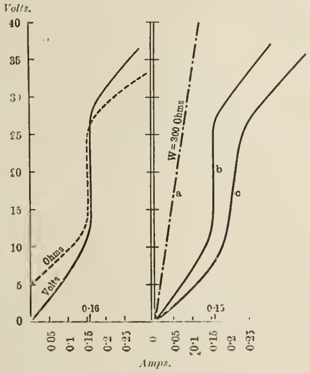

Fig. 1.

If a series combination of a variator and a suitable constant resistance be connected across the supply mains, and a low reading voltmeter be placed across the variator terminals, we obtain a simple and extremely sensitive arrangement for measuring the voltage of the mains. Instead of a voltmeter, a suitably constructed relay might be used, so arranged that when the voltage either falls below a predetermined limit or rises above one, the local circuit of an optical or acoustical indicator is closed, and so an automatic signalling arrangement is obtained for voltage control.

The resistance of the voltmeter or relay shunting the variator must be as high as possible, otherwise the sensitiveness may be considerably reduced. The curve *c* in the right-hand half of Fig. 1 shows the behaviour of a variator when shunted by a resistance of 300 ohms, *b* referring to the unshunted variator.

In Fig. 2 is shown a Wheatstone's bridge arrangement for the measurement or control of voltage. Two opposite arms, *a* and *b*, of the bridge consist of variators, the remaining arms, r_1 and r_2, being constant resistances. R is a high resistance connected in series with the bridge. Two methods of using the apparatus as a voltmeter are available. In the first, which is a zero method, the adjustments are such that balance is obtained, with the multiple-contact switch connected to R in the middle position, when the voltage has its normal value. Any rise or fall disturbs the balance, which, however, may be restored by suitably altering R by means of the multiple-contact switch. The various positions of the latter may be marked directly in volts. The indicating arrangement for the Wheatstone's bridge may consist of a simple galvanoscope (or telephone, if alternating currents are used), or the variators themselves may be employed as sufficiently accurate indicators, in which case the galvanometer branch of the bridge is rapidly short-circuited and open-circuited, and the effect, if any, noted on the brightness of the variators. The second method of using the apparatus is a deflectional one. In this R is maintained constant, and the various values of the voltage are marked on the scale of the galvanometer.

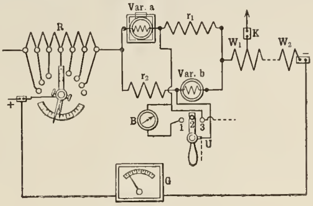

Fig. 2.

Arrangements similar to the above may be conveniently adapted to the method of controlling cable networks described by the author about 13 years ago.* In this method each cable is provided with its pilot wire, but the pilot wires belonging to a district supplied by a given feeder are not connected to those of other districts, and do not form a continuous network like the distributors. A fault occurring in any district is automatically signalled at the station by the apparatus connected to the pilot wires of that district. An advantage of the new arrangement of signalling apparatus over the old one is that whereas in the latter case a relatively high P.D. of from 220 to 440 volts had to be maintained between the main cable core and the pilot wire, in the new method this P.D. is a small one. Two varieties of the method are shown, Fig. 3 representing a relay, G (which controls the signalling instruments), connected as a shunt across a variator, I, at the central station, while in Fig. 4 is shown a Wheatstone's bridge arrangement. L+ and L− in Fig. 3 represent the feeders and P+, P− the pilot wires; the method is equally applicable to two-wire and to three-wire networks, P+ and P− in a three-wire system referring to the outer conductors. In Fig. 3 *a* represents fuses and *w* resistances connected between the feeding

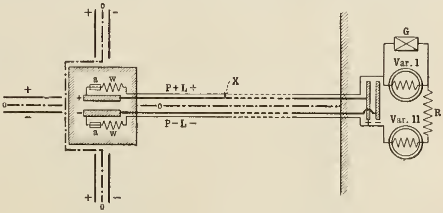

Fig. 3.

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* The ring was perfectly concentric; the arrangement proved, therefore, to be exactly symmetrical.

† Abstracted from the *Elektrotechnische Zeitschrift.*

* *The Electrician*, Vol. XXXI., p. 103.

point and the pilot wires. The variator II at the central station is intended to protect variator I against excessive current, while R is an invariable resistance. If a fault occurs at X, the resistance *w* is shunted by it more or less heavily, and when the fault resistance drops below a certain limit, the rise of P.D. across the variator I terminals is sufficient to actuate the relay G and its signalling apparatus.

In Fig. 4. two feeding centres, K_1 and K_2, are shown, each provided with its own voltage and fault signalling apparatus, connected up on the bridge system. For the sake of simplicity the main cables have been omitted, the pilot wires alone being shown. The relay branches G_1 and G_2 of the bridges are all connected, through suitable resistances, to a set of 'bus bars across which is connected a voltmeter, V_m, which indicates the mean voltage of the system. The bridge arrangement representing a zero method, it follows that a break in a pilot wire unaccompanied by damage to the insulation of the cable core would not be detected without a sepcial device provided for the purpose. This consists of two supplementary resistances, H_1 and H_2, through which the bridge is connected across the station 'bus bars. A break in one of the pilot wires will cause a change of P.D. across the bridge terminals, and the break will be signalled.

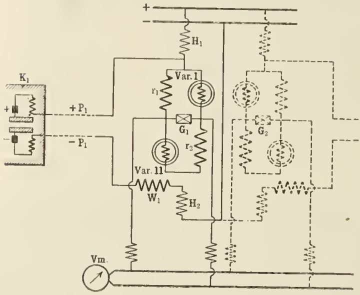


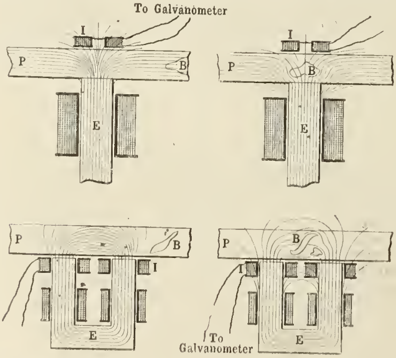
FIG. 4.

The apparatus described serves a double purpose, responding both to voltage fluctuations in the system and to breakdowns of the insulation. As regards the signalling apparatus itself, this may conveniently take the form of a green and a red lamp, combined with two bells having different tones, so that the signal is both a visual and an acoustical one.

MAGNETIC DETECTION OF FLAWS IN IRON.*

BY L. KANN.

It is important in many cases to have a more reliable test for the uniformity of a casting than is afforded by sounding. Such a method may be based upon the alteration of the field of force by a flaw of the casting, when the latter is used as an armature in connection with an auxiliary coil and a ballistic galvanometer.



The arrangement shown in the diagrams has yielded surprisingly good results.

E is an electromagnet, I the induction coil connected with the galvanometer, P the casting, B a bubble in it.

In the simplest case, that of an iron plate, the magnetic flux is not affected in any way by shifting the plate in the same plane, and the galvanometer shows no deflection. But if the bubble B enters the field, the flux is altered as regards strength and distribution. A current is induced in the coil I and indicated by the galvanometer. By a suitable displacement of the plate valuable conclusions may be arrived at concerning the situation and size of the bubble. The adhesion of the casting to the magnet is prevented by a layer of non-magnetic material, or by rollers.

MEASUREMENT OF HIGH ALTERNATE-CURRENT FREQUENCIES.*

BY W. PEUKERT.

The author describes a simple method for measuring frequencies which is applicable to very high frequencies. Last year the same author indicated a method for determining inductances by weighing. If a coil is free to move in an alternating magnetic field, and is put in circuit with an inductionless resistance, R, and a capacity, C, respectively arranged in parallel, it experiences no repulsion, and its inductance is given by $L = R^2C/1 + \omega^2C^2R^2$.

The same method may be used for determining the frequency of an alternating current if the inductance of the coil is known. If ω is unknown, and the repulsion is annulled by suitably choosing R and C, then we have

$$\omega = \frac{1}{CR}\sqrt{\frac{CR^2}{L} - 1},$$

or, since the frequency $p = \omega/2\pi$,

$$p = \frac{1}{2\pi CR}\sqrt{\frac{CR^2}{L} - 1}$$

where C is in farads and L in henrys.

This method supposes that the inductance and capacity are independent of the frequency, which is not always the case. According to recent investigations, the inductance of a coil increases with the frequency. This only occurs at high frequencies, and depends, moreover, upon the initial value of the inductance. Orlich found that the inductance of a coil was 1·0003 henrys at 145 ∽ per second, and 1·0059 at 870 ∽, thus giving an increase of 0·5 per cent. within that range.

The inductances of coils of up to 0·001 henry and 2,000 ∽ may be taken as constant when the coils are made of thin wire. In the method now described the inductance must always be low enough, as otherwise the results become imaginary.

The capacity of ordinary condensers, on the other hand, diminishes with increasing frequency, and this diminution depends upon the dielectric. This source of error is avoided by using air condensers.

In a state of equilibrium the inductance is compensated by the capacity, and there is resonance, and therefore, also, a maximum current. Hence equilibrium may be conveniently indicated by a hot-wire galvanometer or other instrument for indicating feeble currents.

The author used this method for determining the periodicity of an alternating current obtained from a direct-current arc by inserting a capacity and inductance.

He used two coils of inductances, 2,490 and 836 microhenrys respectively. A condenser circuit was inserted in the lamp circuit, and a coil free from iron was connected in series with the condenser. This coil served for generating the alternating magnetic field. The movable coil was suspended in this field by the arm of a balance, in such a manner that the magnetic field did not affect the balance. The weight of the coil was compensated. On closing the condenser circuit the arc began to sing. The repulsion of the movable coil was annulled by changing the resistance and the capacity, which were mounted in parallel branches in series with the coil. In the case of the second coil equilibrium was re-established by making R = 27 ohms and C = 10 mfds. With the aid of these values and the second equation above, we obtain $p = 1{,}708$.

With the first coil the equilibrium values were R = 53 ohms and C = 3 mfds. This gives $p = 1{,}612$.

To test these results, the author determined the frequency of the current in the condenser circuit from the inductance and capacity by calculation. The inductance of the coil used for generating the alternating field was found from its impedance as determined with a current of 50 ∽, and was found to be 0·00103 henry. The ohmic resistance of the coil was 0·171 ohm, the apparent resistance 0·365 ohm. The inductance of the rest of the circuit, which consisted of short thin wires was negligible. The condenser was a rubber condenser and had a capacity of 8·8 mfds. at 50 ∽. On calculating after the well-known formula

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* Abstracted from the *Physikalische Zeitschrift*, August 1, 1906.

* Abstracted from the *Elektrotechnische Zeitschrift*, August 16, 1906.

$$p=\frac{1}{2\pi}\sqrt{\frac{1}{CL}},$$

the frequency of the condenser current, the result is $p=1{,}691$.

This figure is sufficiently in agreement with that found above, especially considering how difficult it is to keep the singing arc constant for any length of time. Another source of error lay in the capacity of the condenser, which was only known for a frequency of 50 ∽.

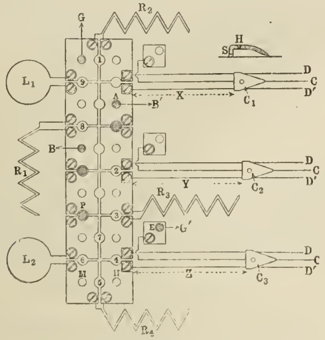
In conclusion, it may be stated that the frequency of an alternating current may be determined by weighing, with the aid of the same method as that used for determining inductances. The new method is especially adapted to high frequencies.

AN INDUCTANCE AND CAPACITY BRIDGE.*

BY A. DE FOREST PALMER.

The author describes an apparatus by which inductances and capacities can be compared, with an accuracy of about one-tenth of 1 per cent., without the use of elaborate or expensive instruments. While the precision sought is considerably below that desirable in the most exact work, it is amply sufficient for the purpose, and, indeed, for most practical work. With the exception of the resistance boxes, condenser and galvanometer, all of the necessary apparatus was built in the laboratory, and, though somewhat roughly constructed, it gave results well within the desired limit.

The apparatus is based upon Maxwell's Wheatstone-bridge method, but all inductances, save those to be compared, are carefully eliminated. It is illustrated in the diagram. It is essentially a connection board provided with a series of brass contact blocks and three double slide wires. The blocks, taken from an old rheostat, are about 1·5 in. by 2 in. on the top face and 0·75 in. thick. They are bolted securely to a slab of slate, and may be connected by large well-fitting plugs. Each block is provided with two binding screws and a socket for the movable binding posts that terminate the battery and galvanometer leads. The slide wires D, C and D′ are somewhat over 1 metre long and are stretched, parallel to one another, along the top of a wooden metre scale. D and D′ are manganin, No. 22 B.S., and are soldered to small brass plates that are securely clamped to adjacent contact blocks by large binding screws. The copper wires C are insulated from D and D′, except at the sliding contacts, and may be connected to the galvanometer as indicated at G′. A longitudinal section of the sliders C_1, C_2 and C_3 is exhibited, on a somewhat enlarged scale, at S. These sliders are essentially small brass tripods with feet grooved to fit the three wires, and they are held firmly in place by inverted U's of vulcanised fibre, terminating in brass springs that bear against the underside of the wooden scale. The contact pressure is transmitted and regulated by an adjusting screw that passes through the bend of the U and engages the hole H. The resistance of these contacts was found to be very small and surprisingly constant.



The diagram also shows connections arranged for the comparison of two inductances L_1 and L_2. R_1, R_2, R_3 and R_4 are variable non-inductive resistances, of the common plug cutout pattern, guaranteed to be accurate within $\frac{1}{10}$ per cent. The galvanometer is connected at G and G′ and the battery at B and B′ through a secohmmeter. In practice equal resistances are included in R_3 and R_4, plugs are placed at 2 and 6, and balance for steady current is obtained by adjusting R_1, R_2 and X. After removing the plugs from 2 and 6, balance is again produced by altering R_3 and Y. Finally, with the secohmmeter in motion, balance for alternating current is attained by moving the contact C_3, and, if necessary, making equal changes in R_3 and R_4. Unless the resistances in the boxes at R_3 and R_4 are very well adjusted, it will generally be necessary to repeat the two latter operations, but in this case the final adjustment can always be made with the contacts C_2 and C_3, so that exact balance is observed with either direct or alternating current.

For the comparison of an inductance with a capacity the coil L_2 is removed, plugs are placed at 2 and 6, the condenser is connected between A and E, and R_3 is made equal to R_4. Balance for direct current is first obtained by altering R_1, R_2 and X. The adjustment with alternating current is then accomplished by making equal variations in R_3 and R_4 and moving the contact C_3.

The advantages gained arise from the compact arrangement of the connections and the employment of non-inductive slide wires. Provided the resistances, included in R_1, R_2, &c., are properly constructed, the bridge is practically free from inductance except in the coils under comparison. The necessary adjustments can be rapidly and accurately made without changing the relative position of the battery or galvanometer leads. The results show that inductances and capacities can be compared, by the methods described, with a precision equal to that of the available resistances.

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* Abstracted from the *Physical Review*, July, 1906.

ELECTRICITY IN STEEL WORKS.

A well-illustrated pamphlet, recently issued by Messrs. Siemens Bros.' Dynamo Works (Ltd.) deals with the applications of electrical working to steel works. Commencing with some illustrations of typical modern generating plant, both for continuous and alternating currents, driven by steam turbines and large gas engines, some details are given of the applications of electrical driving. The most interesting part of the pamphlet is devoted to the driving of line rolls, than which there is probably no class of service in which electric motors are subject to more severe strains. The most usual practice at present is to gear the motors direct to the rolls, making the motor so substantial in construction and designing it with such high overload capacities that it will withstand successfully a reversal of current at full speed, the torque exerted by the reverse current being used for bringing the rolls to rest. Standard motors are, of course, not suitable for meeting such heavy duties, and the firm have designed special motors, both of the continuous and three-phase types, for the purpose, and also special forms of controller. Illustrations of these motors, of various sizes, are shown, the massive nature of their construction being particularly noticeable. For the larger three-phase motors a special liquid starter has been developed, known as the hot-water type, which consists of a series of contact plates suspended in a tank. By means of a small motor-driven circulating pump water is made to rise or fall in the tank and submerge the contact plates to any required depth. The water when it comes into contact with the plates boils at the surface and gives off a small quantity of steam which escapes through an outlet pipe. By thus taking advantage of the great latent heat of steam a starter of moderate size and cost can be produced capable of carrying very heavy currents.

The motors used for most purposes about steel works have a very intermittent load, with periods in which the motor is either standing or running light and drawing only a small amount of current. For the smaller motors about the works this variation in power required does not react unfavourably upon the generating station, since there are usually a large number of motors, and their variations tend to neutralise each other and produce an aggregate demand of fairly uniform character. In the case of large motors such as those for driving main rolls, however, the load variation assumes more serious proportions, and it is sometimes desirable to screen the power station from the excessive peak loads of these large motors.

The most obvious method of doing this is to provide a flywheel on the rolls or motor shaft of sufficient weight for providing, without an excessive reduction in speed, the excess power required at each pass, the flywheel being restored to full speed between the passes. In adopting this plan care must be taken to design the motor and its control gear so as to permit a drop in speed without a corresponding rise in current demand, and thus enable the stored energy of the flywheel to be utilised. The practical means of accomplishing this in the case of continuous-current motors is to provide a compound field winding, and with induction motors to insert a fixed or a varying resistance in the rotor circuit so as to increase the slip of the motor during the period of heavy load.

In order to secure the best results under this plan it is necessary to construct first, with as much accuracy as possible, a load diagram representing the heaviest duty of the mill, and showing the times required for the passes and intervals and the power at each instant. An integration of the area of this load diagram will then give the average power to be supplied by the motor. The motor should then be chosen to meet this power, but with ample overload capacity, and the flywheel proportioned so that by a permissible reduction in speed it will provide an amount of power at each pass equivalent to the corresponding load peak above the average. When it is applicable the plan described above is the simplest which can be adopted. There are cases, however, in which the peak loads are either so high or of such long duration that, in order to completely neutralise them by means of a flywheel direct coupled to the motor or rolls, the weight of the flywheel required would be impracticable.

In considering the design of an electric drive for such a mill very heavy powers are involved. To be successful, a method must be found which will obviate the necessity of handling directly the enormous currents corresponding to such powers, and the method must also be one which will screen the generating station from the enormous fluctuations in the load demand throughout the process of rolling. The method adopted in these cases is similar to the Siemens-Ilgner system, which is well known in connection with electric winding plants. The mains from the generating station are led to the motor of a flywheel motor-generator set. The generator of this set delivers continuous current to the motor driving the mill, the armatures of the generator and mill motor being connected in series. The field of the mill motor is separately excited, the exciting current for this purpose being obtained from a small auxiliary generator, which may be direct coupled to the motor-generator set, but where the main supply is continuous current this auxiliary machine can be dispensed with. The field of the generator on the motor-generator set is controlled from zero to a maximum positive or negative by means of a rheostat placed on the operator's bridge. By moving the rheostat lever the field of the generator is thus varied, and the speed and direction of rotation of the mill motor are controlled. The system involves the handling only of the small exciting current required for the generator field. The flywheel is proportioned so that, by a reduction of about 15 per cent. in speed, it is capable of supplying energy equivalent to the load peaks above the average power line. The speed of the mill motor corresponds to the position of the control lever, and its direction of motion also follows the position of this lever.

It is not difficult to determine with considerable accuracy the amount of electric power required for rolling a given tonnage with the system above described. The following is an estimate for the yearly cost of rolling by this method 300,000 tons of billets, each billet weighing 2·2 tons. It is assumed that the billets would be rolled out to various lengths, as indicated in columns 1, 2 and 3 of table I. For each different final cross-section it is assumed that 75 per cent. of the production would be of soft Thomas or Martin steel, the remaining 25 per cent. being of hard Martin steel. The figures in column 6 give the tonnage of each kind. In column 7 are given the corresponding number of billets of each kind; in column 8 the energy required per billet taken from a curve, taken from a series of actual tests, and in the last column the total work.

A capacity of 1,500 H.P. is set apart in the generating station for supplying the mill in question, this power corresponding to the average required, with adequate allowance for losses and occasional overloads. It is assumed that the engines in the generating station would be gas engines driven by blast-furnace gas. The cost of a 1,500 H.P. gas-engine generating plant would be about £17,500. Allowing 15 per cent. of this per annum, or £2,625, for interest, depreciation and repairs, £250 for gas purification, £400 for attendance in the generating station, and £750 for oil, waste, &c., in the generating station, the total cost per year would be about £4,000. Dividing this by the total production of 300,000 tons, the cost per ton is 3·2d.

It is difficult to obtain reliable figures for the corresponding cost of driving by steam. There is no doubt that in an ordinary reversing mill engine the steam is used in a very uneconomical manner. From published figures it would appear that the cost per ton produced varies between 8½d. and 1s. 2½d. With older plants it is probable that the cost considerably exceeds the latter figure. If, for comparison, we take the smaller steam cost mentioned above, it would correspond in the case in question to a yearly cost of £10,625, and the difference between this and the cost of driving electrically amounts to £6,625. Taking the higher steam cost mentioned—viz., 1s. 2½d. per ton, the total annual cost of driving by steam would be £18,125, and the yearly saving £14,125.

The total energy equals 2,300,000 kw.-hours. With 300 working days of 24 hours the average load = 320 kws. The combined average efficiency of the main roll motor and flywheel converter, including all losses, is about 40 per cent. Hence the average power required for the rolls equals 800 kw.

Table I.

Production: 1,000 tons in 24 hours, 300,000 tons per year (300 days); weight of billet 2·2 tons; cross-section 16½ in. by 16½ in.; length 67 in.

Per centage.	Final cross-section in inches	Times elongated.	Soft Thomas steel and Martin steel.	Hard Martin steel.	Production in tons.	Production in billets.	Energy required per billet.	Total energy in meter-tons.
2	12×12	2	75%	..	4,500	2,050	2,000	4,100,000
..	..	..	..	25%	1,500	683	3,000	2,100,000
40	7×7	5·4	75%	..	90,000	41,000	4,500	185,000,000
..	..	..	..	25%	30,000	13,600	6,500	88,500,000
40	5·1×5·1	10·5	75%	..	90,000	41,000	6,200	255,000,000
..	..	..	..	25%	30,000	13,600	8,700	118,000,000
18	43·×4·3	14·5	75%	..	40,500	18,400	7,000	129,000,000
..	..	..	..	25%	13,500	6,150	9,600	59,300,000
					300,000			841,000,000

The maximum power per hour would be required for rolling out 38 blocks to the final cross section of 7 in. by 7 in. The corresponding energy required per hour is 1,770,000 kw. secs. This corresponds to an average of 492 kw. during the hour. The combined efficiency under this load would be about 45 per cent., and the resultant power required would be 1,100 kw.

The efficiencies of generators in the generating station, including mains, would be about 85 per cent. For the maximum output the corresponding output of the gas engines would therefore be 1,740 H.P. For the average power the output of the gas engines would be 1,260 H.P.

It is assumed that the cost of the electrical equipment of the mill, including the flywheel motor-generator, is about the same as that of a reversing mill engine and condenser. The following table shows the relative cost of the electrical and steam installations.

Table II.—*Electrical Installation.*

Interest, depreciation and repairs, 15 per cent. of the first cost of a 1,500 H.P. gas-engine unit, including gas engine, dynamo, excitation, switchboard, foundations, building, piping, gas, purification plant and electric conductors (£17,500)	£2,625
Gas purification	250
Attendance at generating station.........................	400
Oil, waste, &c., in generating station......................	750
	£4,025

For a production of 300,000 tons, cost per ton = 3·2d.

Steam Installation.

Cost per ton, 8½d. to 1s. 2½d., or for a yearly production of 300,000 tons: £10,625 to £18,125.

The pamphlet also contains a large number of illustrations of the various auxiliary purposes to which electric power can be applied in steel works, and concludes with a long list of Siemens main roll equipments installed or under construction in this country and abroad.

THE PRESERVATION OF TIMBER.*

An exhibit at the Milan Exhibition of special interest to electrical engineers is that of Himmelsbach Brothers, of Freiburg, Baden (Switzerland), showing the results of various methods employed for the preservation of timber—principally for railway sleepers and the poles used for telegraph and power transmission lines.

Of the various methods for the preservation of timber the most usually adopted in modern practice consist in impregnation with chloride of zinc, creosote, corrosive sublimate and copper sulphate. The first named is open to the objection that owing to its deliquescent properties the zinc chloride keeps the wood more or less damp, while the diffusion of moisture causes a continual dilution of the preservative salt. Thus sleepers of pine impregnated with zinc chloride were found after three years to have lost 80 to 85 per cent. of the salt, while oak sleepers in the same time had lost 90 to 95 per cent. The combination of chloride of zinc with creosote has been attempted, a superficial coating of creosote being given with a view to prevent the dilution of the chloride referred to above. This is, however, inferior in its results to a complete impregnation with creosote amounting to 6·2 lb. of creosote per cubic foot of oak, or 20 lb. per cubic foot of beech. A method of partial impregnation has recently been developed in consequence of the high cost of creosote for the complete impregnation with the above quantities, and this is found to give very satisfactory results.

For complete impregnation the timber is placed in a closed vessel from which the air is exhausted to produce a vacuum of at least 24 in. After 10 minutes the creosote, previously heated, is allowed to enter to cover the timber. The temperature of the creosote is maintained by steam pipes at 105°C. to 115°C., and the exhaustion continued while the air and steam from the timber bubble out through the liquid. The heating and exhaustion are continued for three or four hours, the moisture from the timber being condensed and measured. The vessel is then filled up with creosote and pumped up to a suitable pressure to give the following impregnation :—

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* Abstracted from *l'Elettricità*.

(*a*) First quality beech sleeper, 9 ft. long, 80 lb. creosote; first quality beech sleeper, 8 ft. 4 in. long, 75 lb. creosote; first quality oak sleeper, 9 ft. long, 17·5 lb. creosote.

(*b*) 1 cubic ft beech, 20 lb. creosote; 1 cubic ft. oak, 4·5 lb. creosote.

The partial impregnation is adopted for softer woods, owing to their less value and the cost of the greater quantity of creosote they would require for complete impregnation. In this case the vessel containing the timber is not exhausted and the creosote is not heated above 100°C. Pressure is put on gradually so as to inject the desired quantity without allowing the pressure to rise above 2½ atmospheres. The creosote is then withdrawn and the vessel is subjected, for 15 minutes, to a pressure of 1½ atmospheres, and again, after an interval of five minutes, for another 15 minutes, to a pressure of one atmosphere, the air being maintained meanwhile at a temperature of at least 50°C. This process, as applied to pine, gives a degree of impregnation of 4 lb. per cubic foot.

The life of sleepers, treated in various ways, is only given approximately in the following table, owing to the absence of complete statistics :—

Timber.	Non-impregnated.	Impregnated.		
		Chloride of zinc.	Mixed zincchloride and creosote.	Creosote.
	Years.	Years.	Years.	Years.
Oak	12—15	16	18—20	25
Beech..........	2—3	5—8	14—16	30—35
Pine	5—7	7—12	13—15	18—20

The Eastern Railway of France gives the following statistics in the *Revue Générale des Chemins de Fer*, March, 1898. for the replacements of sleepers during the previous 24 years :—

Oak sleepers non-impregnated	67 per cent.
Oak sleepers impregnated with creosote	46 per cent.
Beech sleepers impregnated with creosote	12 per cent.

More recent statistics from the same source give the proportion of impregnated beech sleepers in service after 27 years as 80 per cent., while the proportion of oak sleepers after 24 years was only 54 per cent. The chief engineer of the line estimated the life of the impregnated beech sleepers at 35 years.

For the preservation of poles for telegraph and power lines, the method of Boucherie, by impregnation with sulphate of copper, has been extensively used. To obtain the best results, however, the impregnation must take place within a few days of felling the tree, and the neglect of this precaution sometimes brings the method into undeserved discredit. The method developed by Kyan of impregnation with corrosive sublimate—sometimes called Kyanisation—is found to give uniformly good results, and no apparatus for impregnation under pressure is necessary, simple immersion in the liquid for 10 to 14 days—according to the temperature and the condition of the timber—being sufficient. An analytical investigation of a section of timber so treated shows the presence of the sublimate in a small external layer of the timber only, but the results obtained in practice show that there is a preservative action throughout the timber—perhaps by the penetration of the sublimate in quantity too small for chemical analysis.

From statistics published by the Bavarian Postal and Telegraphic Administration, the average life of "Kyanised" poles is 17·5 years, while figures published by a member of the German Imperial Postal Administration give 16·8 years, compared with 13·9 years for poles treated with sulphate of copper and six to seven years for natural poles.

Fire at Merchant Venturers' Technical College, Bristol.—A destructive fire occurred at Bristol on Tuesday last, when the Merchant Venturers' College buildings in Unity-street were practically destroyed. It is reported that the fire broke out in the laboratories on the top storey in the early morning, and, owing to the large amount of pitch pine used in the building, spread so rapidly that in 10 minutes the whole structure was in flames. The buildings were erected at an original cost of about £50,000, which is covered by insurance, but a number of manuscripts of value in the library have been destroyed.

CORRESPONDENCE.

ELECTRICAL MEASUREMENT OF TIME INTERVALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is rather amusing to see the ascription of this very old method of "measuring very small intervals of time" (*The Electrician*, p. 971, October 5th) to a Prof. Radacowic, seeing that it was proposed and fully described by R. Sabine in 1876, vide the *Telegraphic Journal* (1876), Vol. IV., p. 141, or the *Phil. Mag.* for May of same year.

The method is so simple in application and thought to be so well known, that one hardly realises how soon the work of a former generation becomes re-invented or devised by a later.

The great difficulty experienced in practically carrying out the method is the making of a firm contact. I remember discussing this point with Dr. Muirhead, I know not how many years ago, and he told me the only method he had found successful was a hard steel point digging into lead, a fresh plane surface of lead being presented for each making of contact.—Yours, &c.

London, S.E. F. JACOB.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An improver is wanted for the Perth lighting and traction station; must have had practical training. Applications to burgh electrical engineer and manager, Mr. John Lambert. See an advertisement.

The Government of New South Wales require a chief commissioner of railways and tramways (salary £3,000), an assistant railway commissioner (salary £1,500), and a tramway commissioner (salary £1,500), to control the street and other State tramways (chiefly electric). Particulars from the Agent-General, 125, Cannon-street, London, E.C., to whom applications by Nov. 19.

Mr. A. G. Shearer has resigned his appointed as assistant tramway engineer at Reading, and Mr. Matthew Cable, shift engineer, has been appointed to fill the vacancy at £130 per annum.

Mr. James Livingstone, assistant superintendent of Post Office telegraphs at Glasgow, has been appointed chief superintendent of telegraphs at Leeds, in succession to Mr. Holliday, who recently resigned.

Mr. J. F. Heslop, assistant in the mains department, has been promoted to the position of mains superintendent at Barrow-in-Furness.

Mr. G. F. A. Cowley, of Sheffield, has been appointed assistant lecturer in mechanics at Bradford Technical College; and Mr. J. B. Polding, of Preston, instructor in draughtsmanship in the Engineering department of the college.

Mr. Cowley has held a position in the steam turbine and experimental department of Vickers, Sons & Maxim's works in Sheffield. He has had a distinguished career at college and is a Whitworth Exhibitioner. He will take charge of the newly established mechanics laboratory in the department of engineering. Mr. Polding was trained in the shops and drawing offices of Yates and Thom, at Blackburn, and was last employed with a firm engaged in the manufacture of motor buses.

Mr. C. E. Greenslade, of the Central Technical Institute, London, S.W., has been offered the post of assistant instructor in electrical engineering at Crawford Municipal Technical Institute, Cork.

Mr. A. Sparkes, B.Sc., has been appointed demonstrator in physics at the Boy's Secondary School, Portsmouth.

EDUCATIONAL NOTICES.

General Engineering College.—At this college individual coaching is given in engineering subjects, especially in preparation for the technical schools and London University examinations. Particulars from the principal, Mr. J. H. Reeves, M.A., 2, Penywern-road, Earl's Court, London, S.W.

Engineering and Scientific Association of Ireland.—During the autumn session a course of lectures on Engineering Jurisprudence will be delivered by Mr. W. H. Boyd. The opening lecture will be given on Nov. 5 in the physics theatre of the Royal College of Science, Dublin.

Alleged Theft of Electric Cable.—At West Ham Police Court on Tuesday John Warriner was committed for trial on a charge of breaking and entering a warehouse and stealing 369 ft. of cable valued at £26. 7s., the property of the Charing Cross, West End & City Electricity Supply Co.

Argentina.—Official statistics show that Argentine imports for the first six months of 1906 included electrical goods to the value of $1,089,641, compared with $1,000,770 for the first half of last year.

Australasia.—The "Australian Mining Standard" says that the borough electrical engineer of *Launceston*, Tasmania (Mr. W. Corin), has submitted an estimate of the cost of constructing, equipping and working municipal electric tramways.

Mr. Corin puts the cost of constructing 7·6 miles of track at £21,280, overhead equipment £10,184, 14 cars £8,400, car shed, workshop, &c., £2,000, two rotary converters and battery £4,830, and additions to sub-station £800; total (with £2,375 for contingencies) £49,869. The annual expenditure (including interest and sinking fund) is estimated at £8,304 and the receipts at £8,387. A plebiscite of the ratepayers is to be taken.

Brunswick (Victoria) Council have decided to take supply of electricity in bulk from either Melbourne Corporation or the Essendon Tramway Co.

The ratepayers have voted in favour of the present system of management of the *Fremantle* (W.A.) tramways and electricity supply undertaking—*i.e.*, by an elective board, drawing aggregate fees of £800 per annum.

Melbourne Council have decided to extend the option of the maximum demand system to consumers of current for power and heating. Since 1904 the flat rate has been 2d. per unit. It is intended to give consumers the option of paying 2½d. per unit up to 75 hours maximum demand per month and ¾d. per unit after.

In regard to the project for electric tramway facilities in and between *Malvern* and *Prahran*, which the two Councils propose to carry out jointly, Noyes Bros. have submitted estimates for two alternative schemes, one for single track with passing places to cost £52,660, and the other consisting of about three-fifths double and two-fifths single track at £76,260. Messrs. Noyes recommend the latter scheme. At the recent Malvern municipal elections all the councillors favourable to the larger scheme were re-elected. The Railway Commissioners have, however, intimated that they cannot permit the level crossing over the railway at Armadale Gates, and the Premier (Mr. Bent) says it would cost £120,000 to raise the tram line over the railway.

Ayr.—The Council approved on Monday the proposal to apply for powers to extend the electric tramways to Whitletts, about 2 miles from the centre of the town.

Battersea (London).—The borough electrical engineer is reporting to the Council upon the estimated cost of wiring and fitting different classes of premises.

Bo'ness, N.B.—The Council applied some time ago to the Secretary for Scotland for sanction to a further loan of £4,000 to cover excess expenditure on the electricity works, and to provide for future extensions of the mains, &c.

The Secretary for Scotland drew attention to the decision in the action "Sudbury Corporation *v.* Empire Electric Light & Power Co.," and suggested that the Council should communicate with the Board of Trade as to the best course to be adopted under the circumstances. This suggestion was adopted, and a reply has been received to the effect that the Board were not prepared to consent to any divestiture by undertakers of their powers under an electric lighting order save in cases where special authority was obtained by a provision in an order granted by the Board under the Electric Lighting Acts. The Board had had before them several cases in which local authorities had entered into agreements of a similar character to that entered into by Bo'ness Council, and in order to remove the legal difficulties which had arisen the parties in certain instances proposed to enter into fresh agreements by which the local authority would lease the existing works to the company, and would transfer their powers to the company (after having first obtained a further order to enable them to do so), the transfer to be complete, all capital money required for the undertaking during the term of the transfer to be provided by the company, and the existing agreement to be cancelled. The Board were informed that in the event of the procedure outlined being adopted by the Council the Secretary for Scotland would be prepared to consider an application for the borrowing of such further sum as might be necessary.

On Tuesday the Town Clerk explained to the Council that the gist of the agreement which the Board had sent was that the Council should lease the undertaking, the company simply paying the Council a rent to cover sinking fund and interest.

The Council decided to ask the Board whether, in the event of the Council applying for a private bill to legalise the present agreement, the Board would oppose such a measure.

Bolton.—The Tramways committee have declined to adopt a suggestion of local traders to carry parcels on the tramcars.

Brassworkers and Overtime.—At a meeting of the Conciliation Board, consisting of manufacturers in the electric light and gas fittings trade and representatives of the workmen, held at Birmingham on Monday, Mr. R. H. Best (Best & Lloyd) presiding, it was resolved "That Sir David Dale's award, dated Dec. 10, 1900, as to payment of time and a quarter for overtime must be strictly observed by all employers and by all workmen."

Bristol.—A long report presented to the Corporation on Tuesday by the Electric Light committee, gave particulars of the electric lighting extensions which formed the subject of the L.G.B. inquiry reported in our issue of the 28th ult.

The chairman of the committee (Ald. Pearson) gave an explanation of the position, and defended himself and the committee against the criticism levelled at the administration of the electricity department. The staff (he said) were not quite fairly dealt with, but he supposed those gentlemen would take it as part of their life and put up with it. He did not think the chief engineer (Mr. H. Faraday Proctor) felt the subject very acutely; at any rate, he had not expressed it to him. The L.G.B. inspector had, however, said that their accounts were well and accurately kept. He also said he thought the city of Bristol had a very valuable asset in the electrical undertaking. The inspector actually wanted their engineer to give him, at a moment's notice, and in the presence of everybody, a statement as to precisely how the charges in the estimates for public lighting were made up. It seemed to him that if he went to a person and asked him how he made up the various items in his contract, the average gentleman would tell him to mind his own business. He was not prepared to accept the suggestion of the inspector as to paying the wages of the permanent staff out of revenue. The inspector admitted that if the committee chose to contract for the labour it would be a proper subject for a loan. In his (Ald. Pearson's) opinion they had put sufficient burden upon the consumers of electricity, and if the inspector's idea had been acted upon, they would have paid nearly £2,000 a year for the last five years out of revenue in wages to permanent men. The committee could have contracted and borrowed the money and it was only because they had thought fit to keep men permanently in their employ that the inspector had raised the question. Perhaps contracts would be the proper course in future.

Colchester.—At a meeting of the Council last week, Mr. Shaw moved that, on the grounds of economy and greater efficiency of management, it was desirable the electricity supply and the tramways departments should be amalgamated, and that a standing committee of nine members be appointed to undertake the management of the undertaking.

In support of his motion, Mr. Shaw referred to certain towns where joint administration of the electricity and tramways undertakings had resulted in economy, Lowestoft and Darlington being cited as particular instances. The chairman of the Tramways committee (Mr. Marshall) proposed the resolution, and the chairman of the Electricity committee (Mr. Barritt) pointed out that the idea of amalgamation was really the initial scheme which was formulated when the tramways were first considered. He thought the great economy would be in preventing the continual overlapping that occurred when two departments that had so much in common ran on separate ground. Should the amalgamation take place he would see that every possible precaution was taken to keep the finances as distinct as they were at present.

Ultimately the resolution was lost by one vote.

Coventry.—An inquiry was held here on Wednesday into the application of the Corporation for permission to borrow £37,432 for extensions of the electricity works.

The town clerk (Mr. G. Sutton) and the city electrical engineer (Mr. J. A. Jeckell) gave evidence in support of the application. It was stated that the amount applied for included £2,000 for laying spare pipes for cables to obviate the necessity of taking up streets, £432 for 17 new arc lamps and posts, and £35,000 for new generating plant, mains, &c. The revenue of the undertaking had increased from £5,897 in 1901 to £19,493 in 1906.

The inspector (Mr. H. Ross Hooper) put several questions to the officials as to the character and age of the generating units, the capacity of the station, &c.

Darlington.—The Council have decided to abolish ½d. stages on the municipal tramways and to revert to 1d. fares on Nov. 1. Halfpenny fares have been tried for 18 months.

East Ham.—The electrical engineer (Mr. W. C. Ullmann) is preparing estimates of cost of electric lighting at the typhoid fever and diphtheria block hospital, and of providing telephonic and fire alarm inter-communication between the various hospital blocks.

Electricity in Cotton Mills.—A new mill, erected on the river Irwell, at Prestolee, started running last week. This will ultimately have 110,000 spindles. At present one of the four spinning rooms is fully equipped, while the second is nearly full. About half the card and preparation rooms are equipped, and other machinery is being rapidly delivered. The principal feature about the new mill is that it is one of the first of its kind driven by electric motors. Electrical energy is supplied from independent plant on the premises, consisting of two turbo-generators of 750 kw. each. The various rooms are controlled from the main switchboard, there being a motor for each of the four spinning rooms and five motors in the cardroom.

Electricity in Mining.—In a circular issued to the shareholders giving information as to the position of the Kent Collieries (Ltd.) the directors state that the electrical installation for dealing with the water at Dover is practically completed, and pumping has been commenced, the pumps proving equal to nearly double the quantity of water that has to be dealt with.

Electric Railways.—At the conference of the Amalgamated Society of Railway Servants at Cardiff last week a resolution was adopted stating that, while recognising that it was not the men's duty to retard the progress of science in the evolution of the railways from steam to electricity, their interests could only be safeguarded by joining the society. The congress also expressed approval of the efforts of the general secretary in his representation to the Board of Trade and the Metropolitan District Railway with a view to having two men in the cab of every train conveying passengers.

German Union of Electrical Supplies Dealers.—The Einkaufsvereinigung für Elektrotechnische Bedarfsartikel G.m.b.H., formed at Frankfort-on-Main in April with seven members, has since increased to 55, and is now extending its operations over the whole of Germany.

Hackney (London).—The Electric Lighting committee reported on Monday that, owing to the increasing demand for electric energy, it would be necessary to put down additional generating plant.

With the rapid developments in power supply that are now taking place, and the continued progress of the lighting department, it is estimated that by December the demand will reach 2,200 kw., and in the winter of next year at least 2,500 kw. The committee have not overlooked the possibility at some later date of a bulk supply by the L.C.C. being available, but they desire to point out that the rejection of the L.C.C. bill last session makes it impossible for such supply to be available by next year. Moreover, it is problematical whether the new bill which the L.C.C. is preparing will be accepted by both Houses of Parliament, and further whether the L.C.C. would be able, if the powers were granted, to supply the Borough Council on more favourable terms than those upon which they themselves can generate their own electricity. The Hackney works are extremely well adapted for the economical generation of electrical energy, and for each of the five years they have been at work they have continuously held the record for London for lowest working costs. Last year the working costs were 0·84d. per unit sold; a figure never yet attained by any other London electric lighting undertaking. In order to meet their statutory obligations the committee think it is essential that additional generating plant should be laid down, and, after consideration of the reports of the consulting engineers (Messrs. R. Hammond & Son) and borough electrical engineer (Mr. L. L. Robinson), they recommend that an additional 1,500 kw. set (of the same size and type as the last), with condensing plant, pipes, valves and feed pump, be obtained, at an estimated cost of £18,500, including foundations, engineering fees, &c. The plant would be put into commission in time to cope with the peak load of the winter of 1907-8, so as to enable the committee to take on new consumers during the whole of the year. With an estimated maximum demand during the winter of 1907 of 2,500 kw., it is estimated that, owing to the increase in power load, the all-round load factor would reach 21 per cent. Under these conditions current sold for the year would be 4,600,000 units, yielding, at an average price of 1·90d. per unit, £36,540. In view of the increased demand it is estimated that for the year ending March 31, 1908, the works costs will not exceed 0·67d. per unit. In addition, there are the usual capital charges (estimated for the year in question at £19,500), making a total of £32,340, and leaving a profit balance of £4,200.

Italy.—It is stated that the Felten and Guilleaume-Lahmeyerwerke A.G., Mulheim-on-Rhine and Frankfort-on-Main, have undertaken the construction and erection of water-power plant of 18,000 H.P. for electrochemical works at Tronto, near Ascoli Piceno, Italy, for the Societa Industriale, of Rome. Current will be transmitted at a pressure of from 40,000 to 50,000 volts.

Johnstone.—Paisley Council have been asked to supply electricity in Johnstone, and both Councils are to meet in committee to arrange terms.

Leyton.—The Council have decided, after several discussions, to adopt ½d. fares on their electric tramways, and in consequence of this decision Councillor Musgrave, chairman of the Tramways committee, has resigned.

Light Railway.—The Board have confirmed the Clayton West and Darton Light Railway Order, 1906.

L.C.C. Tramways.—Holborn Council will oppose the proposals of London County Council to construct tram lines in the Bloomsbury district.

London County Council.—At Tuesday's meeting (the first after the summer recess) it was agreed to lend Shoreditch £5,000 for works in connection with the change of supply of electricity in the borough; and £1,150 to Wandsworth Guardians for two electric lifts in the infirmary.

New Tramways.—The adjourned report of the Highways committee, with proposals for the construction of new tramways, and asking that parliamentary authority be sought, was submitted. The length of the suggested tramways is 32½ miles, of which 26½ miles represent new lines and six miles connecting lines. At present 121 route miles of tramway are constructed in London, and 25 miles are authorised. At the end of the year it is anticipated that 58½ miles will be electrified. The estimated cost of the schemes is £765,530. Details have already been given of the suggested route. Consideration of the report adjourned.

School Lighting.—It was agreed to accept the offer of the South London Electric Corp. to supply electric current to the new Lawn Lane School at 3¾d. per unit, and to reduce the charge for current at the Norwood Technical Institute and two schools in Clapham and Brixton from 4d. to 3¾d. when Lawn Lane School is connected.

Tramway Receipts.—The Highways committee reported that the total traffic receipts on the tramways from April 1 to Sept. 29 was £366,787 from lines worked by electric traction, and £320,917 from lines worked by horse traction—total £687,704, compared with £712,011 last year.

Tramway Accounts.—The Highways committee reported that the accounts of the receipts and expenditure for the year ending March 31, 1906, showed that for the southern system the net capital expenditure had been £3,070,828. 14s. 5d., of which £293,491. 10s. 7d. had been repaid out of revenue, the debt outstanding therefore being £2,777,337. 3s. 10d. The net expenditure on capital account during the year was £374,582. 0s. 5d. The total receipts and working expenses were—

	Electric traction.	Horse traction.	Total.
Total receipts	£626,860 1 1	£155,350 4 1	£782,210 5 2
Working expenses ..	407,557 15 10	154,198 1 4	561,755 17 2
Making the gross surplus on working ..	£219,302 5 3	£1,152 2 9	£220,454 8 0

Debt charges amounted to £174,863. 14s. 4d. and £8,000 for income tax. £35,000 was transferred to renewals reserve fund, leaving net surplus £2,319. 17s. to be carried to appropriation account, compared with £7,054. 9s. 10d. last year. The renewals reserve fund now amounts to £103,683. 14s. 7d. The expenses on electric traction worked out at 8·04d. per car-mile.

On the northern system the capital expenditure was £1,118,166. 3s. 3d. and the outstanding debt £903,282. 4s. 10d. The receipts totalled £62,411. 2s. 4d. and the surplus revenue carried to appropriation account was £25,256. 14s. 3d., compared with £22,836. 1s. 1d. in 1904-5.

Loughborough Labour Dispute.—The strike of the car department hands at the Brush Co.'s works has not yet been ended. Two meetings of the men directly affected and others were held on Sunday, at which resolutions approving the action of the employés were passed. At one of these meetings the chairman announced that the mayor was anxious to arbitrate in the dispute. On Wednesday one man was fined at the Petty Sessions for assaulting one of the present employés at the company's works, and three others were fined for attempting to compel another employé to abstain from working for the company.

Louth.—The Board of Trade have inquired as to the steps taken by the Council to carry out their obligations under the Louth provisional electric lighting order, 1902, but the Council expresses regret that they have no proposal to put before the Board at present.

Manchester.—On Tuesday the Tramways committee approved the draft agreement between Manchester and Oldham Corporations as to the running of through tramcars. In view of the steep hills over which the Oldham tramways run, the committee gave instructions for a number of cars to be used for the through service to be fitted with special track brakes.

The construction of the tramlines from West Timperley to Altrincham will shortly be proceeded with.

At the meeting of the Electricity committee on Wednesday Mr. Geo. Howarth gave a sketch of the history and development of the department.

He submitted figures showing the results for 1904-5 and 1905-6. For the past year the gross profit was 8½ per cent., against 7 per cent. for the previous year, and the net surplus increased from £29,000 (1·4 per cent.) to £56,000 (2·5 per cent.). The capital expenditure was £2,267,127, against £2,199,690 in 1904-5. The committee did not feel justified latterly in allocating any portion of the surplus towards the relief of rates. They considered their first duty was to reduce the price of current and so to benefit the general consumers, and their second duty was to build up substantial depreciation and reserve funds, which might be drawn upon from time to time for renewals of plant and for meeting any emergencies that might arise.

Dealing with the two recent reports of the chief engineer (Mr. S. L. Pearce), Mr. Howarth said the committee felt that they only required to be carefully perused for it to be seen that there was nothing extravagant or revolutionary about them, but that they embodied proposals which any common-sense body of business men would deem both prudent and economical. The committee realised that the cost of production was naturally very much lower at their new station in Stuart-street than at Dickinson-street station, with its older plant. Consequently they had deemed it advisable to use to the fullest extent, especially during the summer, the more efficient plant at Stuart-street, and thereby lowered the working costs. As to extra plant required by the winter of 1908, the committee had the records of the past three winters to guide them, and they were in a position to know that if more plant were not installed by the winter of 1908 they would not be in a position to meet future demands. Contracts and arrangements had been entered into within the last twelve months with several of the largest manufacturing firms in the district for the supply of some 10,000,000 units. The extension at Stuart-street, to be completed two years hence, was warranted by the present rate of yearly increase in the demand. No further expenditure would be incurred in respect of Dickinson-street before the end of 1907, or for Stuart-street extension before the end of 1908, although it was necessary to obtain sanction to borrow at present. So satisfied were the Electricity committee that the two extension schemes referred to were eminently sound, prudent and necessary that they had not seen the necessity for calling in expert advice.

Marylebone (London).—At Marlborough-street Police Court on Wednesday the Borough Council was summoned by Messrs. Mappin & Webb for failing on Sept. 24, 25, 26, 27 and 28 to maintain a supply of electric energy to their premises sufficient for the use of the firm, contrary to the regulations of the St. Marylebone Electric Lighting Order, 1901.

Mr. NEWTON, for the prosecution, said that for some months past the lighting had been so bad that constant complaint had been made to defendants. The undertakers had (under their order) to declare to the consumer the pressure they proposed to supply and maintain this pressure at consumer's terminals. That pressure was subject to a variation of 4 per cent. above or below that stipulated. If there were default there was a penalty provided of £5 for every such default. Since the summonses had been issued others for several dates at the beginning of

October had been taken out, making 10 in all, as no improvement had then taken place. An employé was directed carefully to watch the voltmeter and found that on Sept. 24 the pressure varied from 84 to 94 instead of being the minimum 96. The following day they were within the proper limit, but there was a shortage on all the other days mentioned. As a result of correspondence the Council informed complainants that they were proposing to alter the voltage to 240. If that had been done Messrs. Mappin would have been put to some expense, and insurance difficulties might have arisen. They declined to accept the alteration to the higher voltage and the Council decided that for the present they would continue to supply under the old voltage of 100. A promise was made to supply a new cable, but that had not been carried out.

Mr. Haddock, one of the directors of Mappin & Webb, gave evidence in support of the summonses and said that when they declined to accept the 240 voltage the Council had obtained the consent of the Board of Trade to employ the higher pressure over their heads.

The magistrate (Mr. Plowden) asked why, having obtained that consent, the Council did not offer that voltage or nothing.

Mr. Montgomery (for the Council) explained that, without the consent of the firm, they could not enter the premises to make the necessary alterations. Not wishing to act in a high-handed manner, the Council had continued the supply at 100 volts temporarily, but they could supply electric current at the higher voltage cheaper. By the Board of Trade Regulations the borough would have to bear all reasonable expenses of the consumer in making the necessary alterations.

Mr. Haddock stated that the company's electrical engineer's advice was taken and the Council's offer declined, as he was informed they would probably have to pay 33⅓ per cent. more on the higher voltage.

Other evidence having been given, Mr. Montgomery submitted that there was no case for the Council to answer, because the only voltage that had been declared in an agreement with complainants was 50, though they had supplied an expensive machine in order to give them current at a voltage of 100. If complainants had agreed to take supply at 240 volts they could have compelled the Council to supply that voltage; but in the present circumstances he contended that no penalty could be inflicted.

Mr. Plowden said it was not disputed that on 10 days there was a serious diminution of light at complainants' premises on the basis of the 100 volt system of supply. The Council having obtained consent to the alteration in voltage, did not say that complainants must accept the 240 volts or nothing, but continued to supply at 100 volts. Having taken that course they were thrown back to their original position, and there was obviously no answer to the case. Defendants were to blame throughout, and had brought the trouble upon themselves. They must pay the full penalty of £5 on each of the 10 summonses and £10. 10s. costs. If there were future defaults there would be a continuing penalty of £2 a day.

On the application of counsel for Marylebone Council, Mr. Plowden consented to state a case.

The Electric Supply committee report receiving a communication from the Metropolitan Electric Supply Co. questioning the right of the Council to lay mains and to supply electricity for certain street lamps to be erected on the south side of Oxford-street. Counsel's opinion is said to have confirmed the Council's view of their rights in the matter.

Milan Exhibition Awards.—Simplex Conduits (Ltd.) have been awarded, at the above exhibition, two gold medals, one for the Marine Section and one for the Land Section; also two silver collaborateur medals, and one bronze medal.

Newport (Mon.)—The Council have applied for sanction to a loan of £20,000 for extension of cables, &c., for three years.

By five votes to four the Council have rejected a proposal to provide a Sunday tramway service.

Paraguay.—The Government are about to invite tenders for electric tramways and electricity supply at Asuncion.

Perth.—A report is being prepared for the Lighting committee on the probable cost of erecting electric and gas lamps in the centre of the South Inch.

P.O. London Telephone Service.—A new exchange, to be known as the "P.O. Harrow exchange," was opened, in connection with the Post Office London Telephone system, on Wednesday.

Presentations.—On Monday the staff of Ilford electricity works presented Mr. J. A. Lee with a gold albert on the occasion of his leaving to take up an appointment as charge engineer at Stepney electricity works.

On Tuesday the staff of Buxton electricity works presented Mr. W. J. Leeming, the chief electrical engineer and manager, with a handsomely-fitted leather travelling bag on the occasion of his marriage, which took place on Wednesday.

The Rochester and Chatham staff of the National Telephone Co. have presented Mr. A. L. Curling, local manager, who is leaving for Tunbridge Wells, with their photographs framed, a gold-mounted umbrella and walking stick.

Redcar.—The Council have asked the Cleveland & Durham County Electric Power Co. to submit terms for supply of electricity in the district.

Seaforth and Sefton Junction Electric Railway.—It is announced that the promoters of this railway have acquired some of the land required for the line. The increased earnings of the Southport and Cheshire Lines Extension Railway have given a great impetus to the scheme, which will provide a new short route for passengers from the south end of Liverpool and Seaforth to Southport.

South Africa.—The "British and South African Export Gazette" states that Mr. T. Parker, electrical engineer, Port Elizabeth, recently met with an accident. A splinter from a tramrail entered his eye and necessitated a serious operation. It is feared the sight of the eye may be destroyed.

Johannesburg Corporation will shortly place orders for material for private and street lighting, amounting to £7,700.

The French Rand Gold Mining Co. will shortly place an order for a 50 kw. or a 90 kw. c.c. shunt wound dynamo (125 volts), and a switchboard, &c.

The electric tramway from Kimberley to Beaconsfield is now open for traffic. Dick, Kerr & Co. supplied the cars, each of which is equipped with two 35 H.P. motors and a Hudson-Bowring life-guard and seats 40 passengers.

Spain.—The "Madrid Gazette" of Sept. 30 contains a copy of a contract between the Director-General of Public Works and the Sociedad Los Tranvias de Zaragoza for substituting electric for horse traction on the company's Zaragoza tramways. The overhead trolley system is to be adopted and the rails are to be of the Brocka type, and of 35 to 40 kilogs. (77 lb. to 88 lb.) per lineal metre.

The "Madrid Gazette" of Oct. 3 states that the Compania General de Tranvias de Barcelona have applied to the Director-General of Public Works for a concession for the construction of an additional electric tramway in Barcelona. The Compania Nacional de Tranvias have also applied for a concession for two electric tramways in Barcelona.

The "Gazette" containing particulars may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

Stepney (London).—On Wednesday the Council decided to terminate the engagement of the consulting electrical engineer, Mr. Arthur Wright.

Application is to be made for a loan of £13,713 for electricity extensions. Wapping High-street and Wapping Wall are to be lighted by arc lamps.

Additional feeder mains are to be laid through 17 streets owing to the large increase in load.

The following rates have been decided upon for charging accumulators of motor cars: 5s. per car per charge and 1s. per ignition battery or other small portable battery per charge; further 8d. per unit for current consumed between sunset and 10 p.m., and 1d. per unit at all other times For cars and batteries charged regularly the fixed charge per car is not to exceed 10s., and the fixed charge per ignition or other portable battery 2s. in any one month.

Stockton-on-Tees—A fire occurred recently on the premises of a local tradesman, and, as usual, it was attributed to "the fusion of electric wires."

The borough electrical engineer (Mr. J. J. Smith) has made an investigation into the matter, and after inspection has expressed his firm conviction that the fire was not caused by the electric light wires. In the position where the fire was first noticed the wires were intact, excepting for such injury as they had sustained from the fire external to the wires. In the next place, there must have been some fused copper to be seen had the wires come in contact, and in addition the Corporation fuses would have been melted, but these fuses were in perfect order until removed by the Corporation foreman.

Sunderland.—The Town Council resolved on Wednesday to rescind the recent appointment of Mr. A. A. Day, of Bolton, as borough electrical engineer at £1,000 a year.

Mr. Lawson, who moved the rescission, said that the terms of the advertisement were that applicants must not be over 40 years of age. Mr. Day in his application gave his age as 40, but he (Mr. Lawson) obtained a birth certificate, which proved that Mr. Day's age was 42 years and three months.

The chairman of the Electricity committee (Ald. Bruce) asked the Council to accept Mr. Day's explanation, as he had resigned his Bolton appointment. The mayor and the town clerk of Bolton had given Mr. Day an excellent character, and it was for his ability that he was selected.

The matter of the appointment will be again considered in committee.

Swansea.—The Strand is to be lighted by arc lamps attached to the existing tramway poles. There are now over 870 customers of the electricity department.

Swindon.—A special meeting of the Council was held on Tuesday to consider a report of the Electricity and Tramways committee in relation to the tramway accident in June.

The committee submitted that the accident was not due to overloading, and that when the brakes were in order they were fully equal to controlling the car with the load on the journey. In their opinion, the mechanism of the brake became displaced during the day's working, and the examination of the brake mechanism made before the commencement and during the day's work was not adequate. They did not blame the electrical engineer for the design and brake equipment of the three cars, but were of opinion that he did not adequately examine the mechanism of the brakes before the acceptance of the cars, and consequently did not discover the inadequate fastening of the rocking lever on the rocking shaft. They also regretted that the traffic manager did not make stronger representations to the electrical engineer, and they attributed a certain amount of blame to the driver and fitter. The proposal to relieve the electrical engineer of part of his duties had been modified by the resignation of the engineer.

The meeting lasted two hours and a half, and the report came in for a good deal of criticism. A portion of it was approved, and the remainder, having relation to the reorganisation of the system, was referred to a further meeting,

Swindon.—Tantalum lamps are to be substituted for 111 gas lamps at a cost of £253.

Swinton and Pendlebury.—Sanction has been received by the Council to a loan of £12,300 for electricity supply. The Lancashire Electric Power Co. will supply current in bulk and the Council will act as distributors.

Village Lighting.—Mr. David Davies, M.P., is about to supply electricity free of charge for public lighting in Llandinam streets and in the parish church, a chapel, the village hall and a school, while private lighting will be provided at a nominal charge.

Watford.—The Council have decided to apply for sanction to a further loan of £13,500 for additional generating plant, extensions of mains, &c. The estimate of the electrical engineer (Mr. Weston) is as follows: Generating station, £4,739. 18s.; distributing system, £6,222; general, £50; outstanding on schemes to date, £1,112. 17s. 6d.; contingencies, £1,375. 4s. 6d.

West Bromwich.—The Council have received sanction to a loan of £5,150 for extensions of mains, &c.

West Ham.—Application is to be made for a provisional order authorising the construction of three additional lengths of tramway. The Board of Trade have consented to the construction of the extension to Leyton.

Electrical energy on the two-phase system is now being supplied in Canning Town, and it is hoped to extend the supply to Stratford in a few days. Estimates are to be obtained for improving the electric lighting arrangements at the Plaistow, Custom House and Canning Town libraries.

West Hartlepool.—The Electricity committee have decided to make an experiment with two Crossthwaite furnaces for three months, and if found satisfactory, to purchase the furnaces at £85 per furnace. The charge to photographers for current for lamps for photographic purposes is to be at the same rate as charged for motors.

Worcester.—The Electricity committee reported last week that they proposed to concentrate the whole of the steam generating plant at the new city generating station and to use Powick station for generating current by water power. It was desired to replace the obsolete steam plant originally laid down at Powick by up-to-date machinery, at a cost of £6,500. £4,072 was still owing upon the obsolete plant and the L.G. Board inspector refused to recommend the necessary loan unless an undertaking were given to pay off the amount owing by equal instalments in three years, which meant a special rate of 1½d. The committee recommended that the necessary undertaking be given so that the work might be proceeded with at an early date, and this was agreed to by the Council.

Workhouse Lighting.—Brentford Guardians are recommended to enter into an agreement with Heston and Isleworth Council for the supply of electric current for lighting the workhouse, infirmary, union offices, and (if necessary) the schools and any other building or buildings under the control of the Guardians at 3d. per unit.

Workmen's Fares.—At Wakefield a miner has been summoned for refusing to pay tramcar fares.

On Sept. 15 defendant rode on a tramcar from Wakefield to Outwood, and only paid 1d. instead of 2d., the ordinary fare. He did the same on Sept. 22.

For the defence, it was urged that defendant was a workman, entitled to travel at workmen's rates, and in fact he did travel every night and morning by workmen's cars. On the days named he was travelling for the purpose of drawing his wages.

The Bench considered that defendant was neither going to work nor returning from work, as provided by the company's bye-laws. They ordered him to pay 18s. fines and costs on the two charges, with the alternative of 14 days, but they agreed to state a case.

Yarmouth.—The Corporation will apply for powers in their next omnibus Bill to construct three tramway extension lines.

Dinner.—Mr. S. E. Fedden, general manager of Sheffield Corporation electric supply department, entertained the chairman of the Exhibition sub-committee (Councillor Crowther) and the heads of the staff of the department to dinner on Wednesday evening, last week. An excellent dinner was served, the whole of the viands being electrically cooked, including the coffee, which was roasted by electricity. Each person present received a neat menu, designed by Mr. C. E. R. Biggin, the items being set out in "electrical" language.

Mr. Fedden said he had arranged the dinner to show his great appreciation of the splendid way in which the whole of the staff had worked in arranging the electrical exhibition and to celebrate the successful completion of the work. He had been congratulated on all hands on the success of the show, and the Lord Mayor had honoured the committee by attending specially to congratulate them. He (Mr. Fedden) had visited a large number of exhibitions in this and other countries, but he had not been more interested in what he had seen anywhere than at the present exhibition, and he thought this reflected great credit on all concerned.

Mr. Councillor Crowther expressed thanks to Mr. Fedden for his kindness and for the opportunity afforded him of meeting the assistants who had worked so admirably in making the exhibition such a great success. He thanked them all for the deep interest they had shown in the work. He could not tell at that stage whether the exhibition would be a financial success, but in all other respects it was an unquestioned success, and he had great hopes of the benefits which would follow as a result.

Mr. J. W. Beauchamp, deputy manager, seconded, on behalf of the staff, a vote of thanks to Mr. Fedden. The amount of extra work which the exhibition had involved had, he said, been a duty of pleasure to them

ELECTRICITY SUPPLY ACCOUNTS.

Bradford.—At the meeting of the Council on Tuesday, Ald. D. Wade submitted a statement as to the financial position of the various trading undertakings of the Corporation.

The capital of the tramways department directly earning revenue was £870,431. The total income for the year (including traffic revenue of £220,147) was £228,978, and working expenses £158,699, leaving £70,279. Interest and sinking fund charges absorbed £58,642, leaving £11,637 to be carried to renewals account. Upon the adequacy or otherwise of the renewals fund to meet reconstructions or renewals of permanent way in the near future turned the much debated question as to whether the fund, with its yearly accretions, might be regarded as profit or as being merely held in suspension pending its appropriation to renew track worn out long before the expiration of the period allowed for repayment of debt. If the permanent way would survive without renewal the full period of 30 years which was granted for repayment, while every other part of the undertaking was strictly renewed out of revenue, and if they could be assured of absolute immunity from contingencies, then clearly the £38,000 might be regarded as profit; but seeing that the permanent way would not, and had not, survived more than 12 to 15 years, then just as clearly the £38,000 was merely held in reserve, and was no more a profit than if used year by year for renewal purposes. If they were to make profits for relief of rates, then Bradford (in his opinion) was conveying the public at too low a charge. It was estimated that in the current year £7,000 would be required for renewals, and if to that sum was added £5,000, the extra amount required for current, with a further sum of £1,200 for employés' holidays, it would be seen that the renewals fund must be proportionately depleted, and the unwisdom of counting on that fund as profits available in relief of rates was emphasised. Before they could safely begin relieving rates with tramway surpluses there should be accumulated between £80,000 and £100,000 for renewal of track. The weight of opinion was that £200 per mile per annum was required for renewals, and on that basis they would require annually £17,600 for renewal of track in Bradford.

The electricity department, with a working capital of £706,238, had had in its later years a chequered career. It had suffered reverses peculiar to the character of the undertaking, due largely to unforeseen developments with other considerations outside the control of the committee, and which had handicapped it somewhat in its progress towards financial success. Unfortunate accidents and the cost of repairing consequent damage had dipped deeply into its resources and left it with a considerably depleted exchequer. No less than £17,244 had been required for renewals during the past year. At the beginning of the year the accounts showed a balance of unappropriated profit, together with a renewal fund, of £40,447. The income for the year was £98,095, and the working expenses £47,062, leaving £51,033. Interest and sinking fund required £47,048, leaving £3,985 to be added to reserve. Against that there had been required for renewals before mentioned £17,244, whilst it had been found necessary to write down hired motors and arc lamps to the extent of £7,925, and to depreciate marine boilers, &c., by £5,670, a total of £30,839, leaving about £13,593, compared with £40,447 at the beginning of the year.

Islington (London).—In his report on the electric lighting accounts for the year ended March 31 the district auditor states that the charge for current for public lighting for the year remained practically unaltered, the figure being 3·47d. per unit, apart from trimming and maintenance of lamps.

The Council have resolved not to exceed the aggregate charge made in 1904-5 (£15,734 5s. 5d.), and the auditor estimates that the increase of street electric lighting will in 1907-8 have reduced the charge per unit to 2·24d. per unit.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The directors of the *Great Western Railway Co.* invite tenders for supply of stores for 12 months ending Nov. 30, 1907, including telegraph instruments, apparatus (insulators, &c.), iron work and tools and telegraph drysalteries, electric light carbons, incandescent electric lamps, wire, glass, acids, alkalies, &c., oils and turpentine, colours, paint, steel tools, ironmongery, brasswork, locks, rivets, bolts and nuts, &c. Samples and patterns may be seen at the company's general stores, Swindon, from 17th to 26th inst. Specifications (with forms of tender) from the Stores Superintendent, Swindon. Tenders, addressed to the secretary (Mr. G. K. Mills), Paddington Station, London, W., not later than Monday, Oct. 29. Further particulars are given in an advertisement.

Swinton and Pendlebury Urban District Council invite tenders for the following work in connection with their electrical engineering undertaking: (1) Sub-station buildings, (2) l.-t., d.-c. switchboard, (3) mains, and (4) d.-c. electricity meters. Forms of tender and specifications from the clerk to the Council, Mr. W. T. Postlethwaite. Tenders to the Chairman of the Electricity committee, Council Offices, Swinton, Manchester, by Nov. 3. See also an advertisement.

Portsmouth Corporation invite tenders for supply, erection and maintenance of electrically-driven centrifugal storm water pumps, with switch gear and accessories. Specifications from Messrs. Bramwell & Harris, 5, Great George-street, Westminster. Tenders by noon Nov. 15.

Manchester Electricity committee invite tenders for supply, delivery and erection at Stuart-street generating station of one 500kw. turbo-alternator, complete with condensing plant. Tenders to the Chairman of the committee, Town Hall, Manchester, by 10 a.m. 31st inst.

Wigan Corporation invite tenders for the supply and erection of air and circulating pumps with necessary pipework for the condensing plant at their Pemberton electricity station. Tenders to the town clerk (Mr. Harold Jevons) by Oct. 15.

Wallasey Council require tenders by 16th inst. for steam and exhaust pipes, &c.

Wallasey Tramways committee want tenders by 16th inst. for 60 tons of tramrails, with fishplates, points, crossings, &c. Specifications, &c., from Mr. W. H. Travers, Public Offices, Egremont.

Beckenham Council require tenders by 29th inst. for supply and erection of induced-draught apparatus at the electricity and destructor works.

The *Postmaster-General* requires tenders by noon Oct. 22 for creosoting Norwegian, Swedish, Finland or Russian red fir telegraph poles. Forms of tender, &c., from the Controller of Stores, 17-19, Bedford-street, London, W.C.

Antwerp Municipal Council invite tenders for 2,400 metres of electric cable for a 120 ton sheer. Specifications from the Hotel de Ville, Antwerp. Tenders to the Burgomaster, by Oct. 18. A deposit of £20 is required. Copy of specification may be seen at the offices of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Last week Rathmines Council had under consideration 56 tenders for the supply of mains, meters, &c., and the following were accepted:—

British Insulated & Helsby Cables, electricity supply mains, £16,270. 6s. 11d., and house fuse boxes, £183. 15s.; Ferranti Limited, meters, at schedule rates; Electric Construction Co., extension of switchboard, £480, and battery booster £587; Tudor Accumulator Co., accumulators, £2,848.

The consulting engineers are Messrs. Robt. Hammond & Son.

P. J. Mitchell has recently received the following orders for Rateau patent exhaust steam utilisation turbo plants:—

Bolckow, Vaughan & Co., one 500 kw. three-phase turbo-alternator, condensing plant and pipework; David Colville & Sons, one 500 kw. d.-c. set (230 volts) with condensing plant; Penrikyber Navigation Colliery Co., one 500 kw. three-phase turbo-alternator, condensing plant and pipe work. In each case a second set is to be added later.

The contract for electrically-driven centrifugal pumping plant for the Kleinfontein Deep Mines (S. Africa) has been placed with the A.E.G. Electrical Co. of South Africa. The contract includes four 140 B.H.P. motors for a 2,000 volt circuit, the pumps being by Sulzer Bros.

Battersea (London) Council have accepted the tender of the British Thomson-Houston Co. for two 10 H.P. motors for the public wash-houses and one 5 H.P. motor for the laundry at the disinfecting station at £126. 10s.

Camberwell Guardians have decided to take their supply of electrical goods for the ensuing year from the General Electric Co. and Reed's Electrical Co. The lowest price is to be taken when ordering, after allowing for discounts.

Stepney (London) Electric Lighting committee received 15 tenders for additions and structural alterations at the Osborn-street electricity works, the lowest (that of B. E. Nightingale, at £1,066) was accepted.

An order to supply the Village Main Reef Mine, S. Africa, with poles, cross-arms, insulators, &c., for carrying cables in connection with the electrification of a section of the mine has been received by Hubert Davies & Spain.

The Mirrlees-Watson Co. have recently received orders for condensing plant from (among others) the Central London Railway Co., Liverpool Corporation, Adelaide Electricity Supply Co., and the Bournemouth and Poole Electricity Supply Co.

An order for a 400 kw. steam turbo-generator, with condensing plant, pumps and switch gear, for Pretoria Municipal Electricity Works has been received by the Brush Co.

Stalybridge, Hyde, Mossley and Dunkinfield Electricity and Tramways Board have accepted the tender of T. Beeley & Sons for superheaters.

Newcastle-under-Lyme Council have accepted the tender of the Chloride Electrical Storage Co. for a storage battery at £205, and that of R. Hornsby & Sons for two gas engines at £807.

Bradford Council have accepted the tender of Saunders & Co. for supply of signalling apparatus for the Nidd Valley Light Railway at £434. 15s.

Hubert Davies & Spain have recently supplied a motor and a 54 cell battery to the Hon. H. Wyndham's stud farm, near Standerton, S. Africa.

Arc Lamps (Ltd.) have received (through Messrs. Coates & Sons, Dublin) the order for the entire lighting of the Irish International exhibition with their enclosed arc lamps.

Ferryhill Council have accepted the tender of Bolckow, Vaughan & Co. for installing 48 32 c.p. lamps at £201. 5s., and supplying current at 30s. per lamp per annum.

C. C. George & Co. Johannesburg, have secured an order for a 40 H.P. motor for the Crown Deep Mine, S. Africa.

Wolverhampton Corporation have accepted the tender of the Electric Construction Co. for switchboard extension at £207.

Southport Council have accepted the tender of the Vulcan Motor Co. for a motor tower waggon at £345.

Guildford Council have accepted the tender of Bowden, Higlett & Co. for wiring 10 police cells.

Dundee Electricity committee have accepted the tender of the British Insulated & Helsby Cables for tramway cables at £210. 5s.

Lea & Warren have secured the contract for the electric light installation at the new and extensive Piccadilly Hotel, London, W.

The A.E.G. Electrical Co. (S. Africa) have received an order for a 400 kw. d.c. generator for the Langlaagte Estate, S. Africa.

An order for three electric watering cars has been placed with Dick, Kerr & Co. by Johannesburg Municipality.

Aston electricity department have placed an order with Johnson & Phillips for an extension to the switchboard at the electricity works.

Ingleton Council have renewed the contract with the local electric light company for street lighting at £40 for the season.

East Ham Council have accepted the tender of W. R. Reynolds for wiring the new hospital at £122. 12s. 6d.

Brandon Council have accepted the tender of F. Reid, Ferens & Co. for incandescent electric lamps, &c., at £36.

Electrically-operated Bulkhead Doors.—The Spanish Royal Naval Commission in London has entered into a contract with the "Long-Arm" System Co. for the installation of 19 electrically-operated bulkhead doors for the Spanish cruiser "Reina Regente," now building at Ferrol. The system of electrical-power doors adopted by the Spanish navy is the same as that in use on nearly all the new vessels of the U.S. navy. It enables closure of the main bulkhead doors to be effected from an electrical central station located on the bridge.

BUSINESS NOTICES.

Mr. John F. C. Snell, M.Inst.C.E., M.I.E.E., M.I.Mech.E., past president of the Incorporated Municipal Electrical Association, will resign the position of chief electrical and tramways engineer to Sunderland Corporation at the end of the present year. He has been retained as joint consulting engineer in connection with the London County Council power bill and will shortly commence to practise at Caxton House, Westminster, S.W., as a consulting electrical engineer. He has taken into partnership Mr. Stuart S. Moore Ede, who has had considerable experience in railway and tramway work in America and in the East. Messrs. Snell and Moore Ede will be prepared to give expert advice upon power, railway and tramway work and the application of electricity to industrial purposes, &c. The firm's telegraphic address is "Sned London"; telephone No. 5,194 Westminster.

The registered telegraphic address of E. P. Allam & Co., 11, Red Lion-street, Clerkenwell-road, London, E.C., is "Smoothbore London."

The new telephone number of the Union Cable Co. is "975 North."

Albert E. Hart and Arthur T. Jones, electrical engineers, &c., 39, Durban road, Watford, have dissolved partnership. Debts by Mr. Hart, who continues.

Jas. & David H. Hutton, trading as Hutton Bros., electrical engineers, &c., 12, St. Aldate's-street, Gloucester, and 8, Commercial-road, Swindon, have dissolved partnership. Mr. J. Hutton continues the Gloucester and Mr. D. H. Hutton the Swindon branch, each under the style of "Hutton Bros."

BANKRUPTCIES, LIQUIDATIONS, &c.

Robert O. Thompson, electrical engineer, was examined at Brighton on Oct. 4. Liabilities £510. 17s., assets £74. Debtor took over the business from his father without payment. Examination closed.

The trustee (Mr. H. C. Howard, Bassishaw House, Basinghall-street, London, E.C.) in the bankruptcy of W. Rowbotham, electrical engineer, Holmville, Stanley-road, Teddington, has been released.

Claims against Albert Dickinson, electrical engineer, 19, Upper Mill-hill, and the Electrical Works, Dixon Lane-road, Wortley, Leeds, by Oct. 26 to Mr. J. Bowling, 22, Park-row, Leeds.

Claims against the Kettle River Power Co. (Ltd.) (in vol. liq.) to Mr. A. G. Bartholomew, 695, Salisbury House, London, E.C., by Nov. 15.

A meeting will be held on Nov. 7 at 120, Bishopsgate-street Within, London, E.C., to receive an account of the winding up of the Pollok Virag Telegraph Synd. (Ltd.)

The Raymond Phillips Electric Railway & Tramway Equipment Co. (Ltd.) is being wound up voluntarily. Mr. P. Mordant, 9 and 10, Fenchurch-street, London, E.C., is liquidator.

A meeting will be held on Nov. 16 at the offices of Mr. W. Dearden, 36, Spring gardens, Manchester, to receive an account of the winding up of the Prism Globe Co. (Ltd.)

Meetings will be held on Nov. 19 at the offices of Mr. E. H. Stringer, 110, Cannon-street, London, E.C., to receive an account of the winding-up of the British Miller Synd., Ltd., and the Miller Signal Synd. (Foreign Patents), Ltd.

Sale by Auction.—Messrs. Wheatley Kirk, Price & Co. have been instructed by the receiver for the debenture holder of the Thames Electric & Motor Boats (Ltd.) to sell by public auction in one lot, upon the works premises, Eel Pie Island, Twickenham, on *Tuesday next* at 10 a.m. (for 11 a.m. prompt), the freehold works and land, containing about 1¼ acres, with a frontage to the river Thames of approximately 300 ft., together with substantially-built boat-building shops, engine and battery house, machine shop, stores, &c. Messrs. Wheatley Kirk, Price & Co. will also sell by public auction, piecemeal, in the lots of the catalogue, immediately after offering the freehold, the contents of the works, including sliding, surfacing, screw-cutting and other lathes (by well-known makers), wood-working machinery, planing, drilling, bending and other machines, engine, boiler, dynamo and switchboards, electric motors and accessories, loose tools, utensils, &c. Catalogues (gratis) from the auctioneers, 46, Watling-street, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester.

During the sale of the above plant the newly-built electric launch "Victory" (capable of accommodating 350 passengers) will be offered at auction. Further particulars are set out in an advertisement.

Plant for Sale.—Barber & Coleman (Ltd.), 38, King-street West, Manchester, advertise for sale two electric motors (2½ H.P. and ½ H.P.).

A 250 kw. d.-c. Schuckert dynamo (with spare armature, &c.) is advertised for sale in another column.

Plant Required.—The British Electric Equipment Co. (Ltd.), 265, Strand, London, W.C., require one 150 kw. (about) d.c. dynamo (440-500 volts); also two 40 H.P., one 30 H.P. and one 20 H.P. d.c. motors (500 volts). See an advertisement.

Works Site for Sale.—Messrs. R. Heber Radford, Son & Squire, 15, St. James's-row, Sheffield, advertise some conveniently situated land (over 20 acres) in Sheffield, suitable for large works.

House to Let.—Mr. A. Broome, Thorncliffe, Clifton-road, Heaton Moor, near Manchester, advertises to let (for five months) a detached house with convenient railway accommodation, &c.; would suit engineer and family for temporary residence.

CATALOGUES, &c.

Tantalum Lamps.—Incandescent lamps always make a good subject for a trade booklet, and the tantalum lamp is no exception to the rule, judging by the attractive brochure on its use which has come to hand from Siemens Bros. Dynamo Works (Ltd.) The cover bears an embossed full-sized reproduction of the Siemens tantalum lamp, apparently dispelling the nether darkness with a blaze of white light. The effect produced is very striking, and yet appropriate to the subject. The body of the book contains figures relative to the economies of the lamp, as well as numerous illustrations of typical installations within the London district. Some of these examples we have seen, and in a particular case we have in mind the effect of the lighting by tantalum lamps was very pleasing.

An Echo of San Francisco.—From the Joseph Dixon Crucible Co., 26, Victoria street, London, S.W., comes a booklet, entitled "Through Frisco's Fire," in a somewhat startling cover. Particulars are given of the numerous buildings in the stricken city which were coated, as to their steel framework, with Dixon's Silica Graphite Paint, and which withstood the shock of the earthquake and subsequent heat of the fire. The makers claim special preserving properties for the paint when applied to steel and iron work for buildings of any kind.

The Slack Belt Drive.—Users of belts with electric motors will find a little booklet, entitled "The Tensionless Drive," issued by Thomas & Bishop, Finsbury-pavement, London, E.C., to contain some valuable hints as to the use of belts in general, and a belt dressing or "food," known as "Cling-Surface," in particular. This preparation, when applied to a belt, will, according to the claims made for it, admit of a belt being run slack with an increased load.

Nernst Lamps.—Messrs. Drake & Gorham, 66, Victoria-street, London, S.W., are sending out a booklet dealing with Nernst lamps and fittings. The patterns described are those now in general use.

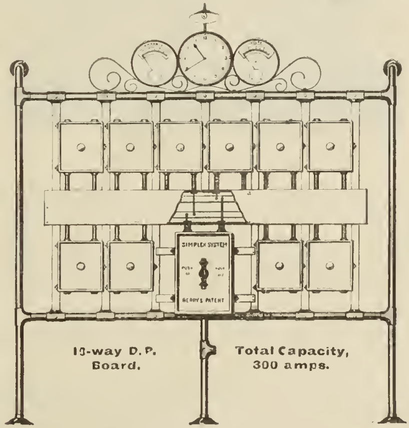
From the same source comes an interesting pamphlet on the tantalum lamp.

A very neat and effective embossed and assembled paper model of a Nernst lamp is being issued by the Electrical Co. and should form an excellent medium for enabling the trade to introduce the Nernst lamp to prospective clients. The Electrical Co. have provided an envelope for this neat device, and announces that more than 7,000,000 of Nernst lamps and burners have already been sold.

Gear Cutting.—J. B. Hamilton & Co., Southey-road, South Tottenham, London, N., who are specialists in gear cutting, have published two leaflets giving details of the sizes and kinds of gear they supply. Among these are the "Unica" silent pinions, stated to be specially useful for motor driving.

B.T.-H. Pamphlets.—Two recently-issued B.T.-H. pamphlets are to hand dealing with lightning arresters and enclosed arc lamps. Both are produced in the company's usual good style and taste, and are punched for dropping into a standard file.

Simplex Ironclad Switchboard.—Simplex Conduits (Ltd.) have introduced an entirely new form of main switchboard for colliery work and other situations where electric circuits are exposed to risk from damage by moisture or mechanical injury. The board is built up of a series of units and the whole is mounted on a framework of Simplex screwed solid drawn conduits. Each unit consists of a separate combined ironclad switch and fuse, and any number can be arranged for, double or triple pole, and for single or polyphase currents. The 'bus bars are enclosed in an iron casing and are entirely out of harm's way, the branch circuits between the 'bus bars and switches being enclosed in conduit. The board is suitable for lighting and power circuits, is perfectly flame-tight as the live parts are out of reach, being totally enclosed. A blown fuse cannot be replaced unless that particular circuit is dead. Fuses can be replaced on any circuit without interfering with others. Every circuit is separately controlled at the distributing centre, and no switch is necessary at the point where power is utilised.



Simplex Ironclad Switchboard.

American Trade Index, 1906.—We have received a copy of the eighth annual issue (English edition) of this book, which is a descriptive and classified membership directory of the National Association of Manufacturers of the United States of America. The book is divided into two parts, an alphabetical list of members and an alphabetical classified list of articles supplied by members.

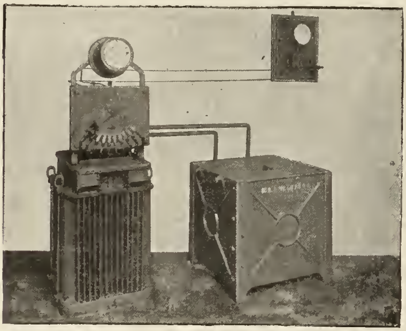
"**Zone" Motors.**—In reference to a notice which has appeared recently in the technical journals, we have received from Newtons Limited, of Taunton, the following letter:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We notice in the technical papers an announcement by Mr. H. F. Joel to the effect that he is the patentee of the "Zone" patent electric motor. As this may lead to some confusion, we beg to say that, while Mr. Joel may be the inventor of *a* motor, the machine we are making under the licence of the Zone Dynamo & Motor Patents Co. is, we believe, the only "Zone" machine now being made, and the invention of our chief electrician, and not that of Mr. Joel.

We may say that the remarks referred to by Newtons Limited did not appear in the note in *The Electrician.*

Annealing and Hardening Furnaces Heated by Electricity.—The subject of electric furnaces is one which always engages attention, as developments in this branch of electrical application to industrial uses are looked for by those whose daily work requires increased facilities for the handling of steel goods. The Electrical Co., of 121-125, Charing Cross-road, London, W.C., make a claim that the tool steel manufacturing and kindred trades will derive considerable advantage from the use of a novelty which the company now places on the market. Amongst the claims made for these furnaces is that of an absolutely uniform heat and that this uniform heat can be maintained absolutely constant for any length of time and be regulated to any requirements. In this way a rapid process of hardening, even with temperatures up to 1,300°C., can be obtained without danger of "burning" the steel. One of these furnaces is, we understand, on exhibition at Sheffield and is receiving considerable attention from steel manufacturers in that great centre of the steel industry. The complete outfit of these annealing and hardening furnaces, which are heated by electricity, is shown in perspective in the accompanying illustration.



Annealing and Hardening Furnace Heated by Electricity.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during September, 1906:—

Electrical machinery, £44,783 (increase of £8,340); telegraph and telephone cables, £20,460; telegraph and telephone apparatus, £31,271; other electric wires and cables (rubber insulated), £6,468 (with other insulations), £3,285; other electrical goods and apparatus, £33,042. Total of electrical goods and apparatus (other than machinery and telegraph and telephone wire) for the month, £94,526 (increase, £23,179), and for the nine months ended Sept. 30, £864,366 (increase £142,915).

Exports of Electrical Goods and Apparatus.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and materials, but not including electrical machinery which is not separately specified) from Oct. 3 to 9, with the ports of destination:—

Aden, £19 (telegraph material). *Africa*—Alexandria, £168 (including £14 telegraph material); Cape Town, £136; Delagoa Bay, £18; Durban, £504; East London, £92 (telegraph material); Port Elizabeth, £449; Suakim, £56. *Argentina*—Buenos Ayres, £9,437; Rosario, £776. *Australasia*—Fremantle, £193; Launceston, £50; Lyttelton, £176; Melbourne, £491; Perth, £509; Sydney, £951; Townsville, £108; Wellington, £24. *Austria*—Trieste, £14 (telegraph material). *Belgium*—Brussels, £26; Ostend, £161. *Brazil*—Rio de Janeiro, £884 telegraph material). *British Guiana*—Demerara, £75 (telegraph material). *Burma*—Rangoon, £153. *Canada*—Halifax, £55; Montreal, £107. *Canary Islands*, £11 (telegraph material). *Ceylon*—Colombo, £79. *Chili*—Boca, £308; Valparaiso, £586 (including £201 telegraph material). *China*—Hankow, £702; Shanghai, £1,601. *France*—Paris, £22. *Gibraltar*, £20. *Holland*—Amsterdam, £15; Rotterdam, £12; Terneuzen, £16. *Hong Kong*, £302. *India*—Bombay, £1,007 (including £19 (telegraph material); Calcutta, £1,248; Madras, £503 (including £5 telegraph material). *Japan*—Yokohama, £887. *Malta*, £24. *Mauritius*, £31. *Mexico*—Vera Cruz, £445 (telegraph material). *Straits Settlements*—Penang, £25; Singapore, £306. *U.S.A.*—New York, £219. *Zanzibar*, £426 (telegraph material). Total, £24,430, against £17,749 in the corresponding week last year (Oct. 4 to 10).

According to official returns for Sept., 1906, the value of electrical goods and apparatus (other than machinery and telegraph and telephone wire) exported from the United Kingdom was £122,110, compared with £122,136 in the corresponding month of 1905 and with £95,727 for September, 1905, a decrease of £26 compared with 1905 and an increase of £26,383 over 1904. For the nine months of 1906 ended Sept. 30 the total value of these goods was £1,936,790, compared with £1,797,137 for the same period in 1905 and with £1,156,230 in 1904, showing increases respectively of £139,653 and £780,560.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

August 27, 1906.

19,074 Potterat. Current takers for locomotors in series.
19,083 Pendred. Commutators for internal-combustion engines.
19,086 Mertz. Multi-stage impulse turbines. (Date applied for, 30/3/06.)*†
19,094 Wallace. Incandescent lamp.
19,116 Wasley. Turbines.
19,120 B.T.-H. Co. (G.E. Co., U.S.) Electric motors.
19,139 Bray, Markham, & Bray, Markham & Reiss. Switches.
19,150 Edwards. Controllers for trolley poles.

August 28, 1906.

19,161 Drysdale. Permanent way for tramway and light railways.
19,199 Dixon. Automatic railway signalling by contact.
19,219 Watkinson & Payne. Controlling pressure of current in a circuit.*
19,235 B.T.-H. Co. (G.E. Co., U.S.) Circuit protecting devices.
19,239 Allgemeine Elektrizitäts Aktien-Gesellschaft. Cooling of electrical machines. (Date applied for, 30/8/05.)*†
19,248 Chilton, Newton & Brush Electrical Engineering Co. Liquid seal glands for fluid pressure turbines.*
19,249 Hayden. Sparking devices for explosion engines.*
19,255 Wright. Automatic magnetoelectric piano player.

August 29, 1906.

19,287 Reen. Either side hand brake for vehicles.
19,299 Olver & Crawford. Flush type switch mountings.
19,306 Davis, Davis & Davis. Rods for pulling through conduits.
19,319 B.T.-H. Co. & Clinker. Apparatus for determining acceleration of rotating bodies.
19,331 Leach. Supporting devices for electric fans and fittings.*

August 30, 1906.

302a Siemens Bros. & Co. (Siemens Schuckertwerke G.m.b.H., Germany.) Electricity meters. (Date applied for, 4/1/06.)*
19,335 Fitton & Milnes. Automatic adjuster for trolley ropes.
19,341 Skidmore. Joints of tramway rails.
19,363 Mackay. Recording dynometer or power meter.
19,373 Brown. Electrical maximum demand meters.
19,378 Bounevialle Signalling Synd. & Bounevialle. Electric signalling apparatus for use with locomotive engines.
19,385 Sankey. Gauges for measuring pressure in suction gas producer plants.
19,386 Young. Telephone intercommunication systems.
19,387 Kaeferle. Electromagnetically operated temperature regulating apparatus.*
19,389 Siemens Schuckertwerke G.m.b.H. Alternating-current commutator machines. (Date applied for, 30/8/05.)*†
19,393 B.T.-H. Co. (G.E. Co., U.S.) Graphite filaments for electric lamps, furnaces, &c.
19,402 Cox. Apparatus for passing cables through conduits.
19,410 Wallis-Jones. Automatic devices for cutting out faulty electrical circuits.
19,411 Cowper-Coles. Electrodeposition of alloys.
19,413 Hanson & Schrenkler. Sound magnifier for telegraphic instruments.*

August 31, 1906.

19,431 Northcott. Chimneys and globes for electric and other lamps.
19,461 Thomas. Systems of electrical distribution in which vapour electric devices are employed. (Date applied for, 1/9/05.)*†
19,462 Hunter. Destination indicators for tramway cars.*
19,466 Hirst & Gunner. Securing electrical continuity in conduit tubes.

19,467 Hirst & Collings. Adjustable carriers for electric light reflectors.
19,468 Rignon. Arc lamps.*
19,469 Wallis & Sibthorp. Electric lighting of vehicles.
19,479 Schäfer. Electrolytic resistance.*
19,482 Eisemann. Electric ignition for explosion motors.*
19,486 Belliss & Morcom & McGregor. Electromagnetos.*

September 1, 1906.

19,548 B.T.-H. Co. (G.E. Co., U.S.) Transformers.
19,560 Gadsby. Tramway rails.

September 3, 1906.

19,593 Siemens Bros. Dynamo Works. (Siemens Schuckert-Werke G.m.b.H., Germany.) Controlling the speed of motors or other machines, from a distance or otherwise.*
19,599 Stevens & Heller. (Cervenka, Austria.) Arc lamps.
19,601 Mills. (Hawk, U.S.) Power transmission apparatus.*
19,608 Corthésy. Turbines.
19,620 Forster. Incandescent lamps.*
19,623 Sandy & Middleton. Batteries.
19,626 Brown, Boverie & Cie. Electrically-driven ring spinning machines. (Date applied for, 14/9/05.)*†
19,627 Mather & Platt. (Rosenberg, Germany.) Self-regulating dynamo-electric machines.
19,639 Siemens Bros. & Co. (Siemens & Halske A.-G., Germany.) Operating electrically worked semaphore signals.*

September 4, 1906.

19,662 Cuthbert. Tramway rails.
19,666 Brassington. Rods for cable-wire drawing, &c.*
19,679 Warner. Vapour lamps. (Date applied for, 20/10/05.)*†
19,690 Hirst & Gunner. Fittings for effecting junctions between main and branch cables in conduit junction boxes, without soldered joints.
19,695 Legrand & Gersant. Turbines.
19,701 Dubs. Electrical indicating clocks. (Date applied for, 5/9/05.)*†
19,704 Morgan Crucible Co. & Speirs. Brushes for dynamo-electric machines.
19,705 Morgan Crucible Co. & McCourt. Compound for use in commutator brushes.
19,709 Bastian & Calbert. Sealing conductors into or through glass or like material.
19,717 Felten & Guilleaume - Lahmeyerwerke A.G. Alternating-current electric machines. (Date applied for, 4/9/05.)*†
19,719 Wilkinson. Adjustable supporting means for turbines and rotary motors.*
19,731 Hildebrand & Diessl. Automatic switches for telephone systems. (Date applied for, 6/9/05.)*†
19,736 & 19,737 B.T.-H. Co. (Kintner, U.S.) Signalling systems and safety appliances for railways and the like.

September 5, 1906.

19,756 Mitchell. Electromagnetic variable gear for motor cars, motor cycles and the like.
19,762 Mather. Tramway point and operating mechanism therefor.
19,793 B.T.-H. Co. (G E. Co., U.S.) Electric measuring instruments.
19,805 Artom. Receivers for wireless telegraphy.*
19,807 Sheffield & Brush Electrical Engineering Co. Construction of motor and other vehicles.

September 6, 1906.

19,835 Hepburn. Relating to railway carriage or tramcar wheels.
19,849 Brock. Holder for files for rubbing joints of tramway or railway metals and the like.
19,853 Hele-Shaw. Transmission of power.
19,861 Von Pindtershofen. Cable conduit for electric mains.*
19,865 B.T.-H. Co. (G.E. Co., U.S.) Electric heating devices.
19,874 Marquis. Switch-throwing or operating devices. (Date applied for, 21/11/05.)*†
19,878 De Forest Wireless Telegraph Synd. (De Forest, U.S.) Apparatus for signalling by electromagnetic waves.*
19,881 De Forest Wireless Telegraph Synd. (De Forest, U.S.) Wireless telegraph systems.*

September 7, 1906.

5,333 Clark & Strachan. Brakes for tramcars and other vehicles. (Date applied for, 5/3/06.)
19,916 Longford. Switches.
19,917 Dixon. Electrically controlling and operating coal hoists.*
19,945 Boyle & Hartley. Storage batteries.
19,951 Jones. (Decker Electrical Mfg. Co., U.S.) Primary batteries.*
19,963 Bloxam. (Siemens & Halske A.G., Germany.) Electrically operated fire-alarm installations.*
19,972 Warwick Machinery Co. & Ahlquist. Turbines.
19,980 Rowbotham, Gospel & Archer. Electromagnetic safety lock.
19,986 Fearnhead. Tramcars.
20,014 Noy. Fender or guard for tramway vehicles.*
20,028 Headland & Plutte. Arc lamps.
20,041 Siemens & Halske A.-G. Apparatus for winding closed iron cores for transformers, choking coils and the like. (Date applied for, 12/9/05.)*†
20,043 Newbold. Automatic switch.*
20,050 Allgemeine Elektricitäts-Gesellschaft. Regulating the voltage of alternating-current distribution systems. (Date applied for, 9/9/05.)*
20,056 Perret. Electrically measuring height or pressure of fluids at a distance. (Date applied for, 9/9/05).*†

SPECIFICATIONS PUBLISHED.

1905 Specifications.

12,999 Webber & Standard Time Co. Means for ensuring continuity of movements derived from electric energy.
15,196 B.T.-H. Co. (G.E. Co.) Electric signalling systems particularly applicable to telephony.
16,003 Roloff. Increasing the capacity of accumulators.
17,357 Alexander. Manufacture of brushes.
17,362 Hoegerstaedt & Townsend. Elastic fluid generator.
17,674 Warren, Busschots & Wood. Accumulators.
17,699a Field & Ferranti (Ltd.) Controllers for electric circuits. (Date applied for, 1/9/05.)
17,814 Ellis & Taylor. Controlling and supplying current on consumers' premises during certain periods.
17,997 Cushing. Insulators.
18,015 Westinghouse. Turbines.
18,087 Jones. Incandescent lamp holders.
18,125 Maonuson. Electric motor control systems.
18,128 Belliss & Morcom & Jude. Construction and assembly of guide blades and vanes for turbines.
18,694 Higgins. Type-printing telegraph transmitters.
19,034 B.T.-H. Co. (G.E. Co.) Wireless telegraphic apparatus.
19,099 Judd, Fraser & Hardie. Automatic transmitters for telegraphy.
19,111 Hess. Substance for electrical insulation.
19,568 Holt & Wallis. Electrically controlled semaphore signals for railways.
20,599 B.T.-H. Co. (G.E. Co.) Switches or cutouts.
20,974 Quertier. Apparatus for clearing rails of tramways.
21,078 Dayol & Schmitt. Brake actuating gear.
21,480 Holden. Electrical ignition devices for internal combustion engines.
21,659 Védrine & De Quélen. Electric vehicles. (Date applied for, 26/10/04.)
21,683 Merritt. Mechanism in connection with prepayment electricity meters.
22,198 Day. (Fabrik Elektrischer Zunder.) Contact apparatus for electrical igniters.
22,654 Wood & Lancashire Dynamo & Motor Co. Equalising the output of main dynamo-generators supplying energy to a fluctuating external load.
22,802 Smith. (Boulanger.) High-tension magneto-ignition systems.
23,261 Lacey. Folding platform step and gate for tramcars.
23,728 Simmonds. Shade holders for incandescent lamps.
24,024 B.T.-H. Co. (G.E. Co., U.S.) Controlling self-exciting generators.
24,025 B.T.-H. Co. (G.E. Co., U.S.) Vapour electric apparatus.
24,145 Peckham. Trucks for railway, tramway, and like vehicles.
24,265 De Macedo. Double-decked tramcars.
24,729 Atkinson. Electric controllers.
24,877 Hills, Urquhart & Honey. Dynamo-electric machines.
24,962 Mitchell & Dolter Electric Traction. Electric traction systems.
25,049 De Retz. Explosion turbines. (Date applied for, 16/12/04.)
25,464 Mantle. Mouthpieces for telephones.
27,138 Comings. Switches.

1906 Specifications.

488 Towlson & Moulton. Rotary fluid pressure motors, pumps and air compressers.
1,487 Bláthy. Electricity meters.
1,652 Kerkau. Hot-air turbines. (Date applied for, 21/1/05.)
1,961 Kastler. Pole for supporting electric transmission lines. (Date applied for, 1/4/05.)
2,185 Mair. Electric controller for lifts, hoists and cranes.
2,554 Zerning. Filaments for incandescent lamps.
2,811 Gardner. (Brémant.) Electric apparatus for rapidly warming and distributing liquids.
3,415 Hatherly & Hatherly. Adjusters for electric light cords.
3,677 Siemens Bros. & Co. (Siemens-Schuckertwerke Ges.) Regulation of alternating-current circuits subject to fluctuations of load.
4,803 Smith. Steam turbine engines.
4,813 Siemens & Halske A.-G. Temporarily producing alternating currents in a circuit at one or more points and application thereof to printing telegraph apparatus. (Date applied for, 21/3/05.)
5,093 Shaw-Browne & Williams. Telephonic and similar instruments.
5,154 Elektrizitäts A.-G. vorm. W. Lahmeyer & Co. Magnets for alternating currents. (Date applied for, 31/5/05.)
6,155 Collins. Electric circuit-closing devices.
6,300 Brockie. Regulation of enclosed arc lamps.
6,515 Kufferath & Marquart. Arc light carbons.
6,632 Graetz & Graetz. Alternating-current arc lamps. (Date applied for, 6/9/05.)
6,805 Poscher. Turbine engines.
7,033 Barth. Steam turbines. (Date applied for, 14/9/05.)
8,785 Elektrizitäts A.-G. vorm W. Lahmeyer & Co. Dynamoelectric generators. (Date applied for, 28/4/05.)
8,792 Lentschat & Drahonowsky. Electric gas igniter for street lamps.
8,840 Imray. (Siemens & Halske A.-G.) Incandescence bodies for electric lighting.
9,488 Siemens Bros. & Co. (Siemens Schuckertwerke Ges.) Rotating field magnets of electric machines.
9,904 Weiss. Electric motor mechanism for automobiles. (Date applied for, 16/1/06.)
12,855 Allgemeine Elektricitäts-Ges. Switches. (Date applied for, 5/6/05.)
13,885 Scoccimarro. Electric cutout and distribution box.
15,007 Schaffer. Suspension of arc lamps. (Date applied for, 28/11/05.

COMPANIES' MEETINGS AND REPORTS.

Edison & Swan United Electric Light Co. (Ltd.)

The twenty-third ordinary general meeting was held yesterday, Mr. Henry Wolfenden presiding.

The SECRETARY (Mr. H. Charles Gover) having read the notice convening the meeting,

The CHAIRMAN said the shareholders might congratulate themselves upon the continued improvement of the company. This improvement, if slow, was steady, and therefore more likely to be permanent. It had been attained in the face of active competition which spoke well for the solidity and vitality of the business. Some shareholders might consider that the directors could have recommended payment of a rather larger dividend. On the face of the accounts a larger dividend might conceivably have been paid, but the directors unanimously agreed that this year, at all events, the better policy was to recommend the dividend they now proposed. The question of the payment of an interim dividend during the current financial year would be carefully considered at the proper time. The company's volume of trade continued to show satisfactory progress. In regard to the accounts, they had this year commenced the formation of a general reserve fund by allocating £5,000, and this would, no doubt, commend itself to the shareholders' judgment. The net balance available for distribution was £18,150, or, with the balance from the previous year (£6,834), £24,985, and the dividends set out in the report were now recommended. He moved the adoption of the report and accounts.

Mr. E. B. ELLICE CLARKE seconded the motion, which was carried unanimously without discussion.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—An extraordinary meeting will be held on Monday, Oct. 22, to authorise the exercise of the borrowing powers conferred upon the company by their 1903 Act. Additional capital is required to meet expenditure on the Rainham extension, which was opened for public traffic in August, the receipts from which are (we are informed) very satisfactory.

CLYDE VALLEY ELECTRICAL POWER CO.—At the half-yearly meeting last week Sir D. Richmond moved the adoption of the directors' report, which stated that contracts for the supply of current to the extent of 9,382 H.P. had been made, the consumers including Yarrow & Co., the Coventry Ordnance Works and William Beardmore & Co. It was estimated that this would represent the consumption of 10,000,000 units per annum, and it was hoped that the necessary connections would be made by the end of the year. The quantity of current sold for the last half-year was 358,312 units, compared with 154,873 in the previous half-year.

CUBA SUBMARINE TELEGRAPH CO. (LTD.)—The report for the half-year ended June 30 states that the total receipts of the six months were £19,097. 19s. 1d., while expenses amounted to £6,404. 6s. 8d., leaving £12,693. 12s. 5d., added to £5,603. 19s. 11d. brought forward, making £18,297. 12s. 4d. £5,000 has been added to reserve, which now stands at £92,000. Preference dividend absorbs £3,000, leaving £10,297. 12s. 4d., out of which the directors recommend payment of a dividend at the rate of 5 per cent. on the ordinary shares (tax free). £6,297. 12s. 4d. is carried forward. Since the close of the half-year a rising has taken place in Cuba, resulting in the intervention of the United States Government. Some slight damage was done to the company's property, but the cables have not suffered in any way and continue in good working order.

GENEVA TRAMWAYS CO. (LTD.)—At a meeting on Thursday last resolutions were confirmed empowering the directors and liquidator to carry into effect the selling and transferring of the undertaking and assets to a new company. Mr. C. Pakeman, 241, Salisbury House, London, E.C., is liquidator.

MONTEVIDEO TELEPHONE CO. (LTD.)—The annual report of the directors shows that, after providing for all working expenses in Montevideo and London, the net profit for the year ended July 31 was £17,294. 10s. 6d., against £15,473. 4s. 6d. for the previous year. The interim preference dividend and 2 per cent. on the ordinary shares absorbed £3,615. 18s., leaving £13,678. 12s. 6d., added to £2,047. 3s. 7d. brought forward, making now available £15,725. 16s. 1d. After transferring £5,000 to general reserve and £4,000 to reserve for renewal of plant, the directors recommend payment of the balance preference dividends and a dividend of 3 per cent. on the ordinary shares, leaving £2,383. 2s. 1d. to be carried forward. There has been a continued increase in the number of subscribers to the company's system, and a proportionate increase in the receipts for the year.

SWANSEA IMPROVEMENT & TRAMWAYS CO.—The report for the half-year ended June 30 states that gross receipts from the tramway undertaking amounted to £21,703, increase £4,952, and expenses to £18,512, increase £6,059. The profit was £3,191, added to £1,808 brought forward. The directors propose to place £1,000 to reserve and depreciation, and to pay the 6 per cent. and 5 per cent. preference dividends, leaving £2,700 to be carried forward. In order to cope with the increased traffic requirements an arrangement has been made with the British Electric Traction Co. for 10 new cars, payment to be spread over a series of years.

CIE. INTERNATIONALE D'ELECTRICITE, LIEGE.—The revenue for 1905-6 was 940,742fr., and the profit was 486,018fr., of which 260,760fr. is required to meet previous losses, and 225,288fr. has been written off, so that no dividend will be paid. The company is to take preference shares in the Société Internationale d'Entreprises et Exploitations Electriques (which is to be reorganised) in satisfaction for an advance of 2,300,000fr. made to the latter company.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANY.

PERCIVAL SPENCER (LTD.) (90,324).—Reg. Oct. 2, capital £1,000 in £1 shares, to take over the business of engineers and machinery merchants and agents carried on by Percival Spencer (Ltd.) (in liquidation), and to carry on the business of electrical, telegraph, telephone and general engineers, cable makers, manufacturers of dynamos, electric lighting, power and transmission plant, &c.

STATUTORY RETURNS.

BRITISH CONTINENTAL ELECTRICITY CO. (LTD.)—According to return to July 31, capital is £20,000 in 1,000 preference and 1,000 ordinary shares of £10 each, of which 906 ordinary and 1,000 preference have been taken up. £10 per share has been called up on 756 ordinary and 790 preference and £15,460 has been received. £3,600 is considered as paid on 244 ordinary and 116 preference. Mortgages and charges, nil.

CHILI TELEPHONE CO. (LTD.)—Return to July 26 gives capital as £250,000 in 50,000 shares of £5 each, of which 44,000 have been taken up. £5 per share has been called up and £220,000 has been received. Mortgages and charges, £12,000 bonds to bearer.

CHILIAN ELECTRIC TRAMWAY & LIGHT CO. (LTD.)—The capital in return to Aug. 8 is £1,150,000 in 500,000 ordinary and 650,000 preference shares of £1 each, all of which have been taken up. £650,000 has been paid on the preference and £500,000 is considered as paid on the ordinary. Mortgages and charges, £500,000.

CLARKE, STEAVENSON & CO. (LTD.)—The capital in return to Sept. 12 is £3,000 in £1 shares, all of which have been taken up. £1 per share has been called up on 1,400, 15s. per share on 600 and 10s. per share on 1,000 and £2,350 has been received. Mortgages and charges, nil.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—Return to Aug. 9 gives capital as £600,000 in £10 shares, all of which have been taken up and paid for in full. Mortgages and charges, £485,400.

ELECTRICAL OIL REFINING CO. (LTD.)—In return to Aug. 8 capital is £5,000 in £1 shares, of which 4,375 have been taken up. £882 has been received and £3,493 is considered as paid. Mortgages and charges, nil.

JANDUS ARC LAMP & ELECTRIC CO. (LTD.)—Return to Aug. 14 gives capital as £30,000 in £10 shares, of which 2,041 have been taken up. £5 per share has been called up on 1,195 and £10 per share on 250 and £8,475 has been received. £5,960 is considered as paid on 596 shares. Mortgages and charges, £8,000.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—In return to June 7 capital is £400,000 in 2,500 preference and 17,500 ordinary shares of £10 each and 175,000 preference and 25,000 ordinary shares of £1 each, of which 14,630 £10 ordinary, 1,957 £10 preference and 150,000 £1 preference have been taken up. £10 per share has been called up on 1,957 £10 preference and 14,630 £10 ordinary and £1 per share on 150,000 £1 preference, and £185,830 has been received, leaving £130,040 in arrears. Mortgages and charges, £150,000.

MORTGAGES AND CHARGES.

ELECTRIC VEHICLES DEVELOPMENT CO. (LTD).—Issue on Sept. 26 of £1,410 4 per cent. debentures, part of series created same date to secure not more than £3,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees.

NEW PHONOPORE TELEPHONE CO. (LTD.)—A mortgage dated Sept. 10 to secure an unspecified amount, but stamped to cover £2,500, charged on the company's freehold property at Southall, and the unissued capital, has been registered. Holders, Barclay & Co.

CITY NOTES.

MEMORANDA (Oct. 11).—Bank rate 5 per cent. (Oct. 11, 1906). Price of silver 31⅞d. per oz. Consols 86¼—86⅜ for money, $86\frac{7}{16}$—$86\frac{9}{16}$ for account; 2½ per cent. annuities 84¾—85¼. Consols Pay Day, Nov. 2; Stocks and Shares Continuation Days, Oct. 24 and Nov. 12; Ticket Day, Oct. 25; Pay Day, Oct. 26; Mining Share Carry-over Day, Oct. 23.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock (less tax) payable 1st prox.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.).—The transfer books and register of holders of second debenture stock will be closed from 20th to 31st inst. inclusive, preparatory to payment of interest due Nov. 1.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved upon the payment of an interim dividend of 4s. per share (tax free), being at the rate of 4 per cent. per annum, for the quarter ended Sept. 30, payable 26th inst.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, tax free, payable 1st prox. The transfer books will be closed from 18th to 31st inst. inclusive.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to grant a quotation to 22,900 £5 fully paid 5½ per cent. cumulative preference shares of the *Manx Electric Railway Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Oct. 3	2,105	+ 770	18	29,671	+ 1,887
Airdrie	Sept. 28	240	− 3	39	8,653	+ 682
Anglo-Argentine	Oct. 7	16,718	+ 2,133	40	596,511	+ 66,599
Ashton-under-Lyne Corp.	,, 6	373	+ 80	28	10,180	+ 1,315
Ayr Corporation	,, 6	228	+ 19	21	8,668	+ 156
Baker St. & Waterloo Ry.	,, 6	1,645	...	14	19,465	...
Barnsley	Sept. 28	163	+ 8	39	6,395	+ 89
Barrow	,, 28	289	+ 29	39	10,293	+ 656
Bath Electric Trams, Ltd	Oct. 3	912	+ 180	40	33,869	+ 6,174
Birkenhead Corporation	,, 7	1,118	+ 117	1	1,118	+ 117
***Birmingham Corporation**	,, 6	1,549	+ 1,160	27	27,529	+ 17,813
Birmingham & Mid.	Sept. 28	10,154	− 199	39	396,520	+ 16,635
Blackburn Corporation	Oct. 3	1,138	− 28	¶27	29,773	+ 1,802
Blackpool Corporation	,, 4	1,228	+ 265	26	44,019	+ 3,064
Blackpool and Fleetwood	,, 6	744	+ 268	1	744	+ 268
Blackp'l,St.Anne's&Lytham	...	...	...	...	...	...
Bolton Corporation	,, 7	2,145	+ 194	27	59,387	+ 4,464
Bournemouth Corporation.	,, 3	1,675	+ 289	†27	49,825	+ 9,910
Bradford Corporation	,, 6	4,561	+ 203	27	127,705	+ 5,206
Brighton Corporation	,, 6	987	+ 65	27	30,251	− 812
Brisbane Trams	...	...	...	...	...	...
Bristol Trams & Carriage	,, 5	5,347	+ 514	8	26,833	+ 2,501
Buenos Ayres & Belgrano	Sept. 30	3,649	− 314	39	133,794	+ 6,419
Buenos Ayres Elec. Trms.	,, 8	1,440	+ 86	37	48,840	+ 7,607
Burnley Corporation	Oct. 6	1,372	+ 151	1	1,372	+ 154
Burton Corporation	,, 6	342	+ 11	§27	8,502	− 451
Bury Corporation	Sept. 30	1,001	...	26	26,667	...
Calcutta Tramways Co.	Oct. 6	R40,586	− R9,034	14	R626,380	+ R15,600
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	Sept. 29	2,089	+ 143	27	58,733	+ 403
	Oct. 6	2,172	+ 226			
Cavehill	Sept. 28	129	+ 79	39	3,721	+ 1,657
Central London Railway	Oct. 6	6,326	− 450	14	78,478	− 3,433
Chatham & Dist. Lt. Rys.	,, 4	903	+ 6	†40	27,657	+ 721
City & South London Rly.	,, 7	2,636	− 97	14	35,214	+ 2,087
Colchester Corporation	..	...	...	...	...	...
Cork Electric Trams Co.	,, 4	508	+ 17	40	19,636	− 189
Croydon Corporation	,, 5	1,504	+ 231	18	29,008	+ 2,366
Devonport & Dist. Trams.	Sept. 28	474	+ 22	39	18,077	− 142
Dover Corporation	Oct. 6	257	+ 3	‡27	7,795	+ 1,111
Dublin & Lucan Railway	,, 5	125	+ 16	§14	2,005	− 39
Dublin United	,, 5	5,188	+ 377	‡14	79 629	+ 4,467
Dundee Corporation	,, 3	1,167	+ 172	§20	22,943	+ 4,508
East Ham Council	,, 6	935	+ 147	27	25,777	+ 2,379
Exeter Corporation	,, 5	351	+ 95	27	8,501	− 147
Falkirk and District	,, 3	310	...	1	310	...
Gateshead & Dist. Trams	Sept. 28	997	+ 12	39	37,858	+ 2 058
Glasgow Corporation	Oct. 6	17,851	+ 2,250	19	314,624	+ 28,289
Glossop	,, 6	146	+ 12	41	5,381	+ 464
Gloucester Corporation	...	...	...	...	...	...
Gravesend—Northfleet	Sept. 28	251	+ 5	39	9 617	+ 420
Gt. Northern & City Rly.	Oct. 6	1,810	+ 112	14	22 366	+ 1,611
Greenock & Port Glasgow.	Sept. 28	853	+ 63	39	26,778	+ 1,337
Halifax Corporation	...	...	...	...	...	...
Hartlepool Tramways	,, 28	300	+ 11	39	12,024	+ 1,506
Hastings Elec. Trams Co.	Oct. 4	957	...	14	15,959	...
Huddersfield	,, 6	1,581	+ 229	27	42,148	+ 3,991
Hull Corporation	,, 6	2,385	+ 206	27	61 682	+ 1,536
Ilford Dist. Coun.	,, 6	489	+ 37	27	13,937	+ 148
Ilkeston Dist. Council	,, 3	143	+ 31	27	3 777	+ 431
Ipswich Corporation	,, 6	435	+ 59	27	12,955	− 78
Isle of Thanet Co.	Sept. 30	680	+ 117	52	32,249	+ 188
	Oct. 6	525	+ 93	1	525	+ 93
Keighley Corporation	,, 4	157	+ 20	14	2,231	+ 176
Kidderminster & District	Sept. 28	114	− 20	39	4,900	− 35
Kilmarnock Corporation	Oct. 6	173	+ 25	21	3,472	− 32
Kirkcaldy Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	,, 4	960	+ 80	†10	35,365	+ 5 986
Leamington	Sept. 28	164	+ 6	39	7,029	+ 2,640
Leeds Corporation	Oct. 6	6,429	+ 555	27	174,008	+ 10,275
Leicester Corporation	,, 6	2,350	+ 349	40	88,503	+ 5,408
Leith Corporation	,, 6	545	+ 155	‡21	11,376	+ 4,909
Lincoln Corporation	,, 6	115	..	27	3,233	...
Liverpool Overhead Rly.	,, 7	1,423	+ 29	14	21,572	− 562
Liverpool Corporation	Sept 29	1,177	+ 584	39	421,078	+ 7,616
***London County Council**	,, 29	25,904	+ 11,346	26	687,704	+ 292,032
London United	Oct. 5	6,321	+ 1,056	†10	253,487	+ 18,659
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 6	128	+ 4	27	3,513	− 323
Manchester Corporation	,, 6	14,872	+ 2,134	27	379,561	+ 25,681
Mersey Railway	,, 6	1,749	+ 138	14	23,114	+ 1,759
Merthyr	Sept. 28	211	+ 29	39	7,700	+ 240
Metropolitan Dist. Railway	Oct. 7	8 091	+ 615	14	102,801	+ 9,963
***Metropolitan Elec. Trams**	Sept. 28	3,636	+ 721	39	134,951	+ 30,771
Middleton	,, 28	359	+ 38	39	14,129	+ 577
Nelson Corporation	Oct. 6	157	+ 20	2	294	+ 26
Newcastle-on-Tyne Corp.	,, 6	4,119	+ 332	27	104,023	+ 7,131
Newport (Mon.)	,, 6	654	+ 94	27	17,803	+ 1,186
Northampton Corporation.	,, 5	477	+ 59	27	12,740	+ 285
Oldham, Ashton & Hyde	Sept. 28	592	+ 6	39	22,361	+ 599
Oldham Corporation	Oct. 7	1,900	+ 232	28	51,775	+ 5,168
Perth (N.B.) Corporation	...	...	...	...	...	...
Perth (W. A.) Elec. Trams	,, 5	1,363	− 11	40	58,163	+ 3,376
Peterborough	Sept. 28	125	− 1	39	5,190	− 314
Pontypridd District Coun.	...	...	...	...	...	...
Portsmouth Corporation	Oct. 6	2,031	+ 286	27	61,048	− 118
Potteries	Sept. 28	1,823	+ 60	39	69,195	+ 3,307
Preston Corporation	...	...	...	...	...	...
Reading Corporation	Oct. 4	664	+ 26	...	...	..
Rochdale Corporation	...	..	...	...	...	...
Rotherham Corporation	,, 4	503	+ 32	27	13,864	+ 1,248
Rothesay	Sept. 28	357	+ 27	39	10,353	+ 1,583
Salford Corporation	Oct. 8	4,610	+ 485	27	125,533	+ 3,763
Sheerness	Sept. 26	61	− 2	39	2,391	− 457
Sheffield Corporation	Oct. 7	5,506	+ 583	28	149,586	+ 9,857
Singapore Trams	,, 6	$8,724	...	15	$112,324	...
Southampton Corporation.	,, 3	1,022	+ 46	...	...	...
Southend Corporation	,, 3	407	+ 72	27	12,958	+ 690

(a) These comparisons are with the corresponding period last year. ¶ Plus 3 days. † Minus 3 days. Minus 2 days. § Plus 2 days. * Partly electrical.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line.	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Southport Tramways	Sept. 28	362	+ 49	39	13,163	+ 326
South Metropolitan	,, 28	481	...	33	10,804	...
Stalyb'dge, Hyde, &c., Jt. Bd.	...	...	...	...	...	...
Stockport Corporation	...	...	...	...	..	...
Sunderland Corpn.	Oct. 7	1,414	+ 190	27	39,892	+ 2,273
Sunderland & District	,, 3	416	...	40	16,137	...
Swansea Trams	Sept. 28	901	+ 102	39	32,954	+ 5,057
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 28	47	+ 47	39	1,827	− 40
Tynemouth and District	,, 28	274	+ 42	39	10,817	+ 106
Tyneside Trams Co.	Oct. 3	454	+ 64	40	18,401	+ 1,565
Wallasey District Council	,, 6	825	+ 95	27	23,508	+ 1,159
Walsall Corporation	,, 6	540	+ 29	40	20,694	+ 1,024
Warrington Corporation	...	...	...	...	...	...
West Ham Corporation	,, 6	2,358	+ 268	27	62,826	+ 14,555
Weston-super-Mare	Sept. 26	199	+ 51	39	6,898	+ 532
Wolverhampton Corpn.	Oct. 3	878	...	14	12,357	...
***Worcester**	Sept. 28	300	+ 2	39	11,373	− 835
Wrexham	,, 28	108	+ 8	39	4,104	+ 92
Yorkshire W.R. Trams	Oct. 7	845	+ 105	40	33,487	...
Yorkshire Woollen District	Sept. 28	927	+ 264	39	35,533	+ 10,114

(a) These comparisons are with the corresponding period last year. * Partly electrical.

COLONIAL AND FOREIGN INVESTMENTS.

Share.	Last Dividend	Name.	Price Wed., Oct. 10.	Rate per Cent. Yielded.	Dividend Due.	Business, Week to Oct. 10. Highest.	Business, Week to Oct. 10. Lowest.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.		£ s. d.			
5	4/0	†Anglo-Argentine Ord. Shs.	$7\frac{1}{16}$—$7\frac{5}{16}$	5 8 0	Ap, Oct	$7\frac{9}{32}$	$7\frac{1}{8}$
5	2/9	Do. 5½% Cum. Pref.	$5\frac{13}{16}$—$6\frac{1}{16}$	4 11 6	—	$5\frac{15}{16}$	$5\frac{13}{16}$
St.	6%	Do. Permanent 6% Deb. Stock	139 —142	4 4 0	—	140½	..
St.	5%	Auckland Elec. Trams 5% Deb. (red.)	103 —105	4 15 0	—	..	..
5	..	Brisbane Electric Trams. Invest. Ord.	1½—1¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—4⅞	5 2 6	—	4⅞	4¾
St.	4½%	Do. 4½ per Cent. Db. Prov. Cts.	100 —104	4 6 6	—	102	101½
St.	6%	British Columbia Elec. Rlwy. Def. Ord.	125 —130	4 12 0	—	27	124½
St.	5%	Do. Pref. Ord. Stk	110 —115	4 7 0	—	113¼	111½
10	5%	Do. 5% Cum. Perp. Pref. Stock.	103 —111	4 10 0	—	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Dbs.	104—106%	4 5 0	—	—	—
100	4½%	Do. Vancouver Power Debs.	102 —105	4 5 6	—	..	—
5	8/0	Buenos Ayres and Belgrano Ord.	8 —8½	5 0 0	—	8¼	$8\frac{7}{32}$
5	8/0	† Do. 6 per Cent. "A" Cm. Pref.	5⅛—5⅜	5 6 0	—	5⅝	..
5	3/0	† Do. "B"	4⅞—5⅛	5 2 0	—	..	..
St.	5%	Do. 5 per Cent. Debs.	105 —107	4 13 6	—	..	..
St.	5%	Do. 5% 2nd Deb. (red.)	102 —105	4 15 0	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd.	93 —101	4 19 0	..	..	..
100	5½%	Buenos Ayres Grand National 5½% Pref. Debs.	101 —105	5 4 9	..	—	—
100	6%	† Do. 6% 1st Deb. Bonds	100 —105	5 14 0	..	..	—
5	3/6	†Calcutta Tramways (Nos. 1 to 105)	8 —8½	4 14 0	—	8¼	..
5	2/6	Do. Nos. 105,001 to 137,610	7⅞—8⅜	4 14 6	—	..	..
10	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	—	..	..
1	0/6	Cape Electric Tram Shares	½—¾	3 6 6	—	⅝	$\frac{9}{16}$
St.	5%	Colombo Trams & Ltg. 5% 1st Mt. Deb. (red)	100 —103	4 18 0	—	..	..
..	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	94 —96%	5 4 0	..	..	..
St.	5%	Kalgoorlie Elec. Trams 5% "A" Deb. Stock	92 —94	5 7 0	..	..	..
St.	6%	Do. 6% "B" Ditto	83 —87	6 18 0	..	..	..
1	1/0	Lisbon Elec. Trams Ord.	1¼—1½	3 6 6	..	..	..
1	0/7½	Do. 6% Cum. Pref.	1⅛—1⅜	4 7 4	..	..	..
100	5%	Do. 5% Reg. Mort. Debs.	100 —103	4 17 0	..	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	100 —103	4 7 6	Ja, Jul	..	..
100	4½%	Montreal St. Ry. Sterling 4½% Debs. (1922)	104 —106	4 5 0	—	105⅛	104¼
St.	5%	Perth (W.A.) Elec. Trams. 1st Mt. Deb. Stk.	104 —106	4 14 8	..	..	..
..	$2	† Sao Paulo Tramway, Light and Power Co. $100 Stock	138 —140	5 10 0	..	..	..
..	5%	Do. 5% 1st Mt. $500 Dbs.	99%—101%	4 19 0	..	100½	99¾
		ELECTRICITY SUPPLY.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5¼—5¾	4 17 0	..	..	..
5	5/1	Calcutta Elec. (1–50,000)	8 —8½	4 16 0	..	$8\frac{7}{16}$	8
50	6%	City of Wellington Elec. Lt. and Power 5% Reg. 1st Dbs.	48 —50	5 0 0	..	..	..
..	5%	Cordoba Lt. and Power Co. 1st Mt. Stk. £100,000 5% Bds.	92 —94	5 6 4	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6% Cum. Pref.	2½—3	..	..	..	—
St.	5%	Do. 5% Debs.	88 —92	5 8 6	—	90½	..
St.	6%	Indian Elec. Sup. and Trac. Co. Db. St. Rd. Prov. Certs.	108 —111	5 8 0	—	..	..
1	0/7½	Kalgoorlie Elec. Power & Ltg. 6% Cum. Pref.	$\frac{23}{32}$—$\frac{27}{32}$	7 8 6	—	..	..
1	1/6	Rand Electric	$1\frac{1}{16}$—$1\frac{3}{16}$	—	—	—	..
1	..	River Plate Electricity Co. Ord.	$\frac{9}{16}$—$\frac{11}{16}$	..	..	⅝	$\frac{9}{16}$
1	1/2¾	Do. 6% Non. Cum. Pref.	⅞—1	6 0 0	..	..	..
St.	5%	Do. 5% Deb. Stock	99 —102	4 18 1	..	100	..
5	8/0	†Rosario Elec. Co. 6% Pref. (1–20,000)	5 —5½	5 9 6	..	5⅜	..
100	4½%	*†Royal Elec., Montreal 4½% 1st Mort. Deb	97 —101	4 9 0	Ap, Oct	—	...
..	5%	Shawinigan Water and Power 5% Bds., Scrip	99 —101%	4 19 0	..	..	..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex Dividend.

ELECTRICAL COMPANIES' SHARE LIST.

SHRE.	LAST DIVIDEND	NAME.	Price Wed., Oct. 10.	RATE % YIELDED.	DIVIDEND DUE.	BUSINESS, WEEK TO OCT. 10.	
				£ s. d		Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5/0	Bournemouth & Poole Elec. Sup. Ord.	10 – 11	6 7 0	..	10⅝	..
10	4/6	Do. 4½ per Cent. Cum. Pref	9½–10	4 10 0	..	..	..
10	6/0	Do. 6% Cum. Second Pref.	10½–11	5 9 0	..	11 1/16	—
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	103 –105	4 5 6	..	..	—
5	2/0	†Bromley (Kent) El. Lt. & Power Shares	5 – 5½	5 0 0	..	..	—
St.	4½%	Do. Do. 1st Debs	101 – 104	4 7 6	—	[illegible]	..
5	4/6	Brompton & Kensington Elec. Sup. Ord.	5¼–5¾	5 14 0	—	..	..
5	8/6	Do. 7 per Cent. Pref.	7½–8	4 7 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	101 – 104	3 17 0	—	104	[illegible]
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	4 – 4½	5 11 0	Feb, Aug	4	..
5	2/3	Do. 4½ per Cent. Pref.	4½–5	4 10 0	Feb, Aug	4⅞	..
St.	4%	Do. 4% Deb. Stock (red.)	101 –104	8 17 0	—	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	4 – 4½	5 0 0	—	..	..
5	2/3	Chelsea Electric Supply Ord.	5¼– 5¾	5 3 0	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	106 –109	4 2 6	Jn, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	9½–10½	5 14 0	Feb, Aug	10 3/16	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4 16 0	Jan, July	—	..
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	125 –126	8 19 4	Jn, Dec	125	124¾
St.	4½%	Do. 4½% 2nd Deb. Stock (red.)	100 –103	4 7 6	..	101	..
5	4%	County of Durham Elec. P.D. Ord. £8 pd.	2⅞–3	4 0 0	April, Oct	[illegible]	—
5	5%	Do. Do. 5% non cum. pref.	5¼–5½	4 13 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	8¼–8¾	5 7 0	—	8⅝	8⅜
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12	5 4 0	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 0	..	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	101 –104	4 6 6	..	101½	..
5	2/0	†Folkestone Electricity Supply Co. Ord.	5⅛–5⅝	5 2 6	..	—	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	4⅞–5⅜	4 12 6	..	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	99 –102	4 8 0	—	—	..
5	5/0	Hove Electric Lighting Ord.	8¼–8¾	5 5 0	—	..	..
St.	4½%	I. of W. Elec. Lt. & Power 4½% Db. St. (red.)	98 –101	4 9 0	—	..	..
5	5 0	Kensingtn. & Kngtsbdg. Ord	9¾–10⅜	4 13 0	—	..	—
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	—	..
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 –102	8 18 6	..	..	—
St	4%	†Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stck. (red.)	99 –101	8 19 0	—	100⅝	100
8	2/4½	London Electric Supply Ord.	1¾–2¼	4 5 0	—	—	..
5	8/0	Do. 6 per Cent. Pref.	5 –5½	5 7 0	—	—	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	96 –99	4 0 10	Mr, Jn, S, D	..	..
5	4 0	Metropolitan Electric Sup. Ord.	7½–8½	5 6 0	April, Oct	8⅛	7 15/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅛–5⅝	4 8 6	Jan. July	5 5/16	5¼
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	109 –113	4 1 10	Jn, Dec	—	..
St.	8½%	Do. 8½ per Cent. Mrt. Db. Stock (red.)	95 –97	8 12 0	—	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	98 –101%	4 9 1	—	100	..
10	5%	Newcastle & Dist. Elec. Ltg. Ord. £9 paid	11 –11½	4 0 0	Feb, Aug	..	..
100	4½%	Do. 4½% Deb.	[illegible]	4 7 5	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	7½–7⅝	5 5 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. Non. Cum. Pref.	5¾– 6	4 6 11	Feb, Aug	..	..
100	4%	Do. 4% Mort. Deb. red. 1907	98 –100	4 0 10	Jan, July	..	..
1	8%	Northern Counties Elec. Sup.	1 3/16–1¼	2 8 0	Mar, Aug	..	..
100	4½%	Do. 4½% Deb.	102 –103	4 7 4	Jan, July	—	—
10	6/0	Notting Hill Electric Ord.	13½–14½	5 8 5	March	..	..
100	4%	† Do. 4 per Cent. 1st Mt. Debs.	96 –98	4 1 6	..	..	..
5	2/6	Oxford Electric Ord.	6 – 6½	5 1 0	March	..	..
St.	4%	Do. 4% Deb. Stock	98 –100	4 0 0	—	..	..
5	5.0	St. James' & Pall Mall Elec. Ord.	9½–10½	5 18 0	Feb, Aug	..	..
5	8/6	Do. 7 per Cent. Pref.	7 – 8	4 7 0	Feb, Aug	..	..
St.	8½%	Do. 8½ per Cent. Deb. Stock (red.)	95 –97	8 12 2	—	..	..
5	4/0	Smithfield Markets Electric Sup. Ord.	1 – 2	10 0 0	..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	74 –78	5 2 0	—	..	..
5	4/0	South London Electric Supply Ord	2⅝– 2⅞	6 5 0	..	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	[illegible]		..	..	..
1	0/8¾	Do. 7% Cum. Pref.	1 3/16–1 7/16	4 14 6	..	..	—
St.	4½%	† Do. 4½ 1st Db. Stk. Red.	102 –105	4 5 6	—	..	..
5	2/6	†Urban Electric Supply Ord.	3¼–3¾	6 15 0	—	..	—
5	2/6	† Do. 5% Cum. Pref.	4½– 4¾	5 2 6	—	..	..
St.	4½%	† Do. 4½% 1st Mort. Deb.	97 –100	4 10 0	..	99	97½
5	5.6	Westminster Elec. Sup. Ord.	9 – 10	6 10 0	Mar, Sept	9 11/16	9½
5	2/3	Do. 5 per Cent. Cum. Pref.	5½– 5¾	4 11 0	..	5 13/32	5¼
		ELECTRIC RAILWAYS, TRAMWAYS &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	89 –92	4 7 0	—	90	89¾
1	1/0	Bath Elec. Trams Pref. Ord.	15/16–1 1/32	4 14 0	..	1	..
1	0/6	Do. 5% Cum. Pref.	15/16–1 1/16	4 9 0	..	1	..
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	102 –105	4 5 6	—	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	98 – 100	4 10 0	..	9 ¼	..
10	9½%	Bristol Tramways and Carriage Ord.	14½–15	6 5 0	Feb, Aug	—	—
10	4%	Do. Cum. Pref. (fully paid)	9½–10	4 0 0	..	—	—
St.	4%	Do. 4 per Cent. Debs.	101 –108	8 17 6	Feb, Aug	..	—
10	6/0	British Electric Traction Ord.	4 – 5	6 0 0	—	4½	4
10	6/0	Do. 6 per Cent. Cum. Pref.	8 – 9	6 18 0	Feb, Aug	8⅝	8⅛
St.	5%	† Do. 5 per Cent. Perpetual Debs	107 –111	4 10 0	..	110	108½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	90 –93	4 16 9	..	93	..
St.	4%	Central London Ordinary Stock	83 –85	4 14 0	June, Dec	84	83½
St.	4%	Do. 4 per Cent. Pref. Stock	97 – 99	4 1 0	..	98	—
St.	4%	Do. Deferred Stock	78 –76	5 5 0	..	75	71¾
100	4%	Do. 4 per Cent. Debs.	108 –110	8 12 8	..	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	84 –89	4 10 0	..	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Prf.	5⅛– 5⅝	4 13 0	..	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	100 –103	8 17 6	..	..	..
St.	2¼%	City and South London Rly. Con. Ord.	42 –44	4 11 0	Feb, Aug	44	43
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	119 –122	4 2 0	Feb, Aug	..	..
St.	5%	Do. (1896)	115 –118	4 4 8	..	..	..
St.	5%	Do. (1901)	113 –116	4 6 0	—	[illegible]	..
St.	4%	Do. 4 per Cent. Perpetual Debs	104 –107	8 14 8	May, Nov	104½	..
10	6/0	Dublin United Trams. (1896) Ltd., Ord.	14 –15	4 0 0	..	..	..
10	6/0	Do. 6 per Cent. Pref.	14 –15	4 0 0	..	..	..
10	4/0	Gt. Northern & City Rly. Prf. Ord. (4%)	3½– 4	10 0 0	..	3¾	3½
St.	4½%	†Hastings & Dist. Elec. Trams. Co. 4½ Db. St.	99 –102	4 8 0	..	..	..
10	9%	‡ Imperial Tramways Ord	14½–15½	5 16 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	11 –11½	5 4 0	Mar, Sept	—	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	103 –104	4 6 6	Jan, July	—	..
5	2/6	Isle of Thanet Elec. Trams & Lt. 5% Pf.	2 –2½	..	—	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 –83	4 16 6	—	..	..
10	1½%	Liverpool Overhead Railway Ord	[illegible]	8 18 0	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	9¾–10¼	4 15 8	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	99 –102	8 19 8	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	9 – 9½	5 5 0	—	9⅝	9 5/16
St.	4%	Do. 4% 1st Mort. Deb. Stock	98 – 96	4 8 0	—	93	..
St.	..	Mersey Con. Ord. Stock	5 –7	—	—	..	..
St.	..	Do. 8 per Cent. Perp. Pref.	7 –10	—	—	..	..
1	—	Metropolitan Elec. Trams Def.	⅛– 3/16	..	—	..	..
1	0/6	Do. 5% Cum. Pref.	13/16–15/16	5 9 0	—	..	..
St.	4½%	Do. 4½% Deb. Stock	98 –100	4 10 0	—	..	..
5	—	New Gen. Tract. 6 per Cent. Cum Pref.	½–1½	..	May	..	..
10	8/0	Potteries Electric Traction Ord.	6¾–7¼	5 10 0	..	..	..
10	5/0	Do. 5 per Cent. Cum. Pref.	7¼– 8¼	6 2 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 –103	4 7 8	—	..	..
100	5%	Sunderland Dst. Elc. Trms. 5% 1st Mt. Db.	87 –92	5 8 8	—	..	..
..	5%	Und. Elec. Rys. Co. of Lond.	90 – 92	5 8 8	—	90⅝	90
St.	8%	Waterloo and City Ord.	101 –104	2 17 6	June, Dec	102	101
5	..	Yorkshire W.R. El. Trs. Ord.	1½–1¾	..	..	—	..
5	..	Do. 6% Cum. Pref.	3 –3½	..	—	—	..
St.	4½%	Do. 4½% 1st Debs.	91 –94	4 15	—	..	—

SHRE.	LAST DIVIDEND	NAME.	Price Wed., Oct. 10.	RATE % YIELDED.	DIVIDEND DUE.	BUSIN WEEK OCT.	
				£ s. d.		Highest.	
		ELECTRIC MANUFACTURING, &c.					
1	10½d.	Aron El. Met. 6% Cm. Pf.	9/16–11/16	..	—	..	
1	1/7½	†Babcock & Wilcox Ord	3⅞–4⅛	4 12 6	..	4 1/16	
1	7½d.	† Do. Pref	1 7/16–1 9/16	8 17 0	..	..	
5	4/0	British Insulated & Helsby Cables Ord.	6¼–6¾	5 10 0	July, Feb	..	
5	8/0	Do. 6 per Cent. Pref.	[illegible]	4 18 0	Jan, July	..	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	102 –105	4 5 6	..	..	
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94 –98	4 12 8	..	..	
5	..	British Westinghouse 6% Pref.	1 –1½	..	..	1⅜	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	77 –83	4 16 6	..	[illegible]	
2	1/0	Brush Electrical Engineering	¾–1	..	March	[illegible]	
2	2/4⅘	Do. 6 per Cent. Pref. Non-Cum.	1¼–1¾	6 16 6	Mar, Sept	1⅝	
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	96 –98	4 11 9	Mar, Sept	..	
St.	4½%	Do. Perpetual 2nd Deb. Stock	82 – 84	5 7 2	Jan, July	..	
5	10/0	Callender's Cable Con. Ord.	10½–11½	4 10 6	Jan, July	..	
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝–5⅞	4 5 0	Jan, July	5⅞	
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (rd.)	108 –110	4 2 0	Nov, May	..	
1	[illegible]d.	Castner-Kellner Alkali Co.	1 1/32–1 5/32	5 4 6	..	1 1/16	
St.	4½%	Do. 4½% 1st Mort. Deb. (red.)	97 –102	4 8 0	—	—	
1	9½d.	†Chadburn's (Ship) Telegraph Ord.	1¼–1⅜	7 5 6	—	—	
1	7½d.	† Do 6% Cum. Pref.	1 1/16–1 3/16	5 8 0	..	..	
8	1/6	Crompton and Co. (Nos. 1 to 54,000)	1½–1¾	3 15 0	Jan, July	1⅝	
100	5%	* Do. 5 per Cent. 1st Mort. Debs. (red.)	95%– 9[illegible]%	5 2 0	Jan, July	..	
5	10/0	Dick, Kerr & Co. Ord.	1⅝–1⅞	5 11 0	Sept	1¾	
5	7½d.	† Do. 6% Cum. Pref.	1 1/16–1 5/16	4 11 6	Sept	[illegible]	
St.	4½%	Do. 4½% Deb. Stock	103 –105	4 5 0	..	..	
5	1/6	Edison & Swan United ("A" Sh.) (£8 pd.)	1⅝–1⅞	4 4 0	Feb, Aug	1¾	
5	2/6	Do. (£5 paid)	2½–3	4 4 0	Feb, Aug	2⅞	
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	86 – 88	4 11 0	June, Dec	..	
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	90 –95	5 5 0	—	..	
5	1/6	Edmundson's Elec. Corp. Ord.	3¼–3¾	10 0 0	H'lf-yearly	[illegible]	
5	8/0	Do. 6 per Cent. Cum. Pref.	[illegible]	5 11 6	..	[illegible]	
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 – 103	4 7 4	—	..	
2	1/7½	Electric Construction Co.	¼–½	14 0 0	July	..	
2	2/9⅗	Do. 7 per Cent. Cum. Pref	1¾–2¼	6 4 0	July	..	
St.	4%	Do. 4 per Cent. 1st Mort. Deb. (red.)	84 – 87	4 12 0	Jan, July	..	
10	5/0	General Electric (1900) 5% Cum. Pref.	9 – 9½	5 5 8	..	..	
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	91 – 94	4 5 0	—	..	
5	5/0	Henley's Telegraph Works Ord.	12 –13	5 15 0	Feb, Aug	..	
5	2/8	Do. 4½ per Cent. Pref.	5¼– 5½	4 2 0	Feb, Aug	..	
St.	4½%	Do. 4½ per Cent 1st Mt. Db. St.	107½–109½	4 2 0	..	107½	
10	[illegible]	India Rubber, Gutta Percha, &c., Wks.	17 –18	2 17 2	Feb, Aug	..	
100	4%	† Do. 4% Debs. Red.	99 –101	3 19 0	..	..	
10	5/0	Mather & Platt 5 per Cent. Cum. Pref.	11½–12	4 8 4	Mar, Sept	..	
1	1/2⅔	Richardsons, Westgarth & Co., Ltd. Ord.	29/32– 31/32	6 3 0	..	[illegible]	
1	7½d.	Do. 6% Cum. Pref.	1 –1 1/16	5 13 0	—	[illegible]	
St.	4½%	Do. 4½% Perp. Deb. Stock	96 – 99	4 11 0	..	97	
1	..	Simplex Conduits Ord.	1½	..	..	..	
5	..	Do. 6% Cum. Pref.	5¼	..	..	..	
12	12/0	Telegraph Construction & Mainten'ce.	33 –35	5 3 6	Mar, July	34	33½
100	4%	Do. 4 per Cent. Deb. Bonds, 1909	100 –102	3 18 3	Jan, July	..	
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	2 7/16–2 9/16	6 5 0	..	2½	
1	6d.	Do. 5% Non-Cum. Preference	1⅛–1 3/16	4 2 6	..	1 3/16	
St.	5%	Do. 5% Non-Cum. Preferred	113 –116	4 6 0	—	..	
St.	4%	Do. 4% 1st Mort. Deb. Stock Red.	104 –106	3 15 6	..	..	
100	4½%	Do. 4½% 2nd Mort. Debs., Red.	103 –105	4 5 6	—	104⅜	
5	—	Willans and Robinson Ord.	½–1	..	Apr, Oct	—	
5	—	Do. 6 per Cent. Cum. Pref.	1¾– 2¼	..	Apr, Oct	1⅜	
	4%	Do. 4 per Cent. 1st Mort. Debs.	75 –80	5 0 0	May Nov	75	72
		TELEGRAPHS.					
10	—	Amazon Telegraph	3¾– 4½	..	Jn, Dec	..	
100	5%	Do. 5% Debs. (red.)	88 –98	5 7 0	..	..	
St.	15/0	Anglo-American	66 –68	4 15 6	F, My, Ag, N	66¾	
St.	30/0	Do. Preferred	112½–113½	5 6 0	F, My, Ag, N	113⅜	
St.	10/0	Do. Deferred	24½–24¾	2 2 0	F, My Ag, N	24¾	
St.	4%	†Commercial Cable 4 per Cent. Deb. Stk	[illegible]	4 1 0	Jn Ap, Jy, O	97½	
10	5/0	Cuba Submarine Ord.	8½–9	6 1 0	Feb, Aug	8¾	
10	10/0	Do. Preference 10 per Cent.	17 –18	5 11 2	Feb, Aug	..	
5	2/0	†Direct Spanish Ord	3⅜–3⅝	5 6 6	April, Oct	..	
5	5/0	† Do. 10 per Cent. Cum. Pref.	8¾–9¼	5 8 0	April, Oct	..	
50	4½%	Do. 4½ per Cent. Deb.	98%–101%	8 19 0	Jan, July	..	
20	6/6	Direct United States Cable	15⅝–15⅞	4 12 0	Ja, Ap, Jy, O	15¾	
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 –102	4 8 0	Jn, Dec	100½	
St.	65/0	Eastern Ordinary	144 –147	5 8 6	Ja, Ap, Jy, O	145½	
St.	17/6	Do. 3½ per Cent. Pref. Stock	90½–92½	8 17 8	Ja Ap, Jy, O	91	
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (rd.)	107 –109	3 13 4	May, Nov	108⅛	
10	2/6	Eastern Extension	14 –14½	4 12 0	Ja, Ap, Jy, O	14 7/16	
St.	4%	Do. 4 per Cent. Deb. Stock	106½–107½	8 14 8	Feb, Aug	..	
100	4%	Eastern & S. African 4% Mrt. Deb, 1909	99 –101	8 19 0	Feb, Aug	..	
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101%–108%	8 17 6	May, Nov	..	
10	5/0	G. N. (of Copenhagen) with coupon 68	36 –38	6 5 0	Jan, July	37¾	
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 –102	4 8 0	June, Dec	..	
25	62/6	Indo-European	59 – 61	5 6 6	May, Nov	60¾	59½
100	4%	Mackay Companies Common	75 3/16–76 3/16	5 5 0	Jan, July	—	
100	4%	Do. Preference	72 3/16–73 3/16	5 9 6	Je, Ap, Jy, O	..	
1	—	Marconi's Wireless Teleg. Co.	⅞–1⅛	..	..	1 5/32	
100	4%	Pacific & Europe'n Tel. 4% Guar. Dbs. (rd.)	99 –102	8 18 5	June, Dec	..	
10	4/0	West African Telegraph Shares	9¾–10¼	4 17 6	..	..	
2½	—	West Coast of America	¾– ⅞	..	—	..	
100	4%	Do. 4 per Cent. Debs.	100½–103½	8 17 8	Jan, July	..	
10	—	West India and Panama	⅜–½	..	May, Nov	⅜	
10	4/0	Do. 6% 1st Pref.	6½–6⅞	8 18 0	May, Nov	..	
10	—	Do. 6 per Cent. 2nd Pref.	4½–5½	..	May, Nov	..	
100	5%	* Do. 5 per Cent. Debs.	99 –102	4 18 0	Jan, July	..	
10	8/0	Western Telegraph	14¼–14¾	4 15 0	Mr, Ju, O, D	14½	14½
100	5%	* Do. 5% Debs. (2nd Series, 1906)	—	4 17 0	June, Dec	..	
St.	4%	Do. 4% Deb. Stock (red.)	103 –106	8 15 6	..	104	
		TELEPHONES					
—	4%	Amer. Telephn. & Telegh. Coll. Trust $1,000 4% Bonds	94 –96	4 8 4	..	..	
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk	101 – 103	4 17 0	..	..	
5	5/0	Chili Telephone (fully paid)	6¾–7¼	5 11 0	August	..	
1	0/4½	Monte Video Telephone Ord.	1 –1⅛	8 11 0	—	..	
1	0/6	Do. 6% Pref.	⅞–1	5 0 0	..	..	
St.	6%	National Co. Pref. Stock	109 –111	5 8 0	—	110⅞	109½
St.	5%	Do. Def. Stock	109 –111	4 10 0	—	110⅛	
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11 –13	4 13 6	Feb, Aug	11 7/16	
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½–12½	4 16 0	Feb, Aug	10½	
5	2/6	Do. 5 per Cent. Non-Cum. 3rd Pref.	5½– 5¾	4 7 0	Feb, Aug	[illegible]	
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 –100	3 10 0	June, Dec	98¾	98½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 –104	8 17 0	—	[illegible]	
1	0/9⅜	Oriental	1 5/16–1 7/16	4 8 6	April, Oct	..	
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	4 11 0	—	..	
St.	4%	Do. 4% Red. Deb. Stock	97 – 99	4 1 0	—	..	
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. Rd.	101 –104	4 6 6	..	..	
5	5/0	United River Plate	7 –7½	5 6 8	July	7½	
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–6½	4 2 0	June, Dec	..	
St.	5%	* Do. 5 per Cent. Deb. Stock (red.)	109 – 112	4 9 8	June, Dec	..	
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	4½– 5½	5 10 0	—	..	
10	2/0	Globe Telegraph and Trust	10⅞–11⅛	4 19 0	Ja, Ap, Jy, O	11⅛	11
10	8/0	Do. 6 per Cent. Pref	14⅜–14⅝	4 0 6	Ja, Ap, Jy, O	14⅝	
10	6%	Submarine Cables Trust (Cert.)	[illegible]	4 11 0	April, Oct	..	

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* In calculating the yields, allowance has been made for accrued interest but *not* for redemption, † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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No. 1, issued with "The Electrician" for Sept. 14, 1906.

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